LIFE09 ENV/IT/000092

FINAL REPORT

Reporting Date
September 30th 2013

LIFE09 ENV/IT/000092
OPERA

(Operational Procedure for Emission Reduction Assessment)

Project location	Parma
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Project end date:	30/09/2013
Total budget	€ 2 301 010
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(%) of eligible costs	47,67%

Data Beneficiary

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List of abbreviations

ARPA-EMR	Agenzia Regionale Prevenzione e Ambiente dell'Emilia Romagna
ASPA	Association pour la Surveillance de la Pollution de l'Air en Alsace
CAFÉ	Clean Air for Europe, http://ec.europa.eu/environment/air/cafe/index.htm
CHIMERE	Chemical Transport Model, http://www.mmm.ucar.edu/mm5/, Institut Pierre Simon Laplace, IPSL
CNRS	Centre National de la Recherche Scientifique
GFS	Global Forecast System. www.nco.ncep.noaa.gov/pmb/products/gfs. National Center for Environmental Prediction, NCEP
IAM	Integrated Assessment Modelling
IAMs	Integrated Assessment Models
LIVE	Laboratoire Image Ville Environnement
NIAM	Network for Integrated Assessment Modelling (http://www.niam.scarp.se/)
MM5	The PSU/NCAR mesoscale meteorological model, http://www.mmm.ucar.edu/mm5/, National Center for Atmospheric Research, NCAR
UNIBS	Università di Brescia
UNISTRA	University of Strasbourg WRF-Weather Research and Forecasting modelling system. www.mmm.ucar.edu/wrf. Mesoscale and Microscale Meteorology Division of National Center for Atmospheric Research, NCAR

Project data and documentation repository

All the deliverables, the meeting minutes, the provided documentation and the extra of the project are also downloadable from the "Intranet" page of the OPERA (website http://www.operatool.eu/) or on the files repository (ftp.terraria.com) in specifics folder protected by password.

The European Commission and Timesis login and passwords are:
username: DeliverableOPERA
password: c9d8f9bf

2 Executive Summary (maximum 5 pages)

ENVIRONMENTAL PROBLEM ADDRESSED

Air pollution is an environmental issue of major concern in Europe, as highlighted by the EU Thematic Strategy for air quality (COM 2005 446) and Directive 2008/50/EC on ambient air quality and cleaner air for Europe. Despite a general improvement in recent years, some regions in Europe still maintain pollutant levels that threaten human health and ecosystems. This is the case, for instance, of the Po Valley, located in Northern Italy, where high population and emission densities, and poor meteorological dispersion lead to severe levels of fine particulate matter (PM2.5) and ozone concentrations, causing evident negative impacts. Although less dramatic air pollution problems are encountered in the Alsace region, the high population density in the Upper Rhine valley, the important traffic fluxes across three countries (France, Germany and Switzerland) as well as the presence of important industrial areas (Ruhr region in the north east and the Basel area in the south) generate a deterioration of the air quality which results in frequent exceedances of the limit values for particulate matter and ozone compounds.
Due to the complexity of the phenomena involved in the formation and accumulation of these secondary pollutants in atmosphere, Decision Makers (European Commission, national and regional authorities) need effective computer tools enabling the assessment of the effectiveness of emission control policies for the environment, the economy and the society.

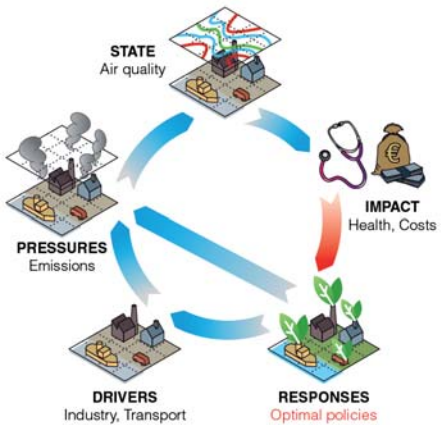
OBJECTIVE OF THE PROJECT

The objective of this project is to develop and apply a methodology to assess the efficiency of locally planned abatement measures, which remain coherent with national and international frameworks.
Each action in the Air Quality Plan had to be evaluated both in terms of air quality benefits and in terms of costs. The goal is to maximize the environmental benefits at fixed costs, or minimize costs at fixed environmental benefits. When designing air pollution reduction policies, regional decision makers face a limited budget that should be used to set-up efficient measures impacting on several pollutants in different ways to obtain the respect of EU air quality thresholds.

DESCRIPTION OF THE TECHNICAL/METHODOLOGICAL SOLUTION

The methodology to face this challenging problem can foresee two possible decision pathways, which can be easily described through the DPSIR (Drivers-Pressures-State-Impacts-Responses) scheme:

- Open-loop, or scenario analysis. This is the approach mainly used nowadays to design the air quality plans at regional/local scale. Emission reduction measures (Policies) are selected on the basis of expert judgment or Source Apportionment and then they are assessed through simulations of an air quality model. This approach does not guarantee the cost-effectiveness of the chosen measures; costs and other impacts are evaluated ex-post.



- Closed loop, or optimization. This pathway indicates the most cost-effective measures technical (end-of-pipe) and non technical (energy efficiency and behavioral) for air quality improvement by solving an optimization problem to reduce pollution, explicitly considering their impacts and costs.

The project developed a software, the RIAT+, being a tool based on an integrated assessment modeling approach, that may be used by a regional authority to determine emission policies or to allow discussion and negotiations among groups of stakeholders.

ENVIRONMENTAL BENEFITS

A methodology and tool (RIAT+) to support local authorities in designing and assessing efficient air quality plans with the best ratio cost/effectiveness.
In RIAT+: different air quality indexes are included (yearly average of PM10, PM2.5, and NO2, PM10 daily exceedances, AOT40, O3 8hrs maximum); the budget can be constrained to a specific value (cost-effectiveness approach) or can be split in different macrosectors; policy application subdomain (e.g. critical air quality zones) can be defined; state-of-art technologies may be fixed for some years while older technology could be substituted; optimization can be limited to a subset of macrosector technologies; scenarios can be simulated fixing aggregated emissions or specific technologies.
RIAT+ application was tested for Emilia Romagna and Alsace assessment of air quality plans in these two regions.

LONGER TERM RESULTS

Air quality plans involving less cost for better pollutant reductions will let European local authorities to reduce air pollution in a more efficient, integrated and successful way.

OPERATIVE RESULTS

- A methodology and tool (RIAT+) to support local authorities in designing and assessing efficient air quality plans.
- RIAT+ application to Emilia Romagna and Alsace and assessment of air quality plans in these two regions.
- A register including existing and new emission reduction measures (technical and non-technical) applied in the areas of the project. (Each action is defined by its abatement efficiency and cost and linked to site-specific implementation strategies).
- A full documentation, workshop and courses to support new users implementing the methodology to other European regions.
- A standardized set of quantitative indicators to monitor the action plans effectiveness.
- Guidelines for local administrations and environmental agencies (this is a national priority for Italy) to integrate local planning to national and European air quality policies.

PARTNERS

Agenzia Regionale per la Prevenzione e l´Ambiente dell´Emilia-Romagna (Regional Agency for Environmental Protection in Emilia-Romagna) - Arpa

is an environmental control technical support body to the regional, district and local authorities and is administratively and technically independent. Arpa develops and promotes control and prevention supporting local and regional governative in order to plan and govern environment.

Università di Brescia – (University of Brescia) UNIBS

The Environmental System Modelling and Assessment (ESMA) research group (http://automatica.ing.unibs.it/esma/esma.html) work mainly deals with air quality modeling and management, concerning emission control strategies, forecast and alarm systems and optimal air quality control policies, through cost-efficient / multi-objective optimization techniques.

Terraria - TA

TerrAria has the aim to join IT (Information Technology) with environmental expertise on deterministic and stochastic modeling has developed several decision support systems applied to environmental sector. TerrAria's environmental sector is focused on the implementation of environmental model, both interesting emission inventory and air quality impact.

Centre National de la Recherche Scientifique (National Center for Scientific Research) – CNRS

The CNRS (National Center for Scientific Research) is a government-funded research organization, under the administrative authority of France's Ministry of Research. The project involves researchers from unity ERL7230 (Laboratoire Image, Ville, Environment) of the CNRS, which studies urban processes linking social and spatial aspects.

Universitè de Strasbourg (University of Strasbourg) - UNISTRA

University of Strasbourg currently has a partnership with CNRS in the unit ERL7230 inboard Live Unistra manage the research group "air pollution and urban climate" where developed an high expertise in physical chemistry of the atmosphere and Numerical modeling of the atmosphere (meteorology and reactive transport).

PROJECT LAYOUT

The project has been realized considering different phases that could be managed in a parallel or sequential way. A first phase is done achieving all the data required and at the same time making a review of the actual situation considering air pollution, national and local legislation in order to check the requirement of the software to develop. Three preparatory actions were performed:

P1 - Review of existing plans and methodologies, identification of requirements.

P2 - Data collection for the Italian case study

P3 - Data collection for the French case study

The first action was performed through direct consultation with European, national and local institutions responsible for air quality planning and this was done during the First Opera Conference on June 2011. It aimed identifying strengths and weaknesses in the currently available methodologies and at proposing a set of requirements to improve them. The next bunch of action leaded to the creation of all the databases required for let the RIAT+ software working on the Regione Emilia-Romagna and Alsace Territory. P2 and P3 actions addressed this specific item.

The core of the project was the improvement of existing tools and their implementation, which can be summarized by four main actions:

I1 - RIAT+ methods and design

I2 – RIAT+ software implementation

I3 - Application to the Emilia Romagna (I) region

I4 - Application to the Alsace (F) region

A Steering Committee has the task of evaluating the correct application of the end users requirements and requests considering its composition that involved Regione Emilia-Romagna, Aspa - Association pour la Surveillance et l'étude de la Pollution atmosphérique en Alsace (Fr) and Join Research Centre - Institute for Environment and Sustainability (JRC-IES) authorities.

Each action was eventually split in two or more sub-action that led to the following deliverables.

Action	Name of the Deliverable
P1	D1 – RIAT+ requirements D1 – RIAT+ requirements-ADDENDUM
P2	D2 – Emilia Romagna preparatory data
P3	D3 – Alsace preparatory data
I1	D4 – Methodology and technical guide
I3	D5 – Emilia Romagna RIAT+ input
I4	D6 – Alsace RIAT+ input
I2	D7 – RIAT+ prototype
I2	D8 – RIAT+ final version and user guide
I3	D9 – Emilia Romagna action plan built with RIAT+
I4	D10 – Alsace action plan built with RIAT+
C1	D11 – Web site
C1	D12 – 1st Opera Conference - Gathering the requirements
C1	D13 – 2nd Opera Conference - RIAT+ Beta version check
C1	D14 – Opera Final Conference - RIAT+ (1.0 version) release
C1	D15 – Layman's report
C1	D16 – Informative panels
C2	D17 – After LIFE+ plan

As test cases some evaluation of RIAT+ were performed in Alsace and Emilia – Romagna.

A list of about 20 measures for improving air quality in Alsace (focus on sensitive zones) has been retained. They have been presented to technicians and decision makers during the final conference and a workshop in Strasbourg. In order to become operational on the territory, they need further analysis and discussion with local experts. The outputs of the RIAT+ tool were used to set the emissions reduction target for the AQ plan (PAIR2020) of the Emilia-Romagna region. The preliminary document of the Air Quality Plan (PAIR2020), including the reduction emissions target set by RIAT+, was approved by the Regional Government in July 2013.

DISSEMINATION

Communication activities have been designed to promote and disseminate the project and RIAT + tool to a specific audience represented by technical and political actors/stakeholders involved in air quality management and policies on a regional/local level. This was done by participating to meeting and conferences on air quality and organizing three Project Conferences, two in Bologna and one in Strasburg. Moreover also different methods of dissemination have been be used:

- Project brochure: leaflets containing a brief description of the project of its principal aims, the partners, the contacts and the addresses where to find more details
- Project website: where to find updated information on Opera Project and RIAT + updated versions, installation kit, user guide, test case, FAQ and so on.
- Layman's report.

SUMMARY OF COSTS INCURRED

All the costs were correctly estimated during the project definition as reported by the standard statement of expenditure. The overall costs incurred, the **eligible ones** are € 2.317. 442,36 for all project duration. In comparison to the original budget estimated (€ 2.285.562,98), the overall expenditure represents the 101% of the original budget. This including reductions made by the auditor for an amount of € 2.446,20. The total eligible costs reported by the partners were € 2.319.888,56. Resulting percentages of co financing were 47% EC, Arpa 35% and the other partners 18%.

EVALUATION OF PROJECT IMPLEMENTATION

OPERA methodology to support regional/local authorities in the definition, application and evaluation of cost-effectiveness air quality plans policies, was successfully applied through the tool RIAT+ in the two regional domains of Alsace and Emilia Romagna. Thanks to general implementation of the tool RIAT+ this methodology could be used in any other European Region and the OPERA After Life+ Plan goes in this direction.

HOW TO GET RIAT+

The design of the system and the software development were realized following EU standards on data exchange (Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community (INSPIRE DIRECTIVE)), using open source software and released to the end-users under a public license. RIAT+ is developed for Windows operating system. To apply RIAT+ in your Region at first you need to download RIAT+ installation kit (the software, the user guide, and the two regional test cases) from the OPERA website. RIAT+ is free of charge: only an end user license agreement (EULA) should be signed online. The license is automatically signed by a registered user as he download the RIAT+ from www.operatool.eu. Signing in everybody will be eligible to use further update of the RIAT+.

3 Introduction

Environmental problem addressed

Air Pollution remains one of the most important environmental issue in Europe as confirmed with the adoption by the European Parliament of the resolution on the Thematic Strategy on Air Pollution which aims to attain levels of air quality that do not give rise to significant negative impacts on, and risks to human health and environment. However in spite of application of the current legislation devoted to air pollution control, some regions in Europe keep pollutant levels damageable to human health and to ecosystems. This is the case of the Po-Valley where the combination of high population densities, high emission densities and poor meteorological dispersion lead to adverse impact on population due to high levels of fine particulate matter (PM 2.5) and on ecosystems due to high levels of ozone and eutrophication. Although less dramatic air pollution problems are encountered in the Alsace region, the high population density in the Upper Rhine valley, the important traffic fluxes across three countries (France, Germany and Switzerland) as well as the presence of important industrial areas (Ruhr region in the north east and the Basel area in the south) generate a deterioration of the air quality which results in frequent exceedances of the limit values for particulate matter and ozone compounds.
The importance of long-range transported air pollution in the Emilia Romagna is different than in the Alsace region but a combination of local, national and international measures is necessary to reduce adverse effects of poor air quality in these two regions.

Objective of the project

The objective of this project is to develop and apply a methodology to assess the efficiency of locally planned abatement measures, which remain coherent with national and international frameworks.
Each action in the Air Quality Plan could be evaluable both in terms of air quality benefits and in terms of costs. The goal is to maximize the environmental benefits at fixed costs, or minimize costs at fixed environmental benefits. RIAT+ should support the understanding of how the pool of the actions chosen could be correctly mixed and implemented to reduce the air pollution considering the budget assigned and obtaining the maximum reduction effectiveness of the plan itself.

Description of the technical / methodological solution

The project developed a software, RIAT+, being a tool based on an integrated assessment modeling approach, that may be used by a regional authority to determine emission policies or to allow discussion and negotiations among groups of stakeholders.

Expected results and environmental benefits

A methodology and tool (RIAT+) to support local authorities in designing and assessing efficient air quality plans with the best ratio cost/effectiveness
Test RIAT+ application to Emilia Romagna and Alsace and assessment of air quality plans in these two regions.

Expected longer term results

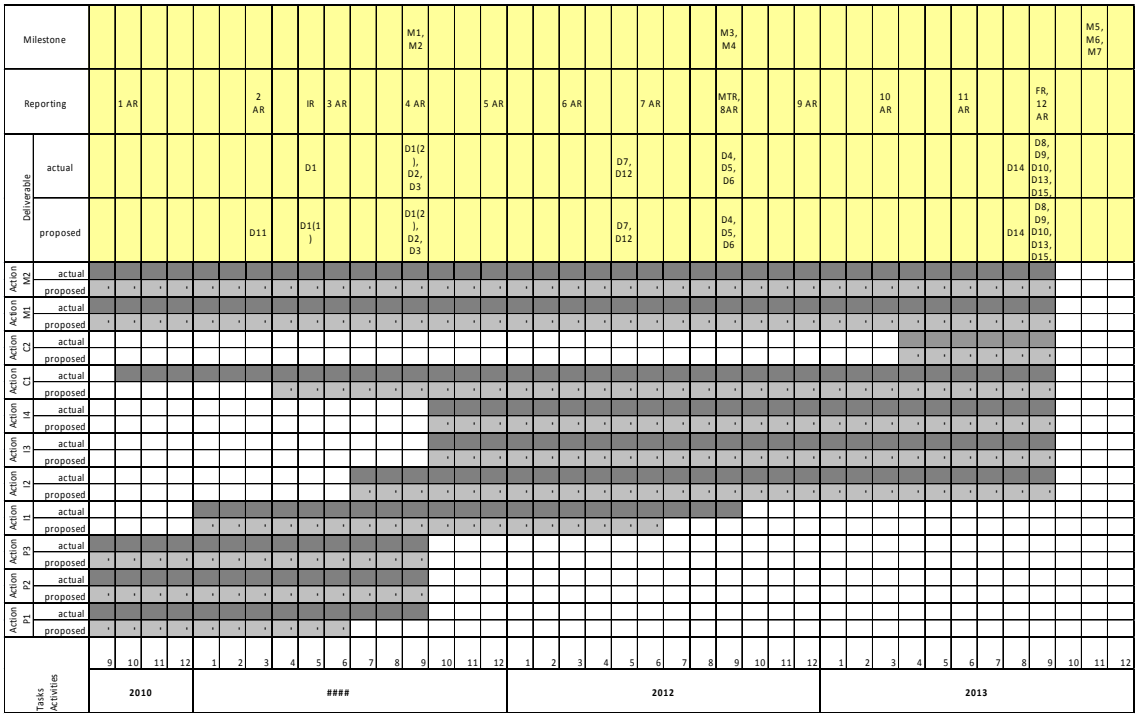
Air quality plans involving less cost for better pollutant reductions will let European local authorities reduce air pollution in a more efficient, integrated and successful way.

4 Administrative part

Description of the management system

The project has been realised considering different phases that could be managed in a parallel or sequential way. A first phase is done achieving all the data required and at the same time making a review of the actual situation considering air pollution, national and local legislation in order to check the requirement of the software to develop. Three preparatory actions were performed:
P1 - Review of existing plans and methodologies, identification of requirements.
P2 - Data collection for the Italian case study
P3 - Data collection for the French case study
The first action was performed through direct consultation with European, national and local institutions responsible for air quality planning and this was done during the First Opera Conference on June 2011. It aimed identifying strengths and weaknesses in the currently available methodologies and at proposing a set of requirements to improve them. The next bunch of action leaded to the creation of all the databases required for let the RIAT+ software working on the Regione Emilia-Romagna and Alsace Territory. P2 and P3 actions addressed this specific item.
The core of the project was the improvement of existing tools and their implementation, which can be summarized by four main actions:
I1 - RIAT+ methods and design
I2 – RIAT+ software implementation
I3 - Application to Emilia Romagna (I) region
I4 - Application to the Alsace (F) region
All the activities involved an Action Manager that was performed by one of the partner of the project. The action, M1 and M2, management actions, were introduced in order to be sure that the project would have flown in the right way. We also establish a a two levels management: the first one for General Management, under the responsibility of the Co-ordinator Mr de'Munari, and the second one for Technical Management under the responsibility of the Technical Manager Mr. Marco Deserti where all the action manager were represented that has the responsibility of setting up the detailed plans of activity, to approve the technical deliverable, to address problem solutions and check time table realization. Mrs Volta that coordinates the Steering Committee has the task of evaluating the correct application of the end users requirements and requests considering its composition that involved Regione Emilia-Romagna, Aspa - Association pour la Surveillance et l'étude de la Pollution atmosphérique en Alsace (Fr) and JoinResearch Centre - Institute for Environment and Sustainability (JRC-IES) authorities. Every 4 month we perform a Technical Meeting and each year we had a Steering Committee meeting. Each meeting has a minute approved by all the members that resume decision and action to be made.
The design of the system and the software development were realized following EU standards on data exchange (Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community (INSPIRE DIRECTIVE)), using open source software and released to the end-users under a public license.

The main focus of the project was to ensure the versatility of the approach and in particular the possible application of the methodology to other locations all over Europe. The two local applications considered were therefore aimed to test the methodology and tool and to finalize the technical documentation and application guidelines.
All actions were scheduled as reported in the following chronogram.



On accounting and administrative system used, we decided of requesting all partners to provide timesheets, invoices and expenditure receipt each 4 months. we got both on paper and on electronic file. Time sheets used are those indicated in the LIFE+ web site, with a number of hours worked per calendar day. Invoices related to the present project are marked with the OPERA stamp, and are validated by the OPERA Auditor.
Each Technical meeting we share some info or request on the administrative part too so each minute meeting helps focusing not only on the technical side but make the administrative monitoring more tight. All financial transactions between the coordinating beneficiary and the partners took place regularly with bank transfers, according to the bank data that the partners have submitted to ARPA Emilia-Romagna.
Financial reporting has been implemented by ARPA Emilia-Romagna with the data provided by all the partners, on a regular and continuous basis.

Partners and Functions

Agenzia Regionale per la Prevenzione e l´Ambiente dell´Emilia-Romagna (Regional Agency for Environmental Protection in Emilia-Romagna) - Arpa

is an environmental control technical support body to the regional, district and local authorities and is administratively and technically independent. Arpa develops and promotes control and prevention supporting local and regional governative in order to

plan and govern environment. Main of the activities of ARPA-ER are focused on technical measurements of environmental pollution (air, waste, water etc) and to support the policy makers. Arpa also collaborates with the Italian Agency for the Environment and Territory, the European Environmental Agency and Italian, European and international institutes and research centres. Arpa Emilia-Romagna has develop a special focus on Air Quality monitoring, forecasting, evaluation and managing.

Università di Brescia – (University of Brescia) UNIBS

The Environmental System Modelling and Assessment (ESMA) research group (http://automatica.ing.unibs.it/esma/esma.html) works at the Department of Electronics for Automation of the University of Brescia. The ESMA team scientific work mainly deals with air quality modelling and management, in particular concerning a) emission control strategies using Eulerian 3D models, b) forecast and alarm systems and c) methodologies to select optimal air quality control policies, through cost-efficient / multi-objective optimization techniques. Present research activities are mainly performed within the following scientific environments: EU Network of Excellence ACCENT, Atmospheric Sustainability and Transport and Transformations (http://www.accent-network.org/portal/science), EU Network for Integrated Assessment Modelling (NIAM, http://www.niam.scarp.se/**), /),** UNECE TFIAM, APPRAISAL FP7 project.

Terraria - TA

TerrAria has the aim to join IT (Information Technology) with environmental expertise on deterministic and stochastic modelling. During these years TerrAria has developed several decision support systems applied to environmental sector. TerrAria's IT sector is focused on developing tools and web based geographical information system based on open source platform such as java platform and web-services technology, which ensure a high level of modularity, scalability and fast access performances. TerrAria's environmental sector is focused on the implementation of environmental model, both interesting emission inventory and air quality impact.

Centre National de la Recherche Scientifique (National Center for Scientific Research) – CNRS

The CNRS (National Center for Scientific Research) is a government-funded research organization, under the administrative authority of France's Ministry of Research. As the largest fundamental research organization in Europe, CNRS carried out research in all fields of knowledge.
The project involves researchers from unity ERL7230 (Laboratoire Image, Ville, Environnement) of the CNRS which studies urban processes linking social and spatial aspects. The research topics include urban management, environmental risks (especially air pollution modelling), risks management and quality of life. It has been involved in the project "Benefits of Urban Green Space" (BUGS, 2001-2004, EU 5th FWP) co-ordinated by the VITO.

Universitè de Strasbourg (University of Strasbourg) - UNISTRA

University of Strasbourg currently has a partnership with CNRS in the unit ERL7230, called LIVE (Laboratoire Image, Ville, Environnement). LIVE is actually a Joint Research Unit (JRU) constituted by the Centre National de la Recherce Scientifique (CNRS) and Université de Strasbourg (UNISTRA). Inboard Live Unistra manage the

research group "air pollution and urban climate" where developed an hight expertise in hysical chemistry of the atmosphere and Numerical modeling of the atmosphere (meteorology and reactive transport). Among activities are the project FRAME-GREEN a study of the ecological role of vegetation in urban areas and PIRVE (2008-2011) a study of vulnerability and resilience to climate change in urban environments.

ACTIONS		ACTION MANAGER	BENEFICIARY
P1	RIAT+ requirements	Pamela Ugolini	Arpa
P2	Data collection for ER	Paolo Veronesi	Arpa
P3	Data collection for Alsace	Nadège Blond	CNRS/UNISTRA
I1	RIAT+ methods and design	Marialuisa Volta	UNIBS
I2	RIAT+ software implementation	Giuseppe Maffeis	TA
I3	ER application	Michele Stortini	Arpa
I4	Alsace application	Nadège Blond	CNRS/UNISTRA
C1	During project communication	Giuseppe Maffeis	TA
C2	After Life+ communication	Giuseppe Maffeis	TA
M1	Project Management	Eriberto de'Munari	Arpa
M2	Monitoring project effectiveness	Eriberto de'Munari	Arpa

Description of changes due to amendments to the Grant Agreement.

During the first Steering committee on 05/10/2010 meeting CNRS introduced the opportunity of involving the University of Strasbourg in the project. This choice has been be successful due to the mix of the theory knowledge on air quality models developed by Prof. A. Clappier of University of Strasbourg that help us choosing the best modeling configuration for Alsace requirements, and the computational skills in charge of the UNISTRA engineer that were successful for implementing all the equations needed to model the air quality scenarios. The including of this two new staff member, at the end, let us develop a better modeling wire frame for the Alsace application of Riat+ due to the opportunity of involve into the project all the resources provided by the LIVE (Laboratoire Image, Ville, Environnement), with results that hardly could be obtained without this. LIVE is a Joint Research Unit (JRU) constituted by the Centre National de la Recherce Scientifique (CNRS) and the University of Strasbourg (UNISTRA). The amendments was approved by EC and signed on September 30th 2011.

RIAT+ Software License Managing

A special focusing was done to manage the RIAT+ License for developing and end-user utilization. This was due both because we need to let the final user to use freely RIAT+ and because UNIBS and Terraria developed for Join Research Centre - Institute for Environment and Sustainability (JRC-IES) a first release of RIAT. So even if the RIAT+ was completely rewritten for a new and better performing software the original code is owned by JRC-IES. JRC-IES grants the partner of a free license for modifying and developing new codes in order to get RIAT+. All the partners plus JRC-IES agreed to give all the users a free license for using the software but not for modifying it. The license is automatically signed by a registered user as he download the RIAT+ from www.operatool.eu.

Evaluation of the management system

Since the beginning in September 2010 the project was running on a regular basis. Even though this required some time table modification because during the works some

actions needed some additional work to be completed even if this doesn't affect the overall project status due to the parallel approach used in the project design. The main modifications on the project timetable where three:

1. The D1 deliverable addendum, completed in September 2011, not inserted in the original project timetable, that was stated and created in order to add to the RIAT+ requirements, more hints deriving from the First Opera Conference in Bologna, June 2011, and from the web survey that started after the conference and ended at the end of September.
2. The Second Opera Conference was held in Strasbourg on 15th November,2012, instead of June 2012. That modification is due to wronged stated on June 2012 without any chance to present the progresses on the RIAT+ design and testing on the French area data as appears considering all the timetable of the referring actions. Considering the results of the First Conference we think we shouldn't miss such an opportunity to gather important data from all the technician and the policy maker joined together at the same time without having all the items needed.
3. The third Conference was delayed from June to September 2013 in order to present the results of the project together with the Emilia-Romagna Air Quality plan that was done using RIAT+ and Opera Tools. In order to achieve this we need some rearranging scheduling in the final version of RIAT+ timeline that doesn't influence the final results of the project but on the contrary give it some more strength due to the opportunity of talking about a real life test.

As reported in the inception report all the timing of the project was changed, but mostly because a misunderstanding made at proposal stage, where we planned the overall project duration within month 36 instead of month 37 (which is the correct deadline according to the end of the project stated in the GA: September 30th2013, i.e. month 37) and the deadlines of deliverables and milestones as KO+ n of months, with KO = "month 1", so all the deadlines should be considered with these assumptions.

We'd like also to note that the 4 monthly Progress Report originally stated has to be considered as an Internal Activity Report as described on action M2. In fact, as discussed during the Monitoring Team Audit, these are agreed that that these reports are internal to the project. We stated that the Technical Committee Minutes had to be considered the Activity Report we talk in our proposal and they had to summarize the progress of the actions.

We need to remark that all the partner strongly work in order to let the project be on time. Arpa Emilia-Romagna and LIVE (CNRS/UNISTRA) has constantly worked side by side with their Stakeholder, Regione Emilia-Romagna and Aspa, while UNIBS and Terraria has being in contact with JRC, Join Research Centre of European Community at Ispra, in order to define and set all the requirements to let the Opera Team work on the JRC RIAT tool.

The Opera Team work hardly on communication and dissemination too, performing various lectures during Meeting and Conference but especially networking technician and policy makers before and during the three Project Conferences that lead to a participation of almost 80-100 qualified person each one that share hints and suggestion about the project giving it some more added value. All this lead to the participation of the Opera Project to the Green Week 2013 in Brussels with a stand who gather the attention of a lot of participants but especially of the EC team that appreciated and endorsed the work done in order to make it more known outside Italy and France.

Nothing to highlight considering the communication between the Project Team and the European Commission even if, if I should stress anything, I had to say that EC take a considerable amount of time to approve the amendment of the grant agreement that let UNISTRA work on the project and this would have been a problem if the UNISTRA didn't decide to work on the project even if nothing officially was already released.

As last consideration but not least I would really thanks the Timesis Auditors, Agnese Roccato, but also Saida Feresin, for their support and problem solving approach that help us managing the project at the best.

5 TECHNICAL PART

All the actions performed were discussed and illustrate in a specific deliverable available as an annex of the electronic copy of this report and together with the data produced on the "project data and documentation repository".

ACTIONS AND DELIVERABLE PRODUCTS OF THE PROJECT

Action	Name of the Deliverable
P1	D1 – RIAT+ requirements D1 – RIAT+ requirements-ADDENDUM
P2	D2 – Emilia Romagna preparatory data
P3	D3 – Alsace preparatory data
I1	D4 – Methodology and technical guide
I3	D5 – Emilia Romagna RIAT+ input
I4	D6 – Alsace RIAT+ input
I2	D7 – RIAT+ prototype
I2	D8 – RIAT+ final version and user guide
I3	D9 – Emilia Romagna action plan built with RIAT+
I4	D10 – Alsace action plan built with RIAT+
C1	D11 – Web site
C1	D12 – 1st Opera Conference - Gathering the requirements
C1	D13 – 2nd Opera Conference - RIAT+ Beta version check
C1	D14 – Opera Final Conference - RIAT+ (1.0 version) release
C1	D15 – Layman's report
C1	D16 – Informative panels
C2	D17 – After LIFE+ plan

5.1. TECHNICAL PROGRESS, PER TASK

ACTION P1 - Existing plans and methodologies, RIAT+ requirements

The goal of this action has been to provide a set of requirements to further develop the RIAT system and interface it in a consistent way with already available tools and modules, to support the development of regional policies aimed at delivering cost-effective and efficient solutions for problems such as the improvement of ambient air quality and global climate change.

The following activities have been performed:

- Analysis and classification of databases and decisional models available in the air quality/climate change field.
- Analysis and classification of databases and techniques to manage dose-response functions for morbidity and mortality, to evaluate secondary pollution population exposure.
- Interviews of Alsatian decision makers after presentations of the OPERA project and the RIAT model to collect their point of view on the methodology and their requirements. Following institutes have been interviewed: City of Strasbourg & Mulhouse; Experts involved in the Regional Air Quality Plan; Urban planning agency; ASPA.

All the requirements for the RIAT+ are completely defined. In order to manage correctly the output of the First Conference, we decided to postpone the ending of this

action in order to develop D1 ADDENDUM receipting the suggestion we gather during the conference.

The activities and results are fully described in the deliverable "D01_RIAT+ Requirement" and "D01_RIAT+ Requirements" ADDENDUM available as annexes of this report and on "project the data and documentation repository".

ACTION P2 – Data collection in Emilia-Romagna

This action was aimed at collecting all the data needed to apply the Air Quality Integrated Assessment Model, RIAT+, to the Emilia Romagna Region. Different datasets have been produced in order to prepare technological and non-technological measures database and the needed input data (emissions, meteorology, boundary conditions) to compute Source-Receptor functions. The data has been mainly collected by ARPA. Input data needed for CTM simulation have been prepared using eFESTo a tool to manage emission inventory and emission gridding and other tools to provide speciated hourly emission data.

The following sub actions have been performed:
- Production of the basecase emissions for CTM application at European scale (Action P2.1)
- Production of the emission inventory 2005 with areal and punctual emissions on the defined domain (Action P2.1)
- Production of the basecase emissions for CTM application at regional scale (Action P2.1)
- Production of the meteorological data for CTM application (Action P2.1)
- Production of the boundary conditions for CTM application (Action P2.1)
- Construction of the Technical Measures database (Action P2.2 and P2.3)
- Construction of Non Technical Measures database (Action P2.2 and P2.3)
- Construction of the mapping (P2.1-3)

These data are available:
- at the OPERA ftp location ftp.terraria.com accessible through password for mapping, TM and NTM;
- at a ARPA EMR local server for CTM input data (emissions, meteorology, boundary conditions. The data are available on request of partners or EC.

The data set is described in the deliverable D2 available as an annex of this report and on the "project data and documentation repository".

ACTION P3 – Data collection in Alsace

This action aimed at collecting all the data needed to apply the Air Quality Integrated Assessment Model, RIAT+, to the Alsace Region. Different datasets have been produced in order to prepare technological and non-technological measures databases and the needed input data (emissions, meteorology, boundary conditions) to compute Source-Receptor functions. Data has been mainly collected by ASPA, the Alsatian Air Quality Agency, subcontractor of CNRS partner in the OPERA project. Input data needed for CTM simulation has been prepared using a series of models, Emiss'air,

Manag'air and the Air Quality modeling system Atmo~RhenA (based on the CNRS tool, MM5-WRF/CHIMERE), which respectively have been designed by ASPA to manage emission inventory, speciation and emission gridding, and air quality modeling in Alsace. CNRS and UNISTRA controlled the data set by performing a series of meteorological and Air Quality simulations with the new WRF/CHIMERE version, and comparisons of the simulations with observation data (Meteo-France and Air quality measurements).

The following activities have been performed:

- Production of the basecase emissions for CTM application at European scale (Action P3.1)
- Production of the emission inventory 2005 with areal and punctual emissions on the defined domain (Action P3.1)
- Production of the basecase emissions for CTM application at regional scale (Action P3.1)
- Production of the meteorological data for CTM application (Action P3.1)
- Production of the boundary conditions for CTM application on Western Europe and France (Action P3.1)
- Production of the boundary conditions for CTM application on Upper Rhine area (Action P3.1)
- Construction of the technical measures database (Action P3.2 and P3.3)
- Construction of the non-technical measures database (Action P3.2 and P3.3)
- Construction of the mapping (P3.1-3)

The data are available:

- at the OPERA ftp location ftp.terraria.com accessible through password for mapping, TM and NTM;
- at a LIVE (CNRS/UNISTRA) local server for CTM input data (emissions, meteorology, boundary conditions. The data are available on request of partners or EC.

The data set is described in the deliverable D3 available as an annex of this report and on the "project data and documentation repository".

ACTION I1 – RIAT+ methods and design

The goal of this action is to design the RIAT+ system, harmonizing the integrated assessment model approach with the requirements identified in Action P1 (Requirements analysis, existing plans, methods and tools).
RIAT+ new formalization and architecture aim is to incorporate in RIAT the user requirements list that has been drafted after the first OPERA Conference, and after the Web Survey filled by various stakeholders. The full list has been at first presented in the "Deliverable D1, RIAT + requirements", and then reorganized and restructured in the "Deliverable I1, Methodology and technical guide".

In particular, the requirements (Action I1, Task 1 and Task 3) implemented in RIAT+ final version are related to:

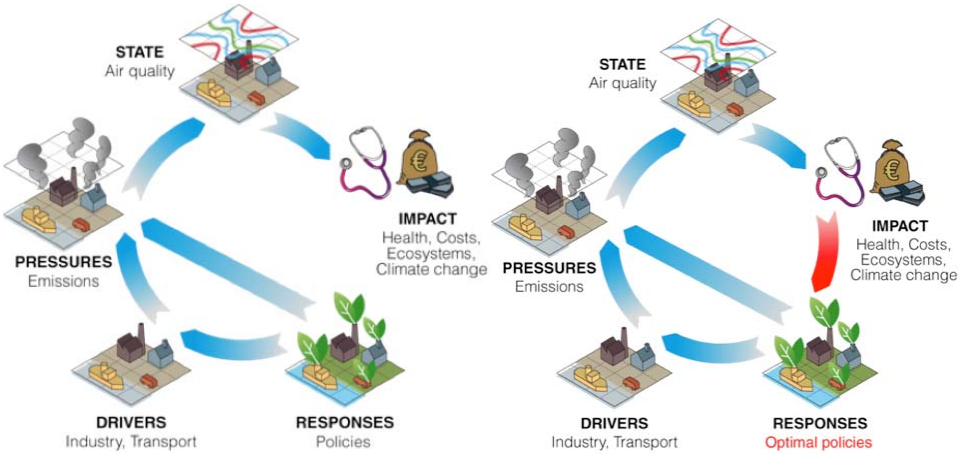
- Internal cost constraints,

- budget constraints,
- seasonal air quality indexes,
- extension to new air quality indexes,
- new air quality indexes aggregation methods,
- code generalization to a generic regional domain,
- traffic management,
- multi-pollutant configuration.
- greenhouse gases management,
- non-technical measures,
- population exposure,
- health effects,
- external costs.

The requirements included in the final version of the tool, fully described in deliverable I1, define the decision problem as follow.

The methodology foresees two possible decision pathways, which can be easily interpreted in the light of the classical DPSIR (Drivers-Pressures-State-Impacts-Responses) scheme, adopted by the EU:

- scenario analysis (Task 3). This is the approach mainly used nowadays to design "Plans and Programmes" at regional/local scale., Emission reduction measures (Policies) are selected on the basis of expert judgment or Source Apportionment and then they are tested through simulations of an air pollution model. This approach does not guarantee that cost-effective measures are selected, and only allows for "ex-post evaluation" of costs and other impacts.
- optimization approach (Task 1-2). This pathway indicates the most cost-effective measures for air quality improvement by solving an optimization problem. In other words, the approach allows for the computation of the efficient set of technical (end-of-pipe) and non technical (energy efficiency) measures/policies to be encouraged and/or introduced to reduce pollution, explicitly considering their impacts and costs.



scenario analysis approach **optimization approach**

Scenario analysis

The scenario analysis approach allows to assess the variations of the air quality indexes due to the application of a set of policies chosen a priori by the user. The problem can be formalized as follows:

$$AQI_n = f(E(\theta)) \quad with\ n = 1,\dots,N$$

where:
E represents the precursor emissions;
$AQI_n(E(\theta))$ are the Air Quality Indexes concerning different pollutants. Each Index depends on precursor emissions through emission reductions;
θ is the decision variable set constrained to assume values in the feasible set. The decision variable set includes:

- for the *detailed approach*, the application rates for each reduction measure. They are constrained to assume values between CLE and MFR values. In this case the AQI computation is similar to an evaluation of the objective function performed during the optimization procedure (see the following section)
- for the *lumped approach*, the emission reductions for each pollutant in each macrosector. These variables are constrained to assume values in the emission range of the surrogate models.

For the detailed approach, the scenario analysis can also estimate the costs associated to the application of the selected reduction measures and, for both approaches, the population exposure costs.

Optimization approach

In this section the multi objective optimization methodology is formalized. The cost effectiveness case is a particular case of the multi objective optimization, in which a unique point of the Pareto curve, given a budget for technologies application, is computed; for this reason, it does not deserve a separate formalization.
A **multi objective** problem consists of a number of objectives to be simultaneously optimized while applying a set of constraints. The problem can be formalized as follows:

$$\min_{\theta}[f_o(\theta)], \quad with\ o = 1,\dots,O_{obj}$$

subject to:

$$\theta \epsilon \Theta$$

where f_o is the *o*-th objective function,

- O_{obj} is the number of the objectives,
- θ is the decision variable set (namely the emission reduction measures) constrained to assume values in Θ (the feasible decision variable set).

The target of this problem is to control secondary pollution at ground level. The solutions of the multi objective problem are the efficient emission control policies in terms of air quality and emission reduction costs. The problem can be formalized as follows:

$$\min_{\theta} J(E(\theta)) = \min_{\theta} [AQI_n(E(\theta)) \;\; intC(E(\theta))], \;\; with \; n = 1, \dots, N$$

where

- E represents the precursor emissions;
- $AQI_n(E(\theta))$ are (maximum N) Air Quality Indexes concerning different pollutants;
- $intC(E(\theta))$ represents the internal (emission reduction) costs.

All the objectives depend on precursor emissions through, as already said, emission reductions. The decision problem complexity can then be reduced to two objectives, considering just a single Air Quality Index (AQI) obtained as a linear combination of the various Air Quality Indexes AQI_n (plus the Cost index). These various AQIs can be aggregated through linear combination of normalized AQIs, using these two configurations:

- with "user-defined" weights (the user defines the relative importance of the AQIs, providing weight values between 0 and 1 for each AQI);
- with the so-called "fairness" approach (an automatic approach that balances the relative importance of the AQIs).

Finally, the previous equation can be re-written as:

$$\min_{x \in X} J(x) = \min_{x \in X} [AQI(x) \;\; intC(x)]$$

where x is a vector containing the application rates of the reduction measures, constrained to be included in the feasible set X.

The multi objective optimization problem is solved following the ε-*Constraint Method*: just the Air Quality objective is minimized, while the Internal Cost objective is included in the set of constraints. In this configuration, the multi objective approach has the same features of the *cost-effectiveness analysis,* where the Figure of Merit is:

$$\min_{x \in X} J(x) = \min_{x \in X} AQI(x)$$

and the second objective is included in the constraints:

$$intC(x) \leq L \qquad 0 \leq L \leq \bar{L}$$

where L can assume different values in the defined range. In this way, a set of effective solutions is computed and a Pareto curve can be drawn.

The **cost effectiveness** approach is thus the solution of the above problem for a specific value of L.

Air Quality objective

The Air Quality objective may consider the following indexes:

- mean PM10 concentration;
- mean PM2.5 concentration;
- SOMO35: ozone concentrations accumulated dose over a threshold of 35 ppb;
- AOT40: ozone concentrations accumulated dose over a threshold of 40 ppb;
- MAX8H: maximum 8-hour running average ozone concentrations;

- NOx mean value;
- number of times that PM10 daily threshold is exceeded (this index is computed applying a linear relation that transforms the "PM10 yearly average" in "daily number of exceedances").

All the indexes can be computed over different domains, and can be related to yearly, winter (October-March) or summer (April-September) periods. More in general, the implemented approach considers the use of different time intervals for AQI temporal aggregation. While the yearly time interval (TI1) is compulsory, other two time intervals (named "TI2" and "TI3") are optional.

The relationship between the decision variables and the indexes is modelled by linear models or Artificial Neural Networks – ANNs (except for the "number of times that PM10 daily threshold is exceeded"), identified processing long-term simulations of a CTM model. Starting from the local value, computed cell by cell, an aggregation function is applied, to get the scalar variable (AQI) that has to be optimized. Such an aggregation function has to be selected among the following:
- spatial Average;
- population weighted average;
- number of cells over threshold.

Emission reduction costs

The emission reduction costs are calculated first for each sector-actvity:

$$C_{k,f} = \sum_{t \in T_{k,f}} C_{k,f,t} \cdot A_{k,f} \cdot X_{k,f,t}$$

where:
- $C_{k,f,t}$ are the technology unit costs [Meuro] for sector, activity, technology *k,f,t*;
- $C_{k,f}$ are the total cost [Meuro] for sector, activity *k,f*;
- $A_{k,f}$ is the activity level for the defined sector-activity;
- $T_{k,f}$ are the technologies that can be applied in a defined sector activity;
- $X_{k,f,t}$ are the application rates of the technologies acting in the sector-activity *k,f*.

Then, the total internal costs [Meuro] is computed as:

$$C = \sum_{k,f} C_{k,f}$$

Decision variables

The decision variables are the application rates of the emission reduction measures. In particular, the two possible decision variables considered in this formalization are technical measures (as i.e. end-of-pipe technologies) and efficiency/non-technical measures (as i.e. behavioural changes).
More in detail, the following definitions (for technical and non-technical measures) are adopted:
- technical measures are the so-called "**end-of-pipe-technologies**", i.e. filters that are applied to power plant emissions, to cars, etc.. These measures neither modify the

driving forces of emissions nor change the structural composition of energy systems or agricultural activities, but are applied to reduce emissions before being released in the atmosphere;

- non-technical measures or **energy efficiency measures** are measures that reduce anthropogenic driving forces that generate pollution. Such measures can be related to people behavioural changes (for instance: the use of bicycle instead of cars for personal mobility, the reduction of temperature in buildings) or to technologies that aim to reduce the energy demand (urban/regional structural planning like densification, road management, building renovation), or to abate the fuel consumption (for instance: the use of high efficiency boilers, of building thermal insulating coats).
-

Applying these measures, the reduced emissions is computed as follows:

$$E_{k,f,p} = \sum_{t \in T_{k,f}} (A_{k,f} \cdot ef^{p}_{k,f}) X_{k,f,t} \cdot eff^{p}_{k,f,t} + \sum_{t \in Z_{k,f}} (A_{k,f} \cdot ef^{p}_{k,f}) Z_{k,f,t} \cdot eff^{p}_{k,f,t}$$

where:

- variable $X_{k,f,t}$: is the application rate (bounded in $[\underline{X}_{k,f,t}; \overline{X}_{k,f,t}]$) of technical measure *t* to sector *k* and activity *f;*
- variable $Z_{k,f,t}$: is the application rate (bounded in $[\underline{Z}_{k,f,t}; \overline{Z}_{k,f,t}]$) of non-technical measure *t* to sector *k* and activity *f;*
- $A_{k,f} \cdot ef^{p}_{k,f}$: is the pollutant *p* emission due to sector *k* and activity *f*;
- $X_{k,f,t} \cdot eff^{p}_{k,f,t}$: is the overall technical measure *t* removal factor with respect to sector *k*, activity *f* and pollutant *p*;
- $Z_{k,f,t} \cdot eff^{p}_{k,f,t}$: is the overall non-technical measure *t* removal factor with respect to sector *k*, activity *f* and pollutant *p*.

The total emission reduction for a pollutant *p*, due to the application of a set of measures, can be calculated as the sum of the emission reductions over all the <sector-activity> pairs:

$$E_p = \sum_{k,f} E_{k,f,p}$$

The Air Quality objective is a function of the emission reductions and, thus, of the technical and non-technical measure application rates.

The emission reductions are computed beyond the CLE scenario. It is important to note that the CLE scenario is estimated starting from the emissions at an initial year if no technology had been applied. Such “no technology” scenario is defined in this report as "virtual emissions”.

The selection of the technologies to be optimized is done through a dedicated flag (for each technology, in fact, the user can select if they must be kept fixed at the Current

Legislation level, or if they can be optimimized). Furthermore, to speed up the computations, "not efficient" technologies are automatically excluded by the optimization, and kept fixed to CLE[1].

Constraints

The first constraint concerns the internal cost (for emission reduction implementation), which cannot be greater than the available budget *L*.
The Internal Cost objective is the total cost to apply the selected measures at the selected rates. As previously introduced, $c_{k,f,t}$ is the internal cost of applying measure $t \in T_{kf} \cup NT_{kf}$ to a unit of sector-activity *k, f*. The total units of activity to which technology t can be applied is given by $A_{k,f}\, X_{k,f,t}$ and $A_{k,f}\, Z_{k,f,t}$ for technical and non-technical measures, respectively.
Thus, the internal costs [Meuro/year] are calculated as:

$$intC(X,Z) = \sum_{k\in K}\sum_{f\in F_k}\sum_{t\in T_{k,f}} (X_{k,f,t}A_{k,f})c_{k,f,t} + \sum_{k\in K}\sum_{f\in F_k}\sum_{t\in NT_{k,f}} (Z_{k,f,t}A_{k,f})c_{k,f,t}$$

The constraint is thus the following:

$$intC(X\ ;Z\ ) \le L$$

The following constraints hold for technical measures.

1. When no technological substitution is admitted, the following constraints are defined:
   to ensure the application feasibility:

$$X^{CLE}_{k,f,t} \le X_{k,f,t} \le \bar{X}_{k,f,t} \quad \forall\, k \in K, f \in F_k, t \in T_{k,f};$$

   to ensure the mutual exclusion of the technical measures application (for each activity and each primary pollutant, i.e. for each activity and each precursor, the sum of all the application rates must be less than one):

$$\sum_{t\in T_{k,f}\,|\,eff^{p}_{kft}>0} X_{k,f,t} \le 1 \quad \forall\, k \in K, f \in F_k, p \in P\ ;$$

   it is worth observing that these constraints imply the so called "conservation of mass" associated with the application of the technical measures (for each activity and each primary pollutant, i.e. for each activity and each precursor):

$$\sum_{t\in T_{k,f}\,|\,eff^{p}_{kft}>0} X_{k,f,t}\, eff^{p}_{kft} \le 1 \quad \forall\, k \in K, f \in F_k, p \in P\ .$$

2. When technological substitution is admitted, the following constraints are applied:

[1] Technologies are defined as "not efficient": a) when the maximum feasible emission reduction associated to a technology is less than 10^{-6} tons; b) when CLE and MFR for that technology assume the same value.

- to ensure the application feasibility:

$$0 \leq X_{k,f,t} \leq \bar{X}_{k,f,t} \quad \forall k \in K, f \in F_k, t \in T_{k,f};$$

- to ensure the mutual exclusion of technical measures application (for each activity and each primary pollutant, i.e. for each activity and each precursor):

$$\sum_{t \in T_{k,f} | eff_{kft}^{p} > 0} X_{k,f,t} \leq 1 \quad \forall k \in K, f \in F_k, p \in P;$$

- to ensure that the emission reduction achieved according to the optimal solution are at least those guaranteed by the application of the technologies imposed by the Current LEgislation (for each activity and each primary pollutant):

$$\sum_{t \in T_{k,f} | eff_{kft}^{p} > 0} X_{k,f,t} \cdot eff_{k,f,t}^{p} \geq \sum_{t \in T_{k,f} | eff_{kft}^{p} > 0} X_{k,f,t}^{CLE} \cdot eff_{k,f,t}^{p}$$

$$\forall k \in K, f \in F_k, p \in P;$$

- to ensure that the emissions controlled according to the optimal solution are at least those controlled applying the technologies at the lower bounds imposed by the Current LEgislation:

$$\sum_{t \in T_{k,f} | eff_{kft}^{p} > 0} X_{k,f,t} \geq \sum_{t \in T_{k,f} | eff_{kft}^{p} > 0} X_{k,f,t}^{CLE} \quad \forall k \in K, f \in F_k, p \in P.$$

Concerning non-technical measures:

- to ensure the application feasibility:

$$Z_{k,f,t}^{CLE} \leq Z_{k,f,t} \leq \bar{Z}_{k,f,t} \quad \forall k \in K, f \in F_k, t \in NT_{k,f}.$$

Moreover, when both technical and non-technical measures are applied, the global conservation of mass constraints have to be stated explicitly (for each activity and each primary pollutant):

$$\sum_{t \in T_{k,f} | eff_{kft}^{p} > 0} X_{k,f,t} eff_{kft}^{p} + \sum_{t \in NT_{k,f} | eff_{kft}^{p} > 0} Z_{k,f,t} eff_{kft}^{p} \leq 1$$

$$\forall k \in K, f \in F_k, p \in P$$

When required, additional constraints are added to manage macrosector budget constraints, and to keep consistency for traffic measures applied to different road types (highway, extraurban, urban).

When macrosector budget constraints have to be imposed, the following inequalities are added to the model:

$$inC(X_{k,f,t}^{i}; Z_{k,f,t}^{i}) - inC(X_{k,f,t}^{CLE,i}; Z_{k,f,t}^{CLE,i}) \leq \phi_i (inC(X_{k,f,t}; Z_{k,f,t}) - inC(X_{k,f,t}^{CLE}; Z_{k,f,t}^{CLE})) \quad i \in \tilde{M},$$

where $\tilde{M} \subseteq M$ identifies the macrosectors whose budgets have to be bounded.

In order to keep consistency for traffic measures applied to different road types (highway, extraurban, urban) the following constraints are imposed :

$$X_{k',f,t} = X_{k'',f,t} \quad k' = H, k'' = E, f \in F_{k'} \cup F_{k''}, t \in T_{k',f} \cup T_{k'',f}$$
$$X_{k',f,t} = X_{k'',f,t} \quad k' = E, k'' = U, f \in F_{k'} \cup F_{k''}, t \in T_{k',f} \cup T_{k'',f}$$
$$X_{k',f,t} = X_{k'',f,t} \quad k' = H, k'' = U, f \in F_{k'} \cup F_{k''}, t \in T_{k',f} \cup T_{k'',f}$$

where *H*, *E*, *U* are the identifiers of the highway, extraurban and urban sectors, respectively. In this way, the values of the variables $X_{k,f,t}$ must be the same when these variables are associated with the same technical measure *t*, applied to the same activity *k*, which is performed in at least two sectors among highway, extraurban and urban.

Ex-post analysis: Exposure Cost computation

The Externe approach **(**Bickel et al., 2005) has been applied to compute health impacts and external costs (Task 1), due to PM10 exposure. More in detail, considering the PM10 maps resulting from optimal air quality policies, the following health impacts /external costs have been considered:

- Asthmatic adults and children
  - Bronchodilator usage
  - Cough
  - Respiratory problems
- Over 65 years-old
  - Hearth attack
- Children
  - chronic cough
- Adults
  - reduced activity
  - chronic bronchitis
- Total population
  - chronic mortality
  - hospital admission for respiratory problems
  - hospital admission for cardiovascular problems
- Over 30 years
  - Years of life lost

The equation to compute impacts is as follows:

$$h^m = \sum_{x,y} \gamma^m \cdot P_{x,y} \cdot \chi_{x,y}$$

Where:

- h^m is the morbidity indicator (m) cost;
- γ^m is the incidence of the indicator m;
- $P_{x,y}$ is the population exposed to PM10 pollution (population of children, adults …, depending on the selected health impact), at cell x, y;
- $\chi_{x,y}$ indicates the mean PM10 concentrations, at cell x, y.

The outputs produced by this ex-post analysis are (for each point of the Pareto curve):
- maps of impacts (years of lost life);
- total cost (over the domain) computed separately for morbidity and mortality.

Ex-post analysis: Greenhouse Gases computation

Also the GHG budget is computed ex-post, as a result of the optimal Air Quality policies application. Starting from the optimal application rates of emission reduction measures and from the activity level for each sector-activity, reduced GHG (beyond CLE) are computed. The GHG considered are the Kyoto protocol regulated ones, that is to say: CO2, CH4, N20, Fgas.
Starting from estimated activity level (A) for each sector-activity (k,f) the removed GHG emissions (g), due to optimal air quality policies, are computed as:

$$GHG_{k,f,g} = \sum_{t \in T_{k,f}} (A_{k,f} \cdot ef^{g}_{k,f}) \cdot X_{k,f,t} \cdot eff^{g}_{k,f,t}$$

Where all the various equation ingredients have already been explained. Finally, the total GHG reduced emissions (for GHG emission g) are defined as:

$$GHG_{g} = \sum_{k,f} GHG_{k,f,g}$$

Sensitivity analysis

In addition to the work declared for this action, a new task (Task 4) has been added in order to evaluate the sensitivity of the RIAT+ results with respect to the uncertainty affecting the emission data.
At first a set of optimizations to be performed is selected, based on a Design of Experiment technique, applying the Sobol number approach to sample in a quasi-random mode the emission variability space (considering a range of -/+10% in the emission uncertainty). Then the selected set of optimizations is run, perturbing the emission fields (as suggested by the Design of Experiment) and computing the resulting Air Quality Index, and optimal emission reductions. Finally, the results are aggregated and processed to analyse how the emission uncertainty affects the optimal solutions. This analysis provides a quantitative view of how the optimization results variability is affected by each single/combined input factor. Methodology and results are described in the updated version of the DEL I1, in the appendix 2.

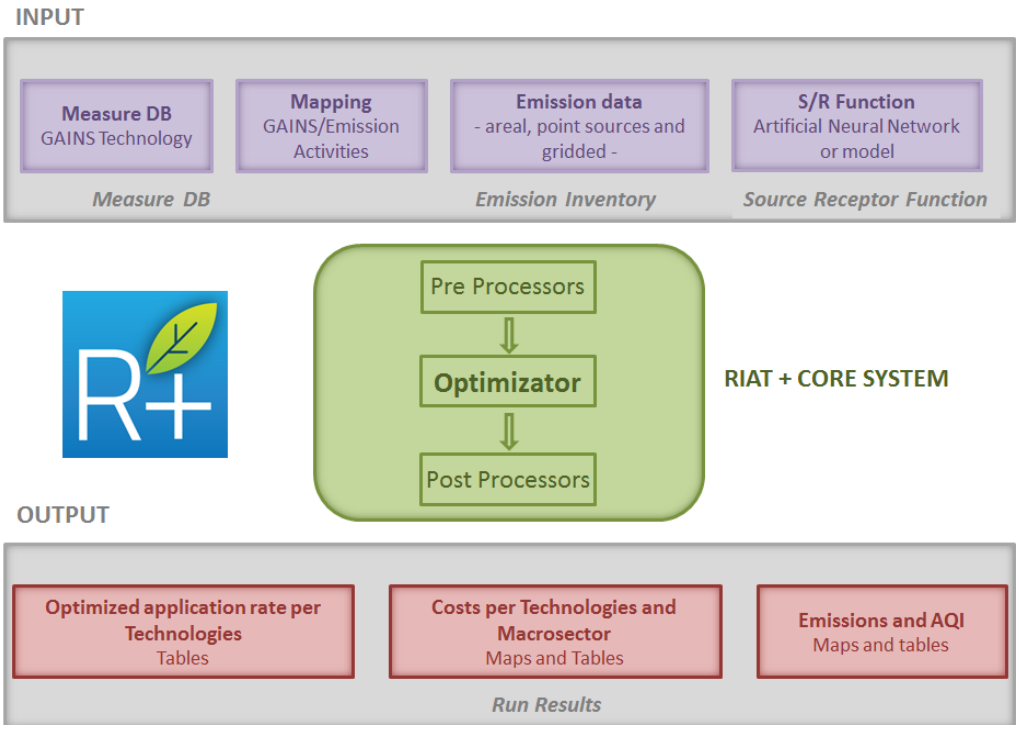
The data set is described in the deliverable D4 available as an annex of this report and on the “project data and documentation repository”.

ACTION I2 – RIAT+ software implementation

This action is focused on realizing RIAT+, the software tool, that implement OPERA methodology to support regional/local authorities in the definition, application and evaluation of air quality plans policies, devoted to the reduction of population exposure to PM10, PM2.5, NO_2 and O_3 - air pollutants.

RIAT+ splash screen (i.e. RIAT+ starting image)

RIAT+ has been developed as a DSS (Decision Support System) thought for regional decision makers who, when designing air pollution reduction policies, face a limited budget that should be used to set-up efficient measures impacting on several pollutants in different ways to obtain the respect of EU air quality standards. RIAT+ is a regional integrated assessment stand-alone software with that helps tackling this challenge, supporting the policy makers in the selection of optimal emission reduction technologies, to improve the air quality at minimum costs.

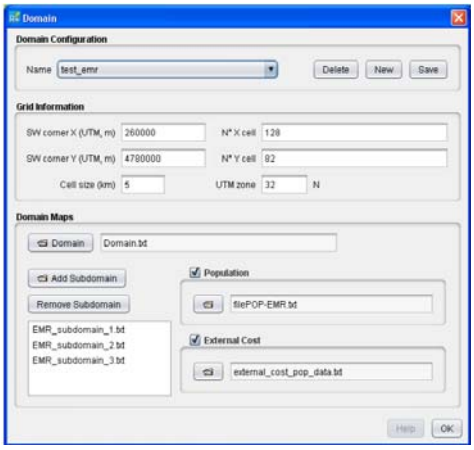


RIAT+ block diagram with I/O and the core system

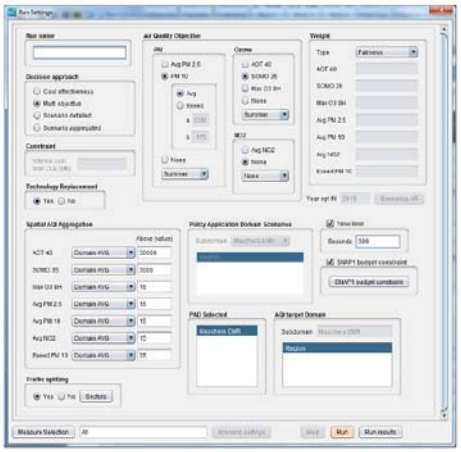
RIAT+ consists in (see **Errore. L'origine riferimento non è stata trovata.** for a scheme of RIAT+):

- user friendly interface to upload input data (see
- for an example):
  1. precursor emissions of local and surrounding sources
  2. emissions abatement measures (technical and non technical)
  3. source receptor functions (or models) linking emissions, meteorology and prevailing chemical regimes to pollutants concentrations
- a pre-processor to elaborate these data (see
- for an example) and prepare them for the optimizer on the base of the input chosen (abatement policies to be included, area of application of these policies, air quality indexes (AQIs) to be considered …)
- an optimizer that evaluate the best mix of measure application to be used to minimize cost and maximizes AQIs reductions (see
- for an example)
- a post-processor to elaborate the output data and show them through a tables, graphs and maps (see
- for an example)

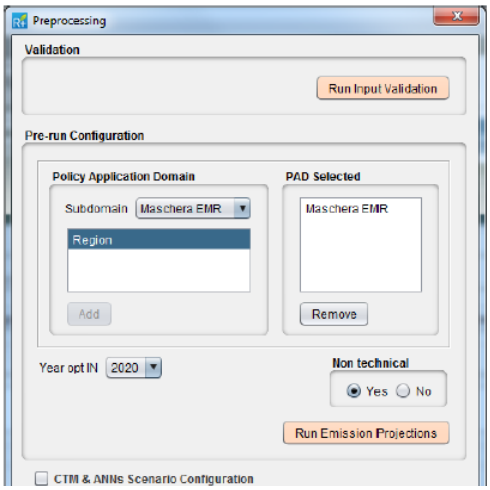
The method and the tool are general and easily applicable to different regions, incorporating explicitly the specific features of the area with regional input datasets.



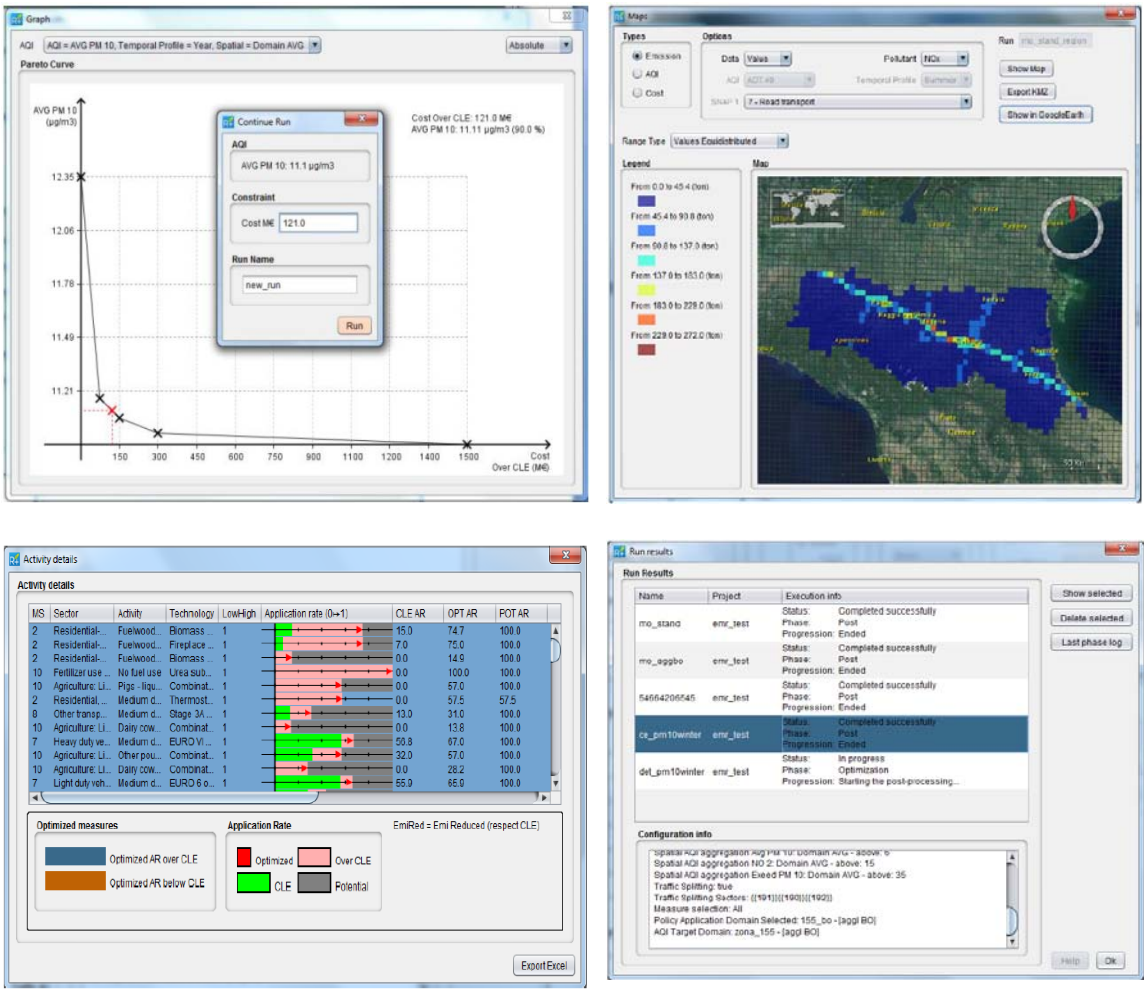
RIAT+ "Domain" input interface



RIAT+ "Run settings" definition interface



RIAT+ "Preprocessing" run interface



RIAT+ "Output" interfaces (from left to right, from top to bottom): Pareto curve, Emission map, Optimal set of policies, Run results

Peculiar components of RIAT+ core system are:

- a multi-objective optimization problem solver, i.e. one or more air quality indicators (e.g. yearly PM10 average) are reduced in the policy application domain, minimizing the costs of emission reduction measures costs to obtain this concentration reduction. RIAT+ is able to select and present to the user the entire set of efficient abatement measures, in terms of application rates (i.e. penetration levels to be reached).
- since a CTM (Chemical Transport Model) cannot be run to link emission reduction to pollutants concentration within RIAT+ optimization procedure for its CPU time requirements, a simpler relationship between emission sources and air quality indicators at given receptor sites (S/R models) is used in RIAT+ optimization algorithm (Artificial Neural Networks – ANN in the first regional applications). This approach compared to the traditional linear regression model (used in other systems), captures the non-linearities in the relationships between emissions and concentrations, maintaining a low CPU time.
- in RIAT+: different air quality indexes are included (yearly average concentrations of PM10, PM2.5, and NO_2, PM10 number of exceedances of the daily limit concentration, AOT40, O_3 8hrs maximum concentration); the budget can be constrained to a specific value (cost-effectiveness approach) or can be split in different macrosectors; policy application subdomain (e.g. critical air quality zones)

can be defined; state-of-art technologies may be fixed for some years while older technology could be substituted; optimization can be limited to a subset of macrosector technologies; scenarios can be simulated fixing aggregated emissions or specific technologies.

All the subtasks forecasted have been fully reached

- I2.1- RIAT+ architecture has been completely defined coherently with requirements specification; on the base of the stakeholders requests functionalities non forecasted, but considered important have been additionally included in the software development (see D1, D4 and D7 deliverables and annexes).
- I2.2- Integration with European level and I2.3- Integration with regional instruments have been completely performed both with GAINS national database (French and Italian database) with a regionalization of some parameters of the principal emission activities and with regional modelling systems.
- I2.4- RIAT+ implementation of existing or/and new databases is completed including non technical measures; in RIAT+ all regional databases (emission, technological measure and S-R functions) are implemented.
- I2.5- RIAT+ implementation of the methodology defined in Action I1 (see D4 and D7 deliverables) has been finalized, including additional features not forecasted (e.g. new region automatic reconfiguration, step by step approach and check of the interface, biogenic emissions inclusion at various step, pre-computation of the optimizer and relative checks …)
- I2.6- RIAT+ test, bug fixing and final release, final version of RIAT+ has applied and tested to both Emilia-Romagna and Alsace Region, bug fixing has been performed during all the application.

In addition to “textual” Deliverable n.8 including RIAT+ final version brief description and screen-shots images, RIAT+ software downloadable version have been prepared and published on the OPERA Website for new regions interested in using RIAT+ tool.
RIAT+ final version installation kit includes:

- jre-7u45-windows-i586.exe (Java Runtime Environment installer)
- Readme_riatplus.txt
- MCRInstaller.exe (MatLab Compiler Runtime installer)
- GoogleEarthSetup.exe (Google Earth setup - need internet connection for installing)
- RIAT+ Setup.exe (RIAT+ setup)
- EULA.pdf (End User License Agreement)

Regarding in particular the EULA, it has been prepared with the support of the Intellectual Property Unit of the Joint Research Center on behalf of the EU and with the click through mechanism it is mandatory signed by each RIAT+ downloader to guarantee a free of charge, but correct use of RIAT+.

JRC
EUROPEAN COMMISSION

END USER LICENCE AGREEMENT
RIAT+ 1.0

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The European Union together with:

Agenzia Prevenzione Ambiente Emilia-Romagna

University of Brescia Dipartimento di Ingegneria Meccanica e Industriale

TerrAria srl

Centre National de la Recherche Scientifique

Université de Strasbourg

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RIAT+ (hereafter the "Software") is an integrated assessment tool designed to identify cost-effective Air Quality abatement strategies at the regional scale. RIAT+ covers the entire chain from emission abatement measures (technical and non-technical) and related costs to the Particulate matter (PM10, PM2.5), ozone (O_3) and nitrogen dioxide (NO_2) concentrations and impacts on health. It is intended to be applied by Regional Authorities to evaluate the efficiency of Air Quality abatement plans.

RIAT+ has been developed in the context of the partnership between the Agenzia Prevenzione Ambientale Emilia Romagna (ARPA ER) and the Associated Beneficiaries or Partners as reported in the Grant Agreement Number LIFE09 ENV/IT/000092 signed the 27th of August 2010 by the Commission and Arpa Emilia Romagna.

First page of RIAT+ EULA (End User Licence Agreement)

Furthermore to document RIAT+ these reports have been prepared

- RIAT+ User Guide (including User instructions, RIAT+ methodology and algorithms)
- A help "online" of the software
- Two regional test cases (Alsace and Emilia Romagna)
- Two tutorial videos and a PREZI presentation (see figure below)

PREZI presentation of OPERA project (Green Week 2013)

All these materials and others are available on OPERA Website to help new user (and in particular the last two ones) to approach and use RIAT+.

ACTION I3 - RIAT+ application to Emilia Romagna (IT) region

The goal of this action is to apply the "RIAT+" methodology and tools to prepare a demonstrative action plan to reduce air pollution in the Emilia-Romagna region (Italy). During this action, as well as during the action I4, the functionalities of the RIAT+ tool were tested and debugged. Moreover for the Emilia-Romagna application domain, the activities of I3 were linked to the development of the Air Quality action plan, under preparation by the regional government with the technical support of ARPA. For that reasons some activities of the action I3 were rescheduled during the reporting period 01/11/2012 – 30/09/2013.

This action has been based on the results of the preliminary actions P1: "Review of existing plans and methodologies, identification of RIAT+ requirements" and P2: "Data collection in Emilia Romagna" and is strongly linked with the I1 (RIAT+ method and design) and I2 (RIAT+ software implementation) actions. Action I3 gave some important feedback to I1 and I2.

The following sub actions / tasks, scheduled at the beginning of the project, have been performed:

- I3.1: NINFA simulations of several emissions scenarios
- I3.2: Identifying the source-receptor models
- I3.3: Identification of the system constraints
- I3.4: Solution of multi-objective problem
- I3.5: Assessment of multi-objective solution
- I3.6: Evaluation in terms of CO2 emissions reductions of the efficient policies defined in I3.4

The task I3.1 provides the information necessary to implement the RIAT+ prototype on the Emilia-Romagna domain by the tasks I3.2, I3.3 and I3.4. Then (task I3.5) the RIAT+ was run to perform a costs-effectiveness analysis.

Task I3.5 start after the delivery of the RIAT+ prototype and the training session (as reported by the minutes of the 17/10/2012 TM). The task was aimed to test the RIAT+ tool. The tool was applied twice. A first application was delivered feeding the system with the dataset of emissions and source-receptor models defined in the first technical meeting. As reported in the minutes of the 12/03/2013 TM, during the realization of the task I3.5 a new emissions inventory (INEMAR 2010) was delivered by the regional government in the framework of the Emilia-Romagna Air Quality action plan. The new emissions data were processed to replace the input dataset previously produced by action P2. Moreover the quality check of the output data revealed the need to take into account the underestimation of PM concentration by the CTMs and to better adjust the simulations domain. Therefore it was decided to perform a new run of the NINFA model (task I3.1) and a new scheduling of the activities was defined. As reported in the minutes of the 28/06/2013 TM, some problems and delays were encountered during the preparation of the new input dataset (bugs in the INEMAR 2010 data and delays in the biogenic emissions data preparation) therefore it was decided to reduce the number of simulations from 22 to 12 in order to respect the deadline of the project.

Some activities of the I3 action were postponed to the activities of the I4 action. That decision, as it is reported by the minutes of the 14/11/2012 TM (RIAT+ methodology

part), was taken to present the results of the application of the tool to the Alsace domain to the French participants at the Strasbourg conference.

The following table summarize the actions performed and the timing.

Subaction/Task	scheduled	delivered
P2.1 new basecase emissions for CTM ER	8/4/2013	28/05/2013
New emission scenarios (TA)	3/5/2013	20/06/2013
I3.1 ARPA runs again the CTM model	30/06/2013	21/06/2013
I3.2 UNIBS identifies a new SR Model	30/07/2013	12/08/2013
P2.2, P2.3 Upgrade of the action database for Emilia – Romagna (1)	30/08/2013	
I 3.5 ARPA applies the RIAT+ to ER	30/08/2013	10/09/203

The output of the RIAT+ tool were used to set the emissions reduction target for the AQ plan (PAIR2020) of the Emilia-Romagna region. The preliminary document of the Air Quality Plan (PAIR2020), including the reduction emissions target set by RIAT+, was approved by the Regional Government in July 2013. All the documentation is available at:

http://ambiente.regione.emilia-romagna.it/aria-rumore-elettrosmog/temi/pair2020/PianoRegionaleIntegratoQualitaAria/?searchterm=pair%202020

Results were presented during the Opera Final conference.
The data set is described in the deliverable D4, all the work done using RIAT+ on air quality plan of Regione Emilia-Romagna are summarized in the D15 Opera Laymaman's and fully described in the D9 deliverable available as an annex of this report and on the "project data and documentation repository".

ACTION I4 - RIAT+ application to Alsace (FR) region

The goal of this action was to apply the "RIAT+" methodology and tools to assess regional and local air quality plans (SRCAE and PPA) recently approved by the decisions makers and to highlight new potential actions. This action was based on the results of the preliminary actions P1: "Review of existing plans and methodologies, identification of RIAT+ requirements" and P3: "Data collection in Alsace".

The following subactions have been performed:

I4.1 Simulations of several emissions scenarios - Production of gridded emission scenarios using the "Emiss'Air" system (Manag'air and ManagairToChimere)

The gridded emissions 2005 were prepared by ASPA starting from the 2005 emission inventory built in P3 action and using the GIS-based tool MANAG'AIR (gridding emissions on a specific domain). The resulting gridded emissions were treated by TerrAria: for each cell in the studied grid domain, it was required to compute three emission levels: B (basecase), L (low emission reductions) and H (high emission reductions). Then the scenarios B, H, L were used by ASPA to produce the 22 emissions scenarios. Finally, before the 22 scenarios could be used as inputs of the Atmo~RhenA system, they had to be prepared with the tool ManagairToChimere (putting the gridded emissions to the format of the CHIMERE system) designed by

ASPA to produce speciation and emission gridding for the CTM modelling on the Upper Rhine Area, which includes the Alsace region.

I4.2 e I4.3 Identifying the source-receptor models and identification of constraints - Simulations by Atmo~RhénA system

The data collected in P3 action (boundary conditions on a grid domain of France with a resolution of 15km2, and meteorological data produced on the Alsatian domain with a resolution of 3kmx3km) have been used as inputs to the Atmo~RhenA system to perform air pollution simulations on the Alsace region using the 22 emission scenarios. ASPA designed the simulation domains and prepared the inputs to focus the RIAT+ study on the main zones, concerned by regional and local air quality plans, and air pollutant exceedances.
CNRS and UNISTRAupgraded the Atmo~RhenA system (MM5/CHIMERE) to a new version using the WRF meteorological model and including few improvements in the CHIMERE model and its pre-processors to improve pollutantssimulations. As in the Atmo~RhenA system, the new WRF/CHIMERE has been based on the use of the 2006 Global Land Cover database to describe the European land use and the MODIS data to describe the vegetation fraction.
Air pollution simulations on emission scenarios have been produced three times in order to take into account changes in the emission scenarios as proposed by TerrAria, meteorological pre-processors and the CHIMERE model. Correlations were gradually improved for all pollutants. The results are stored on the computing data center of the University of Strasbourg.

Processing of the CTM simulations: extracting the AQI indicators database
For each simulation, monthly AQI values (mean PM10, mean PM25, AOT40, SOMO35, mean NO2, Mh8hO3) have been calculated by ASPA.

Source-receptor models identification for the AQI indicators
Monthly emission data (for NOx, VOC, NH3, PM10, PM2.5, SO2) and monthly AQI values (mean PM10, mean PM25, AOT40, SOMO35, mean NO2, Mh8hO3) have then been used by University of Brescia to train and compute the Artificial Neural Networks (ANNs), which describe the relationship between emissions of the precursors and the Air Quality Index for each of the temporal period (year, winter and summer). The results confirmed that the neural network system ensures high capability to simulate the non-linear source-receptor relationship between concentrations and precursors.

I4.4 Solution of multi-objective problem

This sub-action aimed to apply RIAT+ on the Alsace Region and to analyze the results. It has been performed by CNRS, UNISTRA, and University of Brescia, in a close cooperation with ASPA, and regular discussions with Alsatian decision makers to translate the RIAT+ optimal solutions into potential and realistic operational actions. This sub-action helped to identify several improvements to be performed on the RIAT+ database and optimization procedure, and resulted in a series of revisions of the initial data and models.

Definition of objectives

In order to assure coherence withregional and local plans, two objectives for optimization have been retained: mean NO2 concentrations over the year and PM10 in winter.

Definition of procedure to apply RIAT+
A standard procedure to identify potential measures has been elaborated. It starts from different single pollutant optimizations, analyses side effects on other AQI before choosing one point on the pareto curve and further analysing the corresponding set of measures (check of relevance and feasibility). In a final step, the retained measures are tested by "scenario detailed" function of RIAT+.

Results of optimization
A list of about 20measures for improving air quality in Alsace (focus on sensitive zones) has been retained. They have been presented to technicians and decision makers during the final conference and a workshop in Strasbourg. In order to become operational on the territory, they need further analysis and discussion with local experts.
An intermediate report (report D6) describing details about activities done until September 2012 and the final report of action I4 (D10 – Results of application of RIAT+ on Alsace) are provided as annex to this report and available on the "project data and documentation repository".

The above activities and results are described in detail in the deliverable D6 and D10 available as an annex of this report and on the "project data and documentation repository".

ACTION C1 - During project communication

ACTION C2 - After project communication

For both C1 and C2 see section 5.2 - "Dissemination".

ACTION M1 - Project Management

ACTION M2 - Monitoring Project Effectiveness

For both the M1 and M1 action, see Section 2 - "Project Layout", Section 4 – "Evaluation of the management system." and Section 5.3 - "Evaluation of Project Implemention".

5.2 Dissemination actions

Objectives

Communication activities are designed to promote and disseminate the project and RIAT + tool to a specific audience represented by technical and political actors/stakeholders involved in air quality management and policies on a regional/local level. For this reason, different methods of dissemination described below were be used:

- Project brochure: leaflets containing a brief description of the project of its principal aims, the partners, the contacts and the addresses where to find more details

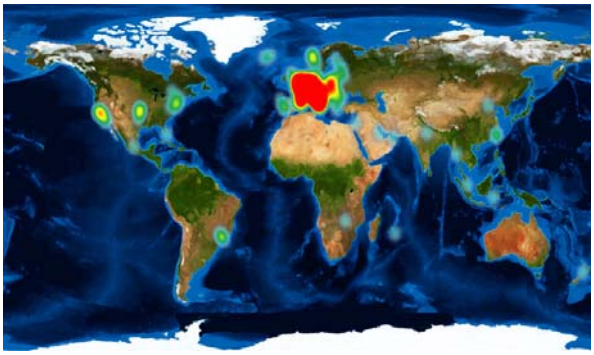
- Project website: where to find updated information and methodological and scientific material on the project and IT tools for RIAT + (online after six months from the beginning of the project). The website is still continuously updated containing the last RIAT + release – continuosly supporting RIAT+ release. The web site publish all the IT material: installation kit, user guide, test case, FAQ on the use of the tool, regional application results ...
- Project conferences:
- Layman's report
- Information panels
- Scientific conference participation:
- Meeting and papers

Dissemination: overview per activity

Communications and disseminations activities were performed by TerrAria in strict cooperation of all the partners and in terms of participation of dissemination events and in terms of preparation of dissemination material. The project declared period of C1 action was April 2011 – end of project; the starting up due to intense activity of communication (website, panel, brochure) was anticipated to October 2010.

Project website:
It included updated information and methodological and scientific material on the project and IT tools for RIAT + The website is still continuously updated and it will be for all the afterlife communication programme, it provide last RIAT + release - installation kit, user guide, test case, FAQ on the use of the tool, Meetings, Dissemination and a brief description of the project, see: http://www.operatool.eu/html/eng/index.html.

Initially published in English has been translated in Italian and French and regularly updated. As shown in the following map, Opera web has been accessed by all over the world but of course with a European prevalence



From October 2013 (the end of the project) OPERA home page has been changed to put evidence on the tool RIAT+ and to its download in an After Life perspective.

Project brochure:
A full color project were done, three language used, English, French and Italian, the overall layout should be seen at:
http://www.operatool.eu/html/pdf/brochure_OPERA_web.pdf

Project conferences

The Project Opera mainly focus on Project Conferences for gathering suggestions, requirements and presents the results to expert panels with technician and policy makers. Three of them were performed as required by project scheduling, some timing adjustments were done for getting better results but no critical timing appears for that.

- Bologna (20th of June 2011, organized by Arpa with Regione Emilia-Romagna support)
  Target Italian and France decision makers (Regions, Provinces, Environmental Agencies)
  Aim to finalize RIAT+ requirements

- Strasbourg (15th of November 2012, organized by LIVE (CNRS/UDS)
  Target French decision makers (Regions, Provinces, Environmental Agencies)
  Aim to show RIAT+ prototype – this conference has been postponed respect to the foreseen date (june 2012) in order to show a more advanced RIAT+ prototype – this delay has no consequence on the project timetable; The conference has been included in the Life+ Event program 2012, decided to celebrate the LIFE 20th anniversary (http://life20.eu)

- Bologna (16 September 2013, organized by Arpa with Regione Emilia-Romagna support)
  Target European technicians and modelers, policy makers

Aim

Show RIAT+ final version. With the support of Regione Emilia-Romagna with the goal to do comparison and discussion with agencies about the added value of RIAT+ application to the AQ plans in several European regions with similar problems (ER, Alsace, Portugal, London, Berlin,) and presenting the testing Air Quality Program of Regione Emilia-Romagna made using RIAT+ tools. This Lead to the presentation of the output of the RIAT+ tool that were used to set the emissions reduction target for the AQ plan (PAIR2020) of the Emilia-Romagna region.

Regarding project conference, three conferences have been realised:

- Bologna (20th of June 2011, organized by ARPAER/ER); target: Italian decision makers (Regions, Provinces, Environmental Agencies); aim: to finalize RIAT+ requirements
- Strasbourg (15th of November 2012, organized by LIVE (CNRS/UDS)); target: French decision makers (Regions, Provinces, Environmental Agencies); aim: to show RIAT+ prototype. The conference has been included in the Life+ Event program 2012, decided to celebrate the LIFE 20th anniversary (http://life20.eu).
- Bologna (16th of September 2013); target: Italian decision makers (Regions, Provinces, Environmental Agencies) aim to illustrate OPERA methodology and results in the two Regions participating (Alsace and Emilia Romagna) and to show RIAT+ final version.

All the three conferences were successful (see the specific reports for details). In particular the final Conference in Bologna saw the presence of different expertise at the various decision levels:

- Total participants 105 of which
- 95 Italians
- 58 Regional Environmental Protection Agencies

- 15 Region technicians
- 5 Province technicians
- 7 representatives of University

OPERA project organized and was present at a lot of additional events, below the most important one are cited. Through the distribution of brochures and other information materials in different conferences and fairs the Consortium made sure that contacts were taken with the persons/organizations that could be interested in using RIAT+ or to get ideas from OPERA methodology. These persons/organizations were mostly the Air quality agencies and Regional administrations responsible for the elaboration of air quality plans and of their assessment. The participation of some of these organizations in this project facilitated the dissemination of the tool and methodology to other similar entities.

- RIAT+ was presented at the 1st Annual Conference of the Appraisal project, Brussels, Committee of the Regions, November 19th - 20th, 2013
- OPERA project was presented at ECOMONDO 2013 on Friday 8 November 2013 with a specific session entitled: "**PAIR 2020 objectives and strategies of the Plan and the Integrated Regional Air Quality**"
- Opera was at Fifth National (Italian) Conference on Physical Agents in Novara (Jun 6, 2012)
- Opera was at Open Day LIFE + Lombardy in Milan (Jun 5, 2012) Palazzo Reale (http://www.life-laika.eu/content.php?p=eve&nid=2).
- "Environment, Energy and Sustainability in the Italian LIFE+ projects", Brescia May 25th 2012 (http://www.ing.unibs.it/life20/home.html). The conference, organized by the University of Brescia (OPERA and COSMOS projects), was the celebration (LIFE 20th anniversary) and dissemination event in Italy with the highest number projects participating. During the conference, 41 LIFE+ projects have been presented to 130 people from SMEs, Environmental Agencies, NGOs and Research. The event was introduced by the Chancellor of the University of Brescia, the delegate for Research of the Lombardia Region Governor, the mayor of the city of Brescia, and the LIFE+ Italian National Focal Point office (Mrs Stefania Betti). A book describing the projects that participated to the conference (including OPERA) has been published.
- Opera dissemination at Air Quality Conference in Athens (Mar 18-23, 2012)
- Rimini (I), 2011 Nov 9-12 EcoMondo 2011
- OPERA project was at the international fair Ecomondo.
- Brussels (B), 2011 May 24-27
- OPERA project was presented at LIFE+ project stand at the Green Week 2011.
- Parma (I), 2011 May 24-26 SPS/IPC/DRIVES Italy
- OPERA project was at the SPS/IPC/DRIVES Italy.
- Stockholm (S), 2011 Feb 23-25 39th UNECE-TFIAM
- OPERA project was presented at the 39th UNECE-TFIAM meeting in Stockholm.

OPERA project was at the Green Week 2013 with a stand (see a photo below) and with a specific presentation (make reference to OPERA Website to find link to the presentations, to LIFE newsletter and to watch the video overview of Green Week including OPERA project).

Finally, all the dissemination and communication activities are detailed and well documented directly on OPERA website at page:
http://www.operatool.eu/html/eng/dissemination.html.

Layman's report

Build for a broader target group of people but thinking at decision-makers and non-technical parties the Layman's report summarize the Project concepts and the results giving all the information for start using RIAT+.
The layman's report will be distributed widely and was since the end of the project available on Opera web site. It's an extended brochure with 8 full color pages printed in English, French and Italian in 300 hard copies. The Layman's report was first distributed during the 3th Conference in Bologna.

Information panels

They were made for each partners and currently used on each public meeting to summarize and explain the Opera Obejectives. Copy of the panels should be seen at:

Scientific conference participation

The Opera Project was presented to NIAM (Network for Integrated Assessment Modeling) and UNECE-TFIAM workshops to present scientific project results. At the same time in order to improve the Opera dissemination within the scientific community it was also presented at:

- Air Quality Conference, Athens, 18-24/3/2012, oral presentation, C. Carnevale (UNIBS)
- EGU Conference, Wien, 22-27/04/2012, oral presentation, A. Pederzoli (UNIBS)
- 14th EuCheMS International Conference on Chemistry and the Environment, Barcelona, 25-28/06/2013, oral presentation, E. Turrini (UNIBS).
- NoE ACCENT Symposium 2013, Urbino, 17-20/09/2013, oral presentation, E. Turrini (UNIBS).

Scientific papers:

- N. Bianchessi, C. Carnevale, G. Finzi, E. Pisoni, M. Volta (submitted). A heuristic approach to compute e ffective air quality strategies, Decision Support Systems.
- C. Carnevale, G. Finzi, A. Pederzoli, E. Turrini, M. Volta, G. Guariso, R. Gianfreda, G. Ma ffeis, E. Pisoni, P. Thunis, L. Markl-Hummel, N. Blond, A. Clappier, V. Dujardin, C. Weber, G. Perron (submitted). Exploring trade-offs between air pollutants through an Integrated Assessment Model, Science of the Total Environment.

Meetings and papers

In order to organize the collect of requirements (P1 action), several preparatory meeting have been done to present the project to decision makers in Alsace :

- Meeting, 23 May 2011, ASPA, Strasbourg. Presentation of OPERA project and discussions with several AQ experts involved in ASPA
- Meeting 8 June 2011, ASPA, Strasbourg. Presentation of OPERA project and discussions with decision makers in Alsace: Alsace region, who participates to the Regional Scheme for Air Climat and Energy (SRCAE); the Regional direction for environment, planning, and residence, involved in SRCAE and PPA Strasbourg; Mulhouse Local Authority, in charge of the Climat Plan; Colmar Local Authority, in charge of the Climat Plan

- Meeting 4-8 July 2011, CUS, Strasbourg. Presentation of OPERA project and discussions with Strasbourg Local Authority

In Italy the work was done strictly teamed with Regione Emilia-Romagna and JRC with meetings and discussions.

We'd like to highlight here the participation at the Brussels (B), 2013 Jun 4-7 GREEN WEEK – Cleaner Air for All. Here we had a Stand were lot of policy makers stops talking about the project together with us and with European Commission Peopled interested on the opportunity for having such a tools used all over Europe. During the Green Week we also had a speech presenting the Opera Project in the 5.2 Conference Session - Managing air quality at regional & local level, making better use of existing EU funds. The Opera Project was also illustrated in a Conference Video you can see at:
http://lifevideos.eu/videos/?id=LIFE13_GREEN_WEEK_13_01_EN_CONF.mp4

Regarding divulgation and communication materials the following table summarizes the main gadgets bought and distributed in all the previous events (conferences, fairs …):

Materials/Gadgets	Produced by	Number
CDs	TerrAria	50
Pens	Arpa EMR	600
Pencils	Arpa EMR	600
Block-notes	Arpa EMR	500
For holding papers binders	Arpa EMR	100
Headed papers	Arpa EMR	1000
Wood tree (Green Week)	TerrAria	1
Pencils	TerrAria	1000
Pens	TerrAria	500
For holding papers binders	Arpa EMR	100
OPERA badge holder	Arpa EMR	100
OPERA bag	Arpa EMR	80
USB key	Arpa EMR	80
Pens	Arpa EMR	240

Lot of news and papers were presented to national and local newspaper. A great dissemination work was done also by participating to a lot of meeting to create networking knowledge on the project. The full list of dissemination activities should be found at: http://www.operatool.eu/html/eng/dissemination.html.

In the following table the printed copies of the various reports/divulgation materials are reported and distributed in all the previous events (conferences, fairs …) – RIAT+ User guide have been partially distributed to interested Regions and will be given in the next RIAT+ courses (see After Life+ plan):

Materials/Gadgets	Produced by	Number
Leaflets/Brochures English	TerrAria	600
Leaflets/Brochures Italian	TerrAria	300
Leaflets/Brochures French	TerrAria	100
OPERA posters/panel roll-up	TerrAria	5
Trifold Brochure (Italian/English)	Arpa EMR	200
Laymans report	TerrAria	400
RIAT+ Userguide	TerrAria	200

In the following the list of the main publications regarding OPERA is reported:
- Opera is on ECOWEB (A Gateway to European Eco-Innovations funded by EC-FP7)
- Article published in the newspaper "Gazzetta di Parma" (Gen 9, 2013)

arpa

GAZZETTA DI PARMA

09/01/13

Estratto da pag. 13

«Lo stop alle auto? Una misura d'emergenza»

■■Si chiama «Opera» ed è il nuovo progetto europeo che vede coinvolta anche la sezione Arpa di Parma, insieme al Servizio Idro Meteo Clima di Arpa, la sezione di Forlì, e a partner tra cui le università di Brescia e di Strasburgo e il Centre national de la recherche scientifique. Obiettivo del progetto, presentato nei giorni scorsi al Parlamento Europeo a Strasburgo, è sviluppare un programma informatico con cui le pubbliche amministrazioni, regionali e locali, possano valutare l'efficacia delle azioni per la lotta allo smog.

«Il software - spiega Eriberto de'Munari, direttore di Arpa Parma, a cui è affidata la direzione generale del progetto - è in grado di valutare l'impatto di provvedimenti come blocchi del traffico, nuove ciclabili, abbassamento del riscaldamento negli edifici pubblici, e indicare quali e quanti garantiscono maggiore efficacia al minor costo».

Per ora il programma è stato testato sull'area dell'Alsazia, e alla conferenza di Strasburgo si sono discussi i risultati. Entro l'anno saranno avviate anche le sperimentazioni sull'Emilia-Romagna, i cui risultati saranno presentati a fine 2013. I provvedimenti adottati dagli enti locali, tra cui il Comune di Parma, sono efficaci? «Possono essere utili - risponde de' Munari - come misure d'emergenza, ma chiudere al traffico il centro storico significa ridurre le emissioni solo in una parte della città e solo per un giorno. Lo stesso per l'abbassamento del riscaldamento. I risultati più importanti si otterranno sul lungo periodo e dovranno essere frutto di azioni strutturali: una pianificazione urbanistica che riduca la necessità delle auto, un servizio di trasporto pubblico più efficiente, un nuovo piano di mobilità, la coibentazione degli edifici. Il software indicherà quali misure hanno il miglior rapporto costi/benefici - conclude de' Munari - poi saranno le amministrazioni a fare le scelte politiche». ◆ L. U.

Figure 1: Newspaper extract on OPERA (09/01/2013 – Gazzetta di Parma)

- Article published in the newspaper "Giornale di Brescia" (Nov 23, 2011)
- Picture, article in Italian: newspaper "Giornale di Brescia"
- "Guidambiente" (Jul 8, 2011)
- "ARPA Toscana" (Jul 2011)

- “Modelli matematici per la qualità dell’aria”, Article published in the trade journal "Automazione e Strumentazione" (Jun 2011)
- All’OPERA per un’aria migliore, BresciaRicerche pp. 26-27, March 2013

ALL'OPERA PER UN'ARIA MIGLIORE

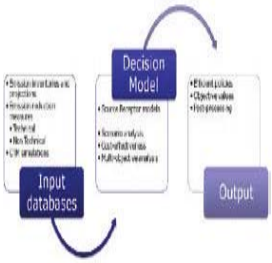
Modelli matematici in aiuto alla politica per risolvere uno dei maggiori problemi ambientali: l'inquinamento atmosferico.

MARIALUISA VOLTA - luisa.volta@ing.unibs.it

L'inquinamento atmosferico è uno dei maggiori problemi ambientali in molte città italiane ed europee. Per questo il Parlamento europeo ha adottato la risoluzione sulla Strategia tematica sull'inquinamento atmosferico (COM(2005) 446) con l'obiettivo di garantire, al 2020, il raggiungimento di livelli di esposizione che non comportino rischi significativi per la salute umana e per l'ambiente.

Eppure, nonostante l'applicazione della vigente normativa sul controllo delle emissioni, alcune regioni italiane ed europee continuano a registrare livelli di inquinanti superiori ai valori limite di legge. Un esempio è la Valle Padana: gli alti livelli emissivi, i grandi insediamenti urbani e la meteorologia sfavorevole alla dispersione degli inquinanti fanno della pianura del Po un esempio di area in cui gli alti livelli di PM e ozono hanno gravi ripercussioni sulla salute della popolazione.

Poiché l'inquinamento atmosferico è un problema sia locale che transfrontaliero, la soluzione richiede la definizione di politiche sia su scala europea e nazionale, sia su scala locale. Le prime sono determinate dalla Commissione europea, le seconde devono essere formulate dalle autorità regionali, che però non dispongono di strumenti adeguati a gestirne la complessità.



Il progetto OPERA sarà di supporto per decidere le politiche più efficaci per il controllo della qualità dell'aria. A fianco database, modelli descrittivi e decisionali del sistema RIAT.

Il progetto OPERA (Operational procedure for emission reduction assessment - LIFE09 ENV/IT/092), finanziato nell'ambito del programma comunitario Life+, vuole offrire alle Regioni uno strumento operativo per affrontare il problema, gestendo le specificità di ciascun territorio. Scopo di OPERA è formalizzare una metodologia per aiutare le autorità locali/regionali nella definizione, attuazione e monitoraggio di piani di qualità dell'aria, per ridurre l'esposizione della popolazione a particolato atmsoferico (PM10 e PM2.5), ossidi di azoto (NOx) e ozono (O3) e degli ecosistemi a NOx e O3. La metodologia consente di identificare l'insieme efficiente di misure tecniche e di risparmio energetico che devono essere incentivate o introdotte per diminuire le concentrazioni degli inquinanti secondari (PM e ozono), minimizzando i costi di intervento.

Schema del sistema RIAT+.

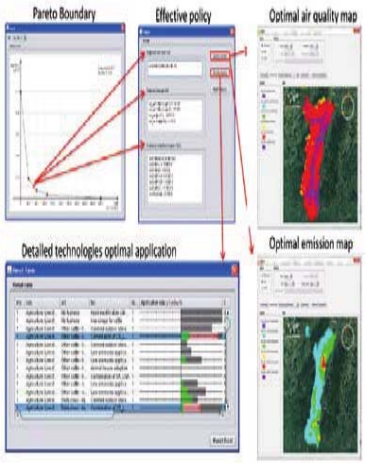
UN SOFTWARE PER L'AMBIENTE

Il progetto prevede lo sviluppo di uno strumento software, RIAT (Regional integrated assessment tool), che supporterà le autorità nella selezione delle politiche efficaci per il controllo della qualità dell'aria, secondo la seguente metodologia:

- identificazione dell'area o delle zone dove le condizioni di qualità dell'aria sono critiche;
- definizione degli indicatori per la selezione di politiche per la pianificazione della qualità dell'aria;
- selezione delle azioni possibili;
- uso iterattivo dello strumento per valutare l'impatto di differenti soluzioni alternative.

RIAT+ è progettato per essere uno strumento modulare, 'user friendly', efficiente ed esportabile in qualunque regione europea, isolando le specificità del dominio di applicazione nei database di ingresso al sistema ed è stato testato in Emilia Romagna e in Alsazia, in Francia.

Tutte le informazioni si trovano sul sito www.operatool.eu



Nell'output di RIAT+ sono indicate le politiche ottime di riduzione delle emissioni, il loro costo e i relativi benefici ambientali, sul dominio test della regione Alsazia (Francia).

IL GRUPPO DI LAVORO È COMPOSTO DA:

- *il gruppo di Modellistica ambientale (Giovanna Finzi, Marialuisa Volta, Claudio Carnevale, Enrico Pisoni, Anna Pederzoli, Enrico Turrini) del DIMI dell'Università di Brescia, che ha studiato e messo a punto la metodologia e la formalizzazione dei modelli decisionali e descrittivi;*
- *l'Agenzia ambientale della Regione Emilia Romagna e il Centro nazionale della ricerca scientifica francese CNRS, che hanno il compito di raccogliere i dati di input al sistema;*
- *Terraria srl, il cui ruolo è l'implementazione software dello strumento di valutazione integrata RIAT+.*

Al progetto collaborano inoltre l'istituto IES del Joint research centre della Commissione europea, la Regione Emilia Romagna e la francese Agenzia ambientale della regione Alsazia ASPA.

Journal extract on OPERA (June 2013 – "Automazione e Strumentazione")

- Article published in the newspaper "Gazzetta di Parma" (Apr 16, 2011)
- Article published in the newspaper "Giornale di Brescia" (Mar 29, 2011)

- Article published in the newspaper "Giornale di Brescia" (Mar 15, 2011)
- Cus Brescia Sailing team promotes the project (Oct 24-29, 2010)
    - Brescia oggi
    - Giornale di Brescia
    - AdessoVela.com
    - AssoVela.it
    - B & Partners
    - Cus Brescia Sailing Team
    - Federvela.it
    - FoxSport.it
    - ItaliaVela.it
    - Sailing Revolution
    - SportVacanze.com
    - Università di Brescia
    - VelaForFun.com
    - Velanet.it

After project communication

The goal of this action is to advertise and promote the use of the RIAT+, provide technical support to its users and steer future developments through a series of courses, workshops and publications. This action may be subdivided into the following sub-tasks:

- The user's manual and installation instruction described in Action C1 will be updated regularly to account for user's feedback and for on-going developments and improvements. A FAQ list will be maintained.
- Courses will be organized to provide new users with a general presentation of the RIAT+ as well as with a detailed description of specific applications of the system. The users will be trained to use the RIAT+ with data corresponding to their specific regional area and constraints.
- Workshops will be organized to share information and experience and to inform about new developments. RIAT+ users will be invited to present their application highlighting the main results and suggesting possible changes/improvements to the system. The main outcome of each workshop will be compiled in a EUR technical report.
- The RIAT+ and its continuous development will be continuously updated on the project website: http://www.operatool.eu/html/eng/index.html and presented at a series of seminars and conferences throughout the world. At the present we already participate to:
    - Rimini "Ecomondo", November 5-8th, 2013
    - Berlin, "Alternative Future Urban Mobility", October 20-21th 2013
    - Brussels "1st Annual Appraisal Conference – FP7 Project" November 19th - 20th, 2013

Action C1 concerns all the communications and disseminations activities. TerrAria is in charge of this action of course with the strict cooperation of all the partners and in terms of participation of dissemination events and in terms of preparation of dissemination material. The project declared period of C1 action was April 2011 – end of project; the starting up due to intense activity of communication (website, panel, brochure) was anticipated to October 2010. The After Life Communication Plan is described in detail in the deliverable D17 available as an annex of this report and on the "project data and documentation repository".

5.3 Evaluation of Project Implementation

- Methodology application: OPERA methodology to support regional/local authorities in the definition, application and evaluation of cost-effectiveness air quality plans policies, was successfully applied through the tool RIAT+ in the two regional domain of Alsace and Emilia Romagna. Thanks to general implementation of the tool RIAT+ this methodology could be used in any other European Region and the OPERA After Life+ Plan goes in this direction (see deliverable D17). During the tests performed on Alsace and Regione Emilia-Romagna few critical situations have been highlight. These should be summarized as:

- the generalization of ANNs (S/R function) tool to efficiently link emission and concentration to make easier its building in a new Region, and more flexible its application
- the generalization of technologies database, converting GAINs classification to emission classification in order to simplify the link between emissions and measures to reduce them

- We are trying to raise funds for making Riat+ more performing regarding the upper points. We think that this upgrade will let the software be even more friendly as today is.

- Compared the results achieved against the objectives are described in the following table:

Task	**Foreseen in the revised project**	**Achieved**	**Evaluation**	**Solution implemented**
P1, P2, P3	Requirements and input data collection	All the foreseen activities were reached	Major difficulties encountered were due to the data collection effort greater than imagined in the proposal design	In RIAT+ an additional part was added to specifically support data pre-processing, and great detail is reported in RIAT+ User-Guide. For future RIAT+ application an important part of the effort should devoted to data preparation.
I1, I2	Methodology and tool implementation.	All the foreseen activities were reached. A major effort was spent in order include in RIAT+ new part not foreseen (e.g. the pre-processing tool)	Besides the success of the methodology implemented and applied in two Regions and ready to be used by other Regions, two major field of future development are foreseen: inclusion of "structural measure" i.e. with the change of fuel, due to complex methodology an important support should be foreseen.	The methodology and consequently the tool face and solve the major part of the challenges included in the efficient air quality planning. Due to the complexity of the methodology, RIAT+ in the future should be simplified as much as possible and some stiffness should be smoothen.
I3, I4	RIAT+ application to Alsace and Emilia Romagna	Due the contemporary planning phase (particularly in the case of the Emilia Romagna Air Quality Plan) the interaction between implementation and application actions was challenging and intense and consequently very helpful for RIAT+ and its regional applications.	RIAT+ has been very helpful for the design of current (Emilia Romagna) and future (Alsace) air quality plan. Regional technicians testing was very useful for RIAT+ bug fixing. Thanks to the intensive use some procedure have been simplified and clarified.	Some of new requirements were implemented in RIAT+ final version (biogenic, scenarios applications…), other have been postponed. Main future focus were: • the generalization of ANNs (S/R function) tool to efficiently link emission and concentration to make easier its building in a new Region, and more flexible its application • the generalization of technologies database, converting GAINs classification to emission classification in order to simplify the link between emissions and measures to reduce them • inclusion of "structural measure" i.e. with the change of fuel,

- Both regional Riat+ applications were immediately visible and integrated in the regional planning process. Further importance will have the spread and the support of RIAT+ tool for new Regions (see Deliverable D17).
- All OPERA conference had a good success considering the limited and specific number of stakeholders to which they are addressed. The after Life+ communication plan seems to be able (thanks to EU-JRC support) to push RIAT+ use.

5.4 Analysis of long-term benefits

Air Pollution remains one of the most important environmental issue in Europe as confirmed with the adoption by the European Parliament of the resolution on the Thematic Strategy on Air Pollution which aims to attain levels of air quality that do not give rise to significant negative impacts on, and risks to human health and environment. However in spite of application of the current legislation devoted to air pollution control, some regions in Europe keep pollutant levels damageable to human health and to ecosystems.

The objective of this project is to develop and apply a methodology to assess the efficiency of locally planned abatement measures, which remain coherent with national and international frameworks.
Each action in the Air Quality Plan could be evaluated both in terms of air quality benefits and in terms of costs. The goal is to maximize the environmental benefits at fixed costs, or minimize costs at fixed environmental benefits. As any decision support tool, the proposed RIAT+ alone (i.e. without implementation of policies) cannot provide direct and immediate environmental benefits. However, the proposed integrated approach to air quality problem has already demonstrated the ability of being extremely important for negotiations as well as for determining improved environmental policies (M. Amann (2007) 'Formal Models and International Negotiations', in 'Diplomacy Games', Eds. Avenhaus R. and Zartman I. W., Springer Berlin Heidelberg). At European level, the RAINS model, for instance, developed by the International Institute for Applied Systems Analysis (IIASA), has been used to reach an agreement on the Second Sulphur Protocol in 1994. RIAT+, being a tool based on an integrated assessment modeling approach as RAINS model, may be used by a regional authority to determine emission policies or to allow discussion and negotiations among groups of stakeholders.
The procedure that the authority has to follow to take advantage of RIAT+ for environment's sake are the following:

- Identify the area or the subarea suffering by unacceptable air quality conditions (for one or more pollutants)
- Determine the criterion for judging alternative policies (e.g., minimum cost, maximum air quality, minimum emissions,…)
- Define the feasible actions (enforce a given cleaning technology, tax emissions, apply reductions to a certain sector or a certain subarea,…)
- Use the system (possibly) several times to determine (possibly) different alternative solutions
- Compare these solutions with the involvement of relevant stakeholders.
- Select one for implementation, i.e. realize the actions that have been agreed.

A key feature of the proposed approach is indeed the possibility of solving the inverse problem, i.e. to allow the stakeholders to set the desired environmental quality and find the best way to reach that result, which is essential when dealing with a region with a variety of activities, land uses and physical conditions, and thus involving several different interest groups.

Moreover EU directives request Member States to plan measures in order to reduce the adverse effects of poor air quality but also to plan measures to limit the impact of

anthropogenic emissions on climate change. As demonstrated with the use of integrated assessment tools at the EU scale, synergies may be found between these two types of measures (air quality and climate). It is one of the objectives of this project to provide local Authorities with a quantitative measure of the climate benefits of their planned air quality actions in their region.

Although the integrated assessment methodology described in this project focuses on two specific regional areas in Europe (Emilia Romagna (I) and Alsace (F)), its general scope is at the EU scale. The selected regional areas are different in terms of environmental concerns (local vs transboundary pollution, meteorological conditions…) and belong to countries where differences might occur in the prioritisation and choice of air quality policies. Although this diversity of approaches might increase the level of complexity it is seen as a necessary step to generalize the methodology and allow its future potential application to any region in the EU.
Regional policies are not always consistent with actions taken at the EU or national scale. This may arise from inconsistencies due to the spatial scale of interest and to the level of detail characterizing the available information at this particular scale. One main objective of the proposed methodology is to ensure consistency across scales in terms of input data (emissions, abatement technology, costs…).
The proposed approach may be used at different sub-national spatial scales and/or for regions including different countries. This approach ensure that neighboring areas plan actions, which are consistent among them and lead to an overall improvement of the air quality conditions in the area.

The project itself is born with the idea to expand a prototypal tool (RIAT – Regional Integrated Assessment Tool) and its first application in a specific Italian region (Lombardy) actually on-going to build a new extended tool (i.e. RIAT+) with the aim to make it usable by all European Regions to produce local air quality planning guidelines and optimized action plan.
Some actions are implemented to reach this scope:

- application in two different regions, Emilia Romagna (another Italian region to make a first national generalization of RIAT+ application) and Alsace (a French region) with an international modelling and tool application domain (including Germany, Switzerland beyond France), guarantying the test of European extension of RIAT+ application.
- moreover the external endorsement of JRC - owner of RIAT intellectual property - help us in maintaining this international approach of the project

The tests done during the project assure us that the RIAT+ could be used all over EU with high confidence levels of transferability reproducibility and economic feasibility. The Open Source Eula is just one of the key point.

The keywords of the Opera Project toward environmental benefits and sustainability are *integration and effectiveness*.
Integration of different policies on different scales for getting the max reduction of air pollutant (at local, national European scale) all over the areas involved.
Effectiveness by maximizing the overall expenditure, choosing the best actions at minimum cost for a more efficient reduction of air pollutant.

Long term indicators of the project success will be the air quality compliance all over the areas where the tools will be applied together at different scales because at the present it seems that only maximizing the pollutant reduction/euro ratio should let us win the game.

Scientific benefit

The OPERA project partners and stakeholders are involved in the APPRAISAL FP7 project (http://www.appraisal-fp7.eu/, 2012-2015).

The expertise of the OPERA project contributes to the definition of the knowledge base on integrated assessment of air quality plans on the regional and the local scale as well as to the use of scientific knowledge by policy makers and regulatory bodies in Member States.

On the other side, the OPERA project benefited both from the close connections among APPRAISAL groups developing and using different regional IAM methodologies and from the participation to the revision process of EU air quality policy.

In the framework of the APPRAISAL project, the RIAT+ tool will be applied in Portugal and Belgium.

6 Comments on the financial report

All the cost were correctly estimated during the project definition as reported by the standard statement of expenditure The overall costs incurred, the **eligible ones** as approved by our external certificatory, dr. Salmi**,** are € 2.317. 442,36 for all project duration. In comparison to the original budget extimated (€ 2.285.562,98), the expenditure represents the 101% of the original budget.

This amount was calculated including the reductions made by the auditor for a few number of expenditures that he considered not eligible for an amount of € 2.446,20.
The total eligible costs reported by the partners were € 2.319.888,56.

The present reports considering the auditor reduction of € 2.445,32 gives the total of € 2.317.443,24 for the total project budget.

6.1. Summary of Costs Incurred

The comments on the eligible incurred project costs are presented in the following tables. We present tables the cost incurred as from partners requests and after the auditor certification of expenditure. As the overall expenditure represents the 101% of the foreseen budget so we can said that the costs are in line with the plans.

OVERALL PROJECT COSTS - PARTNERS REQUESTS			
Budget breakdown categories	Total cost in €	Costs incurred from the start date in €	% of total costs
1. Personnel	€ 1.619.414,00	€ 1.755.170,00	108,38 %
2. Travel and subsistence	€ 73.080,00	€ 46.728,00	63,94 %
3. External assistance	€ 419.000,00	€ 339.978,00	81,14 %
4. Durable goods (depreciation)			
- Infrastructure sub-tot.	€ 0,00	€ 0,00	0,00 %
- Equipment sub-tot.	€ 15.448,00	€ 13.091,00	84,74 %
- Prototypes sub-tot.	€ 0,00	€ 0,00	0,00 %
5. Land purchase / long-term lease	€ 0,00	€ 0,00	0,00 %
6. Consumables	€ 8.350,00	€ 9.271,00	111,03 %
7. Other Costs	€ 1.200,00	€ 5.102,00	425,20 %
8. Overheads	€ 149.071,00	€ 150.548,00	100,99 %
TOTAL	**€ 2.285.563,00**	**€ 2.319.889,00**	**101,50 %**

OVERALL PROJECT COSTS – AUDITOR CERTIFICATION OF EXPENDITURES			
Budget breakdown categories	Total cost in €	Costs incurred from the start date in €	% of total costs
1. Personnel	€ 1.619.414,00	€ 1.753.180,00	108,26 %
2. Travel	€ 73.080,00	€ 46.537,00	63,68 %
3. External assistance	€ 419.000,00	€ 339.937,00	81,13 %
4. Durables: total cost (depreciation)			
- Infrastructure sub-tot.	€ 0,00	€ 0,00	0,00 %
- Equipment sub-tot.	€ 15.448,00	€ 12.867,00	83,29 %
- Prototypes sub-tot.	€ 0,00	€ 0,00	0,00 %
5. Land purchase / long-term lease	€ 0,00	€ 0,00	0,00 %
6. Consumables	€ 8.350,00	€ 9.271,00	111,03 %
7. Other costs	€ 1.200,00	€ 5.102,00	425,20 %
8. Overheads	€ 149.071,00	€ 150.548,00	100,99 %
TOTAL	**€ 2.285.563,00**	**€ 2.317.442,00**	**101,39 %**

Four categories of expenditure have registered an overspending: Personnel (106,26% of the foreseen budget), Consumables (111,03 %), Other costs (425,20%) and Overheads (100,99%). In the first case (personnel) the partners have reported a higher amount in consideration of the need to guarantee a more continuous control over the project actions and outputs; in addition, some daily costs are higher than foreseen. In the second case (Consumables) the partners have reported some costs initially not correctly foreseen as the changes incurred in the market since the project submission.

In the third case (Other costs) the partners reported much higher expenses because of some extra travelling cost of Experts and Policy Makers we invite at the Opera conferences as speakers. These costs were not initially foreseen. Anyway, in these last two cases, the increase is lower than 30.000 euro, the maximum requiring a written additional agreement by the Commission (CP 15.2). As for the overheads, the amount of € 150.547,58 represents the 6,95% of the direct eligible costs, which is lower than the 7% of maximum limit; the overspending is due to the fact that the original budget for overheads (€ 149.071,91) was lower also in percentage terms, i.e. the 6,52% of the direct costs included in the budget.
The other categories have registered an under-spending: travel costs have been only 63,68% of the foreseen budget, since the majority of the meetings was held in Italy (Bologna – Brescia – Milan) without the need to make international transfers. For the travels and accommodation category, the partners paid special attention to take always lower cost choices and limit the overnights outside in hotel. Has to be highlight that during the initial project budgeting we take some additional margins for be sure that we got founds in case some additional meeting or travel would needed due some project problem to be addressed both Italy or in France but as already explained except for minor problems we didn't need to use this extra founding.

The external assistance costs is lower than the forecast (83,13) mainly because Arpa Emilia-Romagna make some of the needed works internally, due to the special requirements needed, without any additive time consumption and because we got some extra saving from the external assistance we got.
As for the VAT, it has to be underlined that only the associated beneficiary Terraria S.r.l. does recover the VAT. Since Terraria is a limited liability company (S.r.l. in Italy), it is not allowed to report the VAT in the OPERA project. CNRS and University of Strasbourg will not intend to claim for non-recoverable VAT cost. Neither CNRS nor University pays VAT costs. Arpa and University of Brescia are public bodies and don't recover VAT as from their declaration. VAT declarations are attached to the present report.
Answers and comments on letter from European Commission (env/e-4/lt /s eb/nl, May 3th 2013) concerning the approval of the mid term report are submitted as an Annex to this report.

6.2. Accounting system

The time sheets used are those indicated in the LIFE+ web site, with a number of hours worked per calendar day.
The invoices related to the present project are marked with the OPERA stamp, and are validated by the OPERA Auditor.

6.3. Partnership arrangements

All financial transactions between the coordinating beneficiary and the partners took place regularly with bank transfers, according to the bank data that the partners have submitted to ARPA Emilia-Romagna.
Financial reporting has been implemented by ARPA Emilia-Romagna with the data provided by all the partners, on a regular and continuous basis.

6.4. Auditor's report/declaration

The auditor, Mr. Enrico Salmi, selected by ARPA Emilia-Romagna after a public procedure, examined the overall documents of expenditure of all the partners, producing the Audit Report of the project.
During the evaluation phase regarding the final expenditures, the Auditor made cuts for a total of € 2.446,20 (of which € 1.989,88 in personnel, € 191,61 in travel, €.40,50 in external assistance and € 224,21 in equipment depreciation) divided among the beneficiaries as follows:

Arpa	11,75
Terraria	2.293,35
Università di Brescia	116,50
CNRS	17,60
Univeristy of Strasbourg	7,00
TOTAL	**2.446,20**

Total requested by partners	2.319.888,56
Auditor certificated non eligible costs	2.446,20
TOTAL ELIGIBLE	**2.317.442,36**

6.5 Summary of costs per action

All tables below, partners requests and certification of expenditure, presents costs divided by actions (including costs for the purchase of the equipment with depreciation), and a comparison with the original budget.

OVERALL PROJECT COSTS - PARTNERS REQUESTS			
Action number and name	Foreseen costs	Spent so far	Remaining
Action P1	€ 125.585,00	€ 121.907,00	€ 3.678,00
Action P2	€ 120.186,00	€ 75.461,00	€ 44.725,00
Action P3	€ 95.534,00	€ 109.006,00	€ - 13.472,00
Action I1	€ 163.995,00	€ 177.199,00	€ - 13.204,00
Action I2	€ 273.675,00	€ 295.845,00	€ - 22.170,00
Action I3	€ 405.510,00	€ 409.193,00	€ - 3.683,00
Action I4	€ 392.116,00	€ 431.877,00	€ - 39.761,00
Action C1	€ 234.920,00	€ 223.985,00	€ 10.935,00
Action M1	€ 273.668,00	€ 257.269,00	€ 16.399,00
Action M2	€ 66.750,00	€ 67.599,00	€ - 849,00
ACTIONS TOTAL	€ 2.151.939,00	€ 2.169.341,00	€ -17.402,00
OVERHEADS		€ 150.548,00	
GRAND TOTAL	€ 2.151.939,00	€ 2.319.889,00	

OVERALL PROJECT COSTS - AUDITOR CERTIFICATION OF EXPENDITURES			
Action number and name	Foreseen costs	Spent so far	Remaining
Action P1	€ 125.585,00	€ 121.740,00	€ 3.845,00
Action P2	€ 120.186,00	€ 75.461,00	€ 44.725,00
Action P3	€ 95.534,00	€ 109.006,00	€ -13.472,00
Action I1	€ 163.995,00	€ 177.199,00	€ -13.204,00
Action I2	€ 273.675,00	€ 295.621,00	€ -21.946,00
Action I3	€ 405.510,00	€ 407.330,00	€ -1.820,00
Action I4	€ 392.116,00	€ 431.877,00	€ -39.761,00
Action C1	€ 234.920,00	€ 223.985,00	€ 10.935,00
Action M1	€ 273.668,00	€ 257.089,00	€ 16.579,00
Action M2	€ 66.750,00	€ 67.587,00	€ -837,00
ACTIONS TOTAL	€ 2.151.939,00	€ 2.166.894,00	€ -14.956,00
OVERHEADS	€ 149.071,91	€ 150.548,00	
GRAND TOTAL	**€ 2.301.011,00**	**€ 2.317.442,00**	

7 Annexes

All the Project Documentation is available also in electronic format at the "Project data and documentation repository", see chapter 1 of this report for connecting to it.

7.1 Administrative annexes

- Auditor's report
- Vat Declarations

7.2 Technical annexes

- Deliverables
  - D1– RIAT+ requirements
  - D1–RIAT+ requirements-ADDENDUM
  - D2–Emilia Romagna preparatory data
  - D3–Alsace preparatory data
  - D4–Methodology and technical guide
  - D5–Emilia Romagna RIAT+ input
  - D6–Alsace RIAT+ input
  - D7–RIAT+ prototype
  - D8–RIAT+ final version and user guide
  - D9–Emilia Romagna action plan built with RIAT+
  - D10–Alsace action plan built with RIAT+
  - D11–Web site
  - D12–1st Opera Conference - Gathering the requirements
  - D13–2nd Opera Conference - RIAT+ Beta version check
  - D14–Opera Final Conference - RIAT+ (1.0 version) release
  - D15–Layman's report
  - D16–Informative panels
  - D17–After LIFE+ plan

7.3 Dissemination annexes

- Layman's report see "Deliverable D15" and http://www.operatool.eu/html/pdf/D15%20Layman%27s%20Report.pdf
- After-LIFE Communication plan see "Deliverable D17"
- CD-ROM with all the material produced with all the photographs produced during the project, brochures, Project Presentation, etc;

7.4 Final table of indicators

7.5 Financial report and annexes

- "Standard Payment Request and Beneficiary's Certificate"
- "Financial Statement of the Individual Beneficiary"

- Tables for:
  - Personnel costs
  - Travel costs
  - External assistance
  - Infrastructure
  - Equipment
  - Prototype (only applicable for ENV and BIO projects)
  - Land purchase (only applicable for NAT projects)
  - Lease of land (only applicable for NAT projects)
  - Consumable material
  - Other direct costs
  - Overheads

7.6 Answers and comments on letter from European Commission

Answers to questions sent by European Commission approving Opera Mid-Term Report. (ENV/E-4/LT/SEB/NL, May 3th 2013).