

## Sub Project 6 – Climate Change in the Urban Context

### 1. Project Statement

This is a three year project, using the Greater Dublin region as a test area, to examine selected impacts on the urban area arising from projected climate change. The objective is to provide national and local authorities with a methodology to anticipate impacts on energy and health care provision, as well as positioning the city to maximise any benefits arising from a warming trend.

### 2. Objectives and targets

The objectives of the sub-project are as follows:

1. To integrate a monthly climatological database (current climate) for the Greater Dublin Region with the MOLAND database and to incorporate also future climate scenarios based on downscaling of global climate models for 2020, 2050 and 2080.
2. To take into account urban heat island effects in projecting future temperature conditions in the Greater Dublin Region and to evaluate future heating energy demand based on accumulated temperature relationships.
3. To project changes in frost frequency and its impacts on de-icing of road, rail and aircraft in Dublin.
4. To quantify changes in heat/cold related mortality in Dublin likely to occur as warming proceeds.

### 3. Review of state of knowledge

A majority of the world's energy consumption takes place in cities or due to the transport of goods between cities. This proportion is set to grow as UN forecasts project 3 in 5 people in the world will live in cities by 2030. This global trend toward increased urbanisation has the consequence that climate change impacts in most countries will mainly affect urban populations, not rural or traditional settlements. Climate change and urban growth are therefore inextricably linked, and general issues of sustainability require an urban focus (Scott, 2001).

In addition, rising temperatures and enhanced 'heat island' effects may alter the energy consumption spatial and temporal patterns of cities. The World Wildlife Fund survey of 16 European capitals, published in mid August 2005, indicated that Dublin's average summer temperature has risen by 0.7°C since 1970. Though this is less than high density capitals elsewhere in Europe, it is still well above the Irish national average (Sweeney, 2002) and is indicative of at least some heat island enhancement effects.

Reduced demand for space heating in winter and increased demand for air conditioning in summer are likely to be a feature of all Irish cities as the present century proceeds. These temperature changes will also have significant impacts for the health of urban dwellers (Kovats, 2000). Some of these effects may already be occurring in response to recent climate trends (McMichael and Githeko, 2001)

It must also be emphasised that cities offer major opportunities for effective and imaginative responses to climate change. They possess governance that is more flexible than larger national units capable of mobilising efforts more easily. Institutional barriers to change can be overcome more easily in urban centres and cities may act as highly effective diffusion nodes for sustainability concepts to be transmitted. For this reason a case study of where the major impacts of climate change can be expected to occur will be undertaken with reference to Dublin.

#### References

Kovats, R. S. and Martens, P. (2000) Human Health, in, *Assessments of potential effects and adaptations for climate change in Europe: The Europe ACACIA Project*, University of East Anglia, Norwich, 227-242.

McMichael, A. and Githeko, A. (2001) Human Health, in, Houghton, J.T. et al (eds. ) *Climate Change 2001: Climate Change 2001: Impacts, Adaptation and Vulnerability*, Third Assessment Report of the IPCC, Cambridge University Press, Cambridge.

Scott, M. and Gupta, S. (2001) Human settlements, energy and industry, in, Houghton, J.T. *et al* (eds. ) *Climate Change 2001: Climate Change 2001: Impacts, Adaptation and Vulnerability*, Third Assessment Report of the IPCC, Cambridge University Press, Cambridge.

Sweeney, J. *et al* (2003) *Climate Change: Indicators for Ireland*, Environmental Protection Agency, Johnstown Castle, Wexford, 71pp.

Sweeney, J. *et al* (2003) *Climate Change: Scenarios and Impacts for Ireland*, Environmental Protection Agency, Johnstown Castle, Wexford, 229pp.

#### **4. Description of Work**

1. Statistical Downscaling of the HadCM3 gcm to a number of locations in Dublin, Kildare, Meath and Wicklow will be carried out. A regression-based interpolation will be used to produce a high resolution database for temperature variables for present and a range of future scenarios for the study area. These will be merged with the MOLAND database as a series of co-registered layers.
2. Present relationships between electricity demand and heating degree days below a threshold will be derived for the Greater Dublin Region. A similar relationship will be developed for natural gas consumption. These relationships will then be used to derive residential space heating demand patterns and quantities for future climate at the three periods projected as part of step 1 above. Subject to the availability of appropriate census data, allowance will be made for age of the housing stock, insulation requirements in future building standards, and enhancement of temperatures by the Dublin Urban Heat Island. Quantification of reduction of space heating demand in winter months and also potentially increasing air conditioning demands later in the study period will be made.
3. Frequencies of frost occurrence and duration of freezing temperatures will be projected for present and future climates as a product of step 1 above. These will be used to estimate the resource allocation changes likely for road salting or aircraft de-icing in the Greater Dublin Region.
4. Mortality data for the Greater Dublin Region on a daily basis will be analysed according to

I.C.D. codes. Relationships with temperature will be derived for Dublin for all causes and for respiratory and cardiovascular causes separately. These are expected to show a characteristic U-shaped distribution with temperature reflecting higher winter mortality and slightly elevated mortality during summer heatwaves. MOLAND will be used to estimate future demographic structures and population distribution. It is anticipated that a major reduction in winter deaths will be accompanied by a modest increase in summer death incidence. Estimates of the scale of these seasonal changes will be made as an advisory for planning health care services.

#### **5. Project Management**

Dr. John Sweeney will assume overall responsibility for the management of this work package, with assistance from the Project Manager.

#### **6. Expected Results**

Significant information of relevance to national bodies and local authorities in the Greater Dublin Region in anticipating and adapting to climate change are expected in the areas concerned. Sustainability policies proposed by under Local Agenda 21 will require specific responses from such bodies and this study will identify where such action should be focussed.

#### **7. Composition and Experience of Team**

##### **Partner 1: ICARUS**

##### **Description of research team**

ICARUS is an Irish research unit that was formed due to a greater need for research on

climate and climate change impacts, with particular relevance to Ireland. Such impacts are likely to have significance for key sectors, such as, water resources, agriculture and environmental planning and on a range of aspects which will impinge on peoples everyday life. Personnel involved with the unit have in excess of 30 years experience working on and researching in the area of climate, climate change and climate impacts in Ireland. The research unit is comprised of 2 permanent staff (Dr John Sweeney, Dr. Rosemary Charlton) 3 full time post doctoral researchers (Dr. Rowan Fealy, Dr. Yassin Osman, Dr. Laura McElwain) and 4 Ph.D. students. ICARUS will be responsible for the Climate Change components of the project (Sub Project 5) which will be directed by Dr John Sweeney.

### **Relevant Experience**

Current Areas of Research: Contemporary Climate Analysis, Climate Scenario Generation for Ireland, Impact Modelling, Hydrological Modelling, Sea level Rise-mapping vulnerable zones, Flood vulnerability mapping coupled with extreme event analysis, Integration of climate and other relevant data into Geographical Information Systems (GIS) to facilitate assessment of likely changes on key sectors, Extreme event analysis eg. return periods of extreme events, such as, storms, heavy rainfall events, extreme temperatures, flooding.

### **Team members**

*Dr. John Sweeney* (Director of ICARUS research group). Over the past 25 years he has published approximately 60 scientific papers and edited/co-authored 4 texts on various aspects of urban climatology and climate change in Ireland. Since 2000, he has led an EPA funded research programme into the impacts of climate change in Ireland which has involved him in the development of climate scenarios for Ireland using statistical downscaling techniques.

*Dr. Rowan Fealy* is Research Manager on a large scale, multi-partner, EPA-funded project which is further researching the potential impacts of climate change on the Irish environment. He has recently completed his doctoral thesis on modelling glacier responses to climate change in Norway and is author or co-author of 15 publications over the past 6 years.

*Dr. Ro Charlton* is a hydrologist currently modelling the impacts of future climate change on Irish water resources. A graduate of the University of Wales and University of Bristol, she has been employed in NUI, Maynooth since 1996, since when she has published a number of papers in fluvial geomorphology and hydrology.

### **Recent relevant publications:**

Sweeney, J. (2003) (Editor), *Climate Change: Scenarios and Impacts for Ireland*, Environmental Protection Agency, Johnstown Castle, Wexford, 229pp.

O'Hare, G., Sweeney, J. and Wilby, R. (2005) *Weather, Climate and Climate Change*, Pearson Educational, Harlow, Essex, 2005, 403pp.

Donnelly, A., Jones, M.B. and Sweeney, J. (2004) A review of indicators of climate change for use in Ireland. *International Journal of Biometeorology* 49, 1-12.

Charlton, R, Fealy, R., Moore, S., Murphy, C and Sweeney, J. (2005) Assessing the impact of climate change on water supply and flood hazard in Ireland using statistical downscaling and hydrological modelling technique, *Climate Change* (in Press)

Holden, N.M., Brereton, A.J., Sweeney, J. and Fealy, R. (2004) Climate Change and Irish Agriculture, in: Keane, T. and Collins, J.F. (Eds) *Climate, Weather and Irish Agriculture*, Joint Working Group on Agricultural Meteorology, Met Eireann, Dublin, 359-382.

Murphy, C., Fealy, R., Charlton, R. and Sweeney, J. (2005) The reliability of an "off-the-shelf" Conceptual Rainfall Runoff model for use in climate impact assessment: uncertainty quantification using Latin Hypercube sampling. Area. (in print).

Fealy, R. and Sweeney, J. Detection of a possible change point in atmospheric variability in the North Atlantic and its effect on Scandinavian glacier mass balance, *International Journal of Climatology*, accepted.

Fealy, R. and Sweeney, J. An analysis of the relationship between synoptic climate and glacier mass balance in Norway, *International Journal of Climatology*, accepted.

### **8. Facilities/Capabilities**

The Department of Geography, NUIM provides ICARUS with access to state-of-the-art equipment and facilities, including advanced GIS and other computing facilities. This is supported by in-house technical and cartographic dedicated staff resources as well as laboratory and administrative facilities. Members of ICARUS are also Associates of the National Centre for Geocomputation and have access to the advanced GIS resources of that centre.

Key focus areas for ICARUS at present are:

- . • Statistical downscaling of global climate models
- . • GIS-based Hydrological modelling
- . • Assessment of future water supply reliability for Dublin
- . • Holistic climate impact analyses
- . • Climate change impacts modelling on biodiversity

### **8. Declarations on Other Sources of Funding and on Tax Clearance**

UCD, TCD and NUIM rely on this funding to cover marginal costs and have not sought additional funding; whereas ERA-Maptec provides 50% funding through their own sources.

University College Dublin will provide a current Tax Clearance Certificate, on request from the Environmental Protection Agency.

### **9. Compliance with National Policies on the Environment, Gender and Poverty**

Urban Institute Ireland (UII), UCD (Project leader) UCD conforms with the university policy with respect to best practice in the areas of ethics, the environment and socio-cultural matters, including poverty. In particular, this project focuses on the development of an in-depth understanding of the environmental issues associated with urban areas. University College Dublin has an Equal Opportunities Committee with the brief to support Gender Mainstreaming within the university.