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Report - Air Quality Status in Barcelona, Marseille, Genoa, Venice and Thessaloniki (WP 3.2)

WP 3.2 TOTAL REPORT
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A Framework

1. National
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1. Introduction

Harbors represent a significant potential for the economic development all over the Med basin, but they also have a potential negative environmental impact due to multiple emission sources. The presence of competing activities in coastal areas can lead to potential conflicts which need to be managed by the institutional actors.

APICE - a project financed by the European program for territorial Cooperation MED 2007/2013 - intends to develop a knowledge-based approach for air pollution mitigation and sustainable development of port activities, managed by spatial planning policies at local level, which includes the territory around the ports. 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 harbour-industrial district organization) and present the same problems of air-pollution affecting seriously not only the populated urban centres 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 current report is based on the five previous reports redacted in lines of APICE project which aimed at briefly describing the air quality of five European port-cities: **Barcelona** (Spain), **Genoa** (Italy), **Marseille** (France), **Thessaloniki** (Greece) and **Venice** (Italy). Based on the air quality and meteorological data collected from the local networks during the last years, main conclusions have been drawn for each port-city. The aim of the present report is a comparative study, focused on PM10 particles which is a pollutant with proven adverse health effects. Additionally, the study of the influence of the port on each city's air quality, under the prevailing meteorological pattern is included.

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2. Partners' presentation

Italy (pilot areas: port of Venice and Genoa)

Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto

Lead Partner: Regional Environmental Agency of Veneto-ARPAV

Regional Authority of Veneto, Territorial Planning Department

Province of Genoa

University of Genoa

University of Genoa, Department of Physic

France (pilot area: port of Marseille)

Port Autonome of Marseille

University of Provence

LCP

CNRS

Greece (pilot area: port of Thessaloniki)

Regional Authority of Central Macedonia

University of Western Macedonia

Aristotle University of Thessaloniki

Spain (pilot area: port of Barcelona)

Spanish Research Council- Institute of Environmental Assessment and Water Research (IDAEA)

EUCC Mediterranean Centre

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3. Field study: 5 sites description

3.1 Barcelona

3.1.1 Barcelona's port presentation

The Port of Barcelona is the main transport and services infrastructure in Catalonia, the second Spanish port in terms of total goods traffic and the first in terms of value. The 450 shipping lines operated by 118 ship owners which regularly link Barcelona with 850 ports of the five continents, set it a head and shoulders above other Spanish ports for international traffic. The Port has nearly forty specialized and multipurpose terminals for attending to the different types of traffic generated in its hinterland - the market which it serves. In addition, the commercial port has a logistics port, the Logistics Activities Area, or ZAL, and an urban port, the Port Veil, which is open to the public. Total traffic in 2007 was in excess of 51 million tones, with 2.6 million containers, 801.406 new vehicles (it is the top Mediterranean port for car traffic) and 2.8 million passengers, of which 1.7 travelled on cruise ships (Barcelona is the top European cruiser port). The Port is growing fast in the area of short sea shipping, which offers a combined service for the transport of passengers and vehicles, aimed especially at trucks. A total of 319 144 passengers and 85 586 trucks used the short sea shipping services in 2006. This is a sustainable model of transport, providing improvements in logistics operations and is also more competitive than road transport.

The enlarged Port will be able to handle annual traffic of 130 million tonnes and 10 million containers and will therefore require road and rail accesses with sufficient capacity to allow this huge amount of goods to leave the Port smoothly and speedily. The Port of Barcelona has opted for the **railway** to connect to its potential markets in the centre and north of Europe in competitive conditions in terms of costs and time, using criteria of sustainability and mobility. The Port of Barcelona's Rail and Road Accessibility Plan involves building infrastructures with the capacity to operate 180 trains a day, equivalent to 150 000 tonnes/day or 30 million tonnes/year. To channel this large amount of traffic, the Port will have rail terminals in each of the new terminals, in addition to the existing rail terminals, and a large loading and unloading station will be built in the old bed of the river Llobregat.

The enlargement and the improvement of the accesses are the foundation for the Port to be able to handle new traffic. The Port is working to attract the growing maritime traffic between Europe and Asia, especially with China. Currently only 24% of the goods flowing between Europe and Asia and passing through the Suez Canal are loaded and unloaded in the ports of Southern Europe. The Port of Barcelona, which already handles 35% of all traffic between Spain and Asia, rising to 38% in the case of China, aims to attract a large part of this potential traffic The enlargement, the increased traffic with Asia, a greater presence in European and Mediterranean markets, the creation of new road and rail accesses and the improved dynamism and efficiency of port processes are all factors that will help the Port of Barcelona to achieve its strategic aim: to become the gateway to southern Europe and the main Euro-Mediterranean logistics hub.

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3.1.2 Barcelona's air quality and meteorological networks

The regional Air Quality network of Catalonia comprises **15 areas** distinguished in function of its population, type of environment, topography and anthropogenic activities occurring in each one (Figure 1). The smallest and more populated zone is the "Àrea de Barcelona", in which the Barcelona city and its harbour are located. Around 3 million people are living in this zone, which is under intense anthropogenic pressure (**traffic, industry, power generation, construction activities, and harbour emissions, among others**).
The "Àrea de Barcelona" has a dense monitoring network composed of **28 stations** in which a number of air quality parameters are measured. Most of them (16) record automatic measurements, mainly **gaseous pollutants (NOx, SO_2, O_3, CO)** and **particulate matter mass concentration (PM_{10})**. Among these 16 sites, in 10 of them manual measurements are also recorded (**PM_{10}, acid rain, metals, benzene**). For the aim of this report, the data from **Luis Solé i Sabaris (Torre Girona)**, operated by the CSIC, were used. At the Torre Girona site, a number of parameters are being measured **(PM_{10}, $PM_{2.5}$, PM_1, black carbon, number concentration**, in addition to **NOx, CO, SO_2, O_3**). A **complete chemical characterization** is continuously carried out in both three PM fractions. Figure 2 presents the network of meteorological stations in Barcelona city.

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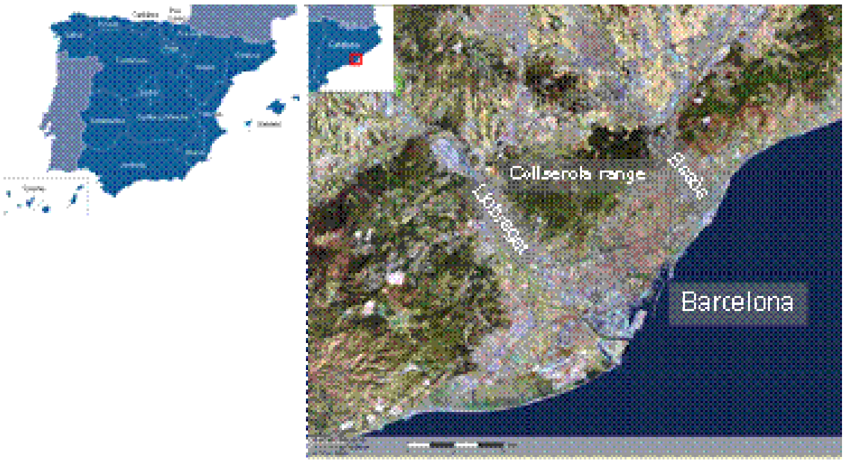

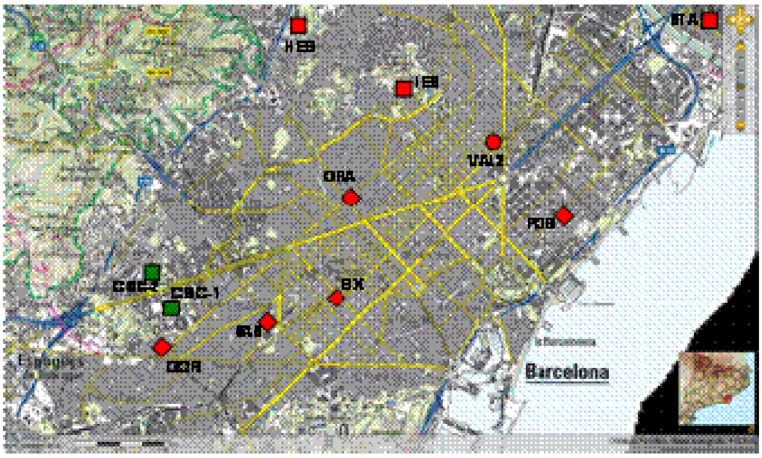

Figure 1: Location of the monitoring stations in the Barcelona city. The green squares indicate those sites operated by CSIC

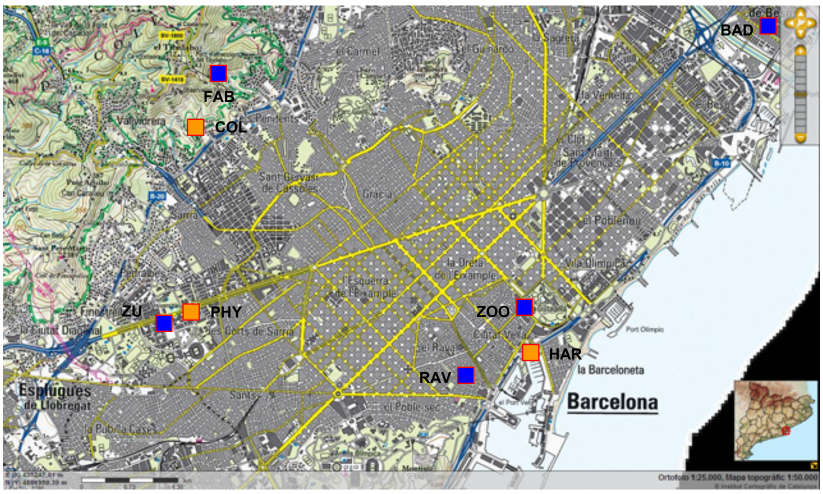

Figure 2: Network of meteorological stations in Barcelona city.

3.2 Genoa

3.2.1 Genoa's port presentation

The Port of Genoa is the first port of Italy on the Mediterranean Sea, the second in terms of twenty-foot equivalent units after the port of transshipment of Gioia Tauro. It 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). 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.

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. **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.

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.

3.2.2 Genoa’s air quality and meteorological networks

The air monitoring network of the Province of Genoa dates back to 1993 and consists of **12 fixed stations in the municipality of Genoa** and **7 fixed stations in the remaining part of the Province**. In addition, **3 mobile stations** are used for yearly monitoring campaigns. Figure 3 shows the position of the fixed stations respectively in the Municipalities of Genoa and in the rest of the Province.

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. 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 (Figure 4).

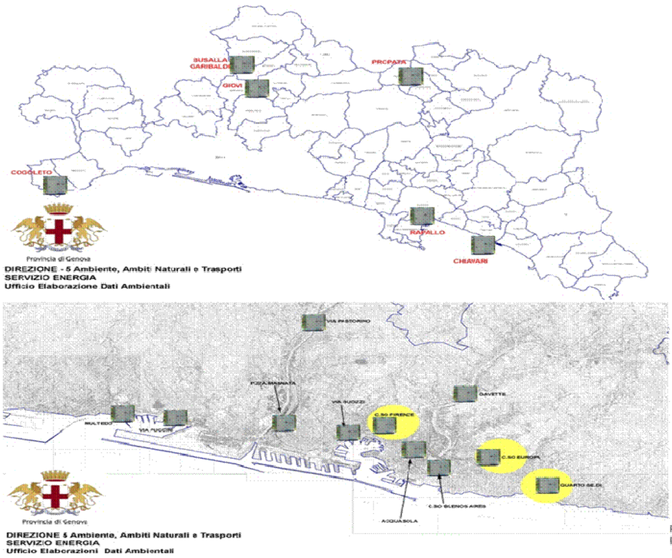

Fig 3 Position of the station inside and outside the Municipality of Genoa.

Fig 4 Satellite image of the city of Genoa and its surroundings. Green dots present locations where the meteorological stations are situated

3.3 Marseille

3.3.1 Marseille's port presentation

The Port of Marseille is one of the oldest and busiest seaports in France. A railroad line was constructed from the port to Avignon and to Toulon in 1849 and 1859 respectively. During the rule of Napoleon III, the port's dock and storage areas were extended. In 1881, the Chamber of Commerce was appointed as the operator of the port's sheds, docks and equipment. The Chamber of Commerce became the Port of Marseille Authority (PMA) in April 1966. In 1970, Dry Dock 10, one of the largest in the world, was constructed at the port. A public container terminal was inaugurated by the PMA in 1994. The port played an important role in governing and maintaining the colonies during the French monarchy. Nazis occupied the port from 1942 to 1944, when it was liberated by Allied armies.

The Port of Marseille handles oil and bulk liquids, bulk solids such as minerals and grains. Controlled by the Marseilles Fos port authority, the port serves as a trade gateway to European markets. In 2009 it served more than 11,200 ship calls. The port consists of an east and a west basin. The east basin covers an area of 400ha while the west basin is spread over 10,000ha. The port's 980m deepwater quay is served by a river station at a maximum draft of 12.8m and three deepwater stations at a maximum draft of 16.5m. The port consists of three main harbors: Marseille, Lavera and Fos. Marseille handles passengers, general cargo, roll-on/roll-off activities and ship repairs. Lavera is used for oil chemicals and refined oil activities, while Fos harbour is used for crude oil and container-related activities.

The port transports over 100mt of freight annually. A pipeline is used to transport petroleum from the port to the Paris Basin. Around 1,500 people are employed in the port's area. As the port houses a large indoor fish market, commercial activities take place in the area. Chemicals, building materials, glass, soap, plastics, textiles, olive oil and sugar are also manufactured on the site.

The port's throughput in March 2010 was 7.99 million tons, including 219,000t of conventional and break bulk cargo. In July 2007 the Marseille Port Board provided €22m to construct a seventh mooring berth at the Fos petroleum terminal. The project is scheduled to be completed by mid-2011. The berth will be used for refined oil products. In March 2009, Shell and Vopak formed a joint venture, Fos Faster, to construct an LNG terminal at the port. The terminal will have an initial capacity of 8 billion cubic meters per annum (bcma) and it can be further expanded to produce 12bcma of gas. In March 2010, Hutchison Port Holdings acquired the contract for developing Marseille's Fos 4XL container terminal. The terminal is expected to be operational by 2018.

3.3.2 Marseille's air quality and meteorological networks

The French law on *air quality and rational energy using*, dated from December 30th, 1996, codified by L220-1 and following articles of Environmental Code, specifies that *State has to assure, with the supports of local authorities and companies, air quality monitoring*. In this way, State gives to AASQA (French Approved Association of Air Quality Monitoring), a survey and information mission about atmospheric pollution. Each AASQA administrator board is composed by four corporations: representatives of State, of local authorities, of industrial companies, of consumer or environmental protection associations and of competent personalities.
In 2009, the national network regroups 34 associations. Over Provence Alpes Côte d'Azur Region (PACA region), air quality survey network is managed by AIRFOBEP and Atmo PACA. The French law, about *air quality survey* and *public information*, asks to AASQA to develop an air quality monitoring program. This obligation has to assure the comparison of air quality monitoring devices at the European scale, in application of European Directives and Convention on Long-range Transboundary Air Pollution. Each AASQA has developed, for five years, an air quality monitoring program. Programs defined by AIRFOBEP and Atmo PACA for 2005-2009 are available on their website. A common program will be realized in 2010.

In total, 47 stations for AtmoPACA and 31 stations for AIRFOBEP equipped with 133 and 79 sensors respectively, measure the air quality in this area. The automated measurements transmitted to a Management Centre (in Marseille) are analysed, broadcast to the general public and can be used to alert the authorities in case of a pollution peak. Atmo PACA participates to studies on the environmental impact of air pollution and provides expertise for designing air pollution abatement policies on the means that could be used to reduce the pollution. The stations measure, every 15 minutes, several pollutants such as particulate matters, NO and NO_2, CO, ozone, benzene, toluene, xylenes, SO_2, as well as climatic

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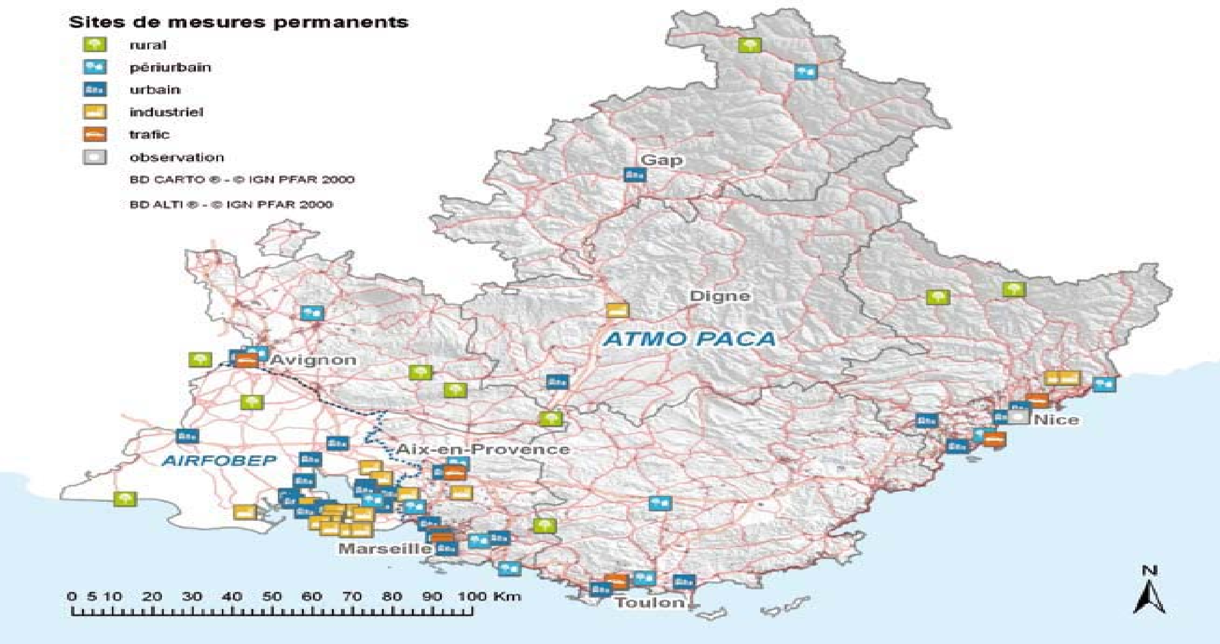
parameters : direction and speed of the wind, temperature, hygrometry. The measures can be done by three ways:
Permanent measurements: whole of measures with a sufficient frequency to give a non-stop result and available in real-time
Indicative measurements: whole of measures done with intermittence over one year,
Sampling campaign: temporal measures over one local area to obtain some information about air quality state in this area.
Figures 5 and 6 show the positions of stations at two different scales. The first one is the network over PACA region and the second is a focus over Marseille Province Metropolitan (MPM) region. Over MPM area, the automatic sampling network is composed by 14 permanent sites with 34 sensors for O_3, SO_2, NO_2, CO and others. In addition, two mobile laboratories, one truck, one trailer, particle samplers for heavy metal and PAH, passive diffusion tubs and "canisters" (for NO_2, benzene, toluene, and VOC) and one laboratory for the measure calibration, level 2, in AIRFOBEP office, are used for sampling campaigns.

Figure 5: Position of stations over PACA region



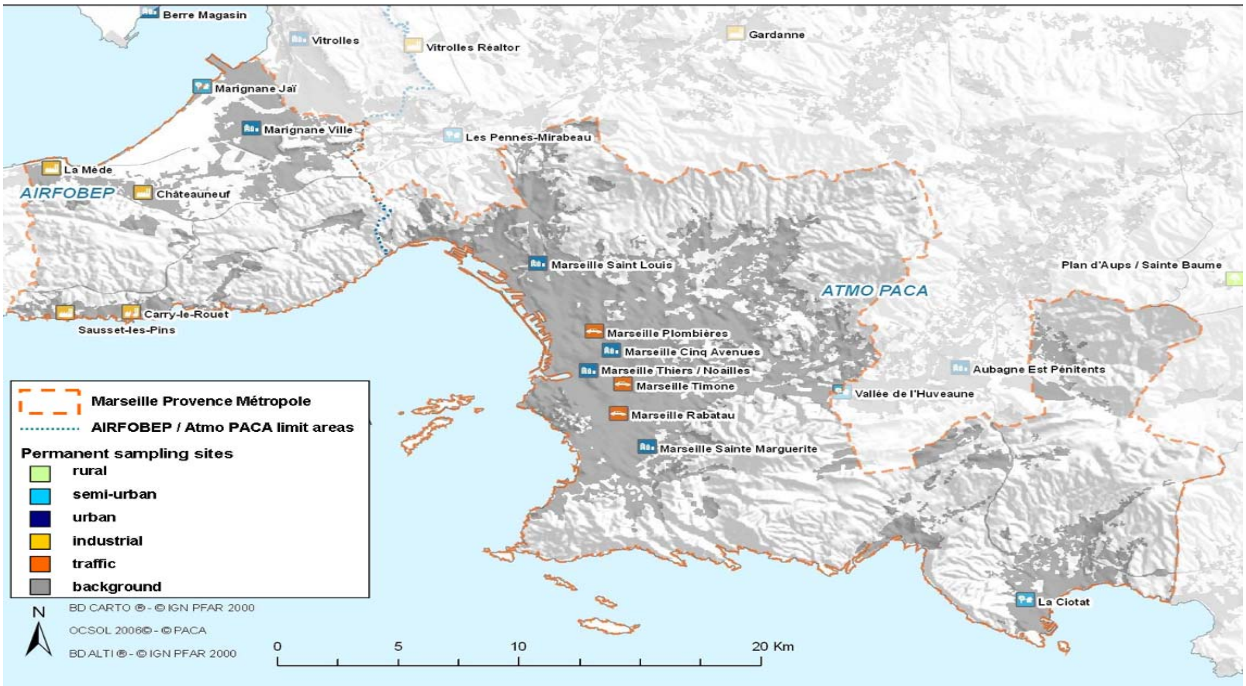


Figure 6: Position of stations over MPM area

Meteorological data are provided by Météo-France, the French network for meteorology and by stations of both air quality networks, AIRFOBEP and Atmo PACA. In this part, we report data for three stations, one inside Marseille, and two in the surroundings, at Marignane and Martigues. These stations are marked on figure 7.
Meteorological data are provided by Météo-France, the French network for meteorology and the stations of both air quality networks, AIRFOBEP and Atmo PACA. In this part, we report data for three stations, one inside Marseille, and two in the surrounding, at Marignane and Martigues.

Figure 7: Locations of Marseille, Marignane and Martigues stations.

3.4 Thessaloniki

3.4.1 Thessaloniki's port presentation

Considering the geopolitical form of the broader area, the city of Thessaloniki is the central pole for implementing a national development strategy. It is co-capital of Greece, the second largest city of the country and the capital of the administrative Region of Central Macedonia (RCM). With a population of over 1,000,000 people, it constitutes a modern European commercial and cultural metropolis, and one of the most important trade and communication centres, situated in the heart of the Balkans.

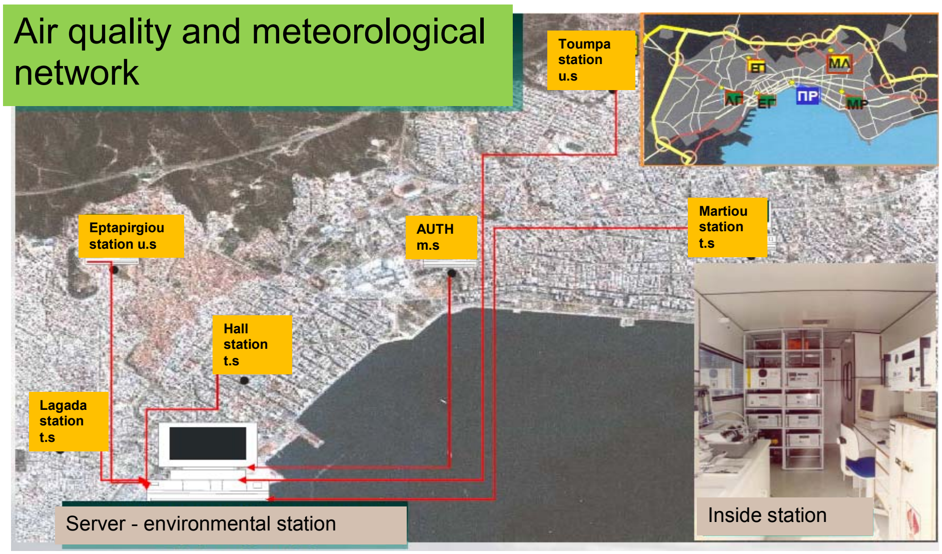
Thessaloniki is the gateway to the Balkans and the hub of a new trading network within South-East Europe and the wider east Mediterranean area, capable of regaining its former importance as the second city in the Roman, Byzantine, and Ottoman Empire. Thessaloniki is being hailed as the new metropolitan centre of the entire Balkan Peninsula, as well as the centre for information and coordination in several European and international initiatives for Balkan reconstruction. The city has a long history as a centre of regional trade and finance and this continues in modern times. Since 1995, Thessaloniki has its own Stock Exchange, whose mission is to become a major stock market in southeastern Europe and the Balkan

region. The impact of globalisation and the realisation that only through trade can smaller Balkan countries achieve competitiveness, both contribute to Thessaloniki's reemergence. Except for being a major port city, Thessaloniki is Greece's second major economic, industrial, commercial and political centre, as well as a major transportation hub for the rest of southeastern Europe. The city's industries mainly produce refined oil, steel, petrochemicals, textile, machinery, flour, cement, pharmaceuticals. A considerable percentage of the city's working people are employed in small and medium sized businesses and in the service and the public sector. In recent years, the city has begun a process of deindustrialization and a move towards a service based economy.
The Port of Thessaloniki is one of the largest Greek seaports and one of the largest ports in the East Mediterranean basin, with a total annual traffic capacity of 16 million tones (7 million tones dry bulk and 9 million tones liquid bulk). It is also the second largest Greek container port after the Port of Piraeus. Thessaloniki's port is a European port and the natural gateway for economic activities between Eastern Europe, Black Sea and Middle East areas. It serves the growing needs of those countries for the import and export of raw material, consumer products and capital equipment. The port is a vital element of the country's economy while it also plays a substantial role in the effort of Northern Greece and its centre city to be established as the economic centre of the Eastern Mediterranean. The port enjoys a privileged position being located at the crossroad of land transportation networks. Moreover, the port is at a driving distance of 16 kilometers from the International "Makedonia" Airport and at a mere kilometer from the Railway Station.
Thessaloniki's port has a total quay length of 6,200m and a sea depth down to 12 meters. It has 600,000 m2 of indoor and open storage area and modern mechanical equipment for the secure and prompt handling of all kinds of cargo, general, bulk and containers. Thessaloniki Port Authority S.A. is currently one of the major employers of Northern Greece with a workforce of more than 600 people while over 2,000 people work daily on its premises. The container terminal has a storage area of 350,000 m^2 and a storage capacity of 4,696 TEU's in ground slots and is currently being expanded by 36 hectares. The cargo terminal has a storage area of 1,000,000 m^2 specializes in the handling of wide cargoes: metal products, ore, chemical products (chloroform, asphalt, chemicals, mineral oils), general cargoes, timber, bulk cargoes and food products. The cargo terminal also serves as a major transshipment hub in the Aegean — Black Sea area being used by other Balkan countries like Serbia, FYROM, Albania and Montenegro. The oil and gas terminal has a total storage capacity of 500,000 m^2 and an annual traffic capacity of 9,000,000 tonnes per year. Finally, the Port of Thessaloniki has one of the largest passenger terminals in the East Mediterranean Sea basin, which handles around 200,000 passengers per year.

3.4.2 Thessaloniki's air quality and meteorological networks

The air quality network in Thessaloniki region includes 8 stations while the nearest to the port station is Aghia Sophia's station. The location of each station is spotted on figure 8

CODE	STATION
Σ1	SINDOS
Σ2	NEOXOROUDA
Σ3	KORDELIO
Σ4	PL.DIMOKRATIAS
Σ5	AG.SOFIAS
Σ6	AUTH
Σ7	PANORAMA
Σ8	KALAMARIA



u.s – *urban station*
t.s – *traffic station*
m.s – *meteorological station*

Figure 8 Air quality and meteorological network in Thessaloniki

3.5 Venice

3.5.1 Venice's port presentation

Strategically located at the top end of the Adriatic Sea, at the intersection of the main European transport corridors and of the Motorways of the Seas (MoS), the Port of Venice is in a position to act as the European gateway for trade flows to and from Asia. The Port of Venice (Venezia in Italian) is a major seaport on the Adriatic Sea and the capital of the region of Veneto in Northern Italy about 65 nautical miles west-southwest of the Port of Trieste and some 274 kilometers east-northeast of the Port of Genoa. The modern Port of Venice occupies the entire lagoon area with about 118 islands as well as to industrial boroughs on the mainland. The base of Venice's economy has always been maritime trade. While trade was first dominated by salt and fish from the lagoon, the Port of Venice became a center for trade between Europe, Asia, and the Middle East. In 2004, over 271 thousand people lived in Venice.

The Port Authority of Venice was created in 1996 as an independent agency to plan, control, and promotes port activities. The port authority strives to strengthen the maritime infrastructure and land access to the Port of Venice and to complement cargo-handling activities by providing logistics services, encouraging the development of trade consistent with the social and economic needs of the community and the nation. In 2008, over 30.2 million tons of cargo passed through the Port of Venice, including 8.6 million tons of conventional cargoes, 3.7 million tons of containerized cargo (in 379 thousand TEUs), 2.6 million tons of roll-on/roll-off cargoes, and 4.3 thousand tons of liquid bulk cargoes. The commercial port area handled 15.0 million tons of cargo. The industrial port handled 4.3 million tons, and the oil port area handled 10.9 million ton of cargo. Conventional cargoes included iron works (2.7 million tons), other dry bulk (1.6 million tons), cast iron? Scraps (1.4 million tons), meals products (898 thousand tons), cereals (847.7 thousand tons), and coal (745.8 thousand tons). Of the 3641 vessels that anchored in the Port of Venice in 2008, 1415 vessels carried over 1.7 million passengers.

Energy products entering the Port of Venice include coal, anthracite, litantrace, petroleum coke, and metallurgical coke. Private interests in the Port of Venice handles large volumes of diverse bulk cargoes that are destined for inland manufacturing companies. Bulk cargoes include betonies, pyrite, fluorite, sulfur, cement, clay, salt, sand, bauxite, feldspar, gypsum, magnesium carbonate, and oxide. The Port of Venice's multi-purpose Intermodal Terminal Venezia SpA (TIV) is entirely private and specializes in fully integrated mixed loads, iron and steel, marble, and project cargoes. TIV is the Port of Venice's largest terminal in both space and number of berths available. More recently, the TIV has begun to handle containerized cargo. Founded in 1997, the Terminal Reinfuse Marghera Srl is the traditional industrial site at the Port of Venice's Porto Marghera. The terminal specializes in handling solid fuels, minerals, and iron and steel products.
Finally, the Port's authorities take part in many projects for reducing its environmental impact. A remarkable reduction of CO2 emissions is achieved by choosing Venice rather than a north European port to transport cargo between the Far East and Central Europe.

3.5.2 Venice's air quality and meteorological networks

In the Venetian area, air pollution monitoring has been an important issue since the early seventies, given the vicinity between the fragile environmental of the lagoon, the monumental heritage of the historical city and the huge industrial area of Porto Marghera. The first air quality network implemented was in fact a private industrial one (EZI, association of industries in Porto Marghera) mainly devoted at that time to monitor SO_2 concentrations. The public air network started in the late eighties and moved to ARPAV's management in 1999, when the Environmental Agency settled in the Veneto Region.
Inside the municipality of Venice, that includes the large mainland of Mestre, at the date of 31/12/2009 the ARPAV's air quality network retained **8 fixed monitoring stations** and **one site for PM2,5 measurements**; at the same date the industrial network presented **13 stations with air pollutants monitors** and **5 stations with meteorological monitors** and a site with a wind profiler and a temperature radio acoustic sounding system (Figure9).

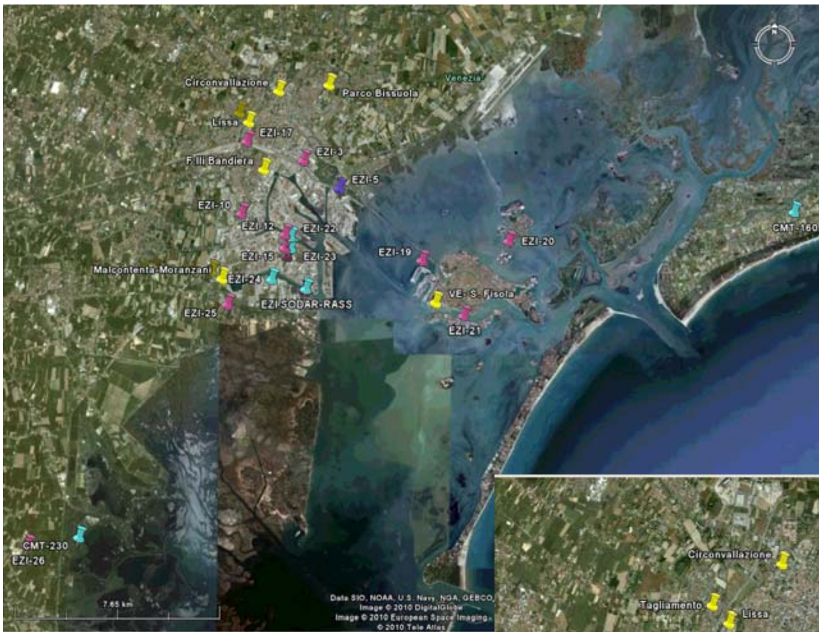


Figure 9: Monitoring sites in Venetian area and zoom to the study area

Both the ARPAV and EZI networks have gone through little changes in the next months of 2010. The ARPAV's network, together with the regional one to which it belongs, is going to an overall process of optimization with likely some monitors relocations. Due to the presence of the important industrial area of Porto Marghera (oil refinery, cracking and petrochemical plants, refineries, incinerators, thermal power plants, metal production and processing plants) just at the inner boundary of the lagoon and in the proximity of the historical city of Venice, an Integrated System for Environmental Monitoring and Emergency Management (SIMAGE) has been running since a few years.
One of the components of the SIMAGE is an air quality monitoring network, dedicated to industrial chemical compounds, for prompt survey and evaluation of accidental releases from the chemical plants. As continuous monitoring instruments DOAS (Differential Optical Absorption Spectroscopy), gas chromatographs and PAS photoelectric sensors for PAH are installed in 5 different sites; as remote control sampling devices, to be switch on for the follow up of accidental episodes: canisters, PM10/PM2.5 low volume samplers, PM10/PUF high volumes samplers and bulk deposimeters.5 stations with meteorological monitors and a site with a wind profiler and a temperature radio acoustic sounding system. In the Venetian area there are also some meteorological stations, belonging to the regional meteorological network operated by ARPAV Meteo Centre of Teolo (CMT-ARPAV).

The air quality of the five cities: a general picture for the last years.

A brief description of the air quality (based on the available measurements) during the last years (different periods of available data in each city) follows for the five cities.

4.1 Barcelona

In general, most of the measured parameters (PM10, PM2.5, CO, SO_2, NO_2, H_2S, HCT,O_3) show a decreasing trend from 2000 to 2009, especially evident in 2009. These trends are probably related to the economic crisis rather than abatement strategies carried out in the last years. Only a slight proportion of these decreasing trends may be related to the mitigation strategies taken at the moment.

On a daily basis, **PM** levels and its size distribution show ***clear seasonal trends***. The highest PM levels and finest size distribution are observed *in winter* (February-March, and November) as a consequence of ***intense pollution episodes that prevent the dispersion of the atmospheric pollutants***. These episodes are usually recorded *under anticyclone conditions*. Relatively high PM levels and coarse particle size are observed *in summer* as a result of ***low atmospheric dispersive conditions*** affecting the Western Mediterranean, together with higher frequency of ***African dust episodes*** and ***enhanced resuspension processes***. The lowest PM levels are recorded in April, September-October and December,

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generally *coinciding with rainy periods and intense advective conditions*. The effect of African dust on PM_{10} levels is evident, with relatively low influence on $PM_{2.5}$ and negligible on PM_1.

The **black carbon concentrations** seem *really sensible to the traffic emissions*, showing *little seasonal variability*. As regards for the number concentration, sometimes the urban pollution episodes give significant numbers of ultra-fine particles ***(elevated emissions in a low-dispersive atmosphere)***, which are simultaneous with PM and BC peaks. Other times important number concentration peaks occur ***under low pollution conditions (nucleation processes).*** In some occasions, the urban pollution episodes are associated with low levels of number concentration which is thought as *the result of coagulation and condensation processes that reduce the number concentration but not the PM mass.*

Regarding the seasonal evolution of $\mathbf{NO_2}$ and $\mathbf{SO_2}$, it is clear that both gaseous pollutants exhibit different patterns. Whereas NO_2 *tends to maximize in winter as a consequence of the lower dispersive conditions of the urban atmosphere*, SO_2 do not show this pattern. In some episodes, NO_2 and SO_2 register simultaneous increments in a daily basis. This basically occurs *under urban pollution episodes*. Nevertheless, it is more frequent to observe a different behaviour between NO_2 and SO_2. In fact, whereas NO_2 is ***highly related with traffic emissions (mainly from diesel vehicles)***, SO_2 concentrations in the urban area of Barcelona are more ***related to shipping and industrial emissions. Clear traffic dependence*** is observed for NO_2, with morning and vespertine peaks coinciding with *the rush hours*, but a midday maxima is observed in SO_2, ***coincident with the entrance of the sea breeze towards the city, with a typical direction from the harbour area.***

Concerning the **chemical composition of particle**s, some atmospheric components have a preference for the coarse sizes such as *mineral matter*, *sea spray* and *nitrate*. Other components such as *organic matter* and *elemental carbon* (OM+EC), *ammonium* and in less proportion *sulphate* are mostly fine. It is important to remark that the amount of coarse components (PM_{1-10}) in the atmosphere of Barcelona is very significant. It is expected that in the harbour area, where some dusty materials are handled, *construction activities are always ongoing, and intense traffic of trucks occur*, the importance of the coarse PM may be even higher than in the urban background. Furthermore,
Mineral matter tends to increase in summer, *probably due to the enhanced resuspension processes.* Nevertheless, sporadic and intense peaks are observed, *coinciding with African dust outbreaks.*
Nitrate concentrations are clearly higher in winter, *when a high frequency of urban pollution episodes* is registered over the study area. In those cases, ammonium nitrate is the commonest inorganic secondary PM component.
OM+EC concentrations are also higher in winter, again *due to the accumulation of PM pollutants during urban pollution episodes.*
Sulphate generally increases in summer, *when the photochemical reactions are enhanced. In addition, the typical summer recirculation of air masses over the Western Mediterranean favors the accumulation of secondary pollutants over the region* (mainly ammonium sulphate, organics and ozone).

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Vanadium and nickel show a clear seasonal trend with higher concentrations in summer, and sporadic peaks out of this period. In the study area *the harbor emissions and some industrial activities are to be the major sources of these trace elements.*
Lead and Zinc register an inverse seasonal evolution when compared to the previous two, showing higher winter concentrations. *It is interesting to note that the study of the Pb-Zn episodes points out to the industrial area located in the Llobregat Basin as the source of these pollution episodes. Over this area large metallurgical activities occur.*
Copper and antimony are the best tracers of traffic emissions. In this case they show a typical winter maximum originated by the *higher frequency of urban pollution episodes.*

4.2 Genoa

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/m^3 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.*

4.3 Marseille

NO_2 is mainly associated with *high traffic emissions.* As reported, since 2006, the annual concentration at three of seven sampling sites (sites of "Timone", "Rabatau" and "Plombières") exceeded the annual limit value for 2009 (42µg/m^3). The maximum annual mean was recorded at "Marseille Plombières" site while for middle size cities, as Marignane the limit value was not exceeded. It is characteristic that in 2009, the hourly limit value of 200µg/m^3 has been exceeded 20 times at "Marseille Plombières" station. *These excesses are mainly associated with stable meteorological conditions, frequently during winter, without wind and thermal inversion, leading to pollutants' accumulation.*

SO_2 mean levels are stable and much lower than quality objective (50 µg/m^3) for all stations. The highest yearly value was noticed at the "Sausset-les-Pins" site. *Due to petrochemical activities and industrial emissions*, the highest concentrations were recorded at sampling sites close to Berre pond border. Among 6 stations, only the "Châteauneuf-la-Mède" station recorded an hourly maximum higher than the limit value of 350µg/m^3. *These peaks of SO_2 are due to fallout of industrial pollutant plumes.*

Regarding **O_3**, it is characteristic that for the year 2009, all sampling stations over MPM area, except for one, exceeded the limit value during more than 25 days. "Marseille Cinq-Avenues" sampling station reached the quality objective: *as the reactions between ozone and nitrogen oxides from traffic are very quick, ozone concentrations are lower at the city centre.*

PM10 measurements since 2006 for MPM area showed that in supplement to ***traffic influence, excavation and building activities*** since 2009 have led to intense particles emission close to the "Marseille Timone" station. For 2009, all stations recorded values higher the than the daily limit value (as for the three last years). For "Marseille Timone" site, daily level reached a maximum value, *due to **dust emissions by surrounding works**, in addition to **traffic emiss**ions.* Since 2006, the most significant excess has been recorded for the particulate matter issues from *fossil fuel used by **ships and industries***. *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 leads to particles levels increase while low pollution conditions can lead to significant levels' decrease.*

Regarding **heavy metals**, just after the *Cu/Cd industry closing* in September 1999, **Cd** levels have significantly decreased at "Saint-Louis" sampling site. From 2001, the annual mean concentration was lower than the European objective value (5ng/m^3). Since 2004, the Cd mean concentration was close to Marseille's background level where there was not any industrial influence. **Pb**, **Ni** (since 2000) and as, annual concentrations did not exceed the limit values.

High levels of **PAHs** were connected to traffic and industries emissions, as recorded in regional scale.

Regarding **benzene**, it is characteristic that in 2009, all sampling stations over MPM area had an annual mean level lower than the limit value (6µg/m^3). Quality objective (2µg/m^3) was not reached at traffic stations located at the city centre. For a comparison, the maximum mean (4,4 µg/m^3) for 2009 is recorded at sampling site "Vallée de l'Huveaune" *due to the existence of an industrial source nearby. Benzene concentrations are higher close to heavy traffic roads and close to industrial sites.*

4.4 Thessaloniki

The atmosphere of Thessaloniki is characterized by aggravated air quality due to several factors: intense source emissions, topography and meteorological/climatic conditions. In particular, the city is densely populated (over 1,000,000 inhabitants) and anthropogenic activities as emissions from vehicles (over 400,000 in a daily basis) and the industrial units at the north-northwestern part of the area contribute to air pollutants' levels under the prevailing meteorological conditions which in some cases, lead to pollution episodes. Furthermore, as

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the climatic pattern of the area is characterized by low precipitation levels (rain during 33% of the year) and low wind velocity values, the accumulation of air pollutants is quite frequent. Photochemically formed pollutants are also produced by the combination of sunlight and sources (vehicles, central heating, plants emissions). In general, higher pollutants levels are observed during cold season due to prevailing meteorological conditions and intense source emissions (central heating, emissions from engine start up). Regarding the hourly variation, pollutants peaks are observed during morning and afternoon hours, coinciding with rush hours with extensive vehicle circulation and usually absence of wind. The problem is aggravated as streets layout enforce pollutants accumulation.

Concerning the period 1989-2008, the **NO_2** annual E.E. limit (40μg/m^3) was exceeded at the stations which are situated at the center of the city. Vehicles' emissions and traffic due to metro construction activities are the main reasons for NO_2 levels increase at these stations.

Regarding **SO_2**, the E.E. daily limit (125μg/m^3) was not exceeded in anyone of the city stations. The highest values are observed at Hall station (center of the city) for the period 1989-1999. However, a reduction during the next years (2000-2006) is noticed -in all stations-possibly because of the fuels' quality improvement, the vehicles' new technology and the construction of a peripheral highway. A further decrease in SO_2 levels was noticed during 2007 and 2008 due to the reduced industrial activity and the natural gas use.

As far as ozone **O_3** is concerned, a different picture is observed. The 8-hour limit of 120μg/m^3 was not exceeded for more than 25 times/year at three urban stations. Nevertheless, at the two suburban stations (Eptapirgiou and Toumpas stations), 80 and 112 exceedances were recorded respectively during 2008, implying an increasing trend. Taking under consideration that ozone is a pollutant which is photochemically produced (under the prevailing meteorological conditions), suburban areas are expected to be characterized by higher levels. This issue should be under consideration, for Thessaloniki's air quality in the near future.

A decreasing trend in **CO** levels during the lasta year is noticed mainly due to the old-technology vehicles withdrawal and their replacement with those of catalytic engine (in the beginning of 90's). An exception is observed for Lagada station where an increase in CO levels was reported for the year 2008, because of the construction activities of Egnatia highway in its background.

The annual level of **benzene** was exceeded at Hall station (ground level) and at Martiou station (first floor level) in the periods 2005-2006 and 2007-2008 respectively.
PM2.5 measurements were available at two monitoring stations for the years 2005-2008. As shown, the annual limit value of 120μg/m^3 was exceeded during all years at the (urban) Hall station. The intense vehicles circulation and the metro construction activities are expected to be the main sources for the increased particles levels.

Regarding **PM10**, at the Hall station (urban station, in the city center), both daily and annual limit values were exceeded during all years. The other two urban stations (Martiou and Lagada stations) reported lower levels, but still exceeding the annual limit of 40μg/m^3 and in same cases the daily limit (40μg/m3) too. In opposition, PM10 levels at the two suburban stations did not exceed the annual limit for the years 2007-2008. It is obvious that particles levels are lower in suburban areas because of the reduced vehicles emissions.

4.5 Venice

Regarding **SO_2**, the highest daily concentrations were recorded at Station Enel Fusina, *close to the coal thermal power plant and the urban waste incinerator.* High concentrations were also recorded in Sacca Fisola, possibly due to *the transit of the ship* along the Giudecca's Channel as well *the parking phase of the big cruise-vessels* in the maritime harbor of Santa Marta. *This hypothesis is going to be confirmed or rejected by APICE apportionment studies.* Relatively high concentrations (especially hourly values) were recorded at the background station of Parco Bissuola. As the peaks are more frequent in summer time and spring time, they *can't be addressed to domestic heating* (moreover because in Venice, according to the special legislation for the safety of the monumental heritage, almost the whole city is feed by methane). Finally, by examining SO_2-wind direction connection, in the case of Parco Bissuola, an evident SE-ESE origin can be observed, for Malcontenta a NE origin, whereas for Sacca Fisola a NW origin. The 3 stations, thus, seem to triangle to a common origin *that could be the shipping areas* (*the maritime harbor and the industrial one in the inner lagoon), but also the north industrial area of Porto Marghera* where are situated some of the major plants emitting SO_2.
NO_2 hourly concentrations present a peak in the morning and a peak in the evening in all the stations. Typical pattern with maximum monthly concentrations during cold months is evident for all the station and particularly for the industrial suburban station of Malcontenta-Garda.
Regarding **PM10**, the number of daily limit exceedances was significantly decreased (from 120 days in 2005 to approximately 70 days in 2009). Furthermore, particles levels during weekend appeared decreased possibly *due to less intense **vehicles circulation***. The lowest values of monthly means were noticed during summer period (May to September). The highest values were observed during January and February possibly due to ***central heating operation and cold engines' starting up***. *Finally, the meteorological pattern of each season plays a crucial role too; as a low dispersive atmosphere leads to particles levels increase while low pollution conditions (i.e. nucleation process) can lead to significant levels' decrease*
Metals monitoring (**Pb, Ni, Cd, As, Hg**) at the urban background station of Parco Bissuola and at the urban traffic station of Circonvallazione showed decreased levels for the year 2009 compared to those of previous years.
As the meteorological pattern of the area is concerned, the stratified analysis bears out **completely different wind regimes**, both in terms of wind intensity and in terms of directions, for the two sites (**Valle Averto** and **Cavallino** stations) during hot and cold months of the year as well as during diurnal or nocturnal hours of the day. The phenomenon,

typical of a coastal site, has obviously important implications for the source apportionment studies that APICE is going to apply on the Venetian area.

5. Focus on PM10 during 2009 for near the port areas

5.1 Intercomparison of PM10 hourly, daily, monthly variation in the five areas.

In an effort to compare particles levels and their variation at the five port areas, the present report has focused on the study of PM10 levels during the year 2009. The data used were obtained from the stations directly affected by the ports (**Torre Girona station** for Barcelona city, **Corso Buenos Aires station** for Genoa city, **Five avenues station** for Marseilles city, **Aghia Sofia** station for Thessaloniki city**, Parco Bissuola station** for Venice city)

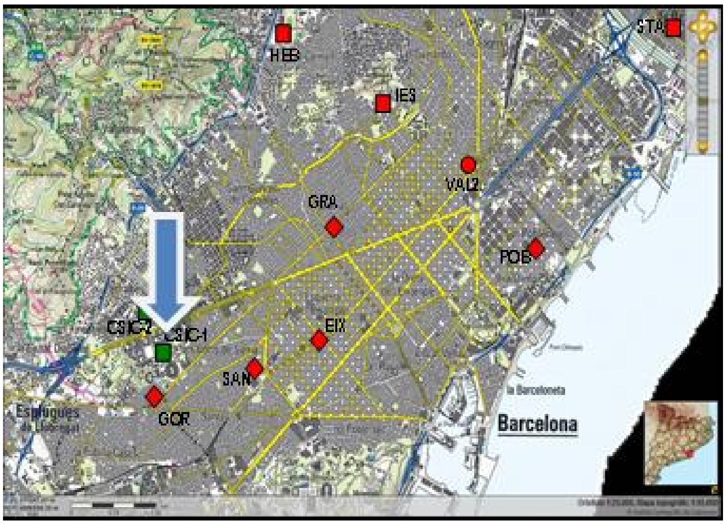

Figure10: The location of Torre Girona station, Barcelona which is marked with an arrow

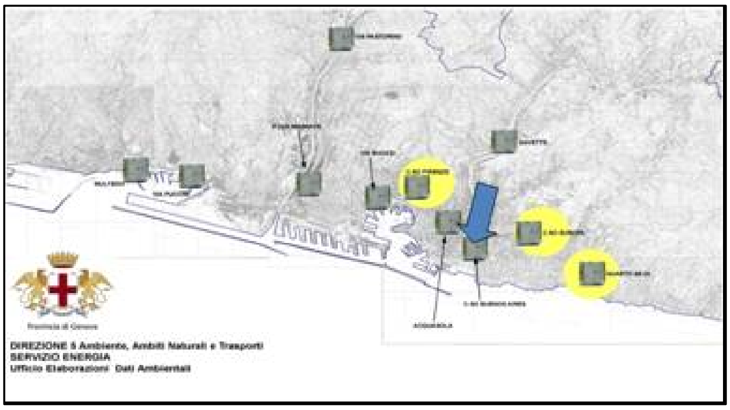

Figure11: The location of GE - Corso Buenos Aires, Genoa station which is marked with a blue arrow

Figure12: Location of Marseille five avenues station.

Figure13: Location of Aghia Sofia station in Thessaloniki

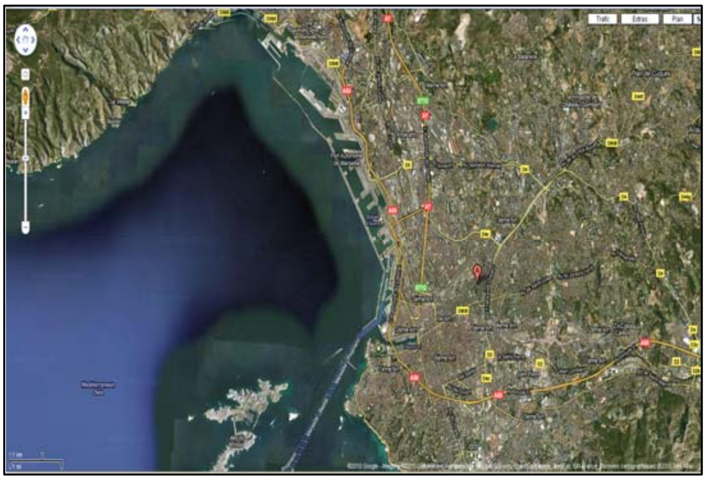

Figure14: Parco Bissuola station, Venice, location (red spot)

In the following, the figures present the **annual average values**, the **monthly**, the **daily**, the **hourly variation** of PM10 and the observed exceeded days during 2009, for the five cities.

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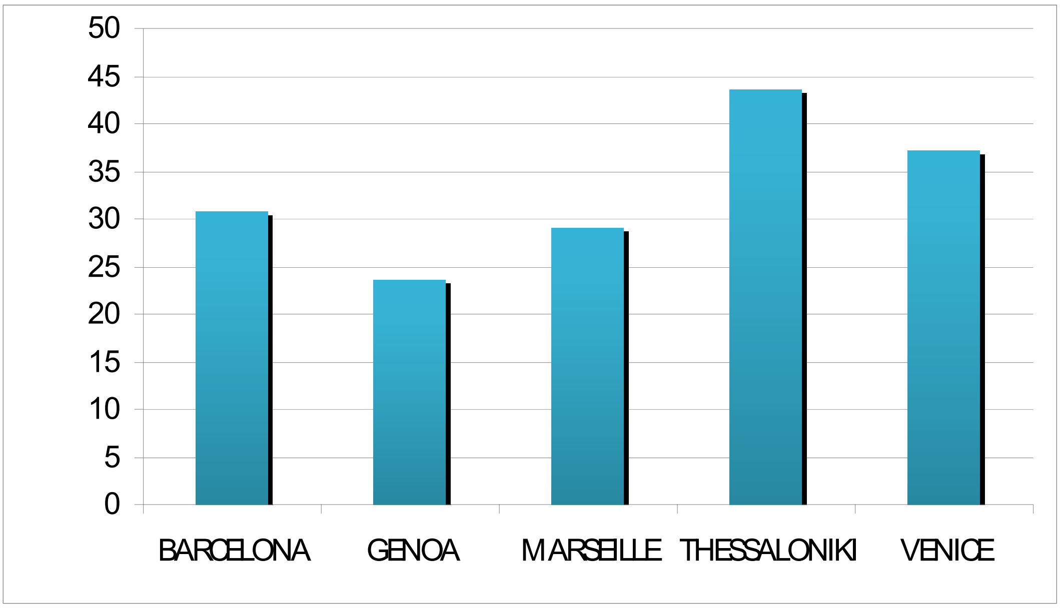

Figure 15 . PM10 annual average values in µg/m^3 during 2009, for the five cities

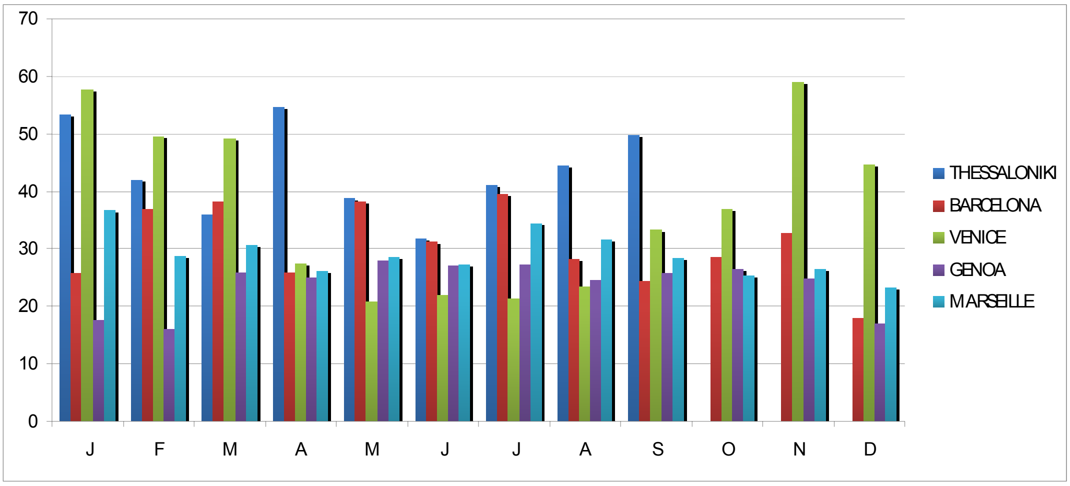

Figure16 Monthly variation of PM10 (in µg/m^3) during 2009, for the five cities.

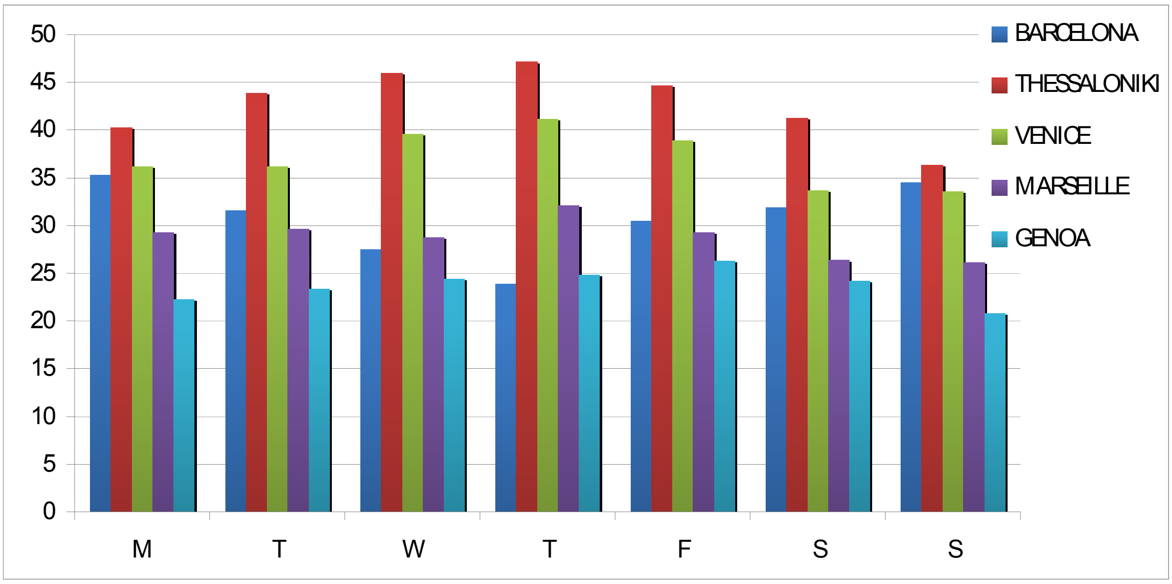

Figure17 Average values (in μg/m^3) for each day of the week, during the year 2009, for the five cities.

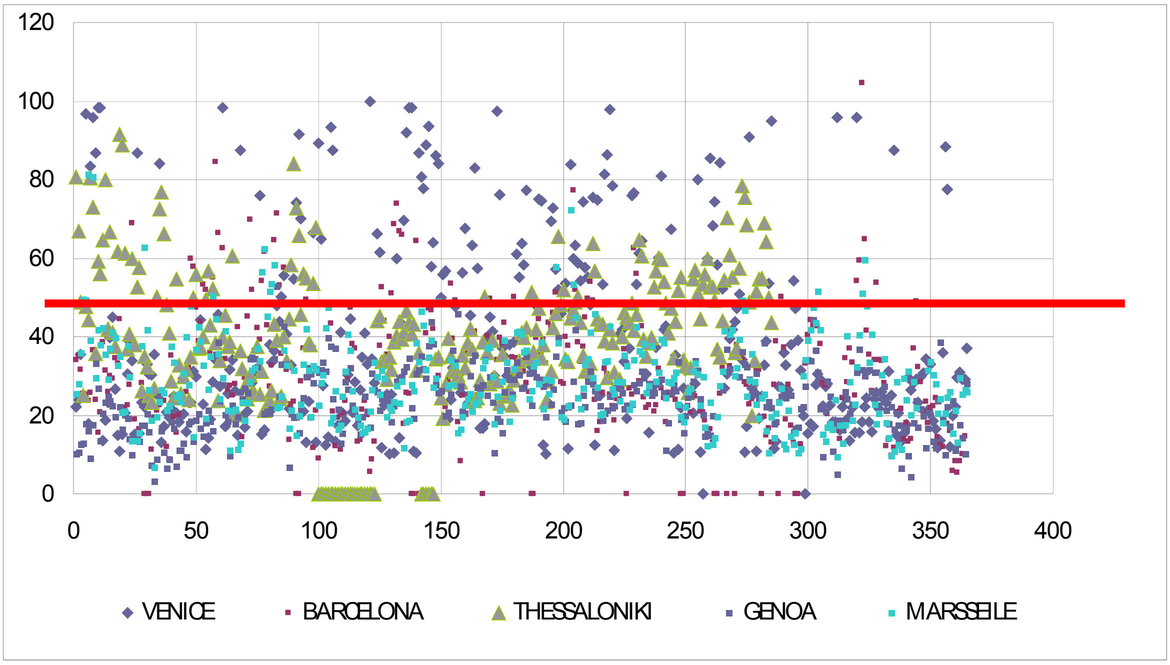

Figure18 Daily variation (in μg/m^3) and exceedances of PM10 concentration during 2009, for the five cities.

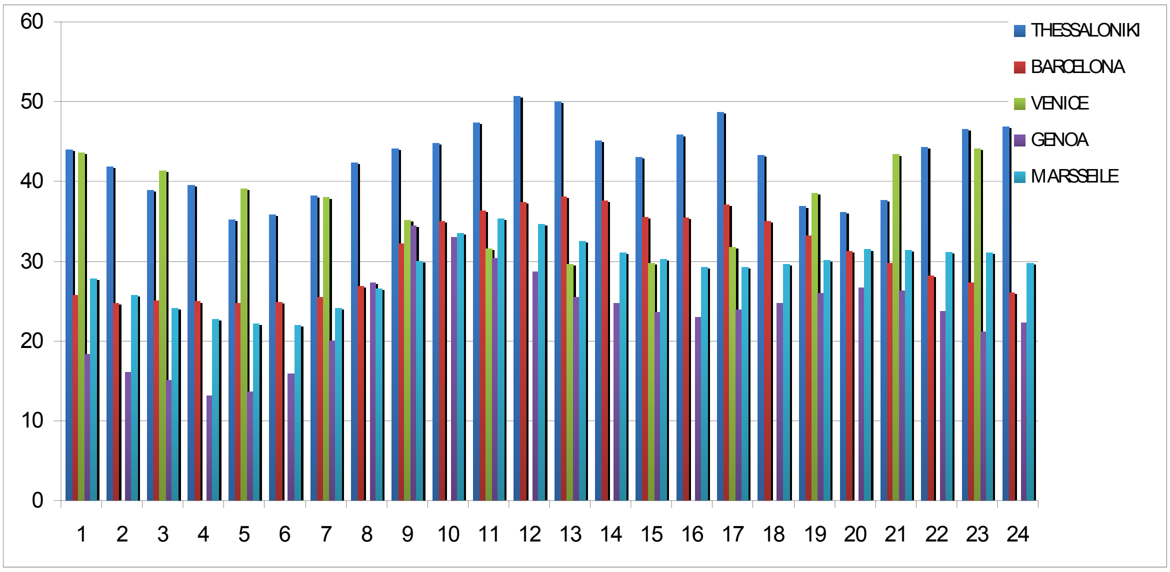

Figure19 Hourly variation of PM10 (in μg/m^3) during 2009, for the five cities.

The **maximum annual average concentration** was observed in Thessaloniki (42.5μg/m^3), followed by Venice (37.1μg/m^3), Barcelona (30.8 μg/m^3) and Marseille (29 μg/m^3). The minimum annual average concentration corresponded to Genoa (23.6 μg/m^3). The annual concentrations were *under the annual limit value* (40 μg m^{-3}) for all the sites except for Thessaloniki where it was slightly higher.

The **monthly variation** of PM10 presents a different picture in the five port areas.

In **Barcelona's** port area,_the maximum monthly average values corresponded to February, March, May and July. As mentioned previously, *in **winter intense pollution episodes** that avoid the dispersion of the atmospheric pollutants are observed*. *In summer as a result of **low atmospheric dispersive conditions** affecting the Western Mediterranean, together with higher frequency of **African dust episodes** and **enhanced resuspension processes***. The lowest PM levels were recorded in ***rainy periods*** (April and September-October), ***vacation period*** (August) and ***windy months*** (December). Attending to the seasonal evolution of the PM_{10}, it is clear that the highest levels have been measured in wintertime, as observed in the urban background.

In **Genoa**, the maximum values of PM10 corresponded to May, June and July. On the other hand, the lowest values correspond to January, February and December.

In **Marseille port area**, the maximum monthly mean values corresponded to January, July and August. During winter, the main sources that contribute to particles levels are the ***buildings' central heating*** and the ***bad operation of vehicle motors in starting because of the cold engine***. During summer, ***chemical processes -connected with intense solar radiation- are responsible for secondary particles' formation***.

In **Thessaloniki**, the highest values were noticed during January, April and September. The lowest monthly value was recorded during June.

In **Venice port area**, the maximum values corresponded to November 2009 to March 2010 period (winter period). On the other side, the lowest values correspond to summer - spring period.

As noticed, the highest monthly averages are observed during different seasons in each city. It is important to note that the factors that contribute to particles levels include permanent or seasonal sources. During winter, intense pollution episodes, central heating and bad operation of vehicle motors in starting because of the cold engine can lead to elevated particles levels. During summer, secondary particles formation, African dust episodes and enhanced resuspension processes are reported as the main factors for high PM levels. The meteorological pattern of each season plays a crucial role too, as a low dispersive atmosphere leads to particles levels increase while rainy (i.e. nucleation process) weather can lead to significant levels' decrease.

The **daily variation** of PM10 is quite similar in the five port areas.

In **Barcelona's** port area, important weekly cycles are evidenced, with highest PM levels in the middle of the week and clearly lower on Sundays. As expected, PM_{10} levels increase progressively during the week to reach the maximum on Thursdays. On Sundays, minimum concentrations of PM_{10} are recorded, which is correlated with the ***lower traffic displacements***. A similar trend may be observed in the levels of Black Carbon, *typically tracing the traffic emissions*.

In **Genoa's** and **Marseille** port areas, it can be noticed that although there are not significant differences, concentration **on Sundays** is lower, as an impact of the ***reduced vehicles circulation***. Friday and Thursday were the days with the maximum daily PM10 concentration average reported, respectively.

In **Thessaloniki**, particles' levels are slightly lower on **Sundays**, possibly due to the ***reduced vehicles circulation* and human activity** in the centre of Thessaloniki.

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In **Venice**, although there are not significant differences, concentration during **weekends** is slightly lower, possibly because of the reduction of vehicles circulation and human activities. Higher values were noticed during **Wednesdays, Thursdays** and **Fridays**.

The common characteristic among the five cases is the decrease of particles levels during weekend due to reduced vehicles circulation and/or human activity. In general, the highest PM10 daily values were observed in Thessaloniki while the lowest were observed in Genoa. The difference is reduced during weekend and especially Sundays, implying traffic as a significant particles source, affecting the port area.

The **hourly variation** of PM10 present similar characteristics among the five port areas.

In **Barcelona's** port area, concentration levels increase during early morning hours owing to the intense vehicles circulation starting at that time. Nevertheless the maximum concentrations are recorded between **12-14 p.m**. This happens because of the **enhanced resuspension processes** as a consequence of the increase in wind velocity. Concentration levels during afternoon remain elevated while following a decreasing trend during night, when **the road traffic activity decreases in parallel to the lowering in the wind velocity.**

In **Genoa's** port area PM10, 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.

In Marseille, concentration levels increase during early morning hours, presenting a peak at **10-12pm**, *possibly because of the* ***intense vehicles circulation***, ***central heating operation*** *(in cold season) and* ***human activities***. Concentration levels during afternoon and night remain elevated as this time period is often characterized *by* ***prevailing favorable meteorological conditions for the air pollutants accumulation****.*

In **Thessaloniki,** concentration levels increase during early morning hours, presenting a peak at **10-13pm**, *possibly because of the* ***intense vehicles circulation*** in the city center. Concentration levels during afternoon and night remain elevated

In **Venice, PM10 levels** present an increasing trend in early evening hours and remain elevated during all night possibly because this time period is often characterized by **prevailing favourable meteorological conditions for air pollutants accumulation**.

It can be concluded that the daily variation of PM10 levels is strongly influenced by two factors: vehicles circulation/intense human activity and wind pattern of the area which affects pollutants accumulation or dispersion during day and night.

As regards the **exceeded days**, the new Directive 2008/50/EC highlights that the PM_{10} limit of *50µg/m³* should not be exceeded for more than 35 times per calendar year. In **Barcelona**, the measured concentration exceeded the limit in **38 days** (during 2009), some of theme coinciding with African dust outbreaks but mostly having a dominant anthropogenic origin. Nevertheless, the daily limit value established for PM_{10} in 50 µg m^{-3} *was exceeded* 38 days whereas only 35 days are allowed. After quantify the contribution **of African dust** for each day, and subtracting this contribution to the PM_{10} concentration, 32 exceedances were recorded.

5.2 The ports' effect on the cities' air quality: the role of the wind pattern

The meteorology pattern of an area can significantly affect the air quality. Winds blowing from the port area, can lead to pollutants (emitted from the local sources) transportation to the city, increasing pollution levels. The cases of the five cities (Barcelona, Genoa, Marseille, Thessaloniki and Venice) are examined in the following. A rose diagram based on PM10 and wind velocity/direction data for the year 2009 is presented.

As shown in fig20, in **Barcelona**, the highest wind speed values (up to 7m/s) are associated with NW wind directions, *coinciding with strong Atlantic air masses advections.* However, the highest PM levels are usually recorded during SW winds, *coinciding with the evolution of the sea breeze during the day* (from approximately 90º to about 240º). It is important to note that the stagnation of air masses over the area favors the accumulation of pollutants at an urban and regional scale. The higher intensity of the sea breezes in summer is evident in the lowering of the PM levels in the harbor area, more evident than in the urban background. As observed, there is not a clear relation between wind direction and PM_{10} concentrations which suggest that most of the PM_{10} in the urban background of Barcelona is *of a local origin*. The North direction appears to be the cleanest.

As regards for the gaseous pollutants, in the case of SO_2, a clear NE and SSE origin may be deduced, *just from the shipping areas*. Concerning the NO_2 concentrations, an evident W-NW origin may be seen, *pointing to the city*, *local roads and ring-roads as the major emission sources of this pollutant in the harbour area.* Finally, H_2S concentrations clearly have a south origin, just from a *factory using sulfur products*.

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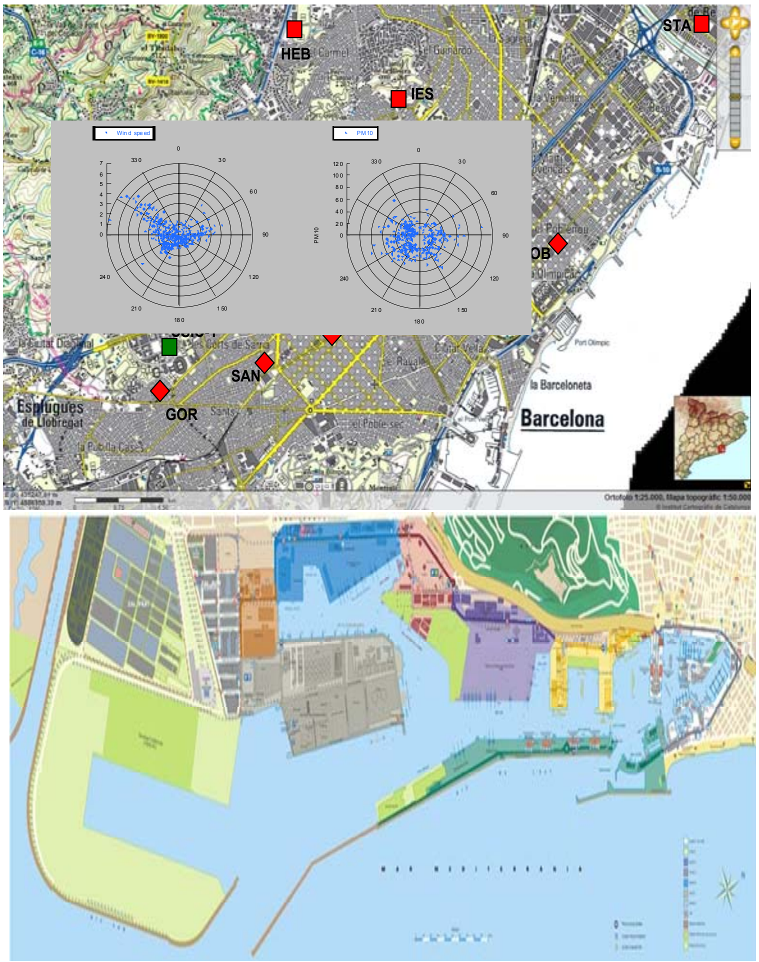

Fig.20 PM10 concentration rose (µg/m^3, degrees) and wind speed rose (m/s, degrees) for the year 2009-activities in Barcelona.

In **Genoa** (fig21) the maximum values for wind speed ranged between 11-17m/s and were mainly observed during periods with prevailing NNE wind. Western winds were rarely observed. Maximum PM10 levels (> 22µg/m^3) were more often recorded during days with prevailing NNE wind implying *an inland to sea transportation*. High PM10 levels also corresponded to winds with NE, SE direction and other directions (less often).

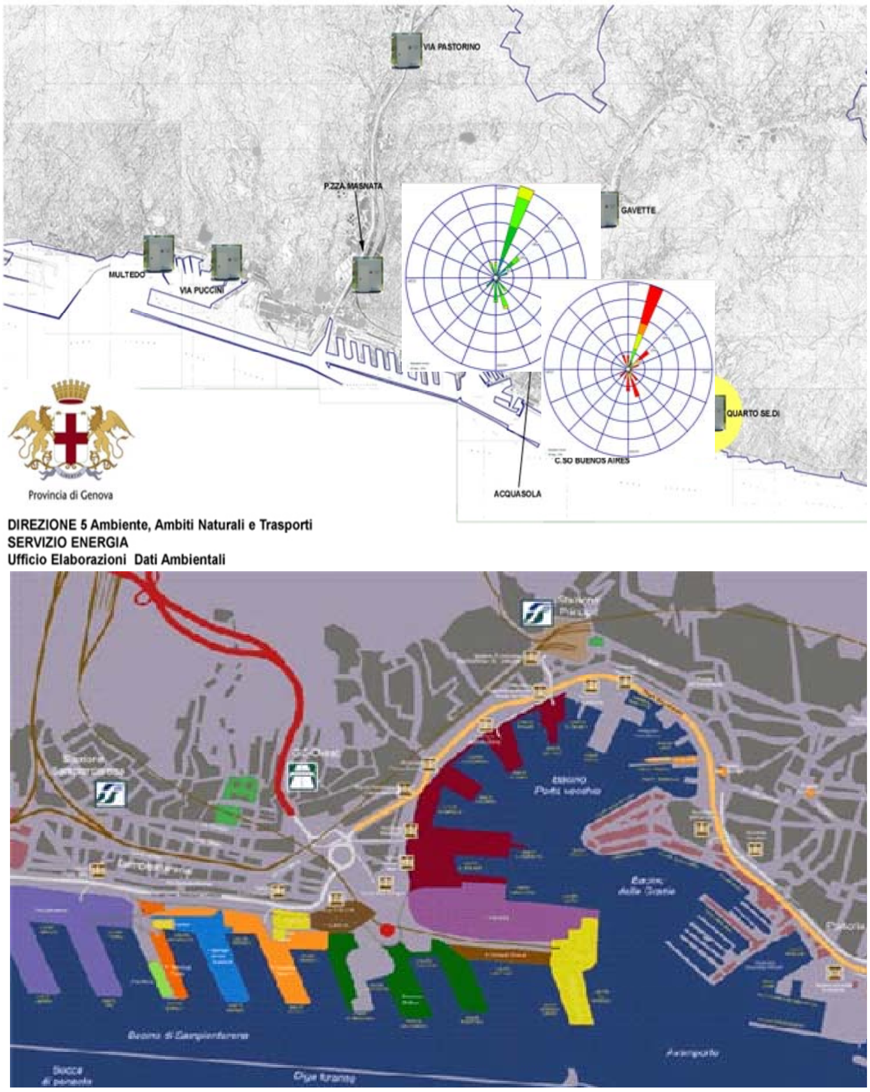

Figure21: PM10 concentration rose (µg/m^3, degrees) and wind speed rose (m/s, degrees) for the year 2009 in Genoa

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In Thessaloniki the maximum values for wind speed were mainly observed during periods with prevailing SE wind. Winds of all directions were observed. Maximum PM10 levels were more often recorded during days with prevailing WSW wind. High PM10 levels also corresponded to winds with SSE, ESE, NE, NW direction (city and port origin).

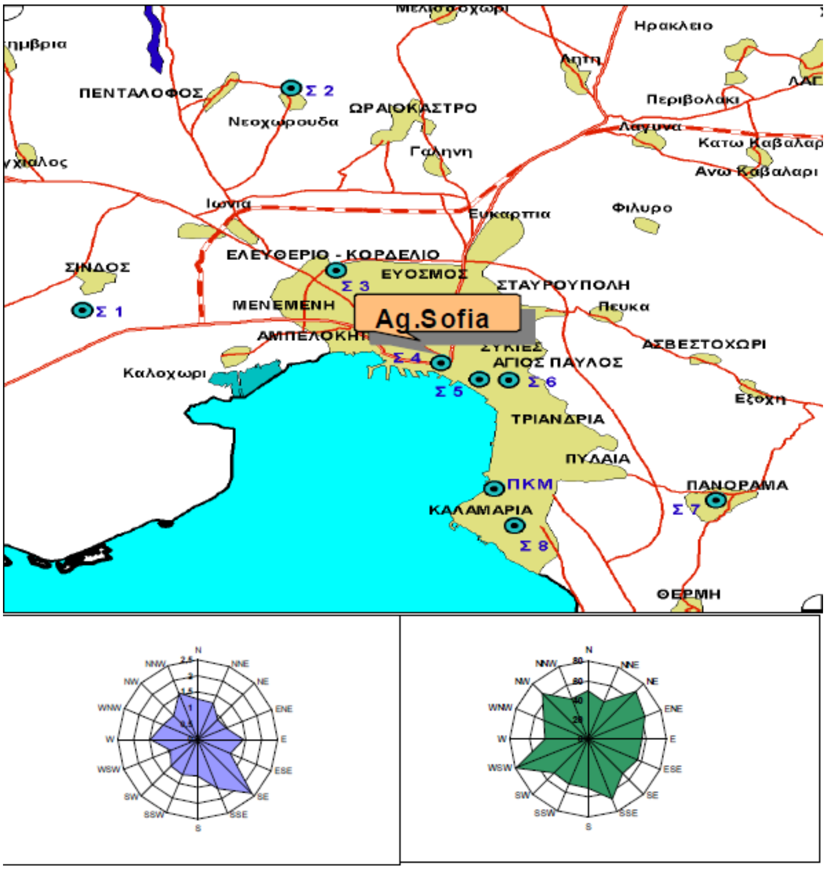

Figure 22: PM10 concentration rose (μg/m^3, degrees) and wind speed rose (m/s, degrees) for the year 2009 in Thessaloniki

In **Marseille** (fig23) the highest wind speed values and the highest PM10 levels are mainly connected to winds from west-northwestern to north-northwestern, east-southeastern and southeastern winds. High PM10 levels are also connected to eastern and eastern-northeastern winds with lower wind speed values. In an effort to identify the sources contributing to PM10 concentration, primary trends can be drawn. To be more specific, *the presence of the west harbour* **(**at a distance of 40km at a north-western direction) plays a crucial role to particles emissions and in combination with *prevailing meteorological* *parameters*, can significantly contribute to PM10 levels at Marseille's station. On the other side, the *nocturnal urban breeze originating* from south-east seems to have a significant impact on PM10 levels through *particles transportation from another industrial area.*

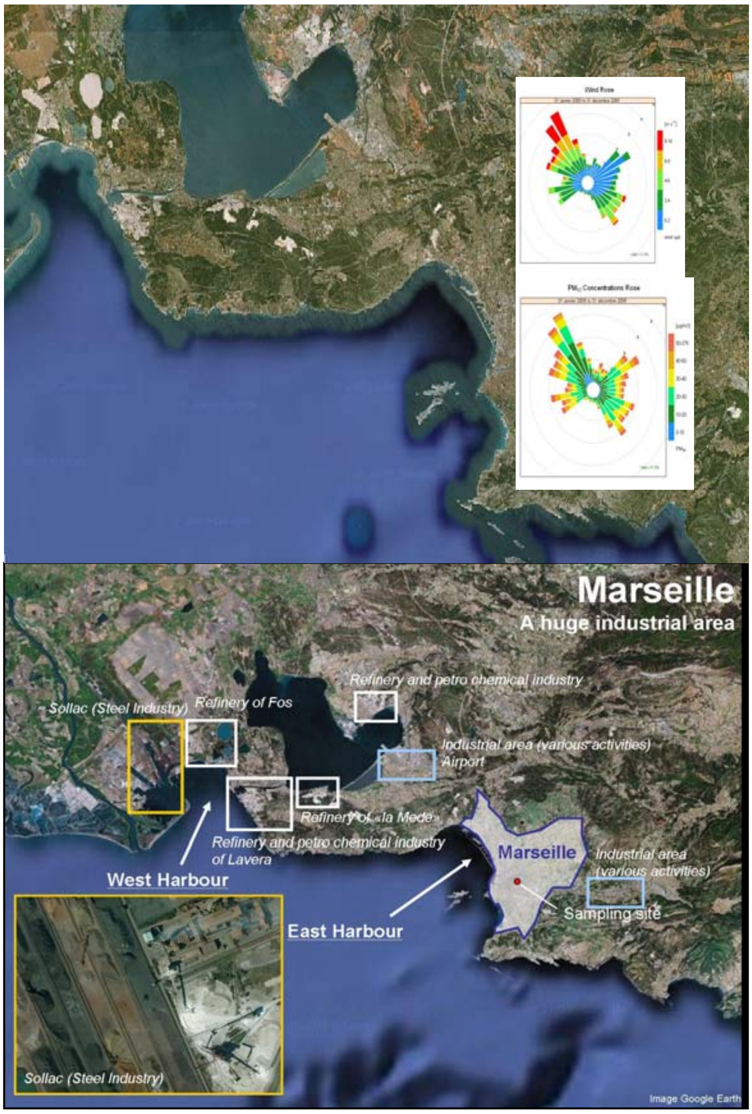

Figure 23: PM10 concentration rose (µg/m³, degrees) and wind speed rose (m/s, degrees) for year 2009 – Industrial activities in Marseille.

In **Venice**, the maximum values (>17m/s) for wind speed are observed during periods with prevailing north-northwestern wind and less often during periods with northern, northeastern and eastern winds. High values of wind speed were noticed (less often) with wind of all directions (fig24)

Concerning PM10, it is observed that their concentration levels are not very high. As it can be noticed, the most frequent wind direction which is North – North – East, is associated with relatively low concentrations. Also, north and west winds are associated with low concentrations as well. On the other hand, concentrations are higher when the wind blows from the North –East, East or South – East axis.

The station is located in the industrial area of Venice. This location is on the North –West side of the port. *Although the wind doesn't blow from the port towards the station very frequently, when it does relatively high concentrations are observed*. Nevertheless, we cannot draw a safe conclusion.

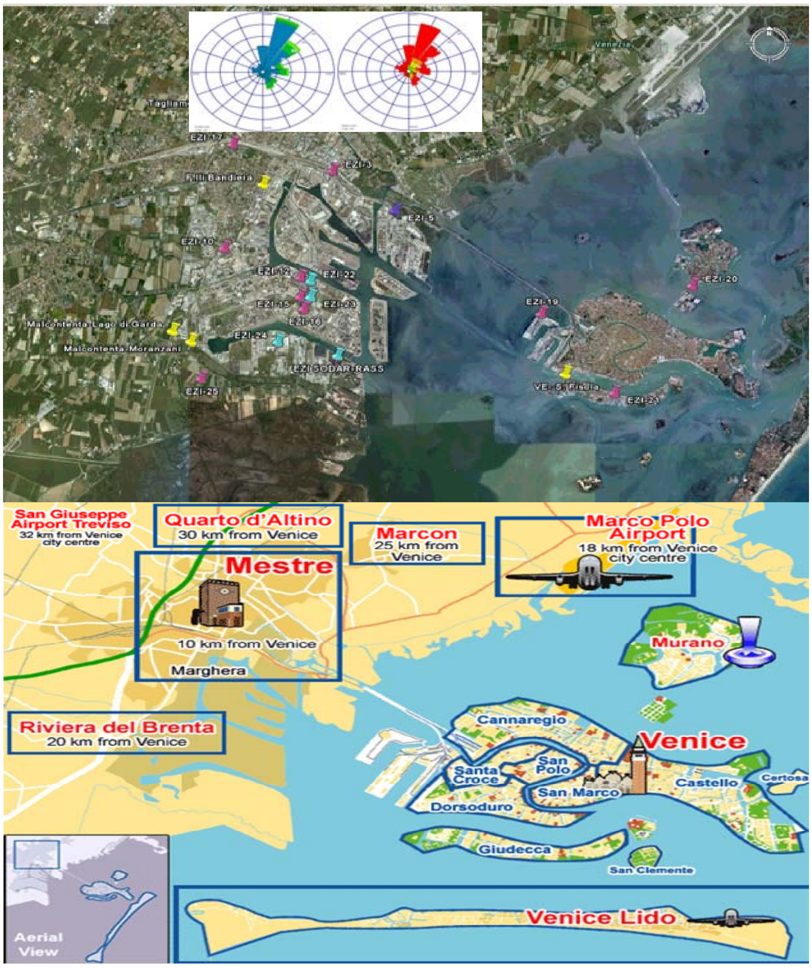

Figure 24: PM10 concentration rose ($\mu g/m^3$, degrees) and wind speed rose (m/s, degrees) for year 2009 – Industrial activities in Venice.

6. Discussion and A.P.I.C.E. contribution

Concluding, the present report aimed at briefly describing the air quality of five European port-cities: **Barcelona** (Spain), **Genoa** (Italy), **Marseille** (France), **Thessaloniki** (Greece) and **Venice** (Italy). Based on the air quality and meteorological data collected from the local networks during the last years, main conclusions have been drawn for each port-city. **The comparative study has focused on PM10 particles which is a pollutant with proven adverse health effects**. Additionally, special interest presents **the influence of the port on each city's air quality, under the prevailing meteorological pattern**.

The main conclusions for PM10 are summarized in the following:

In general, the main identified particles sources in (all or part of) the five cities are: **emissions from vehicles**, **buildings' central heating**, **human activity, construction activities**, **resuspension**, **African dust transportation, emissions from trucks and ships in the ports, emissions from industries in surrounding areas.**

The **maximum annual average concentration** was observed in Thessaloniki (42.5μg/m^3), followed by Venice (37.1μg/m^3), Barcelona (30.8 μg/m^3) and Marseille (29 μg/m^3). The minimum annual average concentration corresponded to Genoa (23.6 μg/m^3). The annual concentrations were *under the annual limit value* (40 μg m^{-3}) for all the sites except for Thessaloniki where it was slightly higher.

As noticed, the **highest monthly averages** are observed during different seasons in each city. It is important to note that the factors that contribute to particles levels include *permanent or seasonal sources*. During winter, *intense pollution episodes, central heating and bad operation of vehicle motors in starting because of the cold engine* can lead to elevated particles levels. During summer, *secondary particles formation, African dust episodes and enhanced resuspension processes* are reported as the main factors for high PM levels.

The common characteristic among the five cases is the ***decrease of particles levels during weekend due to reduced vehicles circulation and/or human activity***. In general, the highest PM10 daily values were observed in Thessaloniki while the lowest were observed in Genoa. The difference is reduced during weekend and especially Sundays, implying traffic as a significant particles source, affecting the port area. In general, it can be concluded that the **daily variation** of PM10 levels is strongly influenced by two factors: ***vehicles circulation/intense human activity and wind pattern of the area which affects pollutants accumulation or dispersion during day and night.***

Information for the particles' **chemical characterization** was not available from all the stations and from all the years. However, **mineral matter** which was strongly connected to coarse particles and *African dust transportation* was found higher during summer due to *resuspension processes*. **Organic** and **elemental carbon** and **nitrate** was observed to be higher during *winter pollution episodes*. On the other hand, **sulphate** was higher during summer as *photochemical reactions and summer recirculations of masses* over W. Mediterranean Sea occur (as noticed in Barcelona area). **Vanadium** and **Nickel** are connected with to *harbor emissions and industrial activities*, as Barcelona's and Genoa's data indicated. **Lead, Zinc** and **Cadmium** seem to originate from industrial emissions and metallurgical activities as reported from Barcelona and Marseille. Finally, **PAHs**, **Copper** and **Antimony** are associated with traffic emissions and winter pollution episodes.

Concerning other pollutants, common characteristics were observed (where available): As reported in all cases, **NO_2** mainly originates from *vehicles emissions* and is higher during periods with lower dispersive conditions (usually cold months). Furthermore, **NO_2** levels present morning and evening peaks, coinciding with *rush hours*. On the other hand, **SO_2** is connected to *shipping and industrial (petrochemical) emissions*. Data from Venice's port area indicate the *transit of the ships,* the *parking phase* as well as *coal power plants* and *urban waste incinerators* as the sources of **SO_2**. Barcelona's data show that maximum SO_2 concentrations correspond to periods with *sea breeze* occurrence or *pollution episodes*. Finally, **ozone** is reported to be lower in the city centre and higher at the surrounding areas (Barcelona, Marseille).

As meteorological conditions are concerned, the five sites present several similarities. Maximum **temperature** values are noticed during summer months, as expected while **relative humidity** present a variation during all year. The maximum values for precipitation correspond to winter and autumn seasons. The minimum precipitation is noticed during summer periods. On the contrary, the **prevailing wind (velocity and direction) pattern** differs significantly in every site, playing a crucial role to pollutants transportation.

The **meteorological pattern** of each season has a significant role too, as a *low dispersive atmosphere* leads to particles levels increase while *rainy (i.e. nucleation process) weather* can lead to significant levels' decrease.

Another factor, characteristic of near-the-sea areas is the presence of the ***sea breeze*****:** a mechanism that can lead to ***pollutants transportation from the port to the city*** or ***pollutants dispersion at the port site*****.** As reported in Barcelona's case, once again the stagnation of air masses over the area favours the accumulation of pollutants at an urban and regional scale. The higher intensity of the sea breeze in summer is evident in the lowering of the PM levels in the harbour area, more evident than in the urban background.

It is important to note that in each of the five cities, there are different factors that contribute to particles levels, including permanent or seasonal sources. Additionally each area's wind pattern plays a different but crucial role to pollutants dispersion,

accumulation or transportation. Up to now, only qualitative and indicative conclusions for the port's effect on the city's air quality can be drawn. More specified measurements, including particles chemical characterization and source apportionment studies in each area would fill this gap. A focused source apportionment study will be conducted in the frame of APICE project. The role of the ports emissions under the meteorological pattern of each area will be extensively examined.

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ANNEXES

A FRAMEWORK ANALYSIS

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.

1. 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 VI to the IMO's MARPOL Convention – was adopted in 1997. But even at the time of adoption it was widely recognized as being insufficient.

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.

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.

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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 6 and presented graphically in Figure 23. Tier I and Tier II limits are global, while the Tier III standards apply only in NOx Emission Control Areas.

Table 6: 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).

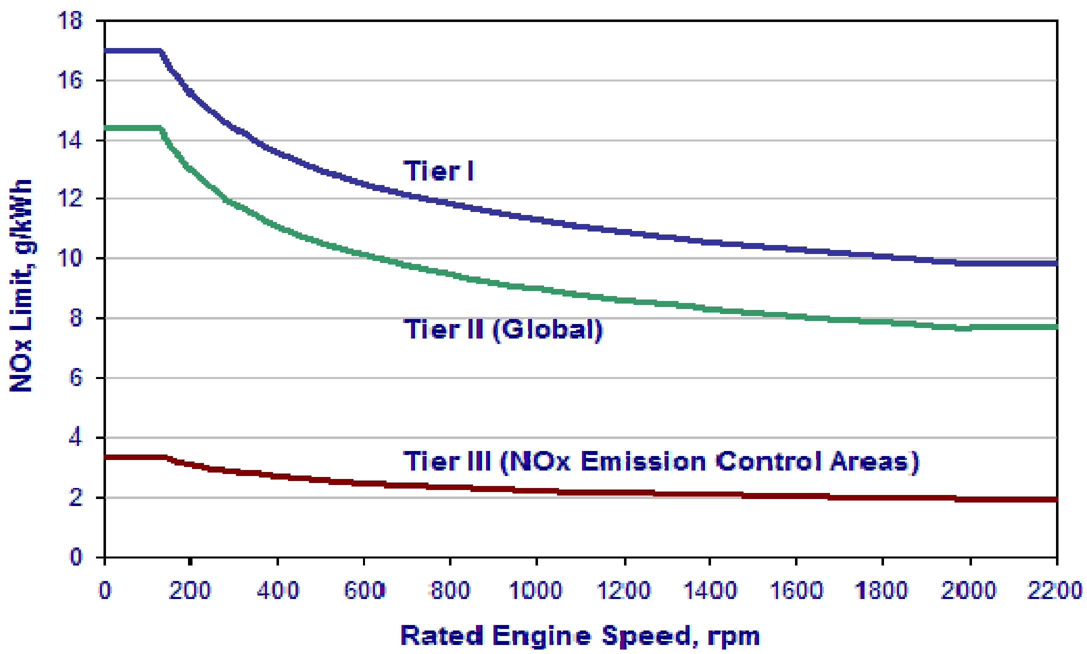

Figure 23: MARPOL Annex VI NOx Emission Limits

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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 between 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 19 and illustrated in Figure 24.

Table 7: 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

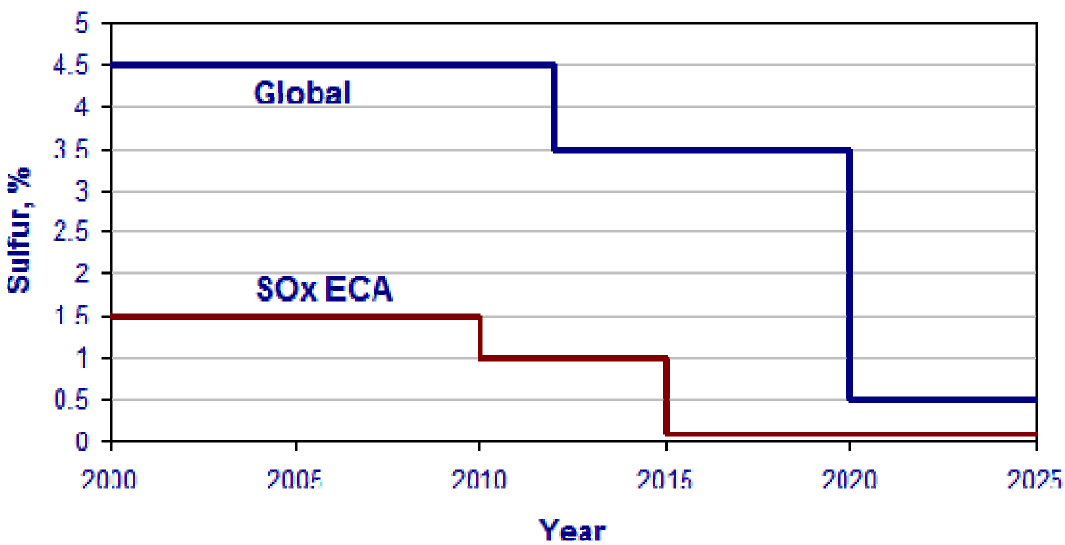

Figure: MARPOL Annex VI Fuel Sulfur Limits

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

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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.

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2. 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 STANDARDS

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.

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Table 8: 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 + 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*

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 9: 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	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

	µg/m3 (AEI)			

** 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.*

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.

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

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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.

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3. NATIONAL FRAMEWORK

Spanish legislative and normative framework regarding air quality and port management

Spanish legislative and normative framework regarding air quality

In Spain, the Law 34/2007 adopts provisions concerning air quality and environmental protection. This law aims at establishing the basis concerning prevention, control and reduction of emission of atmospheric pollution in order to avoid, and when this is not possible, diminish the damage to people, the environment and other goods originated by this pollution. The text of the law contains: object of the Law; extent of application; definitions; guiding principles; authority of public administrations; inter-administrative cooperation; obligations of persons responsible for facilities involved in activities potentially pollutant of the atmosphere; information to the public; evaluation and management of the air quality; prevention and control of emissions; planning; instruments of promotion of protection of the atmosphere; control, inspection, vigilance and follow-up; system of sanctions. It repeals the regulation of unhealthy, harmful and dangerous activities, approved by Decree 2414/1961 of 30 November 1961; Law 38/1972 of 22 December 1972, and annexes II and III of Decree 833/1975 of 6 February 1975.

The institution in charge of air quality is the General Direction of Environmental Quality and Evaluation within the Ministry of Environment. In particular, it is the National Authority for the National Inventory System of Pollutant Emissions to the Atmosphere.

Air quality legislated values

After the adoption of the Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe, Spain is working on a new royal decree to integrate the new regulations on new pollutants, such as the particulate matter with diameter ≤2,5 μm (PM2,5), and new requirements related to assessment and management of air environment quality. Although the directive should be incorporated into the Spanish legislation by 11th June 2010, the royal decree is still not passed.

Thus, the main legal instrument to establish the pollutants values is the Royal Decree 1073/2002 on the evaluation and management of the air environment quality concerning sulphur dioxide, nitrogen dioxide, oxides of nitrogen, particulate matter, lead, benzene and carbon monoxide, which incorporates into national legislation the Directive 96/62/EC, 1999/30/EC and 2000/69/EC. Further details on normative is provided at the following tables which summarize the air quality objectives by pollutant:

Table 10: National normative framework per pollutant

Sulphur dioxide (SO_2)

Reference values according to Royal Decree 1073/2002		
	Period	Limit value
Hourly limit value for human health protection	1 hour	350 μg/m^3 Not possible to exceed

		more than 24 times per civil year
Daily limit value for human health protection	24 hours	125 µg/m^3 Not possible to exceed more than 3 times per civil year
Limit value for ecosystems protection	1 civil year and winter period	20 µg/m^3
Threshold warning	1 hour	500 µg/m^3

Nitrogen dioxide and oxides of nitrogen (NO_2 and NOx)

Reference values according to Royal Decree 1073/2002		
	Period	Limit value
Hourly limit value for human health protection	1 hour	200 µg/m^3 of NO_2 Not possible to exceed more than 18 times per civil year
Annual limit value for human health protection	1 civil year	40 µg/m^3 of NO_2
Limit value for vegetation protection	1 civil year	30 µg/m^3 of NOx
Threshold warning	1 hour	400 µg/m^3

Particulate matter with diameter ≤10 µm (PM_{10})

Reference values according to Royal Decree 1073/2002		
	Period	Limit value
Daily limit value for human health protection	24 hour	50 µg/m^3 Not possible to exceed more than 35 times per civil year
Annual limit value for human health protection	1 civil year	40 µg/m^3

Benzene

Reference values according to Royal Decree 1073/2002		
	Period	Limit value
Annual limit value for human health protection	1 civil year	5 µg/m^3

Lead

Reference values according to Royal Decree 1073/2002		
	Period	Limit value

Annual limit value for human health protection	1 civil year	0,5 µg/m^3

Carbon monoxide (CO)

Reference values according to Royal Decree 1073/2002		
	Period	Limit value
Limit value for human health protection	Maximum daily 8 hours	10 mg/m^3

Ozone (O_3)

Reference values according to Royal Decree 1796/2003		
	Period	Limit value
Objective value for human health protection	Maximum daily 8 hours mean	120 µg/m^3 which can't be exceeded more than 25 days average every civil year within a 3 years period
Objective value for vegetation protection	AOT40	18000 µg/h·m^3 Average within a 5 years period
Long-term objective for human health protection	Maximum daily 8 hours mean within a year	120 µg/m^3
Long-term objective for vegetation protection	AOT40	6000 µg/h·m^3
Threshold warning	Hourly average	240 µg/m^3
Threshold to inform population	Hourly average	180 µg/m^3

Hydrogen sulphide (H_2S)

Reference values according to Decree 833/75		
	Period	Limit value
Semi-hourly limit value	Semi-hourly average	100 µg/m^3
Daily limit value	Daily average	40 µg/m^3

Chlorine (Cl2) and hydrogen chloride (HCl)

Reference values according to Decree 833/75		
	Period	Limit value
Semi-hourly limit value	Semi-hourly average	300 µg/m^3
Daily limit value	Daily average	50 µg/m^3

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Arsenic (As), cadmium (Cd), nickel (Ni) and benzo(a)pyrene

Reference values according to Directive 2004/107/EC from 31st December 2012	
Pollutant	Objective value
Arsenic	6 ng/m^3
Cadmium	5 ng/m^3
Nickel	20 ng/m^3
Benzo(a)pyrene	1 ng/m^3

National emission ceilings

The Directive 2001/81/EC on national emission ceilings for certain atmospheric pollutants aims at limiting emissions of acidifying and eutrophying pollutants and ozone precursors in order to improve the protection in the Community of the environment and human health against risks of adverse effects from acidification, soil eutrophication and ground-level ozone and to move towards the long-term objectives of not exceeding critical levels and loads and of effective protection of all people against recognized health risks from air pollution by establishing national emission ceilings, taking the years 2010 and 2020 as benchmarks, and by means of successive reviews as set out in Articles 4 and 10 of this directive. To this aim, it sets national emissions ceilings (the maximum amount of a substance expressed in kilotonnes, which may be emitted from a Member State in a calendar year) by 2010 for certain pollutants; in particular, for Spain, these are the ceilings:
NOx: 847 Kilotonnes
COV: 662 Kilotonnes
SOx: 746 Kilotonnes
NH_3: 353 Kilotonnes
In order to fulfill these ceilings, Member States must elaborate, revise and update national programs for progressive emissions reduction. Spain elaborated in 2003 its first National Program and later on the second National Program for Emissions Reduction (Resolution of 14th January 2008, of the General Secretariat for the Prevention of Pollution and Climate Change (BOE nº 25, 29.01.08). This plan includes a number of policies and measures related to port activity, such as the Strategic Plan of Infrastructures and Transport 2005-2020.

Spanish legislation on port and navigation management and air emissions

In Spain there are two institutions in charge of navigation and ports which are regulated by the Law 27/1992 and could play a role on air emissions management: the General Direction of the Merchant Navy of the Ministry of Public Works and State Ports of Spain.

The General Direction of the Merchant Navy

It is the competent body for general planning of maritime navigation and the Spanish civil fleet. In the light of the APICE project, two of its functions must be highlighted:
The prevention and fight against marine pollution from ships, boats and fixed platforms, as well as marine waters cleansing
The elaboration and proposal of sartorial normative, especially that coming from commentary regulations or from international organizations, internal legal advice and processing sanction proceedings. The coordination of the international activity of the General Direction of the Merchant Navy, especially related to the European Union and the International Maritime Organization.
For these functions, there are two General Sub directions concerned:
General Sub direction for Safety, Pollution and Maritime Inspection
General Sub direction for Maritime Normative and International Cooperation

Therefore, in terms of the APICE project, these sub directions have an important role to play.

State Ports of Spain

It is a Public Body dependent of the Ministry of Public Works with global responsibilities on the state ports system, in charge of the execution of the governmental port policy and the coordination and efficiency control of the port system made up of 28 Port Authorities (Port Authority of Barcelona, among them). The principal aim of State Ports of Spain is to ensure that the ports contribute efficiently to the economic development of the country. Supporting initiatives, ensuring the smooth functioning of procedures, drawing up plans and designing strategies of combined action and optimizing management efficiency are just a few of the functions carried out by the State Ports of Spain. This implies revising the port policy of the government and serving as intermediary between the ports and the central administration.
Regarding environment, takes responsibility in the environment protection through:
Controlling the compliance with environment legislation.
Promoting the development and review of the current Environment Policy of the port authorities through the implementation of Environment Management Systems and clean technologies in order to achieve the environment purposes established. Involvement in a continuous enhancement.
Increasing State Ports and port authority staff's awareness of environment problems through environmental programs.
Developing prevention strategies to face the pollution originated by operations and activities of State Ports. Analyze and promote the actions required to reduce the impact of these agents on the environment.

The Barcelona Port Authority, though working at a local level, has a character of national body since it is part of State Ports of Spain. Its mission consists in leading the development of the Port of Barcelona, to generate and manage infrastructures and to guarantee reliable services in order to contribute to clients' competitiveness and create value for society at large.

The Environment Service (Servei de Medi Ambient–SMA), as a part of the Barcelona Port Authority structure, is made up of a team of professionals prepared to offer a series of services related with the environmental vigilance. The objective of this vigilance is to contribute to the protection of the environment, with regard to the atmospheric environment (air), the aquatic environment (water) and the edaphic environment (land).

Other important objective is to offer to the concessionaire companies of the Port an advice service about the environmental subjects (licenses, ISO 14000, emissions control, etc.) in order to collaborate in the compliance of the requirements specified by the competent administration.

For the development of its objectives, the Environment Service (SMA) has its own resources (weather stations, automatic and manual pollutant analyzers, marine multiparametrical sound (CTD), water cleaner boats, antipollution barriers, etc.) and, in some cases, supervises the task of the contracted external companies.

The Environment Service of the Port of Barcelona has two different performances. On one hand, it offers to the port companies and to the different public entities the information related to the environmental data which are processed in the measuring stations of the Port of Barcelona, and on the other hand, it offers to the port companies an advice service on environmental subjects.

The vigilance of the air quality in the port environment is carried out through the measurement of the pollutants concentrations in the air and the study of its diffusion on the atmosphere.

In order to achieve this objective, the Environment Service (SMA) of the Port of Barcelona has been equipped with its own infrastructure which turns the Port of Barcelona into a territory with one of the densest atmospheric networks existing nowadays. This infrastructure is made up of a weather stations network, two measuring stations networks of environmental concentration, one manual and the other automatic, and a mobile unit.

The atmospheric problems in the Port have an additional importance because of its closeness to the city; there is a synergy between the two systems which causes that the vigilance of the air quality arouses too the interest of the local entities of public health and environment.

Specific national legislation regarding air emissions in ports and navigation

Spain deposited the Adhesion Instrument to 1997 Protocol to Marpol 73/78 Convention in 2004 (BOE núm. 251, 18th October 2004[1]). This protocol contains the regulations for prevention of air pollution from ships, and it is included as Annex VI of the Convention. The revised Annex VI entered into force on 1st July 2010.

[1] http://www.puertos.es/export/download/puertos/1115208118104.pdf

BARCELONA

Air Quality Plan in the Metropolitan Area of Barcelona

At the regional level, the competence on air quality is hold by the General Subdirection for Prevention and Control of the Atmospheric Pollution, within the General Direction of Environment Quality, Generalitat of Catalonia. In particular, it aims at:
Assessing air quality parameters through the Network of Vigilance and Prevision of Atmospheric Pollution
Reducing and preventing pollutants emissions
Elaborating plans when the air quality is not appropriated
In the light of the APICE project, it is of utmost importance to take into account the current air quality plan in the metropolitan area of Barcelona.
The Decree 322/1987, which develops the Law 22/1983, regarding protection of atmospheric environment, establishes that the zones where the admissible limit values are exceeded must be declared special protected zones, and medium and long term measures are needed in order to restore the air quality. Once the special protection zone has been declared, the Executive Board must pass an Action Plan that comprises the specific needed actions to restore the air quality.
In this context, the Decree 226/2006, of 23rd May, established Special Protected Zones of the Atmospheric Environment for the pollutants NO_2 and PM_{10} (see Figure 18 and 19). The Action plan for the air quality improvement, passed by Decree 152/2007, has been extended by Decree 203/2009 since many measures have not implemented, and the preliminary assessment of the air quality shows that EU objectives by 2009 will not be met.
The plan comprises 73 measures structured in the following areas: prevention (10), industrial (27), energy (4), road transport (6), maritime transport (8), air transport (3), domestic sector (4) and public awareness (11). The selection of the measures of the action plan has been done by the Interdepartmental Commission (promoted by the Department of Environment and Housing and composed by the departments of Territorial Policy and Public Works; Health; Innovation, Universities and Enterprise; and Interior and Institutional Relations and Participation, besides the Catalan Energy Institute and the Metropolitan Transport Authority) keeping in mind, in addition to the environmental efficiency criteria, the social impact, economic costs and whichever other factor that could has an impact on the measure, giving priority to the measures involving public administrations.
Concerning the port, the objective was to reduce 20% NO_2 and 10% PM_{10} through these measures:
Actions over the containers lorries fleet (environmental requirements)
Promotion of rail transport of goods
Electric supply for ships
Inner float ships renewal
Modification of Port taxes
Renewal of auxiliary loading and unloading machinery
Handling of dusty material improvement
Strategic plan for the reduction of the emissions in the port

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The Environment Service of the Barcelona Port Authority is the main responsible for the implementation of these measures and has reported yearly to the Generalitat on the progress. The degree of implementation varies from one measure to other, but remarkable achievements have been met.
The action plan includes the establishment of the Technical Office for the Plan Monitoring, attached to the General Subdirection for Prevention and Control of the Atmospheric Pollution. Its function is to follow-up the schedule and implementation degree of the measures regarding the emissions reduction and the impact on the air quality levels, through indicators, as well as to report about the Plan evolution and to prepare measures or actions proposal to fine-tune the initial measures.

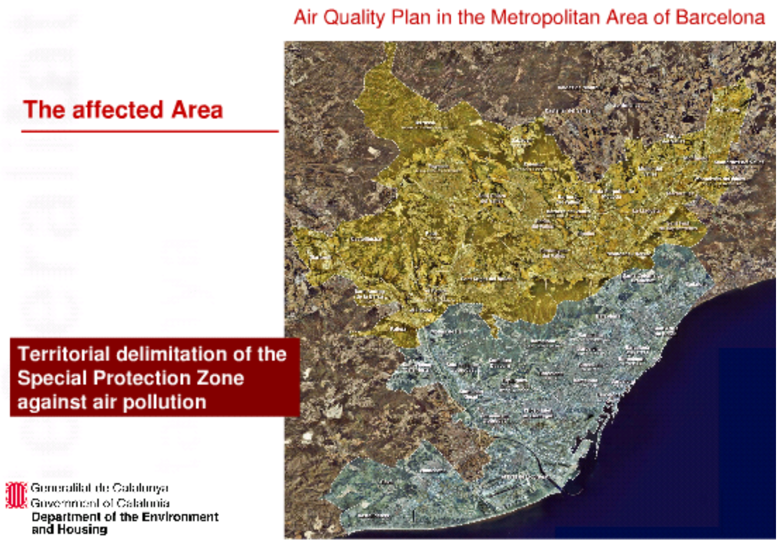

Figure 25: Special protection zone of the Atmospheric Environment for the pollutants NO_2 and PM_{10}.

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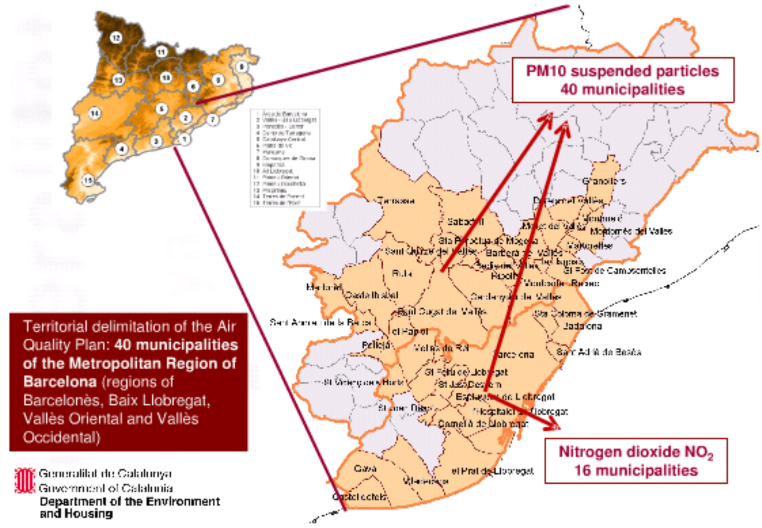

Figure: Territorial delimitation of the Air Quality Plan for NO_2 and PM_{10}.

FRANCE'S NATIONAL FRAMEWORK

The Environmental Code issue from the law n°96-1236 dated from December 30th, 1996 on *air quality and rational energy using*, acknowledges for each one to have a right to breathe a healthy air, aims to improve the air quality monitoring and to set up tools for regional plans (Regional Plan for Air Quality: PRQA) and local planning (Atmosphere Protection Plan: PPA, and Urban Transport Plan: PDU). These plans aim to assess air quality, to define and to evaluate with indicators the orientations/actions to reduce pollution levels. The National Plan for Health and Environment aims to define priority actions to reduce health effects in relation with environmental degradation. For air quality, the priority is for particles, pesticides, indoor environment, urban transport and the identification of overexposure areas. Several actions are interested by the reduction of emissions.
With the framework of this regulation, the State is in charge of the air quality monitoring and of health and environmental effects, with the collaboration of territorial authorities. The technical coordination of the air quality monitoring over the national area is performed by ADEME (Agency for the Environment and for Energy Control). In the regions, the set up of the air quality monitoring is given to approve organizations (French Approved Association of Air Quality Monitoring: AASQA).

FUTURE EVOLUTION ISSUE FROM THE "GRENELLE DE L'ENVIRONMENT"

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Thanks to a global approach for air quality, the legislative background knows an evolution due to parliamentary works[i] issue from the "Grenelle de l'environment".For example, future Regional Plans for Climate Air Energy integrate these three set of atmospheric problem as for Territorial Plans Climate Energy (PCET). So, the activities of AASQA should be involved in the evaluation of the contribution from regional to the global scale. Moreover, limit values have been decreed for the indoor air using as references for survey and action.

[1] *the equivalent of a conference with the participation of representatives of government, of professional associations and of nongovernmental organization*

MARSEILLE

AASQA monitoring strategy at the regional level has to be in agreement with the obligations and/or needs entrusted by their partners (State, local authorities, industrial companies, consumer or environmental protection associations and competent personalities), since their administrator board has acknowledged them with a global interest. For example:
State: besides commitments issue from national level, the specific needs linked with prefectural procedures for information and alert, with actions issue from different plans (PPA …).
Local authorities: specific needs and relative contributions for PRQA, PDU …
Industries: monitoring and environmental reports issue from prefectural order, global interest studies…
Associations: information and reply to preoccupations, information meetings …
PRQA (Regional Planning for Air Quality)
The development of the PRQA has been finished in 1999 and approved in 2000 without updating since. The following orientations are still topical: physical and chemical characterization of PM, sharing of tools and means between AASQA, monitoring of indoor and outdoor pollution and exposition of population.
PRSE2
(In progress) Examples of measures about «air»:

- Pesticide measures
- POP measures
- PM characterization, dispersion studies
- IAQ (indoor air quality) expert group, identification of IAQ priorities
- Evaluation of health impact of pollution
- Decision making tools

PPA (Atmosphere Protection Plan) by department
Bouches-du-Rhône: approved from 06/08/22, no specific orientation about air quality survey.
Alpes-Maritimes: approved from 07/05/23, plans different measures about air quality survey: set up of an olfactory pollution observatory, indoor air quality survey (also radon), and improvement of the monitoring in the hinterland.

Var: approved from 007/05/10, plans several measures about air quality survey: set up of an olfactory pollution observatory, measures of heavy metals and BTX for urban environment, indoor air quality survey, set up of a departmental emission inventory
Avignon: approved from 07/06/01, no specific orientation about air quality survey.
The whole PPA has to be review in 2011.

PREFECTURAL ORDERS
These orders define modes of public information for pollution peaks. Actually, these orders require a minimum of 2 sensors by activation area (expect for ozone in the Bouches-du-Rhône department where only one is sufficient).
02/08/02: prefectural order Bouches-du-Rhône NO_2 and SO_2
04/06/03: interprefectural order O_3
08/10/10: prefectural order Bouches-du-Rhône STERNES (Temporal system normative and regulation framework for sulphuric emissions). See part about sulphur dioxide for more details.
08/11/05: interprefectural order PM10

PDU (Urban Transport Plan)
Air pollution reduction is an objective for each PDU. However, these documents do not contain any measures about air quality monitoring and focuses their actions against nuisance.
Sophia Antipolis: approved from 08/05/01
Nice Côte d'Azur : approved from 08/01/28
Aix-Marseille:
Marseille Provence Métropole: approved from 06/02/13
Communauté du Pays d'Aix : approved from 05/06/24, cancelled by administrative court from 08/06/05
Pays d'Aubagne et de l'Etoile: approved from 19/07/06
Toulon:
Toulon Provence
Méditerranée: project non approved actually
Agglomération d'Avignon
Grand Avignon: project non approved actually

LOCAL REQUEST
A questionnaire has been subjected to Atmo PACA and AIRFOBEP members at the occasion of the redaction of the last PASQA, to know the point of view of local workers for action priority. Cartography is one of priority tools for the following years. Pollution maps are viewed as a tool of communication, awareness, explanation and decision making. Local authorities would like to develop modeling tools. These tools have to allow the set up of more precise maps, representing topical situation and also political development consequences for air quality (scenario).

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ITALY'S NATIONAL FRAMEWORK

VENICE

Green Port strategy

Environmental sustainability is one of the Venice Port Authority's main objectives, encouraging it to sponsor projects to cut the environmental impact of port operations on the city and the lagoon. This is particularly important for conserving the natural balance of this delicate city and its unique lagoon environment. Venice Port is part of the Association of North Adriatic Ports[ii] (Association dei Porti del Nord Adriatico, NAPA), which aims at improving potentialities, quality and efficiency of North Adriatic Ports system and infrastructures. One of the main objectives concerns environmental protection and quality.
Activities undertaken under the "Green Port" initiative focus of four main areas: air, water, soil and the city of Venice. With respect to air pollution, in addition to air quality monitoring and assessment, the port has started up a number of projects aimed at cutting dangerous emissions and promoting the use of alternative energy.
The projects aimed at safeguarding the air in Venice and the port environment also include efforts to save energy and to cut CO2 emissions, also using alternative energy sources. The projects are as follows:
Cold ironing: as a result of the cold-ironing project, ships will be powered from the quayside. This means that when at berth, ships do not need to keep their engines running to generate power;
Photovoltaic Park: the photovoltaic park will be erected in the areas directly managed by the Port Authority in Marghera and the Marittima station. The project will be implemented starting from the Marittima and will generate 2.5 Mwp (i.e. the energy needed by 800 families);
LED illumination: Starting from the Marittima station, the Venice Port Authority will be the first port in Italy to install LED spotlights to achieve a 70% saving compared to traditional illumination systems;
power plant resorting to algae as biomass: The algal power plant project is indeed a technological challenge as it implements zero impact solutions that are a worldwide novelty;
Assessment of ship emissions: the Port Authority has studied the extent to which transiting cruise ships impact the air quality in the city of Venice. State of the art methods and real-time measurements have provided broad understanding of the impact of ships on the air quality in the Port of Venice and have also enabled an assessment of impact reduction activities.

"Blue flag" environmental protection certification (2007)

Venice Blue Flag is a voluntary agreement aimed at reducing emissions and safeguarding the artistic and cultural integrity of Venice. Some Cruises adopted measures to reduce sulphurous anhydride (SOX) and nitrogen oxide (NOX) emissions, utilizing diesel fuel with a sulphur content not exceeding 2.5% during transit and stop off in the Venice Lagoon. This led to the signing of the Venice Blue Flag, a partnership between Cruises and the institutions of

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Venice aimed at preserving the artistic beauty of Italy's canal city. The agreement gives place to the environmental protection certification call “Venice Blue Flag”.
Shipping Companies awarded with “Blue Flag 2007” were: Aida Cruise, Carnival Cruise Line, Costa Crociere, Cunard Line, Holland America Line, Ocean Village, P & O Cruises, P & O Cruises Australia, Princess Cruises, Sea bourn Cruise Line, Pullmantur Cruises, Elegant Cruises and Tours, Crystal Cruises, Regent Seven Seas Cruises, SeaDream Yacht Club, Virtu Ferries, MSC Crociere, Anek Line, Iberojet Cruceros, Island Cruises, Louis Cruises Lines, Marina Cruises Company, Norwegian Cruise Line, Oceania Cruises, Orient Lines, ResidenSea, Saga Shipping, Silversea Cruises, Royal Caribbean International, Celebrity Cruises.

Port Authority Ordinances

Ordinance No. 18 of 30/09/1996, Safety rules for "open loop" filling in of diesel machines by truck in the operational area.
Order No. 30 of 18/03/1997, Rules for the handling of bulk chemical origin of mineral.
Order No. 85 of 04/10/1999, Emergency Procedures for the Port of Venice.
Order No. 104, 29/08/2000, Safety for the “open loop” supply toof oil to the production machinery in the port operational areas by truck and on board ships by tanks.
Planning tools
Veneto Region, Regional Territorial Masterplan (Piano Territoriale Regionale di Coordinamento, P.T.R.C.), Report, Veneto Region Council, decree No. 372 of 17/02/2009.
Province of Venice, Provincial Territorial Masterplan (Piano Territoriale di Coordinamento Provinciale di Venezia, P.T.C.P.), Provincial Council, Decree No. 2008/104 of 05/12/2008.
Veneto Region, Regional Plan of Conservation and Restoration of the Atmosphere (Piano Regionale di Tutela e Risanamento dell'Atmosfera, P.R.T.R.A.), 2004.