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Verification of sources and sinks of Irish greenhouse Gases

Principle Investigator Prof. Colin O'Dowd

Lead Organisation National University of Ireland, Galway (NUIG)

Duration & Start Date 24 months, 01/01/2012

Project Abstract

The project addresses the issue of independent verification of Ireland's green house gas (GHG) emissions (CH₄ and CO₂) through the use of state of the art inverse modelling techniques. Input from a high frequency measurement network (3 sites) will be combined with a priori data (from national inventories, a dynamic vegetation model and an ocean model) and a Lagrangian Particle Dispersion Model (FLEXPART). An analytical inversion is then performed. This Bayesian inversion considers uncertainties for the a priori and the observations as well as an iterative algorithm for ensuring a solution with only positive values. In combination with a quantification of the uncertainties of both unknowns and observations this leads to a corresponding cost function being minimised. This cost function considers misfit model observations, deviation from the a priori values, standard errors of the observations and standard errors of the a priori values to give national estimates. These top down estimates will then be used to verify bottom up national emission inventories as well as being interrogated with respect to recently published biome flux data to gain further understanding of sources and sinks. A box model method will be used in conjunction with Ozone, LIDAR and GHG's to measure emission fluxes.

Expected Outputs

The project offers will build an indigenous inverse modelling research capacity, and autonomy in terms of assessment, through the use of one of Europe's foremost Lagrangian Particle Dispersion Model (LPDM) and inversion procedures. This knowledge transfer has the potential for a diverse range of further environmental applications.

National Forest Inventory Support - Developing Methods to Track Forestry Related Land Use Change

Principle Investigator Dr. John Devaney

Lead Organisation University College Cork (UCC)

Duration & Start Date 24 months, 01/10/2011

Project Abstract

This fellowship sets out to improve the reporting of the National Inventory of GHG emissions related to Land Use, Land Use Change and Forestry. The project will utilise novel data arising from the second National Forest Inventory to assess the extent of forestry related land use change in Ireland. Following the completion of the first repeat NFI, a methodological framework for the integration of repeat NFI data with LULUCF reporting methods will be developed. The primary objective of this project is to integrate National Forestry Inventory data with LULUCF methodology to ensure the scientific validity of estimation of carbon stock change in forestry. Critical to this goal is the completion of the first repeat NFI in 2012. The support provided by this fellowship aims to ensure the timely delivery of the NFI 2012. In addition, this project aims to deliver an area based inventory of forestry related land use change at high spatial resolution and report on the accuracy and validity of current methods to track land use change.

Expected Outputs

This project will support of Forest Service staff to ensure the timely delivery of The National Forest Inventory (NFI) 2012. Work carried out during this project will deliver (i) an area based inventory of forestry related land use change (ii) a fellowship report detailing research findings including a feasibility, accuracy and validity study of current methods to track land use change associated with forestry and (iii) manuscript for publication in an international research journal detailing the integration of forest inventory data with LULUCF Inventory

The Irish Land Mapping Observatory (ILMO)- Mapping and Monitoring Land Cover, Use and Change

Principle Investigator Dr. Fiona Cawkwell

Lead Organisation University College Cork (UCC)

Duration & Start Date 24 months, 01/11/2011

Project Abstract

This project will develop an integrated Geoinformatics approach to detecting land cover and use within Irish agricultural lands, and to monitoring changes on an inter- and intra-annual basis, to facilitate reporting on national greenhouse gas emissions related to land use. Hyper-temporal optical time series satellite data will be used to classify land cover and use at a 250-300m resolution, with higher resolution optical and radar data used to enhance and verify the products generated. The pixel-based classification of land cover will be assigned to vector based objects pre-defined by Ordnance Survey Ireland in their Prime2 database, with robust rules defined to match sub- or multiple-pixel land parcels to the most appropriate land cover and use. The research will focus on test areas which include all major agricultural regimes found in Ireland. From the land cover information greenhouse gas emissions will be determined, and outline documentation provided to demonstrate development of the regional application to a national scale and application to other land covers. The final product will be the Irish Land Mapping Observatory, a flexible system that can be adapted to a range of different land covers and uses.

Expected Outputs

The anticipated outputs are a project report on the key findings and recommendations for national scale land cover and use mapping with a view to greenhouse gas emissions calculation, capacity building through non peer-reviewed publications, website and teaching projects, a workshop at the end of the first year to bring together the main stakeholders and a symposium at the end of the second year to celebrate the main achievements of the project and plan for future work on land cover mapping and monitoring.

Feasibility of Chronosequence of Grassland Soil Carbon Survey

Principle Investigator Prof. Ger Kiely

Lead Organisation University College Cork (UCC)

Duration & Start Date 12 months, 01/01/2012

Project Abstract

This project is a desk-top study on a feasibility survey of soil carbon in Irish grasslands. The researchers will perform a literature review on the carbon sequestration of grassland soils and collate all Irish data on SOC (concentration, bulk density etc) including site information, land use history, land use management practices, site climate, etc. The study will include a review statistical methods to enable SOC stock and stock changes to be quantified with defined precision (e.g. MDD) and assess the suitability of different methodologies (paired plots, repeat sampling, chronosequence work etc) to identify the optimum methodology for use in Irish conditions. An evaluation of the suitability of existing and new sites and identify a suite of suitable sites and measurements for a future survey will be undertaken. Also the study will include a theoretical analysis of the controls and drivers of the equilibrium SOC rate and of the rate at which fields approach their equilibrium (saturation).

Expected Outputs

We will deliver three peer review publications: one – a review paper on carbon sequestration in grassland soils; two – a review paper on statistical methods related to sample size and minimum detectable differences; three – a review of sampling methodologies (paired plot, chronosequence, repeat sampling). We will deliver a CD of all data collected for the EPA archive.

Stress induced molecular and ecological changes in soil autotrophs: carbon capture and novel compound prospecting.

Principle Investigator Dr. Brian Kelleher

Lead Organisation Dublin City University (DCU)

Duration & Start Date 24 months extension, 01/01/2012

Project Abstract

The research group has recently reported that microbial presence in soil organic matter (SOM) far exceeds presently accepted values and that the contribution of micro-organisms in the terrestrial environment and carbon cycling is seriously underestimated. This project will couple powerful analytical techniques that include Stable Isotope Probing (SIP) and advanced NMR, that will allow us to assess ecological and molecular responses of autotrophic soil microbes to environmental stress and to discern actual microbial contributions to atmospheric CO₂ uptake (e.g. photosynthesis). The molecular responses of as yet uncultured microbes to extreme conditions will be investigated to assess potential for use in biotechnology industry.

Expected Outputs

This project is firmly focussed on an extensive research program using recently developed molecular biology techniques to improve the knowledge of soil autotrophic response to stress factors previously not studied although potentially very important for biotechnological application and atmospheric CO₂ uptake. Results will be published in peer-reviewed scientific publications and success stories circulated to the media, professional magazines and association newsletters. The uptake of our developed methods through adoption in a wider Irish and EU research context will mean that developed techniques will become the future “state-of-the-art” for the development of other sustainable bioprocesses.

Next Generation, High Resolution, DEcadal and Long-Term Climate Simulations for IreLAnd (DELTA)

Principle Investigator Dr. Rowan Fealy

Lead Organisation National University of Ireland, Maynooth

Duration & Start Date 24 months, 01/01/2012

Project Abstract

Policy-makers, local government and industry recognise the importance of high resolution climate projections for effective planning, adaptation and mitigation to future costs and disruptions arising from climate variability and change. Although previous research has provided high-resolution climate projections for Ireland, recent advances in climate science, revised emission scenarios and changing technologies have necessitated the development of more advanced high-resolution climate predictions at decadal time scales.

This research will produce next generation decadal (10-30 years) and long term (100 year) climate projections for Ireland at high spatial resolutions using the Advanced Weather Research and Forecasting (WRF) model for selected representative concentration pathways (e.g RCP4.5 and RCP8.5). An additional, and novel, aspect of this proposal will explore the use of a three-way coupled atmosphere-ocean-wave regional model. Boundary data for climate simulations will be provided by the EC-earth model - an earth system model at the forefront of current developments in the climate modelling community.

The research will provide end users with climate information at scales appropriate for strategic decision making over various time horizons. The outputs will provide a robust basis for formulating adaptation policy in support of national and international obligations.

Expected Outputs

Key deliverables include high resolution regional climate scenarios for Ireland (decadal and long term) in support of developing tailored and cost effective adaptation strategies. This will be achieved through the delivery of climate information suitable for use in impacts assessments and for informing strategic decision making. Additionally, a summary report for policy makers will detail likely changes in key variables over relevant time horizons. This proposal will provide and enhance core national capacity in this strategically important scientific area. The research will also support national modelling efforts being undertaken by the Marine Institute and Met Éireann.

Quantifying the costs and benefits associated with climate change risks and adaptation (ADAPT)

Principle Investigator Prof. Peter Clinch

Lead Organisation University College Dublin (UCD)

Duration & Start Date 12 months, 01/01/2012

Project Abstract

The ADAPT project will assess and identify suitable methodologies and guidelines for risk assessment to identify and evaluate sectoral and local climate change risks and the costs and benefits associated with adaptation options. The specific objectives of the study include: formulating methods to allow policymakers to choose between adaptation options in the face of climate and socio-economic uncertainty; the development of draft guidelines on the application of CBA to adaptation choices; testing of the decision support tool through application to a case study or studies; analysing and recommending how this tool should be incorporated into existing adaptation frameworks and recommending a final framework for policymakers. The identified methodologies will enable decision makers to work with climate change information, address uncertainty, and identify suitable methodologies for risk assessment.

Expected Outputs

The principal output will be a step-by-step framework for adaptation at sectoral and local level allowing users to overcome concerns about the uncertainty of alternative climate projections by using CBA and/or adaptation assessment to examine the robustness of adaptation in the face of this uncertainty. To support the use of the guidelines, a full report will be prepared and targeted at policy makers and major economic sectors.

Irish TIMES Phase 2

Principle Investigator Dr. Brian O Gallochoir

Lead Organisation University College Cork (UCC)

Duration & Start Date 24 months, 01/11/2011

Project Abstract

The proposed research will further develop the Irish TIMES model, significantly improving the modelling capability in a number of key areas, with a particular focus on representing behavioural measures by developing Irish TIMES ED (elastic demand), soft linking with PLEXOS_IE to improve the characterisation of variable renewable electricity generation, soft linking with FAPRI Ireland and FLAGGS to include agricultural modelling activity and developing more complete (covering 98% of GHG emissions) climate change mitigation scenarios, and integrating with the Pan European TIMES model to improve the representation of energy flows into and out of Ireland within an EU context. The research will bring together for the first time in one project the disciplines of energy engineering (UCC), macro economics (ESRI) and agricultural modelling (Teagasc and UCD). It will provide a comprehensive set of analytical tools that will together provide least cost pathways to meet specific 2020 and 2050 GHG emissions reduction targets, provide GHG marginal cost abatement curves for different policy options, quantify the impacts in terms of technology choices and costs of specific mitigation strategies, and d) build long term as well as short term mitigation scenarios to inform pathways to 2050 targets.

Expected Outputs

The core outputs from this project will be an enhanced Irish TIMES model (with a new Irish TIMES ED), an elastic demand module that will be soft linked with ESRI's 2050 macro model, FAPRI Ireland, FLAGGS and PLEXOS_IE, multiple policy relevant scenarios for 2020 and 2050 relating to GHG mitigation and energy security, publications, including 6 peer reviewed journal papers, 8 conference papers, 4 TASG presentations, 2 papers for inclusion in SEAI reports, scenario results analysis tool for policy makers, workshop on climate change mitigation modelling and one PhD in Irish TIMES scenario modelling.

Carbon Market and Flexible Mechanisms: Addressing Ireland's GHG Emissions Target Challenge

Principle Investigator Dr. Luke Remond

Lead Organisation University College Dublin (UCD)

Duration & Start Date 24 months, 21/11/2012

Project Abstract

Principal goal of fellowship is to identify how market based instruments could be adapted and/or integrated with other instruments for the policy system to meet legally binding obligations in regard to Ireland's GHG emissions and any new obligations or targets emerging from international or EU agreements. Irish, EU and international market based instruments will be examined and assessed. Developments in the EU and internationally will be monitored for their effect on Irish compliance opportunities via the carbon market.

Expected Outputs

Fellowship will deliver 8 high quality reports on different aspects of the carbon market and Irish use of market mechanisms and create corresponding documents for dissemination to policymakers. It is expected to produce a number of journal publications. Analytical support will be provided to the EPA and government on an ad hoc basis. It is expected to organise and host a workshop on the carbon market. Finally, a final report detailing work undertaken and conclusions, will be produced by the end of the fellowship.

Emission Factors for Domestic Solid-Fuel Appliances (EFDOSOF)

Principle Investigator Dr. Will Smith
Lead Organisation University College Dublin (UCD)
Duration & Start Date 24 months, 01/01/2012

Project Abstract

The project will establish country-specific emissions factors (EF) for domestic-scale, solid-fuel, combustion appliances. Four solid fuels will be assessed: coal, smokeless coal, peat (briquettes and sod), and wood. Three classes of combustion appliance will be used: open fire, stove, and stove with integral water-heating function.

In situ and laboratory measurement of emissions will be carried out, covering PM, UHC, NO_x, CO, CO₂, and SO_x. In addition to determining steady-state EFs, the programme will examine the effect of cold start and refuelling on both the nature and the rate of emissions.

Particular emphasis will be placed on particulate emissions, given their impact on human health, on local air quality, and on transboundary air pollution. Particle number, and size distribution, will be determined in real time using an Electrical Low Pressure Impactor (ELPI), in addition to standard measurements of TSP, PM₁₀ and PM_{2.5}. The UCD Advanced Imaging Analysis Centre will be leveraged to provide physical and chemical morphology data for selected samples.

In so far as practicable, fuel and appliance sales data will be analysed to provide spatially-resolved estimates of emission source intensity.

Expected Outcomes

Interim and Final project reports for EPA incorporating: a critical review of international literature; analysis of impact on emissions of fuel mix and operating conditions; revised, country-specific, emission factors for gaseous and solid emissions from domestic-scale, solid-fuel appliances;

A report for policy-makers outlining historic trends and future projections of emissions from domestic-scale, solid-fuel appliances; spatially-resolved estimates of emission source concentration; a review of emission mitigation options, costs, and opportunities

A comprehensive electronic database of pollutant emission characteristics for domestic-scale, solid-fuel appliances. Post-doctoral expertise in combustion-related emissions research

Integrated Modelling Project Ireland - Climate and Air

Principle Investigator Dr. Andrew Kelly

Lead Organisation APEnvEcon Ltd.

Duration & Start Date 24 months, 01/10/2011

Project Abstract

The IMP Project will build on existing capacity investments to sustain and enhance a number of critical capacities for Ireland. Specifically the project will further develop and refine the GAINS Ireland and GAINS Europe modelling systems so as to ensure that an increasingly robust representation of Ireland is captured and maintained in these systems as time, policy and parameters move on and adjust. Over the next number of years Ireland will face a number of critical junctures in both the setting and compliance testing of international environmental policy agreements in a climate and transboundary air pollution context. The GAINS Europe model will provide a significant portion of the analytical framework in respect of these two thematic areas. The IMP Project, expert team and the GAINS Ireland model will provide Ireland with a robust evidence base on which to form efficient and cost-effective environmental policy decisions, and will establish a strong platform from which to engage with the international research community in development of the state of the art internationally. Perhaps most importantly, the research capacities of the IMP Project will provide direct technical and policy support to Government and Government Agencies in respect of imminent international policy interactions and negotiations.

Expected Outputs

The project will deliver a broad range of physical (reports, papers), technical (GAINS Ireland model system, policymeasures.com resource) and applied policy (direct support) outputs over the two years. This will include 6 researched model parameter reports, a technical piece on related methodology, 3 updated model guidance pieces, annual national scenarios in the GAINS Ireland system, 3 defined exploratory research reports, 2 annual policy reports, hosted meetings and workshops, a web based policy measures resource and a project website. Furthermore the team will provide extensive direct technical and policy support to Government in respect of imminent climate and air policy challenges.