

**RAPPORTO FINALE SUI RISULTATI DEL PROGETTO COMUNE DI RICERCA
FINAL REPORT ON RESULTS OF JOINT RESEARCH PROJECT**

<p>1. Accordo /Agreement</p> <p>CNR / RA</p> <p>anno/ year 2013-2016</p>	
<p>2. Titolo del progetto EFFETTI DELL' OZONO TROPOSFERICO SU CRESCITA E DIVERSITA' FORESTALE</p> <p>2. Title of the project TROPOSPHERIC OZONE EFFECTS ON FOREST GROWTH AND DIVERSITY (TROZGRODIV)</p>	
<p>Parole chiave (massimo 3) INQUINAMENTO ATMOSFERICO, CAMBIAMENTO CLIMATICO, FORESTE</p> <p>Key words (max. 3) AIR POLLUTION, CLIMATE CHANGE, FORESTS</p>	
<p>(solo per parte italiana)</p> <p>Area scientifica / Scientific area (tabella 1/ table1)</p> <p>Scienze bio-agroalimentari</p>	
<p>3. Responsabili del progetto Project leaders</p>	
<p>Responsabile italiano</p> <p>Elena Paoletti</p>	<p>RA project leader</p> <p>Ovidiu Badea</p>
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4. Aims of the project

- 1) Developing research proposals between Romania and Italy for quantifying ozone (O₃) effects on forest growth. The EU funding will further consolidate the scientific cooperation between the participating countries
- 2) Harmonizing methodologies for assessing concentration of O₃, stomatal O₃ uptake and their effects on forest growth and diversity, by means of a multidisciplinary collaboration
- 3) Providing innovative findings about the responses of their forests to O₃ pollution in terms of carbon sequestration and biodiversity
- 4) Establishing the best standards and thresholds for protecting Italian and Romanian forests from O₃
- 5) Investigating the spatial and temporal variability of stomatal O₃ fluxes over a range of forest ecosystems
- 6) Estimating which environmental variables among O₃ pollution, soil water availability, light, air temperature and humidity affect stomatal O₃ fluxes

5. Achieved results (1 page)

- 1) Five joint proposals were developed and submitted within this bilateral agreement: call H2020-SC5-2014, LIFE14 CCA/RO/000223, LIFE14 ENV/IT/000161, 1MED15-3.2-M12-071, and LIFE15 ENV/IT/000183. The last one, entitled Monitoring ozone injury for setting new critical levels (MOTTLES) and coordinated by Elena Paoletti, got approved. The project started on July 1st, 2016 and will last until June 30th, 2020.
- 2) A novel approach was developed for quantifying ozone impacts on real-world forests, which is based on active monitoring rather than passive monitoring of ozone concentrations in the field. The approach was submitted as LIFE15 proposal. The project got accept and will allow to test this approach at 9 Italian and 3 Romanian forest sites, where a permanent new-generation monitoring system for the effects of ozone on EU forests will be installed for concurrently monitoring forest response indicators and O₃ standards across Europe. In addition, a novel ozone FACE (free air controlled exposure) was developed at CNR and tested within this project. This modern facility will allow to expose plants to ozone and co-stressors under realistic conditions.
- 3) The collaboration has produced novel results, as summarized in the 8 publications listed below. One paper is about the long-term effects of ozone on poplar biomass production and allocation. Two papers are methodological and aim to improve genotyping of forest tree species. One paper is on genetic adaptation to climate change in silver fir. Out of the 4 submitted manuscripts, two are about oak responses to ozone (radial growth and nutrient status), one is a nation-wide assessment of ozone impact on tree defoliation in Romania, and one is the description of a novel experimental facility for simulating ozone exposure of plants in free air.
- 4) Data collected during a previous project (for Italy, see Sicard et al., 2016 STOTEN) and during this project (for Romania, see maps below), allowed to conclude that the best standard for protecting forests is the stomatal ozone uptake (namely, the phytotoxic ozone dose POD) accumulated over the growing season, and the best threshold is no threshold i.e. 0 mmol m⁻² POD.
- 5) Mean annual POD₀ were calculated for selected forest species by using Italian data over the period 2000-2010. The results showed a large variability depending on plant species, site, year and season. Overall, values spanned from 8 to 35 mmol m⁻². These results will be summarized in a future publication.
- 6) By applying a non-linear modelling approach (Random Forest and Generalised Regression Models), we develop species-specific predictive models for crown defoliation where the main environmental variables and ozone metrics were included. We found that the correlation between ozone concentrations and defoliation was more important than between ozone uptake and defoliation (see publication No 7).

6. Results obtained

	no.
Publicaz. scient. su riviste internaz./ scientific publications on international reviews con IF 4 senza IF 0	4
Publicaz. in atti congressi internaz./ publications in international congress proceedings	
Pubblicazioni in atti congressi nazionali / publications in national congress proceedings	
Pubblicazione libri nazionali / Publication of national books	
Pubblicazione libri internazionali / Publication of international books	
Altre pubblicazioni / other publications	4
Brevetti / Patents	
Prototipi / Prototypes	
Strumentazione / Equipment and /or Devices	
Programmi software / Software	
Banche dati / Data bases	
Protocolli / Protocols	
Nuovi Materiali / New Materials	
Nuovi processi / New processes	
Cataloghi/inventari/repertori / Catalogues/Inventories	
Atlanti/Carte/Mappe / Atlases/Charts/Maps	6
Progetti di ricerca / Research projects	1
Trasferimento innovazioni / Knowledge transfer	
Laboratori congiunti / Joint laboratories	
Alta formazione / Training	2
Altro / Other	

7. Detailed information on results indicated under point 6

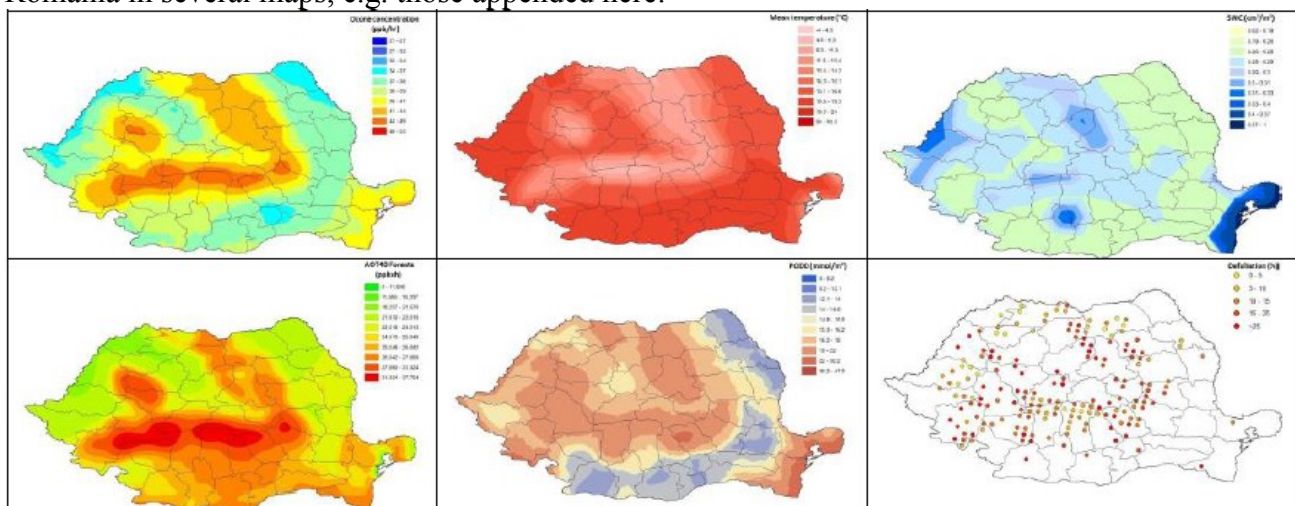
Publications

Four ISI papers were published and four further manuscripts were submitted/in preparation.

1. Hoshika Y., Pecori F., Conese I., Bardelli T., Marchi E., Manning W.J., Badea O., Paoletti E.: 2013, Effects of a three-year exposure to ambient ozone on biomass allocation in poplar using ethylenediurea. *Environmental Pollution*, 180: 299-303.
2. Postolache, D., Leonarduzzi, C., Piotti, A., Spanu, I., Roig, A., Fady, B., Roschanski, A., Liepelt, S. Vendramin, G.G. (2014). Transcriptome versus genomic microsatellite markers: highly informative multiplexes for genotyping *Abies alba* Mill. and congeneric species. *Plant Molecular Biology Reporter* 32, 50–760.
3. Brousseau, L., Postolache, D., Lascoux, M., Drouzas, A.D., Källman, T., Leonarduzzi, C., Liepelt, S., Piotti, A., Popescu, F., Roschanski, A.M., Zhelev, P., Fady, B., Vendramin, G.G. (2016). Local adaptation in European firs assessed through extensive sampling across altitudinal gradients in southern Europe. *PLoS ONE* 11, e0158216 DOI: 10.1371/journal.pone.0158216
4. Roschanski, A.M., Csilléry, K., Liepelt, S., Oddou-Muratorio, S., Ziegenhagen, B., Huard, F., Ullrich, K.K., Postolache, D., Vendramin, G.G., Fady, B. (2016). Evidence of divergent selection for drought and cold tolerance at landscape and local scales in *Abies alba* Mill. in the French Mediterranean Alps. *Molecular Ecology* 25, 776-794.
5. Paoletti E., Materassi A., Fasano G., Hoshika Y., Carriero G., Badea O., Silaghi D.: A new-generation 3D ozone FACE. Submitted to *Science of the Total Environment*
6. De Marco A., Popa I., Anav A., Badea O., Silaghi D., Leca S., Screpanti A., Paoletti E., Vitale M., Do ozone concentration influence the tree defoliation in a continental climate? Submitted to *Environmental Pollution*
7. Paoletti E., Hoshika Y., Carriero G., Silaghi D., Badea O., Effects of ozone pollution and water stress on the nutrient status of three oak species. Submitted to *Trees*
8. Silaghi, D., Badea, O., Popa, I., Paoletti, E. Radial growth response to ozone exposure and uptake of sessile oak (*Quercus petraea*) in Mihaesti-gorun IM plot, Romania. (In preparation).

Maps

We summarized the details about ozone metrics, climatic variables and forest crown defoliation in Romania in several maps, e.g. those appended here:



Research projects

LIFE15 ENV/IT/000183 € 1 838 406 (€ 995 642 for CNR and € 157 480 for INCDS)

Training

1. ICP-Forests Experts Panel and Intercalibration Course, Brasov, Romania, 12-15 September 2016
2. 4th Forum Carpathicum 'Future of the Carpathians: Smart, Sustainable, Inclusive', Bucharest, Romania, 28 – 30 September, 2016

8. Training of young researchers

9 young scientists registered for the participation to the ICP-Forests Experts Panel and Intercalibration Course.

Five temporary contracts possible in the period 2016-2020 thanks to the resources from the LIFE15 project.

9. Reasons for cooperative project developments in the following years, if any (extension to other countries, multilateral collaboration, national or international contracts)

The results obtained during this bilateral project reinforced the collaboration between Italy and Romania in terms of forest protection from ozone. The most important result is the start of a joint LIFE15 project. Unfortunately, during the revision of the project, travel expenses were drastically reduced by the reviewers, even though there is a strong need of visiting the many field sites. Therefore, a new CNR-RA bilateral project is considered instrumental to a successful collaboration of Italy and Romania within the LIFE15 project. The bilateral collaboration will also allow to develop and submit new project proposals for further strengthening of the collaboration between our countries. Personnel from several CNR institutes (IPSP, IBBR, IBIMET, IVALSA) participated in this project. A proposal for a continuation will be submitted, with IBBR as coordinator.



(firma del responsabile italiano del progetto)



(signature of the Romanian project leader)

 Consiglio Nazionale delle Ricerche
Istituto per la Protezione Sostenibile delle Piante
IL DIRETTORE
Dr. Gian Paolo ACCOTTO



(firma del direttore)

date: September 1st, 2016