EPA Research Programme 2014-2020

APPLICATION FORM
Additional Cost Extension – Project Based Awards

Extension to the project "National mapping of GHG and non-GHG emissions sources" (Ref: 2015-CCRP-MS.26)

Section A: Literature Review.

Spatial distribution of emissions is a key element in assessing human exposure to air pollution through the use of dispersion modelling. The quality of the spatial distribution of emissions is crucial for the quality, applicability and reliability of the modelled air pollution levels, the estimated human exposure, incurred health effects and related costs; all issues that are very important information for policy makers in decisions of implementation of environmental policies and measures. Detailed information on spatial emission distribution can allow policy makers to adapt environmental initiatives on a geographical level to optimise the effect and minimise the costs.

In addition to the importance of spatial and temporal resolution of emissions to air quality modelling there is also international requirements regarding the reporting of spatially distributed emissions. Under the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) there is a requirement to report spatially distributed emissions every four years (ECE/EB.AIR/125). The reporting guidelines under CLRTAP specifies the coverage of pollutants, and emission sources and sectors to be covered as well as setting out requirements to the grid used and the deadline for reporting. The reporting by Parties is used in the European Monitoring and Evaluation Programme (EMEP) modelling. The EMEP model calculations have been supporting the decision making within CLRTAP for more than 30 years. Since the 1990s, the EMEP models have been the reference tools for atmospheric dispersion calculations as input to the Integrated Assessment Modelling, which supports the development of air quality polices in the European Union.

In the EMEP/EEA Guidebook (EEA, 2016), there is provided technical guidance for the spatial distribution of emissions. The Guidebook is mandatory to use as a minimum standard in preparing and reporting data under CLRTAP. The Guidebook contains guidance on the selection of spatial data sets, both related to possible nationally available data and internationally available datasets (such as CORINE or Eurostat data) that can be used, if no national data are available.
Many studies have been published regarding spatial distribution of emissions. Several studies have endeavoured to make a spatial distribution for the whole of Europe. These include the EDGAR2 system developed by the European Commission Joint Research Centre and the system developed by TNO (Denier van der Gon et al., 2010). In general, both of these projects used point source information where it was available. This information came from international databases such as EPER (European Pollutant Emission Register) and the World Electric Power Plants Database. For the area sources both studies used very crude spatial proxies to distribute emissions, such as population density, FAO data on distribution of livestock, and CORINE (Coordination of Information on the Environment) land cover. With thorough research at the country level, it is possible to significantly improve the spatial distribution compared to these models attempting to cover the entire European continent. Further improvement of spatial emission distribution can be made for regions or cities where more detailed data often are available for some emission sources or sectors.

Most of the published studies have focussed on single pollutants (Bo et al., 2008; Sahu et al., 2011; Dalvi et al., 2006) or single sectors (Skjøth et al., 2011; Hellsten et al., 2008; Puliafito et al., 2015). In addition, many studies have not been at the national level but at a city or regional level (Sahu et al., 2011; Guttikunda & Calori, 2013; Tian et al., 2004). A few studies have focused on spatial distribution for a range of pollutants at the national level for all emission sectors (Plejdrup & Gyldenkærne, 2009; Tsilingiridis et al., 2010; Tsagatakis et al., 2013; Kannari et al., 2007).

In Denmark, the SPREAD model has been developed for high-resolution (1 km x 1 km) spatial distribution of all sources and all pollutants included in the national emission inventories (Plejdrup & Gyldenkærne, 2009). Spatial distribution is carried out on highly disaggregated emission source level, and resulting spatial emissions corresponds to the emissions in the national inventories. SPREAD is based on detailed national spatial data, e.g. the Danish Building and Dwelling Register, the Civil Registration Register, the national GIS-based road and traffic database, and the Central Husbandry Register. Spatial data are analysed in a Geographical Information System (GIS) and through geoprocessing converted to spatial distribution keys to be included in the integrated database system.

The Danish SPREAD model has been used in a number of studies on city level focussing on specific emission sectors. E.g. improvement of calculation and spatial distribution of emissions from railways in the municipalities of Copenhagen and Aarhus based on detailed data for driving, standing in stations and during preparation by railway sections, and improvement of spatial distribution of emissions from non-road machinery in industry for Copenhagen Municipality through comparison of spatial emissions based on different spatial proxy data. Both local scale projects have been used in air quality modelling for assessment of the influence of trains and industrial machinery on air quality in cities.

Development of bottom-up inventories on city level can serve as case study where improvements from implementation of new and more detailed data sources can be assessed, before large effort are made to obtain the data on national level. This approach has been used with great benefit for the residential combustion sector in Denmark, where highly detailed data on small residential combustion plants, provided by the chimneysweeper association for the municipalities of Copenhagen and Frederiksberg, were implemented in the spatial emission model for the case area and used for improvement and verification of the national distribution methodology. The improved model for residential combustion has been published in Plejdrup et al. (2016). The results of the case study gave rise to further focus from the decision makers, inducing effort for providing a data set of national coverage, which is following being implemented in the Danish SPREAD model. Implementing of the new national data is ongoing and will contribute a great and important improvement of the emission distribution for the residential sector, which is an emission source of high importance for the modelling community, as the emissions occur in in areas where people lives and in low heights, influencing the human exposure.

For Ireland, a study was published in 2001 on the modelling of the spatial distribution of SO_2 and NO_x emissions in Ireland (Kluizenaar et al., 2001). This study provides more detail than the first study reporting spatially distributed emissions in Ireland (McGettigan & O'Donnell, 1995). Kluizenaar et al. (2001) spatially distributed emissions of SO_2 and NO_x at a 1 km x 1 km resolution. The study relied on data from e.g. population census, land cover data from CORINE, road travel statistics, and county based residential fuel consumption. The study lists several areas where the methodologies used could be improved.

In the project "National mapping of GHG and non-GHG emissions sources" (MapEIre), a high-resolution (1 km x 1 km) spatial emission model was developed for Ireland using the best data available. The model mainly uses top-down methodology. However, this means that the model might be less accurate when looking at a local area, e.g. Dublin. In connection with the FAIRMODE project, a methodology has been developed to compare different emission inventories (Thunis et al., 2016 & Guevara, et al., 2016). The method was applied in Norway to assess the discrepancies between bottom-up and regional emission inventories in Norwegian urban areas (López-Aparicio et al., 2017). The Norwegian study shows that a lot of information can be gained by comparing local bottom-up inventories with scaled down national approaches as well as regional models developed by TNO and INERIS.

References

Bo et al., 2008: Spatial and temporal variation of historical anthropogenic NMVOCs emission inventories in China. Atmospheric Chemistry and Physics 8, 7297-7316

Dalvi et al., 2006: A GIS based methodology for gridding of large-scale emission inventories: Application to carbon-monoxide emissions over Indian region. Atmospheric Environment 40, 2995–3007

Denier van der Gon et al., 2010: A high resolution European emission data base for the year 2005. Umweltbundesamt, Germany

ECE/EB.AIR/125: Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution

EEA, 2016: EMEP/EEA air pollutant emission inventory guidebook 2016. Technical guidance to prepare national emission inventories. doi:10.2800/92722

Guevara et al., 2016: A benchmarking tool to screen and compare bottom-up and top-down emission inventories. Qual Atmos Health, 2016.

Guttikunda & Calori, 2013: A GIS based emissions inventory at 1 km x 1 km spatial resolution for air pollution analysis in Delhi, India. Atmospheric Environment 67 (2013) 101-111

Hellsten et al., 2008: Modelling the spatial distribution of ammonia emissions in the UK. Environmental Pollution 154, 370-379.

Kannari et al., 2007: Development of multiple-species 1 km x 1 km resolution hourly basis emissions inventory for Japan. Atmospheric Environment 41, 3428-3439.

Kluizenaar et al., 2001: Modelling the spatial distribution of SO2 and NOx emissions in Ireland. Environmental Pollution 112 (2001) 171-182

Lopez-Aparicio et al., 2017: Assessment of discrepancies between bottom-up and regional emission inventories in Norwegian urban areas. Atmospheric Environment, 154, 285-296, 2017.

McGettigan & O'Donnell, 1995: AIR POLLUTANTS IN IRELAND - Emissions, Depositions and Concentrations 1984-1994. Environmental Protection Agency, Ireland

Plejdrup & Gyldenkærne, 2011: Spatial distribution of emissions to air – the SPREAD model. Aarhus University, Denmark. NERI Technical Report no. FR823

Plejdrup et al., 2016: Spatial emission modelling for residential wood combustion in Denmark. Atmospheric Environment (2016) 389-396.

Puliafito et al., 2015: High resolution inventory of GHG emissions of the road transport sector in Argentina. Atmospheric Environment 101 (2015) 303e311

Sahu et al., 2011: Emissions inventory of anthropogenic PM2.5 and PM10 in Delhi during Commonwealth Games 2010. Atmospheric Environment 45 (2011) 6180-6190

Skjøth et al., 2011: Spatial and temporal variations in ammonia emissions – a freely accessible model code for Europe. Atmospheric Chemistry and Physics 11, 5221–5236.

Thunis et al., 2016: A novel approach to screen and compare bottom-up vs. top-down emission inventories. Qual Atmos Health, DOI 10.1007/s11869-016-0402-7, 2016.

Tian et al., 2004: Model development for spatial variation of PM2.5 emissions from residential wood burning. Atmospheric Environment 38 833–843

Tsagatakis et al., 2013: UK Emission Mapping Methodology 2011. Ricardo-AEA/R/3376 ED57422104.

Tsilingiridis et al., 2010: A spatially allocated emissions inventory for Cyprus. Global NEST Journal, Vol. 12, No 1., 99-107

Section B: Pressures, Policy, Solutions.

Mapping of emissions is an important first step to quantify pressures in the form of deposition of harmful substances to the environment and human exposure to air pollution. Human exposure to air pollution is a significant challenge. WHO estimates that there were 3.7 million premature deaths in 2012 from urban and rural sources worldwide due to outdoor air pollution. Recent results (Brandt et al., 2013a) show that outdoor air pollution caused a total number of 570.000 premature deaths in the year 2011 in Europe. While emissions in Europe are generally decreasing (EEA, 2017) there are still challenges at the local and regional scale that can only be quantified using high-resolution spatial models.

The impacts from air pollution are not equally distributed, but depend on geography, socio-demographic and socio-economic factors, including residence address, age, gender, social status, and level of income. Including detailed spatial and temporal distributed emissions improve air quality modelling and contribute to understand the link between air pollution and distribution of related health impacts by adding knowledge that influences modelling of human exposure levels.

Air pollution, in general, is a transboundary and scale dependent challenge with global, regional, national and local sources giving rise to large geographic variability and thereby large differences in the geographical distribution of human exposure to air pollution. Therefore, the lifetime exposure and personal risk factors for mortality and morbidity outcomes due to air pollution, and thereby their welfare, is very dependent on the individuals possibilities to live in a clean environment.

For larger geographical areas, e.g. Europe, there are large differences in the exposure risks and living conditions due to regional differences in air pollution levels caused by long-range transport of polluted air masses especially from the south and east, as well as the degree of urbanisation and geography in densely populated areas. There are also local differences depending on wind direction and distance from local emission sources such as road transport, power plants and industry (Brandt et al., 2013b). Due to considerable impacts of near-by sources, emission inventories with high spatial resolution are crucial for reliable health impact assessment. Further, implementation of high resolution spatial and temporal emissions contribute to efficient regulation of emission sources to air pollution and to decrease the related health effects and impacts on society.

The development of a high-resolution spatial and temporal model for Ireland will allow for a more detailed regulation implementing measures targeting areas where the emissions are highest allowing for more cost-effective initiatives. Development of a national spatial emission model covering the entire country allows for assessment of effects of measures on local, regional and national scale.
In development of a spatial distribution model, it is advantageous to link directly to the official Irish air emission inventories produced by the Irish Environmental Protection Agency and to design the model to comply with the international reporting requirements under CLRTAP. Additionally, the national model for spatial distribution can be used to evaluate future trends, by adding a geographical component to emission projections prepared frequently by the Irish EPA, which is a valued tool for environmental policy makers.
The development of a bottom-up inventory for Dublin and comparing it with the scaled down national inventory as well as other European scale inventories will provide additional information that can improve the national model and allow for a more accurate assessment of the human exposure to air pollution.

References

Brandt et al., 2013a: Assessment of past, present and future health-cost externalities of air pollution in Europe and the contribution from international ship traffic using the EVA model system. Atmospheric Chemistry and Physics, 13(15), 7747-7764. 10.5194/acp-13-7747-2013
Brandt et al., 2013b: Contribution from the ten major emission sectors in Europe and Denmark to the health-cost externalities of air pollution using the EVA model system - an integrated modelling approach. Atmospheric Chemistry and Physics, 13(15), 7725-7746. 10.5194/acp-13-7725-2013
EEA, 2017: European Union emission inventory report 1990–2015 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP). EEA Technical Report No 9/2017

Section C: Objectives and targets, detailed work-packages, risk and contingencies.

The extension of the project ‘National mapping of GHG and non-GHG emissions sources’ includes further elaboration of the work done as well as including the work package of a bottom-up spatial distribution for Dublin.
The overall objective of the project National mapping of GHG and non-GHG emissions sources is the development of a spatial and a temporal emission mapping model including all sources and all pollutants in the Irish emission inventory, and covering the entire Irish territory defined by the Exclusive Economic Zone. To date the spatial model has been completed and the work on the temporal model has started by identifying relevant datasets and contacting relevant data suppliers. The objective of the extension to the project is development of a bottom-up spatial emission inventory for Dublin and an update of the national spatial emission mapping model with data that has become available since the first version.

The input for the spatial distribution keys (GeoKeys) used for spatial mapping of emissions come from a very large number of organisations, which underscores the importance of very close cooperation with all relevant stakeholders, ensuring that they are well informed on the objectives of the project and how their specific involvement can greatly improve the final result. The spatial model is documented in a technical background report, which has currently been made available to the Steering Committee for commenting.

A project website (www.mapeire.dk) has been created containing information on the project as well as general information on spatial and temporal distribution of emissions. The website also includes a protected area for members of the steering committee where documents and presentations from steering committee meetings are available. The website has been frequently updated to include meeting documents from both the Steering Committee meetings and the stakeholder workshop. Further, the website includes results from the spatial model in terms of emission maps, and GIS files, so that interested users can download and use the results of the project. Currently, the following outputs are publically available from the project website:

- Synthesis report for work package 1
- Synthesis report for work package 2
- Presentation from the first Stakeholder workshop
- Minutes from the first Stakeholder workshop

An abstract has been submitted to the 10th European Forum for Geography and Statistics (EFGS). The conference takes place in Dublin in November 2017. Further, a scientific paper will be submitted during the autumn of 2017 or in case of an extension covering improvements to the model in Summer 2018.

There are two distinct tasks to be carried out during the extension. The tasks are added to the original project as two separate work packages addressing the two tasks separately.

First, an improved spatial emission mapping model will be developed for Dublin taking into account bottom-up data for Dublin. Detailed data available for Dublin will be identified and assessed regarding applicability in a local model, and relevant data suppliers will be contacted to ensure that local knowledge is considered and incorporated to the extent possible. When no detailed bottom-up data are available, the top-down model developed for Ireland will provide input for Dublin. This task will be added to the project as WP6.
Second, the project extension will encompass an update of the national spatial model by preparing new GeoKeys based on updated and newly available data. This task will be added to the project as WP7.
The two tasks are addressed separately in two additional work packages (WP6 and WP7).

Title	Development of bottom-up inventory for Dublin			
Work Package No.: WP6	**Start Month:** 01/10/2017		**End Month:** 01/05/2018	
Work Package Leader Name/Organisation	Ole-Kenneth Nielsen, Department of Environmental Science, Aarhus University			
Other Participant Name/Organisation with major involvement	Marlene S. Plejdrup, Department of Environmental Science, Aarhus University	Henrik G. Bruun, Department of Environmental Science, Aarhus University	Jesper H. Christensen, Department of Environmental Science, Aarhus University	
Participant:	Ole-Kenneth Nielsen	Marlene S. Plejdrup	Henrik G. Bruun	Jesper H. Christensen
Person-months per participant	1.9	2.5	1.4	0.5

Objectives

The objective of WP6 is to develop a bottom-up inventory for Dublin based on the most detailed data available.

Description of Work

Related to ongoing activities in air quality modelling, it is interesting to look closer at a smaller area as a case study. Dublin has been selected as a suitable test area. Working on a city scale gives better opportunities for air quality modellers to compare the model results with results from air quality monitoring, to see how well the model complex of emission modelling, spatial modelling and dispersion modelling matches the measurements carried out. Another advantage of working bottom-up for a city like Dublin is that it will be possible to compare the bottom-up and top-down modelling, analyse the differences and get a better understanding of the uncertainties involved with the different approaches.

The work will focus on the main pollutants (NO_x, SO_2, NMVOC and $PM_{2.5}$) for 2015 and will consider all sectors as included in the Nomenclature for Reporting (NFR) that is used in international reporting under the NECD and UNECE. In principle, all pollutants included in the Irish national emission inventories can be included.

The spatial distribution in the current national model can be improved through development of a bottom-up inventory for Dublin based on data of higher detail than the data used to prepare the national spatial model. Data sources for Dublin will be identified, that can allow for a more detailed spatial distribution than the result of the top-down model. Particular attention will be given to road transport and combustion installations that are not included as point sources in the national inventory. Regarding combustion for point sources, the aim will be to improve the inventory by identifying and including more detailed data on fuel combustion and information on specific industries within the four local authorities comprising Dublin. For road transport, it will be investigated if more detailed data are available for traffic in Dublin. The identification and use of detailed bottom-up data of high quality require cooperation with the local authorities in order to identify and gain access to relevant data and information.

Through the work on designing the national model to handle the large amount of data involved in doing a high-resolution spatial distribution of emissions, a lot of experience has been acquired on how to design the database system in order to ensure the best possible performance and user friendliness. The experiences gained during this work will be applicable in designing the bottom-up model for Dublin.

A comparison of the bottom-up and top-down inventory will be made, using the Delta tool developed in the framework of FAIRMODE, and areas for improvement will be identified.

The bottom-up spatial inventory will be documented in a technical report. Further, a scientific paper on the bottom-up spatial inventory for Dublin and comparison with top-down inventories will be submitted to a peer-reviewed journal during 2018.

Most of the outputs from WP6 should be available in February 2018 due to the schedule of the FAIRMODE project and hence work needs to start as soon as possible. The timeline for the proposed work on a bottom-up inventory for Dublin means that the existing project plan has to be amended. This means that the remaining work on the temporal model will have to be postponed to 2018. Therefore, the original Gantt chart has been included as well as the proposed Gantt chart covering both the original project period and the extension.

Title	Updating of the spatial model		
Work Package No.: WP7	**Start Month:** 01/11/2017		**End Month:** 01/10/2018
Work Package Leader Name/Organisation	Marlene S. Plejdrup, Department of Environmental Science, Aarhus University		
Other Participant Name/Organisation with major involvement	Ole-Kenneth Nielsen, Department of Environmental Science, Aarhus University		Henrik G. Bruun, Department of Environmental Science, Aarhus University
Participant:	Marlene S. Plejdrup	Ole-Kenneth Nielsen	Henrik G. Bruun
Person-months per participant	1.6	1.4	1.2

Objectives
The objectives of WP7 are to update the spatial model by including data from the 2016 census and new data on the natural gas grid. The new data sets will be used to update spatial distribution keys (GeoKeys), and form the basis of developing time-series profiles for GeoKeys where applicable. Further, additional point source data will be used to develop time-series for GeoKeys.

Description of work
Currently, it has only been possible to derive spatial keys relevant for 2015. However, to increase the usability for air quality modelling, it would be relevant to have a time-series profiles for GeoKeys. Therefore, the spatial model will be updated taking into account new datasets that has become available. These data sets include the results of the 2016 census, which were not processed in time for incorporation in the first version of the spatial model, and new data on the natural gas grid. The new data will be used to update spatial distribution keys (GeoKeys), and form the basis of developing time-series for GeoKeys where applicable. Further, additional point source data will be used to develop time-series for GeoKeys.

Several improvements are planned as part of WP7:
- Incorporation of data from the 2016 census as well as earlier census
- Incorporation of data from Gas Networks Ireland, if data become available, to improve the distribution from residential/commercial/industrial sources
- Incorporation of 2000 agricultural census
- Development of spatial profiles back in time based on historic data for point source emissions
- Incorporation of traffic count data for earlier years, if data become available.
- Incorporation of 2011 railway transport statistics
- Development of spatial profiles back in time based on historic data for national aviation (LTO and cruise)
- Development of spatial profiles for population, buildings and heat demand for earlier years if data are available in a applicable format

The development of time-series for the spatial profiles will significantly improve the usefulness of the model for modelling purposes, as air quality modelling will typically focus on modelling longer time-series, in order to establish a development in air quality and human exposure. This will consequently also make the output more relevant in terms of being used for health studies, where the long-term exposure is needed in order to assess links between air pollution and human health.

The updated GeoKeys will be incorporated in the spatial model and the technical documentation report of the spatial model will be updated correspondingly.

As described under WP6 and WP7, several dissemination activities are planned. In addition to the reports and paper mentioned above, the results will be presented at a stakeholder workshop and additionally it is planned that the results will be presented at a conference. Further, the project website will be updated frequently with results from the updated spatial model, including updated emission maps and GIS files. Meeting documents will be published on the closed part of the webpage accessible for members of the Steering Committee.

The proposed activities will provide additional value to the model developed within the original project. The development of a bottom-up inventory for Dublin will allow for sectoral comparisons with the top-down inventory, which can serve to further verify the top-down model, and identify areas for improvement in the top-down model. In addition, the work will contribute to Ireland's participation in the FAIRMODE work.
The update of GeoKeys with new data as well as expanding the model to consider GeoKey time-series will significantly increase the value of the model for future air quality modelling.

Section D: Communication.

Communication plan
Relevance to Research Priorities:

- The bottom-up inventory for Dublin will provide improved knowledge on emission on local scale and serve as highly detailed input to air pollution models
- The update of GeoKeys with new data as well as expanding the model to consider GeoKey time-series will provide improved and more up-to-date spatial emission mapping and significantly increase the value of the model for future air quality modelling purpose
- The bottom-up inventory for Dublin will provide improved knowledge on emissions on local scale and serve as highly detailed input to air pollution models
- The bottom-up inventory for Dublin provides important knowledge to the modelling community, and is expected to improve the consistency between measured and modelled concentrations of air pollutants.
- Detailed emissions and air pollution levels on both national and local level can be used by policy makers in decision making and prioritising of environmental measures, and improve the reasoning for environmental regulation when used as input to e.g. health effect studies.

Target audience:

- National emission inventory compilers, responsible for reporting of spatial emissions to UNECE-CLRTAP can use the models as part of the national system to fulfil reporting obligations.
- The bottom-up inventory for Dublin will feed in to the work in the FAIRMODE project.
- The local authorities of Dublin can gain detailed information on local scale emissions from the bottom-up inventory for Dublin.
- Modellers and researchers working with air pollution, air quality and related fields can benefit from using output from both the bottom-up inventory for Dublin and the updated national model due to the high spatial and temporal distribution.
- Policy makers can include spatial and/or temporal emissions in the process of assessing and deciding on environmental measures, e.g. combined with emission projections to

consider long-term effects of local and national planning.

Expected output of the project include the following products:

- The work of the project extension will be included in the final report, which summarises the work carried out during the whole project. As part of the final report, the written outputs prepared during the WPs will be annexed. These outputs from the project extension include:
    - The work of WP6 on the bottom-up inventory will be documented in a technical report.
    - The work of WP7 on updating GeoKeys will be incorporated in the technical documentation report for the spatial model
- The work of the project extension regarding update of the spatial model (WP7) will be included in all relevant product to be prepared according to the original project proposal.
- A scientific paper on the bottom-up inventory for Dublin including comparison with top-down inventories will be submitted to a peer-reviewed journal. When submitting the paper it will be with open access in accordance with EPA's policy.
- Maps of spatial emissions for Dublin for relevant pollutants will be prepared based on the bottom-up inventory.
- The project webpage will be updated with information regarding the work in and results from WP6 and WP7, including meeting documents. Part of the material will be uploaded to a closed part of the project webpage available for the steering committee only.
- An oral or poster presentation of the work at a relevant conference.
- The integrated model system for spatial and temporal distribution including the associated databases, geographical datasets and spatial distribution keys.

Communication of project activities and outputs:

The outputs and the work carried out through the project will be communicated in a number of different ways:

- The project website will be continuously maintained throughout the project.
- All reports, presentations, status updates, and maps will be uploaded to the project webpage.
- Close contact with the EPA during the entire project period
- Workshops and meetings with stakeholders during the project as needed.
- Publication of results in peer-reviewed journal.
- Presenting the work at an international conference.
- Press release and/or newsletter will be prepared for publishing on e.g. epa.ie.
- Final newsletter to all involved stakeholders at the end of the project summarising the results.

Section E: Project management and project team.

The extension of the project will be carried out by the same institution and the same personnel as the original project proposal. Specifically the experts listed below will carry out the work proposed in this extension.

Ole-Kenneth Nielsen, Special Adviser. Ole-Kenneth has a background in chemical engineering, has more than 10 years of experience within the field of air emissions, and has for the past seven years been project leader of the Danish air emission inventories. Ole-Kenneth has extensive experience within all sectors and serves as an expert reviewer under both the UNFCCC and the UNECE. Ole-Kenneth was the coordinating lead editor of the 2013 edition of the EMEP/EEA Guidebook. Ole-Kenneth will be overall project leader and be involved in the setup of both the spatial and temporal model. http://au.dk/en/okn@envs.au.dk

Marlene S. Plejdrup, Academic Associate. Marlene has a background as a physical geographer and has been responsible for developing the Danish high-resolution spatial model (SPREAD) for distributing emissions. Marlene has been responsible for preparing the official Danish submission of spatial distributed emissions in adherence to the guidelines under CLRTAP. Marlene also has extensive experience in working on the Danish emission inventories and therefore has strong insight into the links between the emission inventory and the spatial modelling. Marlene will be responsible for the development of the spatial model. http://au.dk/en/msp@envs.au.dk

Jesper H. Christensen, Senior Researcher. Jesper has a background in geophysics and has more than 20 years of experience within the field of atmospheric science and in particular atmospheric modelling. Jesper has been a key factor in developing the Danish Eulerian Hemispheric Model (DEHM) and has published extensively both in peer-reviewed journals and scientific reports, and has communicated results to stakeholders and the general public. Jesper will work on the temporal model and will contribute to the visualisation of the results. http://au.dk/en/jc@envs.au.dk

Henrik G. Bruun, IT expert. Henrik has been working with environmental data for more than 20 years and has extensive experience in data processing in spreadsheets and databases. Henrik has built the national emission databases in Denmark and has implemented the Danish reporting system to fulfil obligations for reporting of NFR and CRF tables to the UNECE and UNFCCC respectively. Henrik has large experience with programming in a variety of languages and will contribute to ensure an easy workable link between the Irish emission inventory and the spatial/temporal model. http://au.dk/en/hgb@envs.au.dk

Section F: Budget justification.

The project extension has been divided into two work packages. Most resources have been allocated to WP6 (Development of bottom-up inventory for Dublin) compared to WP7 (Updating the spatial model).

In addition to the two extra work packages, some additional budget has been allocated to WP5 (project management).

In total the personnel costs are 68,000 € excluding overhead and 88,400 € including overhead. The personnel involved will be the same as included in the original project proposal.

In addition to the personnel costs there is budgeted with travel and subsistence expenses of 10,000 € excluding overhead. In assessing this part of the budget, it is taken into account that we believe that the project will need to be carried out in close cooperation with the EPA, the local authorities of Dublin and other Irish authorities/stakeholders. While some of the communication can take place using telephone- and videoconferencing, it is envisaged that several meetings and short work stays will be needed over the course of the project extension. It is also taken into account that participation in FAIRMODE meetings will be needed. During the recent years there has been two FAIRMODE meetings per year.

Category of expenditure	Amount, €
Staff costs	68000
Travel and subsistence	10000
Overheads to Staff costs	20400
Overheads to Travel and subsist.	3000
Total budget for extension	101400

Updated GANTT CHART: Project Milestones and Timetable

Task	Month ⇨ Description ⇩	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	**Development of specifications for the spatial and temporal model**																								
1.1	Literature review																								
1.2	Specifications of the spatial model																								
1.3	Specifications of the temporal model																								
2	**Assessment and selection of geographical data for the spatial mode**																								
2.1	Identification of available spatial data																								
2.2	Review of the spatial data sets																								
2.3	Selection of spatial data																								
3	**Development of the model for spatial distribution of emissions**																								
3.1	Design of the spatial model																								
3.2	Building the spatial distribution model	■	■	■																					
3.3	Consistency with the national emission inventory	■	■	■	■	■																			
4	**Development of the model for temporal distribution of emissions**																								
4.1	Design of the temporal model		■	■	■																				
4.2	Integration with the spatial distribution model		■	■	■	■	■	■	■								■	■	■	■	■				
4.3	Building the temporal distribution model				■	■	■	■	■								■	■	■	■	■				
5	**Project management and communication**																								
5.1	Steering Committee meeting	■						■						■						■					
5.2	Technical Progress Report (TPR)	■						■						■						■					
5.3	Cost Statement	■						■						■						■					
5.4	Project website development																								
5.5	Stakeholder workshops											■											■		
5.6	End-user workshop																							■	
5.7	Final Cost statement																								■
5.8	Final Technical Progress Report (TPR)																								■
5.9	End of Project Questionnaire (EPQ) on SmartSimple																								■
5.10	2 pager project summary																								■
6	**Development of bottom-up inventory for Dublin**																								
6.1	Identifying available data for bottom-up inventory									■	■	■	■												
6.2	Developing the bottom-up inventory									■	■	■	■	■	■	■	■								
7	**Updating of the spatial model**																								
7.1	Developing updated GeoKeys															■	■	■	■	■					
7.2	Incorporate the updated GeoKeys in the model																			■	■	■			

Original GANTT CHART: Project Milestones and Timetable

Task	*Month* ⇨ *Description* ⇩	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	**Development of specifications for the spatial and temporal model**																								
1.1	Literature review																								
1.3	Specifications of the spatial model																								
1.3	Specifications of the temporal model																								
2	**Assessment and selection of geographical data for the spatial mode**																								
2.1	Identification of available spatial data																								
2.2	Review of the spatial data sets																								
2.3	Selection of spatial data																								
3	**Development of the model for spatial distribution of emissions**																								
3.1	Design of the spatial model																								
3.2	Building the spatial distribution model	■	■	■																					
3.3	Consistency with the national emission inventory	■	■	■	■	■																			
4	**Development of the model for temporal distribution of emissions**																								
4.1	Design of the temporal model		■	■	■																				
4.2	Integration with the spatial distribution model		■	■	■	■	■	■	■	■															
4.3	Building the temporal distribution model				■	■	■	■	■	■															
5	**Project management and communication**																								
5.1	Steering Committee meeting	■						■																	
5.2	Technical Progress Report (TPR)	■						■																	
5.3	Cost Statement	■						■																	
5.4	Project website development																								
5.5	Stakeholder workshops										■														
5.6	End-user workshop											■													
5.7	Final Cost statement												■												
5.8	Final Technical Progress Report (TPR)												■												
5.9	End of Project Questionnaire (EPQ) on SmartSimple												■												
5.10	2 pager project summary												■												
6	**Development of bottom-up inventory for Dublin**																								
7	**Updating of the spatial model**																								