



Summary review

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IMPROVE LIFE13 ENV/ES/000263



Coordinated by
idæ^a CSIC







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1. ACTIVITIES FOLLOW-UP

The following summary report covers IMPROVE LIFE13 ENV/ES/000263 activities from **01/10/2015 to 31/12/2015**.

Activities were launched on time and the project progresses according to the proposed timetable. The main tasks initiated or accomplished at each action in progress were as follows:

- **Actions B1 and B2** (Determination of the impact of selected parameters and Testing mitigation measures and development of mitigation strategies). In order to further characterize the impact of air pollutants from renewal works in tunnels/platforms on subway passenger's exposure, air quality measurements were performed at the platform of Santa Coloma station (L1). The sampling campaign started on 1st October and continues until 2nd November. The main objective of this campaign is to evaluate in detail the effect of tracks renewal on air quality during operation hours. On 3rd November, measurement instruments were moved to the platform of Joanic (L4) station, where renewal activities both in tunnel and platform were carried out until 22nd of December. The main objective of these measurement campaigns was to evaluate in detail the effect of rail tracks replacement at tunnels and platforms on air quality at the selected stations. The development of these works included material transport, abrasive cutting, and welding activities. The campaign involved the deployment of several equipments at one end of the platform of a selected station fulfilling all the necessary safety conditions. The monitoring equipment includes a high volume PM2.5 sampler (for daily sampling particulate matter below 2.5 microns), passive samplers for NO₂ monitoring, and automatic equipments registering continuously concentration levels of i) PM in 3 sizes (1, 2.5 and 10 microns); ii) particle number concentrations in 16 size ranges; and iii) CO, CO₂, temperature and relative humidity every 5 minutes.

A second report showing all measuring campaigns carried out from January to September 2015 was prepared. In this report is concluded that:

- i) The addition of ballast carried out at Palau Reial station is the one causing the highest increase of PM_{2.5}, NO₃₋₁₀ and CO concentrations over standard conditions, while the increase resulted much lower when the ballast was added using a dust suppressant, as in the case of Maria Cristina station. The series of activities performed at Sagrera station, including rail cut and movement (abrasion), and ballast levelling, also showed an important effect on concentrations, especially for PM_{2.5} and CO. CO concentrations are shown to be affected by works at Sagrera, Palau Reial and Maria Cristina stations probably due to the use of diesel/gasoline vehicles and machinery. In the case of Tarragona station, standard ventilation settings are recommended in terms of PM_{2.5}, NO₃₋₁₀ and CO₂ concentrations.
- ii) According to the described results, it can be therefore concluded that: (a) PM_{2.5} levels inside the train were higher (c. 20%) during weekdays as compared to weekends (45 and

35 $\mu\text{g m}^{-3}$ respectively), emphasizing how train frequency is a key parameter controlling the PM levels in subway systems; (b) high amplitude transient peaks recorded during the measurements were related to activities during non-operational hours when the train was located in the parking area (e.g. graffiti removal, technical cleaning with compressed air and other forms of cleaning); (c) NO₂ concentrations inside the train averaged $47 \pm 4 \mu\text{g m}^{-3}$, this being 25-30% lower than on platforms; and (d) there is no appreciable difference in PM_{2.5} levels after the same filter has been in service for at least 3 months, indicating that at least in terms of air quality, there is no need to change these filters as frequently as every month, as is currently the case.

Samples of all types of brake pads, catenary, wheels, railways and ballast used by TMB have been now chemically analysed in the CSIC laboratories. The relationship between the composition of airborne particulate matter in the platform and that of particles generated by maintenance works as well as the chemistry of the different pieces used in each subway line (including brakes, pantographs and ballast) will now be studied, and the contribution on PM mass of each pollutant source will be estimated aiming to proposed mitigation strategies to reduce their emissions.

Complete chemical analyses of all the PM_{2.5} samples collected by the high volume sampler were planned in order to determine the variations in chemical composition driven by the influence of the different activities performed. Up to September 2015, a total of 115 samples had been completely analysed (71 samples from Sagrera station and 44 samples from Palau Reial station) and 48 additional samples (27 from Maria Cristina station and 21 from Tarragona station) had been analysed for TC. During the period of this report (October to December 2015), 48 samples (27 from Maria Cristina station and 21 from Tarragona station) have been analysed by ICP-AES, ICP-MS, IC and selective electrode, hence completing the chemical analyses of these samples.

Additionally, 62 samples, among the aforementioned 163, from Sagrera, Palau Reial, Maria Cristina and Tarragona stations, had been selected for organic species analysis, based on the activities carried out at the stations and the PM_{2.5} concentrations. The analysis consists on: extraction in a solvent mixture of methanol and dichloromethane, and subsequent analysis of the extracts on a gas-chromatograph coupled to a mass-spectrometer (GC-MS). A total of 35 organic species are determined with this methodology. The 62 selected samples have been analysed.

- **Action C1** "Effectiveness of the project actions". The impact of the implementation actions of IMPROVE will be evaluated once they have been completed (December 2016). The data obtained during PM sampling and chemical characterization conducted before and after the implementation of the measures scheduled in Action B1 will allow the CSIC partner to quantify how much emission estimates will change as a result of the adoption of the strategies. The estimate of the impact of each air particles source before and after the application of remediation measures will permit the evaluation of the effectiveness and air



quality benefit in terms of PM2.5, PM10 and several PM chemical components related to indoor metro emissions.

- **Action C2** “Assessment of the socio-economic impact of the project”. This action will officially start on July 2016. However, benefiting from the questionnaires that TMB carries out annually among the subway travellers, a first series of questions related to the IMPROVE project was elaborated during October 2015. The questions that were asked to 646 subway passengers were:

Q1. Have you ever thought about how is the quality of the air we breathe in the subway environment?

46% of the interviewed passengers thought that air quality in the subway was an important issue.

Q2. Could you assess the quality of the air we breathe in the premises of the subway on a scale: very good, good, fair, bad or very bad?

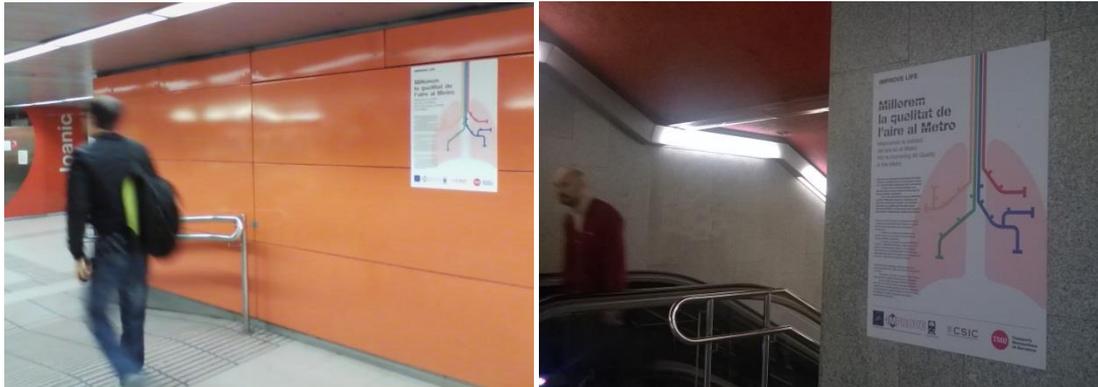
55% of the passengers considered that the air quality in this environment was at least acceptable, whereas 43% thought it was bad.

Q3. Do you know the work that TMB and CSIC are doing to improve air quality in the subway?

4% of passengers knew about IMPROVE LIFE project.

A report on the results of this first questionnaire has been elaborated by TMB and is included in the deliverables of Action C2.

- **Action D1** “A Project website designed as a tool to raise the profile of the project and improve the dissemination of its activities”. The web site of IMPROVE LIFE (<http://improve-life.eu>) was launched in December 2014 and is updated in a 2-week basis. Main updates during this period have been on reports, scientific publications and conference presentations of the project, activities and results. A visitor’s counter has been added to have a more detailed knowledge of the web views.
- **Action D2** “LIFE+ Information board will be on displayed describing the project at the locations where it is implemented, at strategic places accessible and visible to the public”. LIFE+ Information board are on display since January 2015 describing the project at the locations where it is implemented, at strategic places accessible and visible to the public. By the end of 2015 hard information boards on the project have been placed at Sagrera, Palau Reial, Maria Cristina, Tarragona, Santa Coloma and Joanic stations where measurements have been performed. Panels are also permanently displayed in IDAEA-CSIC (Palau Reial) and TMB (Santa Eulalia) main offices. No vandalism problems have occurred during the October-December period.



Action D2. IMPROVE LIFE panel displayed in the lobbies of Joanic (left) and Santa Coloma (right) stations.

- **Action D3** “Dissemination of project results”. During this period the following activities to disseminate IMPROVE LIFE results have been carried out:

- ✓ **Technical publications** on the project results in international scientific journals and presentations in scientific conferences acknowledging the LIFE+ financial support during this period:

Moreno, T., Reche, C., Rivas, I., Minguillón, Mc., Martins, V., Vargas, C., Buonanno, G., Parga, J., Pandolfi, M., Brines, M., Ealo, M., Fonseca, As., Amato, F., Sosa, G., Capdevila, M., De Miguel, E., Querol, X., Gibbons, W. (2015). Urban Air Quality comparison for bus, tram, subway and pedestrian commutes in Barcelona. *Environmental Research* 142, 495–510 (IF. 4.373)

Martins, V., Minguillon, Mc., Moreno, T., Querol, X., De Miguel, E., Capdevila, M., Centelles, S., Lazaridis, M. (2015). Deposition of aerosol particles from a subway microenvironment in the human respiratory tract. *Journal of Aerosol Science* 90, 103-113 (IF. 2.236)

Two other manuscripts were under review during this period:

Martins et al. Factors controlling air quality in different European subway systems. *Environmental Research* (IF. 4.373)

Martins et al. Origin of inorganic and organic components of PM_{2.5} in subway stations of Barcelona, Spain. *Environmental Pollution* (IF. 4.143)

- **Action E1** “Project Management and Audit”. The next report to be delivered is the Midterm report that will be submitted by December 2016.
- **Action E2** “Monitoring of the project progress according to indicators defined by the managing team”. Three-month summary reviews, as the present one, are being prepared since the beginning of the project and published in the web page. Regular meetings every

month of all partners to discuss developments, problems and progress of the project have been hold (more frequently than initially programmed), including:

- ✓ Discussion on the planning of main rail works during the next months in Joanic station during November/December 2015. 06/10/2015. TMB offices. CSIC: Teresa Moreno; TMB: Eladio de Miguel, David Gomez, Sonnia Centelles.
- ✓ Discussion of main results of the measuring campaigns inside train carriages in line 3 to observe the effect of air conditioning filters on PM concentrations through time. 07/10/2015 at Vall d'Hebron TMB offices. CSIC: Teresa Moreno, Cristina Reche; TMB: Josep Calvo, Eladio de Miguel.
- ✓ Possibilities of installing air purifiers in subway platforms. 21/10/2015 at TMB offices. CSIC: Teresa Moreno, Fulvio Amato; TMB: Eladio de Miguel.
- ✓ Possibilities of installing air purifiers in subway platforms. 26/11/2015 at GINSA offices. CSIC: Teresa Moreno; TMB: Eladio de Miguel; GISA: Joaquim Cusí, Eusebio Moro.
- ✓ IMPROVE LIFE annual project meeting. 16/12/2015 at IDAEA- CSIC offices. CSIC: Teresa Moreno, Xavier Querol, Cristina Reche, Cristina Vasconcelos, Vania Martins; TMB: Eladio de Miguel, Michael Pellot. The aim of the meeting was to overview all activities that have been carried out during the year 2015 and to discuss those to be delivered during 2016. The agenda of the meeting was as follows:

09:30	Bienvenida por T. Moreno (CSIC)
09:35	Visión general del proyecto – T. Moreno (CSIC) Calendario y fechas clave 2016
09:50	Planificación T. Moreno (CSIC) : <ul style="list-style-type: none"> • Situación de campañas de muestreo • Planificación de campañas próximos meses • Estudios GINSA y estudiantes • Comunicación y difusión del proyecto <ul style="list-style-type: none"> ○ Cuestionarios ○ Elaboración Video TMB ○ Página web del proyecto
11:00	Pausa para café.
11:15	Gestión administrativa y financiera C. Vasconcelos (CSIC) : <ul style="list-style-type: none"> • Situación de <i>Amendment</i> y <i>Partners Agreement</i> nuevo • Información administrativa • Documentación financiera
13:00	Clausura

- **Action E3** “Networking with other European projects (including LIFE+)”. A list of related projects has been added to the project web page.



2. LIST OF THE PROJECT'S OUTCOMES DURING THE PERIOD

ACTION	DATE	TITLE
2.1. IMPROVE LIFE publications		
D3	10/2015	Moreno, T., Reche, C., Rivas, I., Minguillón, Mc., Martins, V., Vargas, C., Buonanno, G., Parga, J., Pandolfi, M., Brines, M., Ealo, M., Fonseca, As., Amato, F., Sosa, G., Capdevila, M., De Miguel, E., Querol, X., Gibbons, W. (2015). Urban Air Quality comparison for bus, tram, subway and pedestrian commutes in Barcelona . Environmental Research 142, 495–510 (IF. 4.373)
D3	12/2015	Martins, V., Minguillon, Mc., Moreno, T., Querol, X., De Miguel, E., Capdevila, M., Centelles, S., Lazaridis, M. (2015). Deposition of aerosol particles from a subway microenvironment in the human respiratory tract . Journal of Aerosol Science 90, 103-113 (IF. 2.236)
2.2. IMPROVE LIFE reports		
B1&B2	30/10/2015	Technical report on Assessing the effect of extending the service life of air conditioning filters on air quality inside trains
B1&B2	30/10/2015	Second summary report on the <i>Sampling campaigns: Progress and results so far</i>
E2	31/12/2015	Summary reviews
2.3. IMPROVE LIFE other dissemination materials		
D1	22/12/2015	Project website (updated)
D3	31/12/2015	Articles general/trade press



3. DISSEMINATION ACTIVITIES

ACTION	DATE	TITLE
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3.1. IMPROVE LIFE events

C2	10/2015	First annual questionnaire carried out among 646 subway travellers about air quality in the subway system and IMPROVE project.
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3.2. IMPROVE LIFE presentations in other events

3.3. IMPROVE LIFE networking with other projects

4. DELIVERABLES AND MILESTONES CHECK-UP (31/12/2015)

(Shown in green those already completed, and in yellow those in progress)

START	ACTIVITIES FOLLOW-UP	OUTCOMES available on-line at:	DEADLINE
A. PREPARATORY ACTIONS			
A1 Documentation of current status and selection of critical parameters to be tested			31-march-15
1-oct-14	Construction of 1 historical database of studies examining the methods used to identify and resolve the contribution of aerosol emission sources and their major results	Deliverable 2 Historical source contribution	31-jan-15
	Elaboration of 1 list of the main parameters identified to be considered in all studies	Deliverable 4 Parameters to test	31-march-15
	Prioritisation of air pollution sources in subway systems	Milestone D Main Air Pollution sources	31-jan-15
B. IMPLEMENTATION ACTIONS			
B1 Determination of the impact of selected parameters			30-jun-16
1-jan-15	Organisation and coordination of a campaign program	Campaigns calendar	15-dic-14
	Presentation of Technical reports on the advance of:	Report 1 Campaigns	30-apr-15
	- sampling campaigns		
	works		
	air conditioning in trains (series 2 & 3K)	Report 2 Campaigns	31-oct-15
	ventilation		
	air conditioning (series 5K)		
	rail change		
	brake pads		
	ventilation	Report 3 Campaigns	31-mar-16
	graphite pantograph		
	- chemical analysis		
	inorganic	Milestone G Impact of main air pollution source	31-dic-15
	PAH in PM filters		
	NO2 samples		
- results of the chemical analyses	Milestone H Main pollution tracers	31-dic-15	
- statistical analysis,			
- results of source apportionment			
Determination of the impact of main air pollution sources	Database 2 Chemical tracers concentration	31-mar-16	
Identification of the main pollutant tracers			
Construction of 1 database with concentrations of chemical tracers for pollutant sources in subway systems and the impact of each of them on air quality	Milestone K Characterisation emission sources	30-jun-16	
Characterisation of the emission sources			
Report on the overviewing and comparing the full impacts on air quality of each of the selected parameters	Deliverable 8 Report sources contribution	30-jun-16	

START	ACTIVITIES FOLLOW-UP	OUTCOMES available on-line at:	DEADLINE
B2. Testing mitigation measures and Development of mitigation strategies			30-sep-16
1-abr-15	Organisation and coordination of a campaign program	Campaigns calendar	1-dic-14
	Presentation of Technical reports on the advance of:	Report 1 Campaigns	30-apr-15
	- testing mitigation measures and estimated benefit in metro ambient air quality		
	ballast with water	Report 2 Campaigns	31-oct-15
	air conditioning in trains (series 2 & 3K)		
	ballast with dust suppressant		
	ventilation		
	air conditioning (series 5K)	Report 3 Campaigns	31-mar-16
	brake pads		
	ventilation		
	graphite pantograph		
	Proposal of measures for air pollution emission reduction	Milestone I Propose mitigation measures	31-may-16
	Testing of mitigation measures for emission sources	Milestone J Test mitigation measures	31-may-16
	Evaluation of mitigation measures	Milestone L Evaluate mitigation measures	30-sep-16
	Report on the results of mitigation measures in subway systems	Deliverable 9 Report Mitigation measures	30-sep-16
	Preparation of 1Technical Guidance documentation, identifying and comparing effective strategies for reducing the impact of each selected emission source.	Deliverable 10 Technical guide mitigation measures	30-sep-16
C. MONITORING ACTIONS			
C1 Effectiveness of the project actions.			31-mar-18
1-abr-15	Definition of (Management Team) a list of parameters/ indicators to assess the impact of the project including:	List 2 Impact indicators	31-dic-16
	- initial situation regarding PM levels and sources (Action A1)		
	- identification of air pollution sources during the campaigns (Action B1)	Commitment of members	30-jun-15
	- contribution of each of the emission sources identified		
	Nomination of an external committee to evaluate the progress of the project after 2 years		
	Elaboration of 1 Quality plan for the political effectiveness of the project	Deliverable 12 Report policy effectiveness	31-dic-17
	Monitor of the impact of the project	Milestone P Monitor the impact of the project	31-mar-18



START	ACTIVITIES FOLLOW-UP	OUTCOMES available on-line at:	DEADLINE
C2 Assessment of the socio-economic impact of the project.			31-mar-18
1-jul-16	Monitor of the awareness of the problem (annually <i>not every 6 months</i>) with a questionnaire to public:	Deliverable 11 Questionnaires for public	31-dic-17
	- Number of people participating.		
	Incentive other metro systems, or local authorities to apply measures proposed by IMPROVE	List 3 Replicated measures	31-mar-18
	Assessment of the socio-economic effect	Milestone M Assess Socio-economic effect	31-dic-17
	Report on the socio-economic impact of the project	Deliverable 18 Report Socio-economic Impact	31-mar-18
D. COMMUNICATION AND DISSEMINATION ACTIONS			
D1 A Project website.			31-mar-18
1-oct-14	Design and maintenance of the project website	Deliverable 1 Project website	31-dic-14
	Monitor of the number of visitors.	6 Summary reviews	31-mar-18
D2 LIFE+ Information boards.			31-mar-18
1-oct-14	Preparation and placing of 10-15 information boards	Deliverable 3 Information boards	31-jan-15
	Maintenance of boards in the metro facilities	13 Summary reviews	31-mar-18
D3 Dissemination of project results			31-mar-18
1-oct-14	Design and elaboration of 300 leaflets.	Deliverable 7 Informative leaflets	30-jun-16
	Publication of articles (4-6) in local/national press (quantification of their readership), during actions B1 & B2 and at beginning/end of project	Deliverable 15 Articles in general/trade press	31-mar-18
	Submission of 6 technical papers/presentations in international journals/conferences	Deliverable 13 Publications journals/conferences	31-mar-18
	Organisation of 1 open-forum Stakeholders (around 80 people) private and public sector	Milestone E Organize open-forum	30-jun-15
	Publication of the forum's outcomes on the project's web site.	Deliverable 5 Minutes of the open Forum	30-sep-15
	Organisation of 1 international conference (200 people) with researchers, governmental institutions, public transport assoc. and public.	Deliverable 17 Proceedings of the conference	31-mar-18
D4 Production of Layman's Report.			31-mar-18
1-jul-16	Production and dissemination of 2.000 copies to the stakeholders	Deliverable 16 Layman's Report	31-mar-18



START	ACTIVITIES FOLLOW-UP	OUTCOMES available on-line at:	DEADLINE
E. MANAGEMENT ACTIONS			
E1 Project Management and Audit.			31-mar-18
1-oct-14	Nomination of the Project Management Team	Milestone A Project management team	31-oct-14
	Elaboration of the Quality assurance plan	Milestone C Quality assurance plan	30-nov-14
	Submission of the Inception Report	Inception Report	30-jun-15
	Submission of the Mid-term Report	Mid-term Report	31-dic-16
	Submission of the Final Report	Final Report	30-jun-18
E2 Monitoring of the project progress.			31-mar-18
1-oct-14	Revision the progress of the project, according to its indicators.	Milestone B Indicators of Progress	30-nov-14
	Meeting between partners	Deliverable 19 Summary reviews	31-mar-18
	Implementation of corrective recommendations after each meeting if necessary		
E3 Networking with other European projects (including LIFE+).			31-mar-18
1-oct-14	Organisation of 1 expert group workshop	Deliverable 6 Minutes of the expert's workshop	30-sep-15
	Organisation of 1 workshop with other European projects	Milestone F Workshop with LIFE+ projects	30-jun-17
	Participation in other LIFE+ project's meetings	Presentations of IMPROVE	31-mar-18
E4 After-LIFE+ Communication Plan.			31-mar-18
1-jul-16	Preparation of the After-Life communication plan	Deliverable 14 After-Life communication plan	31-mar-18