



PhD in MODELLI E METODI MATEMATICI PER L'INGEGNERIA / MATHEMATICAL MODELS AND METHODS IN ENGINEERING - 38th cycle

**PNRR_351_PUBBL_AMMIN Research Field: ENHANCING DIAGNOSTIC TOOLS AND
DECISIONAL SKILLS FOR REGIONAL AIR QUALITY MONITORING AND MANAGEMENT**

Monthly net income of PhDscholarship (max 36 months)

€ 1325.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

**Motivation and objectives of the research
in this field**

River Po valley (Pianura padana), and Lombardy region in particular, is one of most air polluted area in Italy [3]. Both natural and anthropogenic factors are responsible for this situation. The geographic shape of the area does not favour the exchange of the polluted air masses and, conversely, it favours the build-up of locally emitted pollutants. The high population density, together with the high degree of urbanization, industrial areas, and a dense and trafficked road network are responsible for relevant atmospheric emissions all over the area. Specifically, PM10 and PM2.5 particulate matter concentration levels hardly comply with air quality limit values prescribed by EU directives, especially in the largest urban areas. Pollution is so strong and widespread that Covid lockdown in spring 2020 has not even been able to significantly decrease PM10 level in Lombardy [1] [4]. It is well known that PM10 levels in the Po valley are determined by a relatively high regional background, driven by specific meteorological conditions (e.g., heavy rain, high wind speed events). However, the structure of the meteorological monitoring network is different from that of the air quality; thus, meteorological conditions data might be available at a different space-time resolution from PM10 and PM2.5. The goal of this project is the enhancement of the diagnostic capacity of air pollution monitoring system in Lombardy, while, at the same time,



	<p>identifying the factors driving PM10 and PM2.5 levels and the conditions that lead to the exceedance of the EU directive limit value. More specifically, the objective is twofold: (i) to build an integrated database for institutional air quality and meteorological data for Lombardy region and the whole Po valley;(ii) to develop statistical models to identify spatial variability and temporal patterns of particulate matter pollution, useful for understanding the role of the driving factors.Objectives (i)-(ii) might make available to the institution of local governance knowledge and tools for better understanding the feature and evolution of air quality and design interventions for air quality control both at local and regional level. The research activity is in collaboration with ARPA Lombardia and includes scientific collaboration with prof. Giovanni Lonati, DICA (Politecnico di Milano), a leading expert in air pollution control.</p> <p>In summary, the research activity aims at bringing a significant development of the knowledge in the areas of interest of the PNRR. In particular, the research will develop knowledge in the field of digitalization and innovation of the public administrations (Mission M1C1 of the PNRR - Digitization, innovation and safety in the PA), also including knowledge for a more prudent protection of the territory (Mission M2C4 of the PNRR - Protection of the territory).</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The research will be carried out through univariate or bivariate regression models for particulate matter concentration (PM10 and/or PM2.5) over time applied to multi-annual concentration datasets over the whole Po valley. The main statistical objectives are: (a) identifying meteorological conditions or pollution station features (i.e. station location, station exposure to emission sources) driving the air pollution levels, (b) clustering the location-specific time series of the particulate matter. While (a) might highlight observed factors influencing air pollution, (b) might help in interpreting the estimated clusters ex-post, and suggesting more information to be collected at the station level. Additionally, (b) could provide air quality information at non-monitored sites based on their similarity with clustered sites. The statistical approach we</p>



	<p>assume is the Bayesian framework which automatically allows to measure uncertainty in the estimates and accounts for hierarchical data, though being more challenging from the computational point of view than non-Bayesian methods. Indeed, Bayesian inference can become computationally onerous for modelling massive spatial datasets because of its reliance on iterative estimation algorithms, for instance Markov Chain Monte Carlo algorithms. Hence, specific methods for massive data needs to be accounted for.</p> <p>Bibliography[1] Camelletti, M. (2020). The Effect of Corona Virus Lockdown on Air Pollution: Evidence from the City of Brescia in Lombardia Region (Italy). <i>Atmospheric Environment</i>, 239, 117794[2] Gianella, M., Guglielmi, A., Lonati, G. (2022). A Bayesian spatio-temporal models of PM₁₀ pollutant in the Po valley. In <i>Book of Short Papers - SIS 2022</i>, Pearson. [3] Masiol, M., Squizzato, S., Formenton, G., Harrison, R.M., Agostinelli, C. (2017). Air quality across a European hotspot: Spatial gradients, seasonality, diurnal cycles and trends in the Veneto region, NE Italy. <i>Science of The Total Environment</i> 576, 210-224 [4] Riva, F., Lonati, G. (2021). Effetti degli interventi di contrasto alla diffusione del covid19 sulla qualità dell'aria in pianura padana. <i>Ingegneria dell'ambiente</i>, 8, 24-38.</p>
<p>Educational objectives</p>	<p>The PhD student will have the opportunity to increase his/her abilities as data scientist with strong expertise in statistical learning. In particular the student will study, develop and apply innovative statistical techniques for time series and clustering, in order to enhance the diagnostic capacity of air pollution monitoring system in Lombardy and identify the factors driving pollution.</p>
<p>Job opportunities</p>	<p>The program will allow the student to find a job as a skilled data scientist. Data science, according to the World Data Science Initiative (https://www.worlddatascience.org/world-data-science-initiative), is one of the fastest-growing domains in technology, with a shortage of professionals, especially with knowledge in statistical modelling and compiled</p>



	programming language experts.
Composition of the research group	3 Full Professors 4 Associated Professors 3 Assistant Professors 4 PhD Students
Name of the research directors	Alessandra Guglielmi

Contacts	
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Additional support - Financial aid per PhD student per year (gross amount)			
Housing - Foreign Students	1st year	2nd year	3rd year
	1500.0 € per student	0.0 € per student	0.0 € per student
max number of financial aid available: 3, given in order of merit ..			
Housing - Out-of-town residents (more than 80Km out of Milano)	--		

Scholarship Increase for a period abroad	
Amount monthly	662.5 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	ARPA Lombardia
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): financial aid per PhD student per year 1st year: max 1.800,47 euros 2nd year: max 1.800,47 euros 3rd year: max 1.800,47 euros The PhD students are encouraged to take part in activities related to teaching, within the limits allowed by the regulations. 1 individual PC per student + several shared PC. Access to one cluster with 32 processors and 384 GB RAM, and to several multi-processor servers and 1 individual desk per student are granted.</p>