



5. Discussion and Recommendations

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The Earth's climate has always been changing. However, the rate of change over recent decades has been much higher than that for many tens of thousands of years. This rapid change is due to the enhanced greenhouse effect, caused by human activities which emit a range of greenhouse gases, including carbon dioxide and methane into the atmosphere. The ongoing increase in atmospheric concentrations of greenhouse gases is observed globally and also from monitoring stations in Ireland.

Climate change in Ireland mirrors many of the global trends. Mean annual surface air temperature has increased by approximately 0.8°C over the last 110 years. The number of annual frost days has been decreasing whilst the number of warm days has increased. Average annual national rainfall has increased by approximately 60 mm or 5% in the period 1981 to 2010, compared to the 30-year period 1961 to 1990: however, clear changes in rainfall patterns across the country cannot be determined with a high level of confidence.

Changes in the ocean climate are also evident. Sea surface temperature records from around Ireland exhibit a mean warming trend of 0.3°C between 1850 and 2008 with the warmest years in the record being 2005, 2006 and 2007. Sea level has not historically been measured with the necessary accuracy to determine sea-level changes around Ireland. Nonetheless, observations from southwest England show a sea-level rise of 1.7 cm per decade. These measurements are considered representative of the situation to the south of Ireland. Although there is no long-term national programme to monitor ocean acidification, a recent project conducted in Irish waters confirmed global trends of increasing acidification, which has severe implications for oceanic ecosystems and knock-on socio-economic impacts.

There has been a significant change in the distribution of land-cover type across Ireland in recent decades. The major changes have been an increase in urban areas and the conversion of grassland and peatland to forest. The expansion of forest area has seen the amount of carbon stored or sequestered in forest areas increase by 40% since 1990.

Analysis of long-term river flows from over 40 measurement sites around the country shows a tendency for increasing annual mean flows. Moreover, seasonal analysis indicates that summer mean flows are dominated by increasing trends while there is a tendency also for increases in winter mean flows.

Many elements of the climate observation infrastructure are robust: nonetheless, there are gaps and areas where improvements are necessary. The network of synoptic, climatological and rainfall stations operated by Met Éireann needs to be maintained and further developed to ensure the future of long-term, representative measurements. The Mace Head Atmospheric Research Station, operated by the National University of Ireland Galway, has become a global reference site for the observation of a number of atmospheric composition variables. However, many of its observation programmes are funded on an ad hoc basis via projects and the long-term availability of funding to maintain them is not assured.

There has been a significant growth and consolidation of ocean-observing systems since 2000; this is proving to be invaluable in improving understanding of oceanic climate. It is essential that these systems are maintained and where possible enhanced to increase the number and quality of the measurements made. Only with long time-series data will it be possible to detect trends in the oceanic climate variables and therefore make appropriate adaptation decisions. Ocean acidification is of growing international concern. There is a need for a long-term national commitment to monitoring the ocean carbonate system and ocean acidity in order to improve

understanding of its potential threat to the Irish marine environment and economy.

A number of the land surface and hydrological variables have been monitored by various organisations for many years in support of policy and management objectives (e.g. water supply, land use). It is important to ensure that these observations also contribute to long-term monitoring for climate purposes.

At least a dozen different organisations have a role to play in monitoring aspects of Ireland's climate. It is vital that long-term monitoring is coordinated between these different bodies to avoid duplication and to maximise possibilities for synergy.

As important as the systematic collection and management of climate data is their regular analysis and the reporting of status, trends and projections. Many of the atmospheric composition variables monitored at the Mace Head Atmospheric Research Station have been reported on in a global context (Ramonet et al., 2010; Rigby et al., 2008; Derwent et al., 2007). An analysis of some meteorological variables was carried out in the last decade (Sweeny et al., 2002; McElwain and Sweeney, 2007). A comprehensive analysis of the ocean climate and ecosystem status was recently published by the Marine Institute (Nolan et al., 2010). Long time-series of data, some in excess of 50 years, exist for many of the meteorological and hydrological variables, yet only partial analyses have been carried out to date. Furthermore, regular observations of some of the land surface variables have been made by satellite since the 1980s, but limited analyses of these have been carried out for Ireland.

This report demonstrates that many elements of a climate observation, analysis and reporting system are in place: nonetheless, there are a number of issues that need to be addressed in order to make it more robust and capable of addressing the country's long-term needs with regard to climate monitoring and understanding. The following recommendations are made as a result of this study:

- 1 A structure or body is required to enhance coordination between organisations carrying out atmospheric, oceanic and terrestrial climate observations to ensure an integrated national approach and efficient utilisation of resources.

- 2 Observation programmes for some of the ECVs are well established (e.g. meteorological). Other ECV observations are carried out on a project or ad hoc basis (e.g. atmospheric composition, oceanic). It is vital that adequate resources are provided to (i) maintain existing, established climate-observation programmes and to (ii) guarantee the long-term continuity of project-based monitoring to international standards.
- 3 No long-term national observation programmes exist for a number of the ECVs (ocean acidification, pCO₂, ocean currents, phytoplankton, soil carbon, fire disturbance, water use). A prioritisation and costing exercise should be carried out with a view to implementing appropriate programmes over time.
- 4 Some variables are monitored under various operational and management programmes (e.g. river flows and lake levels as part of the Water Framework Directive; sea state for ocean weather forecasting) but not for climate purposes. Appropriate long-term climate observation sites should be identified and designated from among current observation sites.
- 5 Ensure data from the Irish National Tide Gauge Network established over the last decade by the Marine Institute and a number of public and private sector organisations can be used for the calculation of sea-level change. Provide analyses of these data with historical records from established, reliable tide gauges and link these to regional satellite derived information on sea-level change.
- 6 Safeguard all existing and historical ECV data, complete digitisation of paper records (e.g. air temperature, precipitation, wind) and carry out quality checks and homogenisation of these data to ensure their adequacy for climate monitoring.
- 7 Comprehensive analysis has been carried out for the atmospheric composition and some of the meteorological and oceanic ECVs. However, only partial analyses have been completed for the majority of the other ECVs. Complete and regular detailed analysis should be carried out and reported on all ECV observations, including satellite data records where appropriate.