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## Chapter 9

# Urban Quality Assessment at the Neighborhood Scale: An Experimental Approach

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### **ABSTRACT**

*This chapter describes the approach adopted within the framework of a multi-destination development project; the goal of which is to promote innovative technologies and methods to evaluate the environmental quality of an urban district under construction. This method of analysis has been tested on an area located in the former historic district of the Fiera di Milano, where a series of typical urban functions are inserted within a large public park. The success of the work is represented by indicators (air quality, acoustic, microclimate) that relate to the finished district and that can be compared with average values in the same city. The system may constitute a protocol capable of bringing benefits to local authorities. This type of assessment could be requested of developers/builders for complex projects, resulting in changes to the initial plan if the assessment identifies critical issues related to the design choices (orientation of buildings, green areas, traffic emissions, etc.) with the ultimate goal of creating neighborhoods with better environmental conditions.*

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## **INTRODUCTION**

The assessment of urban quality in the European current practice is carried out following legislative requirements or international standards: the Strategic Environmental Assessment (SEA) and the Environmental Impact Assessment (EIA) are the most widespread environmental impact assessment systems at European and Italian level.

SEA is a decision making support process whose main goal is to estimate the environmental effects of plans and programs before their approval (ex-ante), during their implementation and at the end of their period of validity (ex-post). Currently, the SEA is applied in Italy in fields (ex. articles 6 and 7 of Legislative Decree no. 152/2006), such as: water management, telecommunications, tourism, town and country planning or land use. It also supports the planning process at a large scale (at city, regional, national level, etc.).

EIA is referred to the design and authorization of specific projects, even at territorial scale, and aims to assess their environmental impacts (i.e. the changes in status of the environmental components) normally linked to an authorization process.

These evaluations have a static character and do not consider the interaction of several variables and how they react in relation to changes caused by external factors. In particular, in the case of interventions for new developments (greenfield) or re-development (brownfield): construction of new districts, re-functionalization of old industrial buildings, processing of degraded parts of the city, which in the context of environmental assessments are considered interventions at a microscale, no practical tools are available supporting the analysis of the consequences due to design choices and the actions needed accordingly.

As the design activity is affected by the lack of an integrated view (Malatras, Asgari, Baugè, & Irons, 2008), in the current practice the interventions are conducted by specialists and are the sum of specific contributions and not the best result of a real and effective integration of skills. A real integration can only be realized if we can systematize the process of assessing, checking and evaluating the results of the different contributions.

Useful tools are more and more being adopting, especially at regional level, such as atmospheric models, that can now reliably reproduce the spatial distribution of concentrations of air pollutants and therefore are used extensively, for example in the preparation of the annual report on air quality or in the planning and evaluation of limitation measures.

The planning of measures for the remediation of ambient air quality is therefore up to now carried out at the regional scale (e.g. incentives for markets of cleaner technologies) or urban scale (e.g. pollution charge for accessing low emission zones), but little is worked out at the finer scale of a district, also because of the supposed lack

of operating analytical tools; the perception, on the part of authorities, planners and citizens, that the climate may be somewhat influenced by urban planning at district scale, is still weak. This theme is generally regarded as pertaining to a global scale - obviously the most appropriate - and operations such as a SEA of a neighbourhood tend to contribute to the theme with the quantification of the contributes to global greenhouse gas budget (Roper, & Beard, 2006).

However, assessment tools are now available able to clarify the role of the planning of actions to the scale of neighbourhood on local climate. The nearest instrument to this approach currently existing is the LEED neighbourhood protocol (Leadership in Energy and Environmental Design), the American rating system for the design, construction and operation of high performance green buildings, homes and neighbourhoods. The main weakness of this protocol lies in the fact that it originates in a territorial context deeply different from the European and some of the indicators are not very applicable to the Italian and European context (for example, the protocol positively considers urban density, while in the Italian context, very densely built, high quality housing developments are characterized by low density spaces and greater distances between buildings).

Understanding how the design of the neighbourhood affects the local microclimate is not an end to itself, if we think, for example to the increase in hospitalizations and deaths that usually occurs at extreme temperature events because of summer heat waves, events more and more frequent, at European latitudes, because of the climate change: the introduction of urban design elements that reduce the air temperature even just a few degrees would improve not only the wellbeing state of the neighbourhood inhabitants but also their health (Lee, & Chan, 2009). In this sense, also the improvement of micro-climate must be considered within a protocol aimed at quantifying the design good practices and, as demonstrated by tests carried out by the working group on CityLife district of Milan, tools to quantify changes in the microclimate induced by different design solutions at the neighbourhood scale are now available.

## **FINDINGS AND METHODS**

A new approach, which aims to simulate through specific modelling the constructions and development projects, could be able to give concrete suggestions to improve their quality and, above all, really contribute to an improvement in citizens' quality of life. This goal can be achieved only by identifying indicators that can be assessed in an integrated way and suggesting corrective actions/modification and/or integration of the projects.

### ***Urban Quality Assessment at the Neighborhood Scale***

The project team<sup>1</sup> received in 2012 a private commission, requiring to assess the environmental performances of a large urban project in the City of Milan: the CityLife district.

The work is focused on 3 main areas of research:

1. Three-dimensional rendering of the project area and its surroundings;
2. Measurement of air quality and wellbeing of the microclimate in the finished district, through specific modelling;
3. Measurement of acoustic comfort in the finished district, through specific modelling.

In particular, the parameters related to air quality, acoustic comfort and well-being of the microclimate were compared with an area similar to that of the project analysed.

The approach investigated aims to simulate, through specific modelling, the construction and development projects. It could be able to give concrete suggestions to improve their quality and, above all, really contribute to an improvement in citizens' quality of life. This goal can be achieved only identifying indicators that can be assessed in an integrated way and suggesting corrective actions/modification and/or integration of the projects.

Before the works were carried out, in collaboration with the client, with Milan Council and a series of satellite image display tools, information and data were collected in relation to the project based on a checklist prepared by the work group, with particular reference to:

- Technological solutions, plants and buildings that characterise the features of the urban district CityLife;
- The district's green spaces and parking system;
- The transport system and infrastructure within the urban district CityLife and the network to connect it with the city;
- The services in the area, etc.

The success of the work is represented by specific indicators (air quality, acoustic performance and microclimate) that relate to the district, considering it completely built, and that can be compared with average values in other context within the city. For this reason, it was necessary to model the neighbourhood (in 3D to see it completed) and dynamically simulate all external factors (vehicular traffic, general neighbourhood activity, pollutant emissions, etc.) corresponding to the different seasons.

This system may constitute a protocol able to bring benefits to local authorities; in fact, this type of assessment could be requested of developers/builders for complex projects, resulting in changes to the initial plan if the assessment identifies critical issues related to the design choices:

- Orientation of buildings;
- Quality and presence of green areas, and;
- Traffic emissions inside the urban district, etc.

with the ultimate goal of creating neighbourhoods with better environmental conditions.

## **THE CITYLIFE PROJECT**

This approach of analysis has been tested on an area of about 255.000 square metres, located in the former historic district called “Fiera di Milano”, where a series of typical urban functions (residential, commercial and trade) are inserted within a large public park.

CityLife is the company committed to redeveloping the ex-historical district of the Fair in Milan. This area, free by the move of the Fair plant in Rho-Pero zone, has been object of an international tender of urban qualification, that has involved companies, financiers and great names of the international architecture. The contest winner was CityLife, with a project signed by Zaha Hadid, Arata Isozaki and Daniel Libeskind. CityLife has assured the realization of the plan thanks to a shareholder, participated by 2 main insurance groups in the world: Generali Real Estate and Allianz. The Project started in 2009 and It will be completed in 2023.

The residential buildings designed by Hadid are characterised by:

- 5-13 floors;
- Energy Class A;
- 225 housing units;
- 700 living residents (700);
- 35.000 square metres of Gross Floor Area.

The residential buildings designed by Libeskind are characterised by:

- 4-13 floors;
- Energy Class A;

### ***Urban Quality Assessment at the Neighborhood Scale***

- 382 housing units;
- 1.000 living residents;
- 50.000 square metres of Gross Floor Area.

In the area of the project there are 3 towers, one of which is the tallest in Milan.

Hadid tower is characterised by: 170 metres high, 44 floors (39 floors for office spaces), 3.200 people and it was pre-certification LEED with result gold.

Libeskind tower is characterised by: 150 metres high for office spaces and about 2.000 people.

Isozaki tower is characterised by: 202 metres high (infact it is the tallest tower in Milan), 50 floors (46 floors for office spaces), 3.800 people and it was pre-certification LEED with result gold.

Trading area, in the centre of the project, is characterised by:

- A subway stops called M5, it is the fifth subway line of Milan, the violet line;
- 20.000 square metres of Gross Leasable Area;
- About 100 stores;
- Three sectors:
  - The gallery in the middle of 3 Tower square, with the most important brands;
  - The gallery in the place of underlying square, with a mix of shops and public utility services;
  - The external square, which are surrounded by coffee shops and restaurants.

## **THE IMPLEMENTATION OF A SYSTEM, REGARDING THE ENVIRONMENTAL PERFORMANCE ASSESSMENT FOR URBAN DISTRICTS**

### **Three-Dimensional Rendering of the Project Area and Its Surroundings**

In order to carry out the work, the project area and the area for comparison were rendered in 3D using a shape file, a file containing a plan of building perimeters with their height as an associated attribute. Thanks to the collaboration with the owners and the use of satellite and map image display tools, all necessary data for the three-dimensional rendering were collected, mainly in reference to building perimeters and heights, road networks, green areas, etc.

Starting from the shape file previously developed, the three-dimensional topography was created at high resolution (to the order of one metre) of the land and buildings of the project area and of the area for comparison, nearby and not more than 1 km away.

The software used were:

- Micro Swift Spray for the measurement of the air quality;
- ENVI-Met 3.1 for the measurement of Wellbeing;
- CATT ACOUSTIC for the measurement of acoustic comfort.

The three-dimensional rendering of the project area and its surroundings is shown in Figure 1, Figure 2, and Figure 3.

### **Microscale Assessment of Microclimate Wellbeing and Air Quality in the Urban District CityLife for the Purpose of Comparison With Average Values**

The objective of this phase is the development of specific micro-simulations to assess the benefits contributing to the wellbeing of the microclimate and air quality at a local level in the CityLife project simulating traffic issues and heating. The aim is to compare the results with another district in Milan, Garibaldi district. To do this was used the Model Micro-Swift-Spray (MSS), which allows the microscale reconstruction of pollutants spread into the atmosphere.

*Figure 1. The three-dimensional rendering of the project area and its surroundings*



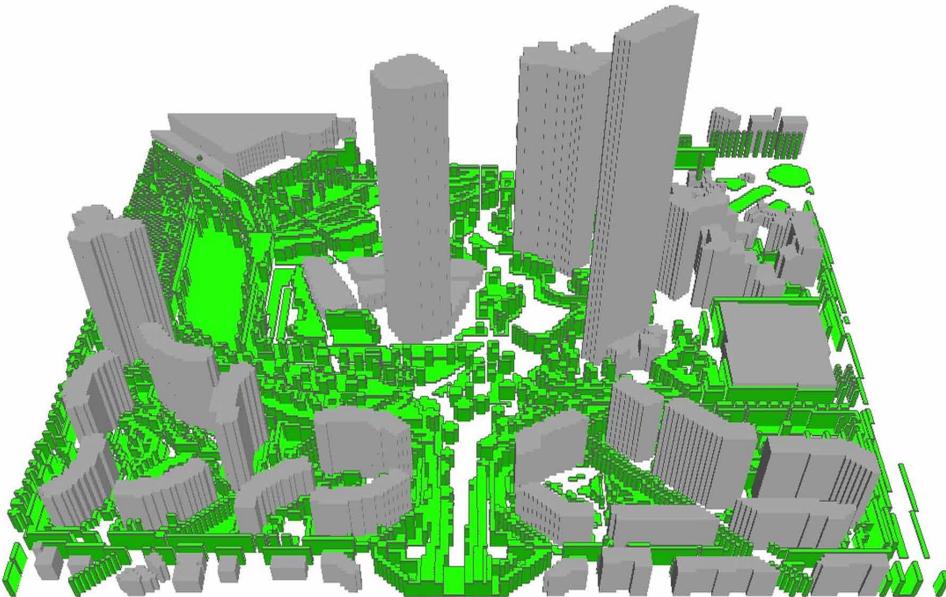
**Urban Quality Assessment at the Neighborhood Scale**

*Figure 2. The three-dimensional rendering of the project area and its surroundings*



*\*For a more accurate representation see the electronic version.*

*Figure 3. The three-dimensional rendering of the project area and its surroundings*



*\*For a more accurate representation see the electronic version.*

A number of parameters have been identified to represent the district in terms of wellbeing, comfort and quality and compared with another district in Milan, which was urbanised in a more traditional way. These parameters refer to practices adopted by individuals and institutional sources for the representation of environmental/urban quality (i.e. “*Report on the State of the Environment in Lombardy*”, ARPA Lombardy, “*Quality of the Urban Environment*” ISPRA; “*Urban Ecosystem*” Legambiente, etc.).

In particular, the calculations made allow us to:

- Quantify the benefits, from the viewpoint of air quality, of the solutions adopted in the urban district project compared to those estimated within a more traditional urban context;
- Highlight the major / minor environmental critical points of the district (relative to air quality and microclimate) transmitting, if necessary, the design choices that are still works in progress (ideal location of cycle and pedestrian paths, play areas, public transport stops, etc.).

The steps of this phase are:

- Selection of the weather-dispersive episodes and weather simulations;
- Definition of the pollution sources and calculation of emissions;
- Study of air quality in microscale;
- Study of the microclimate;
- Study of acoustic comfort, and;
- Comparison with the sampling area.

### **Selection of the Weather-Dispersive Episodes and Weather Simulations**

Simulations were carried out considering two episodes lasting one-two days each, chosen from those typical and / or critical from a weather / dispersive viewpoint for the city of Milan. To select these episodes (winter and summer) one year of meteorological data obtained from a weather station of the regional network were analysed, significant with respect to the location of the project district.

Simulations were carried out on January 29<sup>th</sup>, 2010 for winter meteorological episodes. In this period:

- Mean wind speed is 2-3 metres per seconds, and;
- Wind direction is East and West.

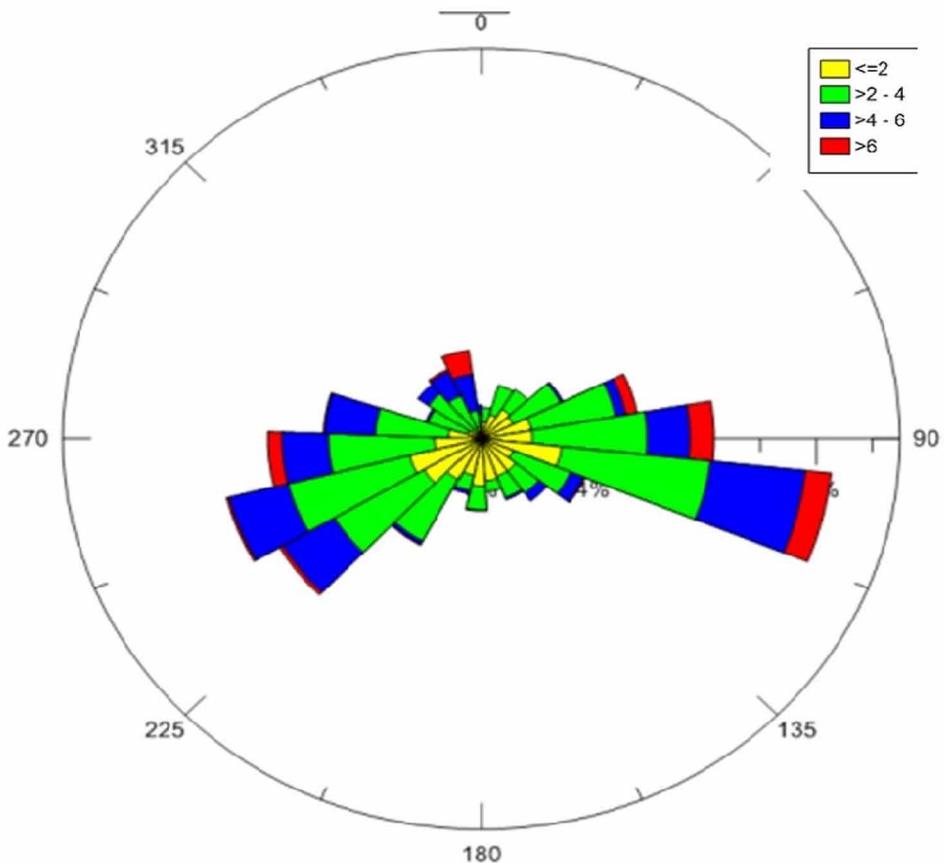
### Urban Quality Assessment at the Neighborhood Scale

The other simulations were carried out on 12th July 2010 for summer meteorological episodes. In this period:

- Mean wind speed is 3 metres per seconds, and;
- Wind direction is North-NorthWest.

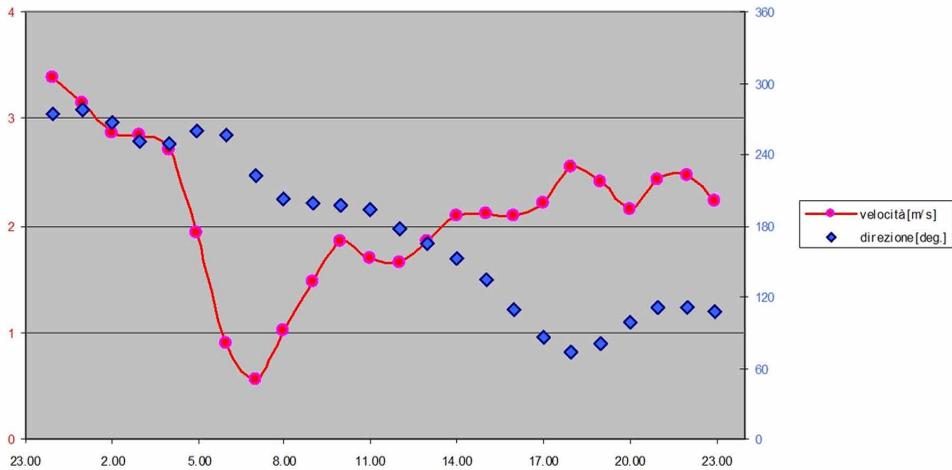
Taking the precise meteorological time series as the starting point, simulations were performed to reconstruct wind fields and turbulence for the area in question, in relation to the two selected episodes.

Figure 4. Selection of simulation period: winter simulation period: 29 January 2010 (wind 0 speed and direction)



\*For a more accurate representation see the electronic version.

Figure 5. Selection of simulation period: winter simulation period: 29 January 2010 (wind 0 speed and direction)



## Definition of the Pollution Sources and Calculation of Emissions

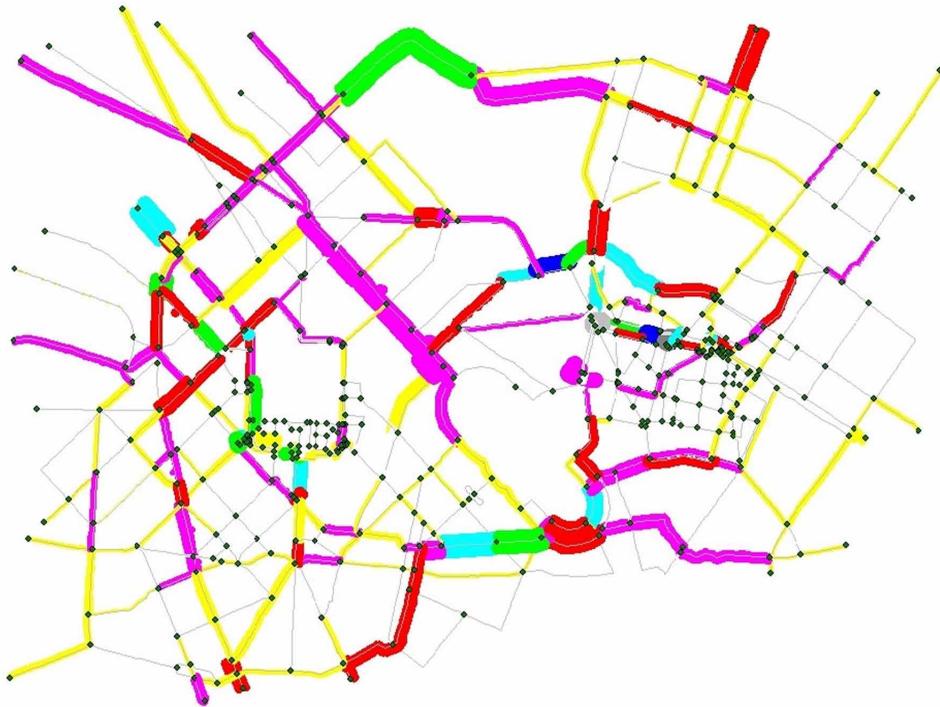
Once the location and characteristics of the sources of air pollutants present were defined (roads, parking areas, power plants, etc.) the corresponding polluting emissions were calculated using standard methodologies at European level documented in *EPER/EEA Air Pollutant Emission Inventory Guidebook*.

Once the location and characteristics of the sources of air pollutants were defined (roads, parking areas, power plants, etc.) the corresponding polluting emissions were calculated. The pollution sources are:

- Road traffic;
- Underground road traffic: (only for CityLife area). The emissions were calculated through metal grids, and;
- Heating: calculated only for winter case.

In regard to the road traffic, emissions ( $\text{CO}$ ,  $\text{NO}_x$ ,  $\text{VOC}$ ,  $\text{N}_2\text{O}$ ,  $\text{NH}_3$ ,  $\text{SO}_2$ ,  $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{Pb}$ ,  $\text{PM}$ ,  $\text{Pb}$ ,  $\text{HM}$ ,  $\text{NMVOC}$ ) were calculated using the program TREFFIC, developed on the basis of the most up-to-date methodology COPERT (*Computer Program*

*Figure 6. A traffic allocation model*



*\*For a more accurate representation see the electronic version.*

to Calculate Emissions from Road Traffic). The work group has been involved in developing the distribution of vehicles in the COPERT categories on the basis of national data of registered vehicles and average distance travelled.

In regard to the road traffic, CityLife also provided data related to the traffic attracted/generated by the new functions. The emissions produced by the vehicles in the parking lot are linked to the heating metal grid emissions. In particular, there are 6 points of access of the traffic flows to the urban road. Finally, in regard to the heating emissions, all activities were:

- Calculation of the volumes;
- Individualization of the building function of (residential, not residential, tertiary, etc.);
- From System Informative Regional Energy Environment carved out the typology of fuels in the city of Milan are used for heating and air conditioning (different for tertiary and residential sector);

- From site CESTEC (Center for the Technological Development, the Energy and the Competitiveness) was collected the middle values of primary energy requirement for the winter climatization, and;
- Calculation of the requirement in cubic metre (for built typology).

The simulations, representing a winter situation and a summer situation, take into account the contributions of both the city's local and background emissions.

## **Study of Air Quality in Microscale**

Through the use of the Model MSS - Micro-Swift-Spray, which allows the microscale reconstruction of diffusion of pollutants into the atmosphere, up to four simulations have been performed, varying the two domains and the two weather-dispersive episodes.

A number of parameters have been identified to represent the district in terms of air comfort and quality. They are:

- **Nitrogen Dioxide (NO<sub>2</sub>):** Due to thermal power stations, domestic heating, gasoline and diesel cars.
- **Dust Particles (PM<sub>10</sub>):** Due to industrial activities (foundries, cement plants, constructions sites and mines), combustion processes relating to thermal power stations, traffic, tyre wear and wear of the brakes.
- Benzene.

In this way maps of the relevant concentration statistics were generated and comparisons made between domains and between episodes. The simulations, representative of a winter situation and a summer situation, take into account both the contributions of both the city's local and background emissions. In the following maps are represented the simulation of the pollutants in winter and summer in the project CityLife (Figure 7 and Figure 9) and in the area for comparison (Figure 8 and Figure 10).

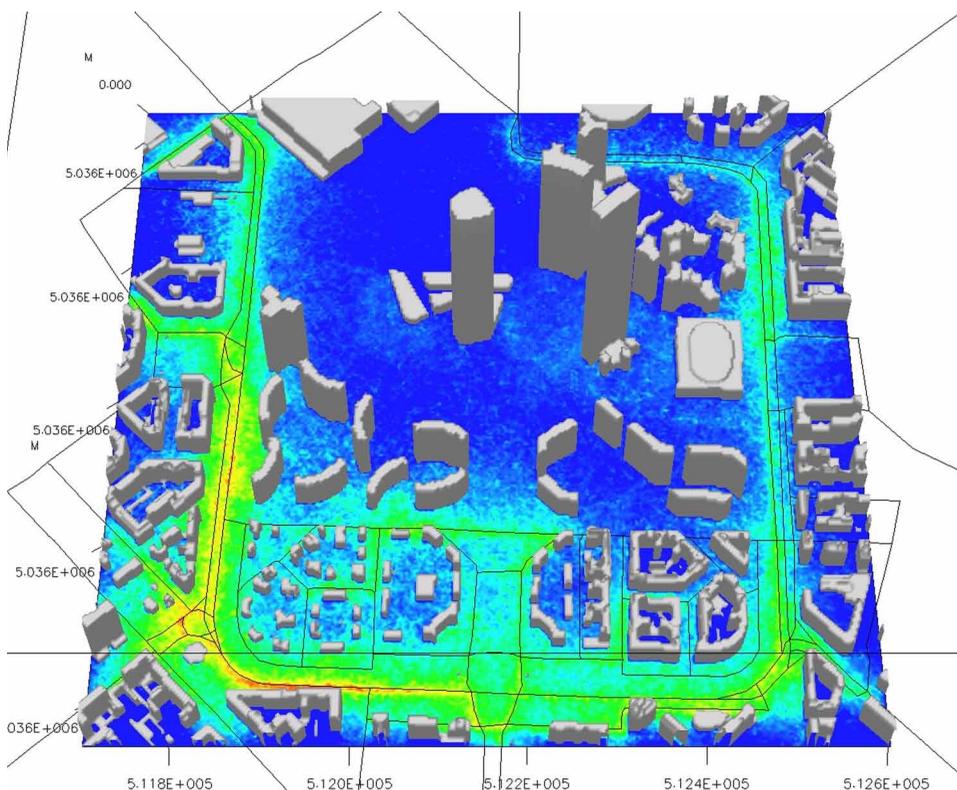
In the following maps you can see the contributions of Nitrous Dioxide (NO<sub>2</sub>) and Dust Particles (PM<sub>10</sub>) concentrations with winter coming from the following emission sources: traffic (Figure 11), metal grids (Figure 12) and heating (Figure 13).

The simulations conducted on vertical section allows to:

- Monitor the development to the upper sections of concentrations, simulating what people can breathe in/or the air input flows into the apartments, and;
- Give an estimate of the vertical decadence of the concentrations.

## Urban Quality Assessment at the Neighborhood Scale

Figure 7. Maximum hourly concentration of Nitrous Dioxide (NO<sub>2</sub>) – Summer case



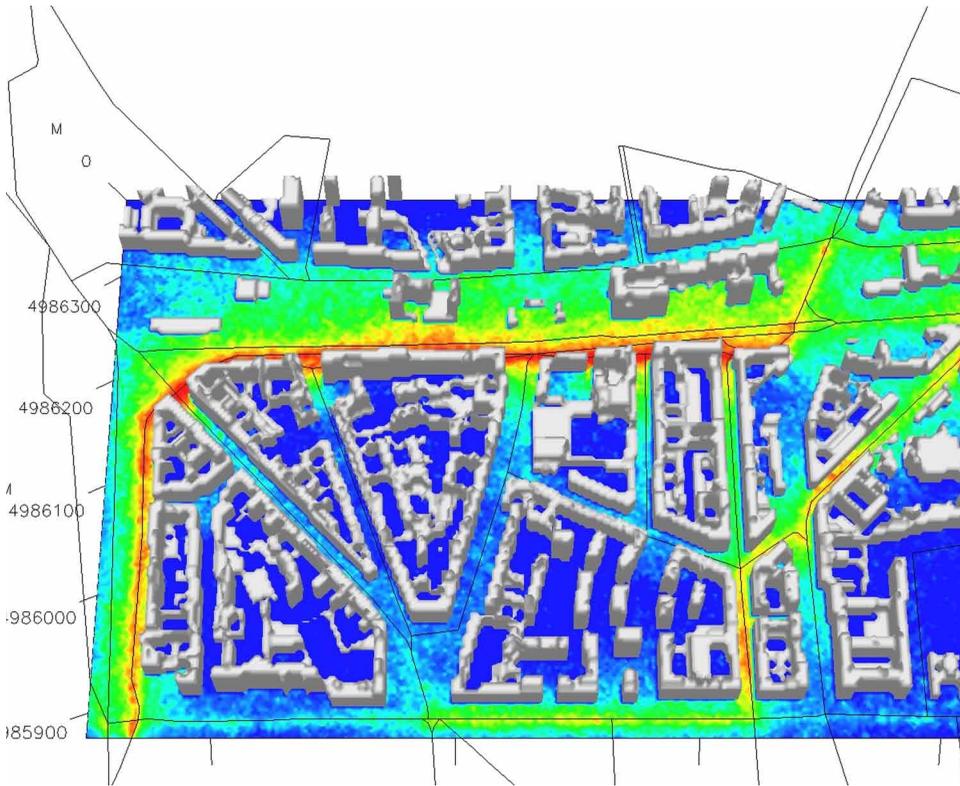
*\*For a more accurate representation see the electronic version.*

In CityLife district, near to the residential area, at 35-40 metres from the ground, the concentrations of Nitrous Oxide (NO<sub>x</sub>) are approximately one third of those at the ground. In Garibaldi significant environmental impact has been calculated in the canyon areas and also upstairs, at 35 metres from the ground. Here the concentrations of Nitrous Oxide (NO<sub>x</sub>) are one sixth of those at the ground.

In conclusion of this phase we can say that:

- The pollution of CityLife is better than in the area for comparison;
- Air pollution levels are affected by the fact that the district is situated inside the city;
- The concentrations of nitric oxide (NO<sub>x</sub>) in CityLife are better than in Garibaldi: the percentage of improvement is 15% in winter and 40-50% in summer.

*Figure 8. Maximum hourly concentration of Nitrous Dioxide (NO<sub>2</sub>) – Summer case*



*\*For a more accurate representation see the electronic version.*

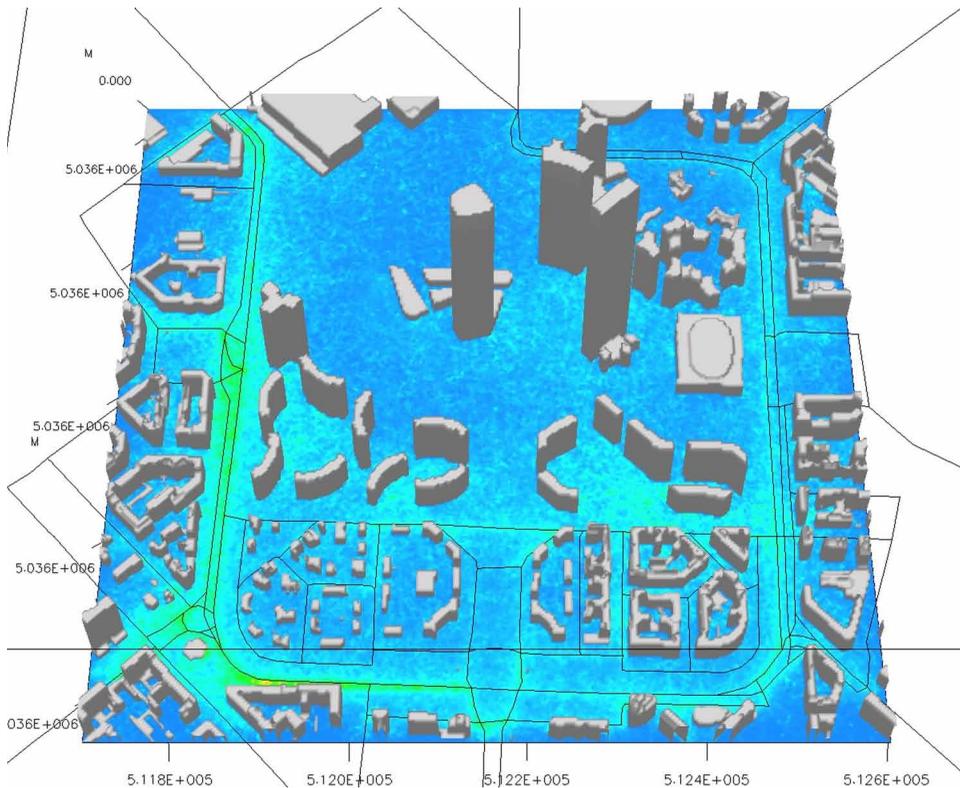
- The percentage of improvement for Dust Particles (PM<sub>10</sub>) is lower than Nitric Oxide (NO<sub>x</sub>). They are: 5-6% in winter and 25-30% in summer.
- The levels of pollution in CityLife are superior for the zones which look out the lot and smaller in the lot.

## **Study of the Microclimate**

Through the use of ENVI-met, three-dimensional model of the microclimate designed to simulate the surface-plant-air interactions in an urban environment, modelling studies were conducted for the reconstruction of the microclimate in the presence of the architectural elements characteristic of the urban intervention in question and of that used for comparison. The simulations conducted for the microclimate study take into account some initial parameters, in particular:

## Urban Quality Assessment at the Neighborhood Scale

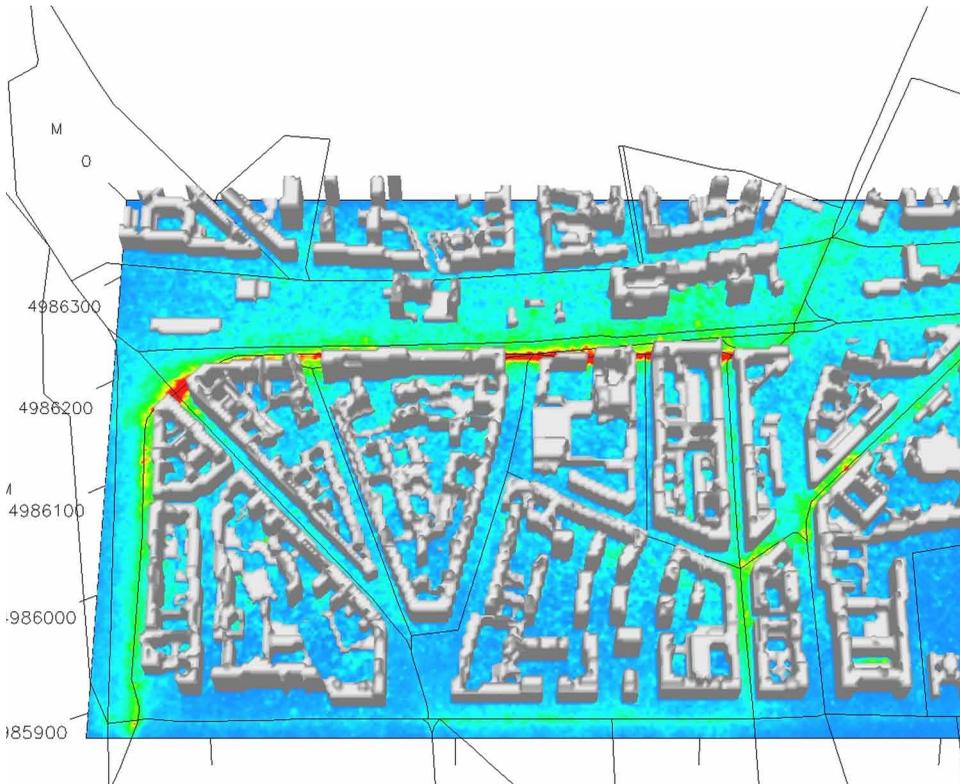
Figure 9. Maximum hourly concentration of Nitrous Dioxide (NO<sub>2</sub>) – Winter case



*\*For a more accurate representation see the electronic version.*

- In winter:
  - The simulation was carried out in 10 January two thousand and ten (2010);
  - In this period the temperature is two hundred and seventy-five point five degrees' kelvin (275,5);
  - Relative humidity at 2 metres from the ground is 81%;
  - Cloud cover is none;
  - Wind speed is 3 metres per second;
  - Wind direction is three hundred and thirty-seven point five degrees (337.5).
- In summer:
  - The simulation was carried out in 10 July two thousand and ten (2010);
  - In this period the temperature is two hundred and ninety-seven degrees' kelvin (297);

*Figure 10. Maximum hourly concentration of Nitrous Dioxide (NO<sub>2</sub>) – Winter case*



*\*For a more accurate representation see the electronic version.*

- Relative humidity at 2 metres from the ground is 66%;
- Cloud cover is none;
- Wind speed is 3 metres per second;
- Wind direction is three hundred and forty-seven point five degrees (347.5).

These were chosen based on the series of climatic conditions measured at Linate (Milan) weather station and, with regard to the wind, on simulations of the national project QualeAria.

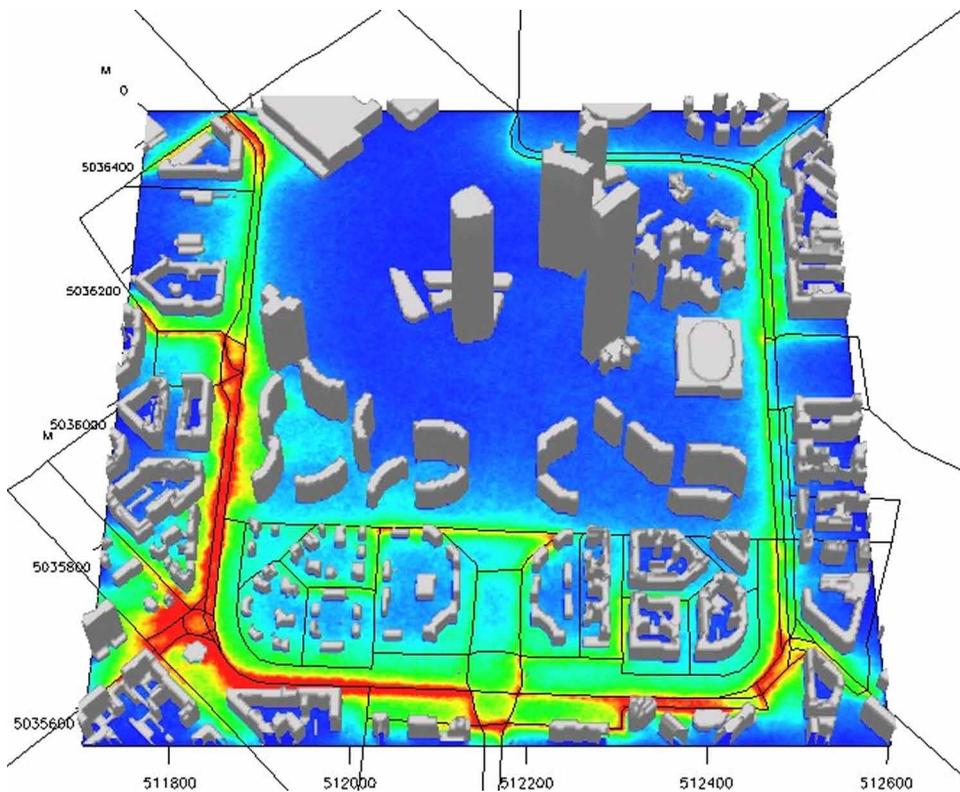
The simulations take into account the following parameters.

For the green areas have been taken into account the following parameters:

- Plant species: with 2, 10, 15 e 20 metres height;
- Conifers;

### Urban Quality Assessment at the Neighborhood Scale

Figure 11. Contributions from Nitric oxide concentrations (background 145 mg/m<sup>3</sup>) in winter coming from the following emission source: traffic



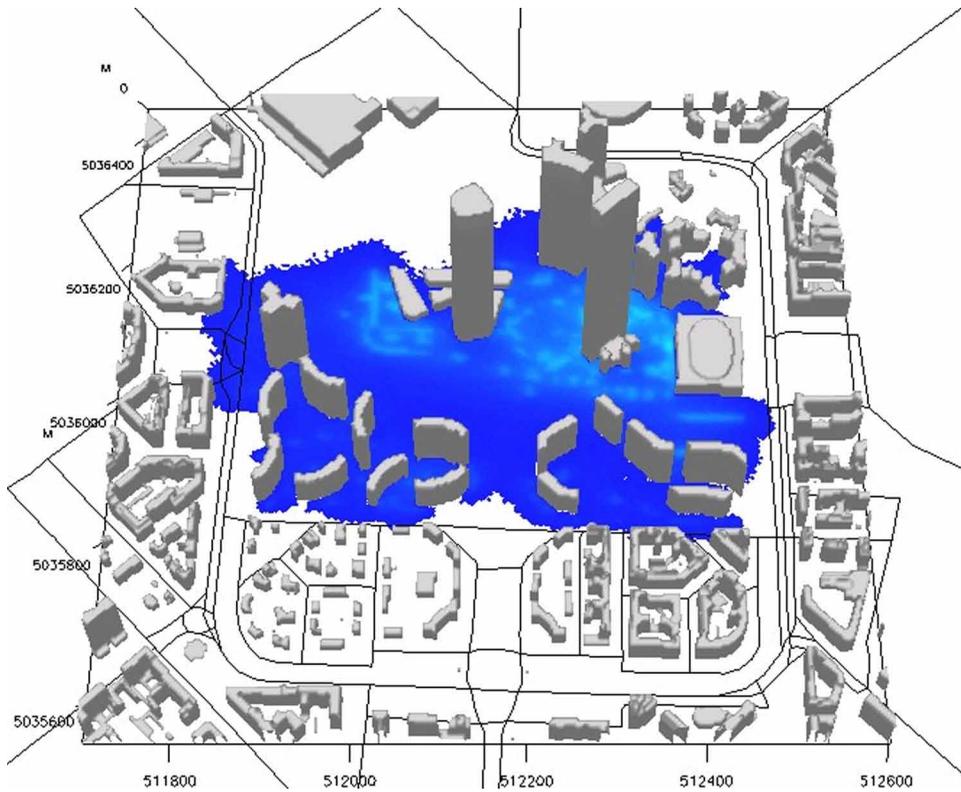
*\*For a more accurate representation see the electronic version.*

- Deciduous plants in summer, in particular:
  - Plants with dense crown;
  - Plants with very dense crown.
- Deciduous plants in winter with very light crown, and;
- Lawn.

For the land have been taken into account the used profiles, in particular:

- Concrete pavement;
- Cobblestones;
- Asphalt, and;
- Soil, etc.

*Figure 12. Contributions from Nitric oxide concentrations (background 145 mg/m<sup>3</sup>) in winter coming from the following emission source: grates*



*\*For a more accurate representation see the electronic version.*

The simulations of the temperature have been developed at 1,6 metres from the ground to know what breathed by people.

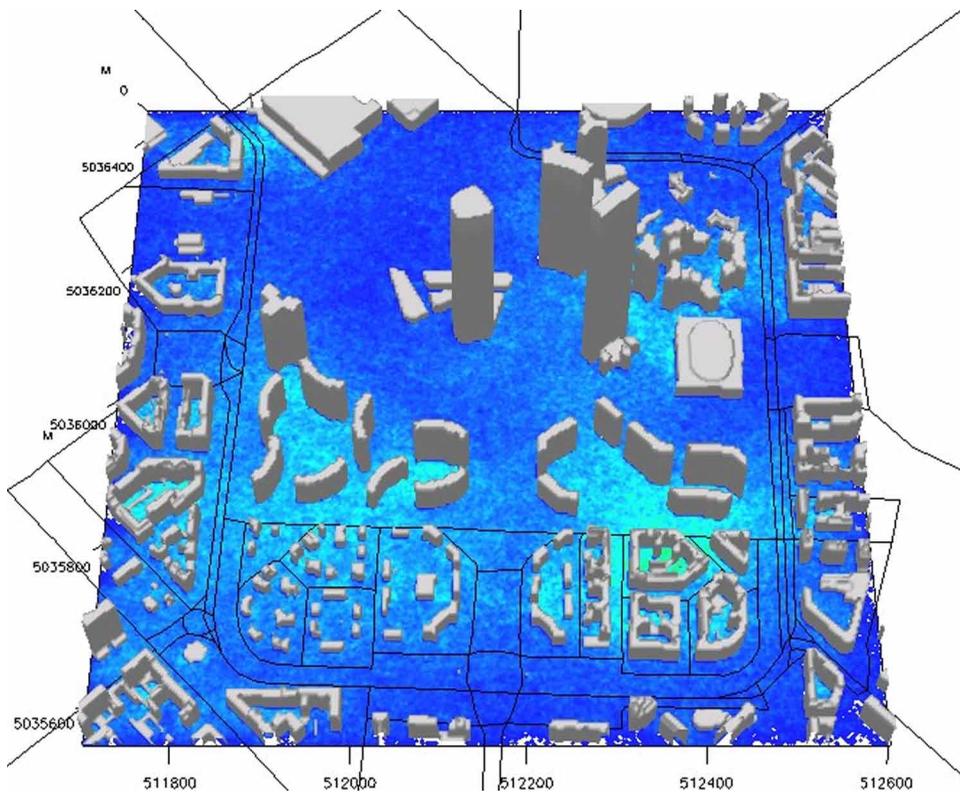
The results were presented as three-dimensional maps (at different altitudes) of meteorological parameters calculated, highlighting the presence of points of particular criticality or, vice versa, particularly advantageous from a microclimate viewpoint.

In the following maps are represented the simulation of the temperature in summer and in winter in the project CityLife and in the area for comparison in different times of the day at 7 A.M. and at 1-3 and 7 P.M:

- Blue part indicates a low temperature;
- Green and white part indicate a medium temperature, and;
- Red and violet part indicate a high temperature.

### Urban Quality Assessment at the Neighborhood Scale

Figure 13. Contributions from Nitric oxide concentrations (background 145 mg/m<sup>3</sup>) in winter coming from the following emission source: heating

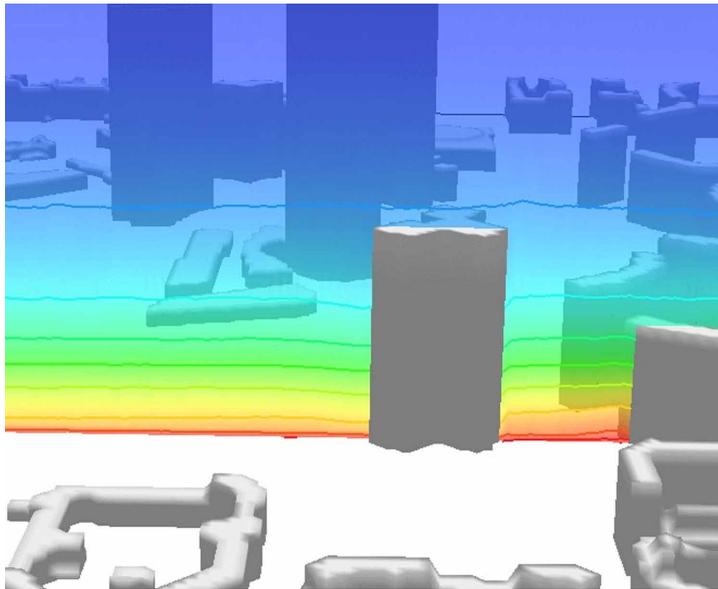


*\*For a more accurate representation see the electronic version.*

The work has continued with the simulation of Predicted Mean Vote. Global comfort is quantitatively valued through Predicted Mean Vote (PMV) index. It represents the value of the average vote expressed by a wide sample of people in regard to the environment in examination. It's based on the equilibrium between the heat produced inside the body and the heat dissipated by the body.

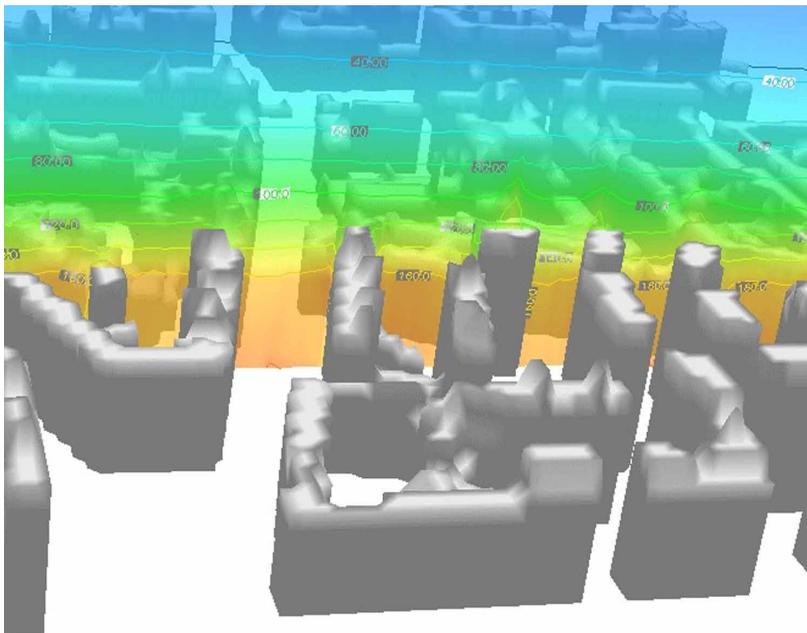
- It shall take account of:
- Air temperature;
- Average radiant temperature;
- Wind speed;
- Atmospheric pressure;
- Heat produced inside the body, and;
- Thermal insulation of clothing.

Figure 14. Decay of average Nitrous Oxide (NOx) concentrations in CityLife



*\*For a more accurate representation see the electronic version.*

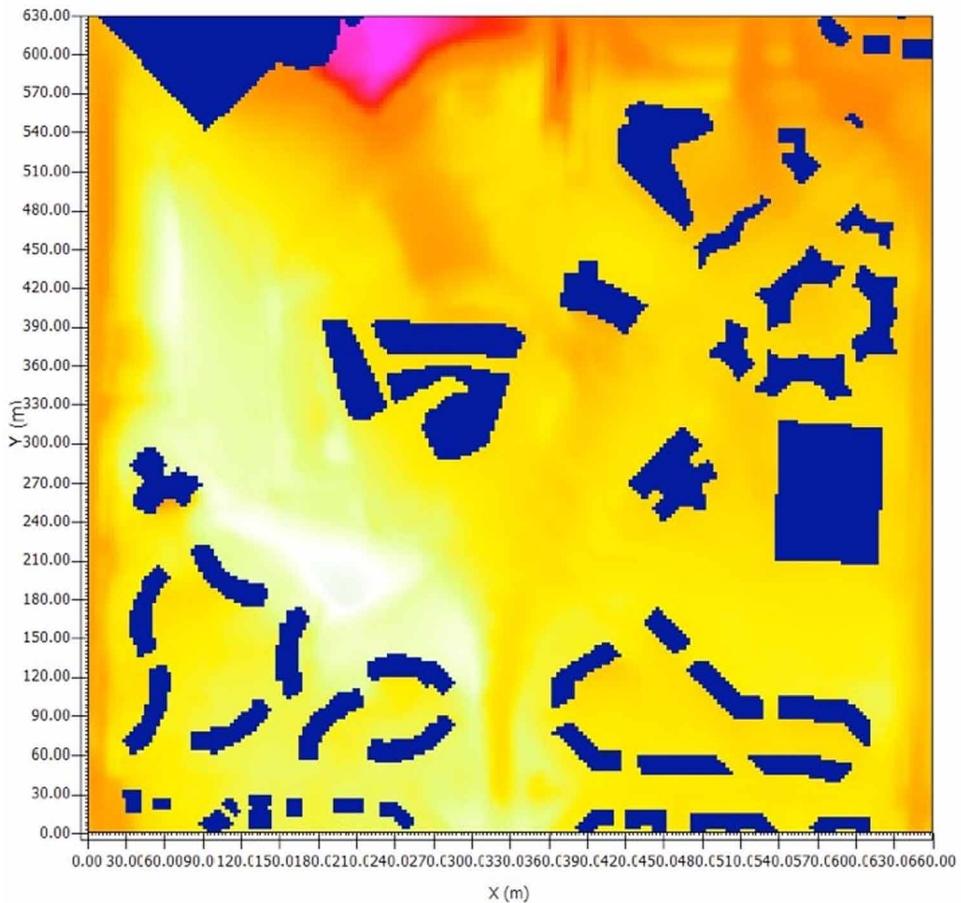
Figure 15. Decay of average Nitrous Oxide (NOx) concentrations in Garibaldi



*\*For a more accurate representation see the electronic version.*

**Urban Quality Assessment at the Neighborhood Scale**

*Figure 16. Summer temperature at 1:00 P.M.*



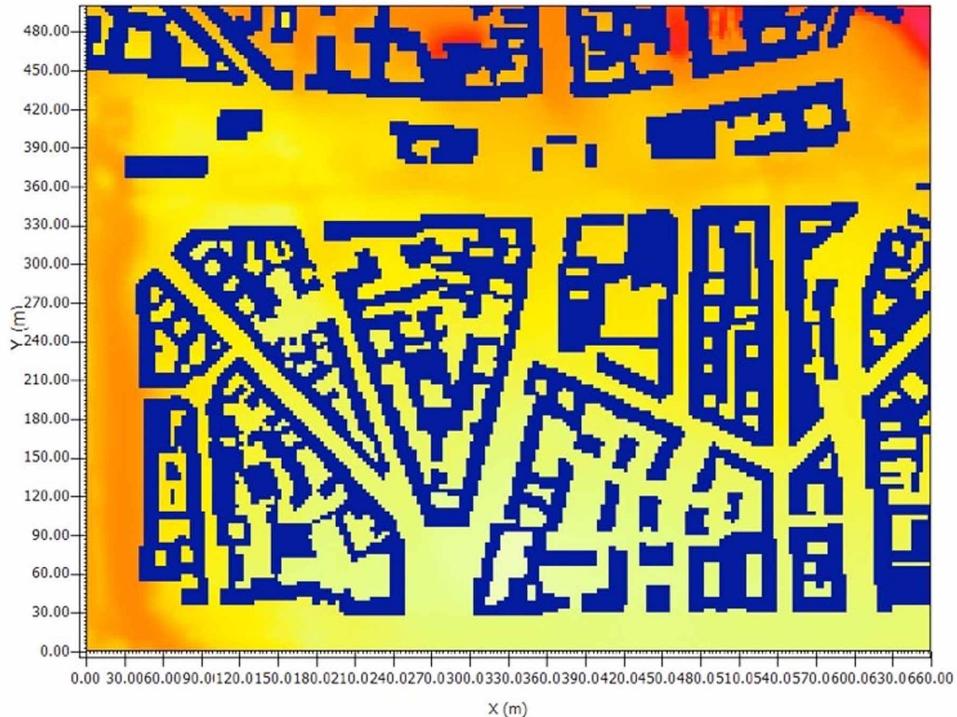
*\*For a more accurate representation see the electronic version.*

The scale of Predicted Mean Vote is from less 3 (very cold) to plus 3 (very hot).

In the following maps are represented the simulation of Predicted Mean Vote in summer and in winter in the project CityLife and in the area for comparison in different times of the day at 7-9 and 11 A.M. and at 1-3-5-7 and 9 P.M.:

- Blue part indicates a low value of Predicted Mean Vote (very cold);
- White part indicates a medium value of Predicted Mean Vote (zero impact for the people);
- Orange part indicates a high value of Predicted Mean Vote (very hot).

Figure 17. Summer temperature at 1:00 P.M.



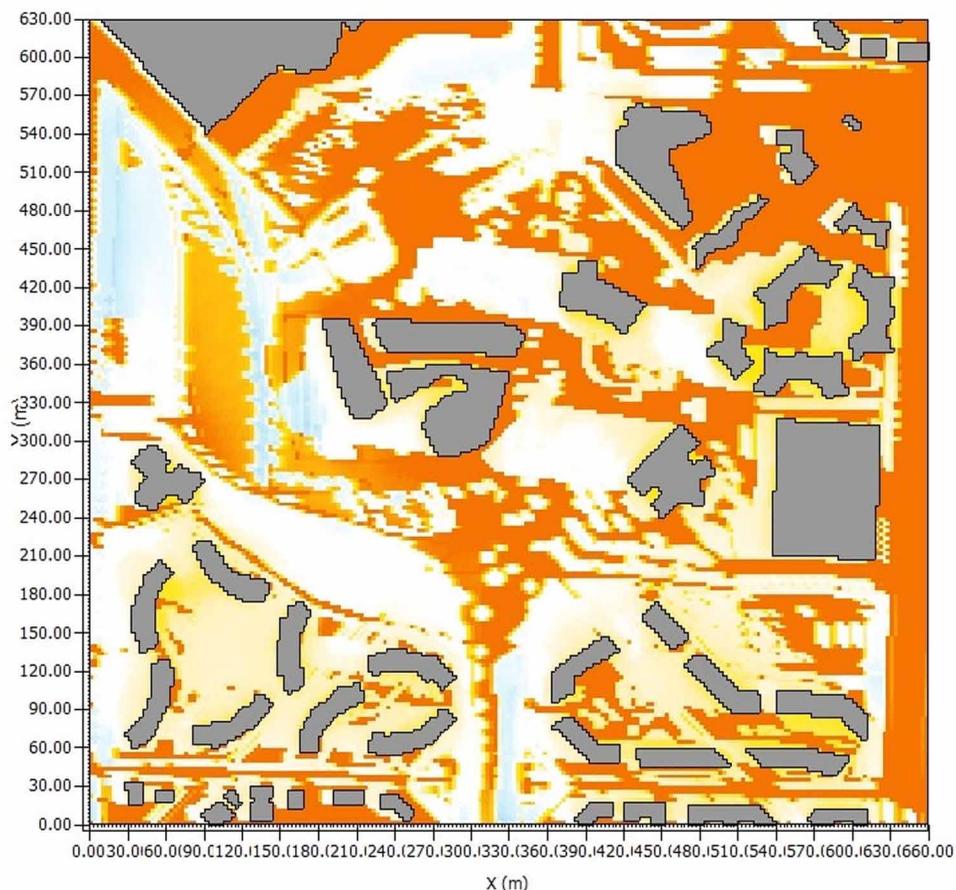
*\*For a more accurate representation see the electronic version.*

In all different times of the day, the simulation shows a value of Predicted Mean Vote better in CityLife than in Garibaldi. Infact the maps show more areas in white, which represents a good condition for the people.

In conclusion of this phase we can say that:

- The green areas of the project contribute to general improvement of the micro-climate in the CityLife district.
- The improvements are evident in CityLife in the following parameters:
  - Air temperature;
  - Predicted Mean Vote index.
- The wellbeing of the microclimate is better in CityLife thanks to the values of temperature and Predicted Mean Vote.
- In CityLife district there are some heat isles.

*Figure 18. PMV at 9:00 A.M. – Summer case*



*\*For a more accurate representation see the electronic version.*

## **Study of Acoustic Comfort**

The last phase of the work concerns the measurement of acoustic comfort in CityLife urban district.

The acoustic comfort evaluation aims to analyse potential acoustic dependence that could be generated in confined environments. Sounds and noises in confined environments must have low intelligibility, clarity and definition so they are not harmful and do not constitute a clear limitation of quality of life and a significant loss of privacy. These parameters can be determined at the planning stage from the position of buildings in the territorial context, the form of each building and the materials used on the exteriors.

Figure 19. PMV at 9:00 A.M. – Summer case



*\*For a more accurate representation see the electronic version.*

The current legislation on the acoustics in Italy provides for two types of assessments:

- **On Urban Scale:** The respect of the limits provided by acoustic classification plan;
- **On Building Scale:** The respect of the limits provided by the passive acoustic requirements of buildings.

In mixed used area the emission limit value is 55 decibels during the day and 45 decibels during the night. In areas of intense human activity, the emission limit value is 60 decibels during the day and 55 decibels during the night.

Quantifying acoustic descriptors for sound levels and intelligibility of speech has enabled the degree of privacy and comfort of the site to be established.

To achieve this objective a study will be carried out consisting of four separate sequential parts:

### ***Urban Quality Assessment at the Neighborhood Scale***

- Virtual modelling designed using the customized proprietary software CATT ACOUSTIC produced by CATT in Gothenburg (Sweden) and simulation of the whole representative built context. This phase of the simulation includes a section on the current scenario simulation, using a source of white noise with the same sound level across the entire frequency range;
- A series of measurements on site using the white noise source mentioned above. Calibration of the model calculated by comparing experimental data with simulated data. The calibration of the model was taken by specific measure carried out on the spot. First of all, it was placed a microphone into the courtyards of the residences and then a Sound level metre was placed to 2,5 – 5 and 9 metres high on the façade of residential buildings
- Future scenario simulation conducted using a source with human voice characteristics.

Computerized acoustic simulation of indoor spaces has been conducted using special software based on principles of geometric acoustics.

The first step has been to reproduce the correct geometry of the environment to be modelled in the software. In a second stage, according to the type of material chosen, each surface has been assigned a coefficient of acoustic absorption ( $\alpha$ ), corresponding to the assumed technical characteristics.

Starting with a specific position of the sound source, which can be positioned at will, the computer has simulated the contemporaneous emission of many thousands of sound rays, using a technique called raytracing:

- If the sound ray hits an absorbent material, the sound is reduced, and;
- If the sound ray hits a reflecting material, the sound is transmitted into the environment.

In these types of studies, unlike in energy studies, the wall construction is not important, just the layer that comes into direct contact with the sound wave. The precision and value of the results obtained depend to a large extent on:

- Surface modelling;
- Absorption characteristics, and;
- Transmission characteristics.

As Catt Acoustic does not have a graphic interface and autonomous modelling system the graphic representation of a confined environment is produced in the form of 3 files in.TXT format:

1. The .GEO file contains all the information needed to reconstruct the geometry of the model and the assignation of a material to every surface, identifying it by its absorption values (ABS) at different frequencies.;
2. The .SRC file provides information regarding the sound sources (positions and spectrum of sound pressure that the source produces for every frequency);
3. The .REC file contains information regarding the positioning of the receptors using Cartesian coordinates.

These files can be produced manually or using special CAD plugins (for example ArchiCAD).

This software can also be used to check the influence of sound transmission on objective parameters such as:

- T60 (reverberation time),
- C80 (clarity index),
- D50 (definition index): it is a percentage of the balance between direct and reflect waves and It controls the communication flow;
- STI (speech intelligibility);
- SPL (Sound Pressure Level): measures (in decibels) the deviation from the environmental pressure of the air caused by a sound wave;

which form the basis of architectural acoustics.

Using this software, it is possible to carry out mapping on confined environments in order to:

- Identify areas with different degrees of reverberation in various scenarios;
- Identify the intelligibility, clarity and definition of the sound from different positions in the room;
- Design a graphic scale that assigns a colour to each value in relation to the objective criterion under evaluation;
- Determine case by case the scale of values best suited to the criterion under evaluation;
- Adapt the geometry or materials to reach an optimal acoustic level.

### **Urban Quality Assessment at the Neighborhood Scale**

With this kind of representation, the results of the simulation will also be easily understood by the layman.

The study carried out showed that:

1. Areas with Leq values of 45 decibels or less, the areas highlighted in yellow, mostly internal courtyards of the houses, are protected from road traffic noise, and;
2. Areas with Leq values between 50 and 55 decibels, which are almost all of the pedestrian areas inside the settlement, correspond to especially protected areas. These pressure levels allow sound to be perceived but this perception is equivalent to a single source of road noise in an open field, located 250 meters away. The settlement in question appears to be, instead, surrounded by noise sources road away from the receptor, in some cases, even less than 200 meters.

*Figure 20. Leq levels in the CityLife urban district*



*\*For a more accurate representation see the electronic version.*

## Comparison With the Sampling Area

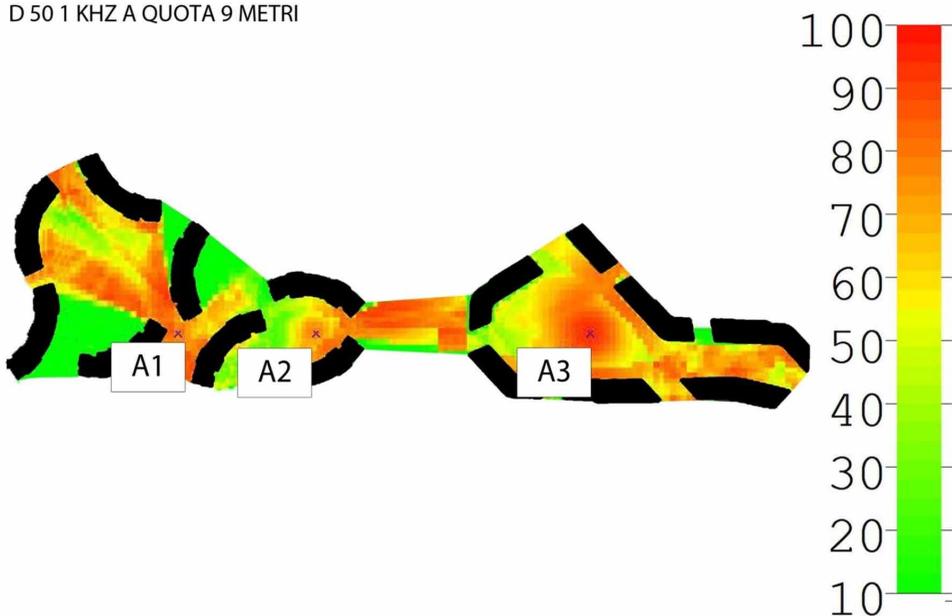
The area for comparison, characterised by traditional urban solutions, has been considered as an area representative of Milan for comparison with the project area. The simulations were carried out in order to follow the temporal evolution of the main physical parameters over a span of 24 hours, and in order to compare the parameters that characterise the microclimatic comfort and local air quality of the two domains. They are, therefore, simulations of very specific episodes; although representative of typical winter and summer conditions, but have no statistical value. The average values were calculated on the basis of simulation results at 1 pm, for both the winter and summer scenarios scenery, so as to maximize the effect of solar radiation.

At the end of this analysis, it has been defined a comparison between different domains and similar episodes of hourly Dust Particles (PM10) concentrations in winter time.

- Events area of CityLife was compared to Gioia Monte Grappa, that it is a park area in Garibaldi with play possibilities for the children:

Figure 21. Simulation of Sound Pressure Level - SPL [dB] in CityLife

D 50 1 KHZ A QUOTA 9 METRI



*\*For a more accurate representation see the electronic version.*

### ***Urban Quality Assessment at the Neighborhood Scale***

- Commercial gallery in CityLife was compared to Corso Garibaldi, that it is a zone with retail outlets;
- 3 Tower square in CityLife was compared to Corso Como, that it is a public space in Garibaldi.

## **CONCLUSION**

This is a project aiming at promoting innovative application of technologies and systems in support of “urban environment” in order to assess the environmental quality at a microscale level in a dynamic way.

The model represented by a set of indicators, refers to the three main areas of activity:

- The measurement of microclimate comfort;
- The measurement of air quality, and;
- The measurement of acoustic comfort.

A specific-oriented modelling will simulate the real conditions of the neighbourhood/district by considering all the internal and external factors.

The model is able to bring a benefit both to the Local Public Administration, which may require this type of assessment on the occasion of complex projects and to the promoters/developers, which could possibly make changes to the initial project should the evaluation identify critical issues related to the design choices (orientation of buildings, quality and presence of green, traffic emissions inside the neighbourhood, etc.).

The main result of the project is the delivery of a protocol for environmental good practice in urban planning and design at the district scale. The project will also monitor the socio-economic impact under several points of view.

During the project, will be quantified the ability:

- To attract and mix highly professional figures from several fields (architecture, city planning, engineering, environmental sciences, physics, etc.), in other words create a new consultancy market in the local territory of Milan metropolitan area where most of the partners are hosted;
- To play an active role in the planning and design process by guiding it towards virtuous interaction with the urban planning and design world, and;
- To increase social awareness.

The protocol that will be developed inside the project is aimed at pointing out and encouraging the best design practice, at the district scale, for improving the protection of the environment and the quality of life of the citizens.

Activities will be performed to monitor the extent of the protocol's capability to drive the district design towards positive environmental consequences.

This experience highlighted the lack of appropriated integrated instruments – applying a general approach – for this scope and, above all, the total lack of validated protocols aimed at guiding both local administration and real estate operators throughout the combined assessment and designing process.

## REFERENCES

Ali-Toudert, F., & Mayer, H. (2007). Effects of asymmetry, galleries, overhanging facades and vegetation on thermal comfort in urban street canyons. *Solar Energy*, 81(6), 742–754. doi:10.1016/j.solener.2006.10.007

Arpa (Agenzia Regionale per la Protezione dell'Ambiente) Lombardia. (2011). *Rapporto sullo stato dell'ambiente in Lombardia, 2010-11*. Author.

Bruse, M., & Fleer, H. (1998). Simulating surface-plant-air interactions inside urban environments with a three dimensional numerical model. *Environmental Modelling & Software*, 13(3-4), 373–384. doi:10.1016/S1364-8152(98)00042-5

Caserini, S., Giugliano, M., & Pastorello, C. (2007). Scenari di emissioni da traffico in Lombardia nel periodo 1998-2015. *Ingegneria Ambientale*, 36(3), 115–118.

*Centro Nazionale di Meteorologia e Climatologia dell'Aeronautica Militare*. (2009). (Vol. 3). Atlante Climatico d'Italia.

Chan, E. H. W., & Lee, G. K. L. (2008). Critical factors for improving social sustainability of urban renewal projects. *Social Indicators Research*, 85(2), 243–257. doi:10.1007/11205-007-9089-3

TRM Engineering. (2012). *Studio viabilistico*. Atto integrativo all'accordo di programma 1994 per la qualificazione e lo sviluppo del sistema fieristico lombardo, Procedura di VAS, Rapporto Ambientale, allegato 3a.

ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale). (2012). *Qualità dell'ambiente urbano - VIII Rapporto, Edizione 2012*. Author.

### **Urban Quality Assessment at the Neighborhood Scale**

LEED 2009 for Neighborhood Development Rating System. (2011). Congress for the New Urbanism, Natural Resources Defense Council, and the U.S. Green Building Council.

Legambiente. (2011). *Ecosistema urbano* (19<sup>th</sup> ed.). Author.

Malatras, A., Asgari, A. H., Baugé, T., Irons, M., (2008). A service-oriented architecture for building services integration. *Journal of Facilities Management*, 6, 132-151.

MATTM. (n.d.). *Geoportale Nazionale*. Available at: <http://www.pcn.minambiente.it/GN/>

Moussafir, J., Oldrini, O., Tinarelli, G., Sontowski, J., & Dougherty, C. (2004). A new operational approach to deal with dispersion around obstacles: the MSS (Micro-Swift-Spray) software suite. *Proc. of 9th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes*, 1-4.

Roper, O.K., & Beard, J. L. (2006). Justifying sustainable buildings- championing green operations. *Journal of Corporate Real Estate*, 91-103.

Rosheidat, A., Hoffman, D., & Bryan, H. (2008). *Visualizing pedestrian comfort using ENVI-met*. Third National Conference of IBPSA-USA.

Tinarelli, G., Anfossi, D., Bider, M., Ferrero, E., & Trini Castelli, S. (2000). A new high performance version of the Lagrangian particle dispersion model SPRAY, some case studies. In S. E. Gryning & E. Batchvarova (Eds.), *Air Pollution Modelling and its Applications XIII* (pp. 499–507). New York: Kluwer Academic/Plenum Press. doi:10.1007/978-1-4615-4153-0\_51

Tinarelli, G., Brusasca, G., Oldrini, O., Anfossi, D., Trini Castelli, S., & Moussafir, J. (2004). Micro-Swift-Spray (MSS) a new modelling system for the simulation of dispersion at microscale, general description and validation. *Proc. of the 27th CCMS-NATO meeting*, 25-29.

Trini Castelli, S., & Piefel, M. (2010). *Evaluation of the Envi-met model simulating the flow around a single obstacle: the CEDVAL A1-1 test case*. Internal Report ISAC-TO/01-2010.

Wania, A., Bruse, M., Blond, N., & Weber, C. (2012). Analysing the influence of different street vegetation on traffic-induced particle dispersion using microscale simulations. *Journal of Environmental Management*, 94, 91-101.

## **ENDNOTE**

- <sup>1</sup> This research work has been done by the Department of Architecture, Built Environment and Construction Engineering, Gesti.Tec Laboratory of Politecnico of Milan; ARIANET Srl: which is a Consultancy firm that operates in the environmental field. It studies the transport and the dispersion of pollutants in atmosphere; SIMULARIA Srl: which is a Services company of environmental modeling. It studies the transport and the dispersion of pollutants in atmosphere.

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