Why study the long-term climate history of Ireland?

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The Quaternary: Unique times: Many people across the world are justifiably concerned about the changes appearing in their surroundings. From melting sea ice and permafrost of the Polar regions to once reliable glacier fed water supplies drying up in the South American Andes, we find ourselves becoming inured to warnings about rapid alterations to our environment. For geographers, questions that arise from these observations might include: are changes happening everywhere?; are they happening at the same speed in different places?; have these change rates been seen before, and if so, why?; are the changes permanent, and if not, how do we reverse them?; what might happen if we proceed unchecked in our environmental modification?; and so on.

When trying to answer such questions regarding modern observations about the Earth's physical environments (e.g. Arctic, tropical, mountain, desert, coastal regions), it has become clear that understanding the root cause of any particular event requires a systems approach, visualising the Earth's environments as the product of interactions between a set of interrelated parts (the oceans, atmosphere, plants etc.). One of the principal controls on what we know of as our 'Environment' is the product of one such set of interrelated components, the climate system. At any one location, this product is known as our 'climate'. Climate is a measure of many environmental variables such as rainfall amount and frequency, air temperature ranges etc. over a limited period of time (e.g. thirty years).

To establish what is the 'normal' operation of the Earth's climate system at any location, our only guide is evidence from the pre-historic past. This is before we began to observe climate ourselves, as man-made (anthropogenic) change had already begun by then. The geological evidence of climatic variability over longer time spans (thousands or millions of years as opposed to our decades of instrumental records) clearly indicates that compared to the vast majority of the Earth's history, we also find ourselves in a pretty unique set of circumstances. I do not mean because of the high amounts of carbon dioxide or other Greenhouse agents in the atmosphere: geology tells us that levels have been the same or much higher in the past. Indeed, Life survived these higher levels and the higher global mean temperatures they brought, and helped bring them back down to amounts our early ancestors evolved alongside. Not that this is an excuse for complacency: recent increases in Greenhouse gas concentrations have never been so rapid in Earth's history and are thus a dangerous test of our climate system's behaviour.

The uniqueness I label is the current large-scale distribution of land and sea on the Earth's surface. The arrangement of land and sea has a distinct pattern that results in: surfaces onto which snow may fall, collect and perhaps turn into ice and upon which vegetation may grow in areas warm and wet enough; a cyclic pattern of deep and surface ocean currents that move heat and nutrients to and fro about the planet; and a pattern of mountain ranges that shape the flow of wind above our heads - in effect all the components of the climate system. The closure of the Panama land bridge linking North and South America due to tectonic forces deep beneath our feet effectively separated the Atlantic and Pacific Oceans and put in place the final piece of the unique physical pattern I describe about three million years ago. It is an especially important time period for us as humans to understand, for it is also our time. The climate patterns it has established have been those that have driven our evolution and have shaped our civilisations. In geology it is known as the Quaternary period.

The importance of Ireland's geographical location in Quaternary studies: Within this grand global geography of land and sea, Ireland lies immediately downwind (our prevailing westerlies) of the North Atlantic Ocean. From climate records encoded in the chemistry of Greenland and Antarctic ice and the content of deep sea sediments, links between rapid oceanic change and atmosphere-cryosphere change in this region have been known about since the mid-nineteen nineties from the work of Emilliani, Shackleton, Ruddiman, Bond, Lotti and Broecker amongst others (see Kunzig and Broecker, 2008 for an excellent

introduction to the subject and references to this work). Not only this, but conditions in the North Atlantic Ocean, directly off Ireland's western seaboard, have been shown to be *the* most important single driver of rapid climate change in the Northern Hemisphere during the Quaternary Period. There is no reason to believe this will not continue to be the case. To give an idea of what *rapid* climate change means, increases in air temperatures of as much as 10°C may have occurred in as little as three years over Greenland 11,700 years ago (Walker *et al.*, 2008). Oceanic currents seem the most likely culprits for this abrupt change, amongst the fastest and most life changing shifts in European climate ever witnessed by humans.

It is precisely because of Ireland's geographical location as the first landfall of wind masses moving over this oceanic region where the heat-bringing 'Gulf Stream' divests its energy and denies us a climate more like Alaska's, that we sit in an ideal position to expand global understanding of the effect of rapid climate system alteration upon the Environment (plants, animals, people). Records of past environmental change exist all over and around Ireland in sediments and landforms in lakes, bogs, caves and on the seabed. Irish geoscientists measure and analyse an extensive list of useful indicators or *proxies* of climate change to extract climate change 'signals' over critical intervals of past rapid flux (e.g. changes in wetness, temperature, growing season length or timing).

Critically, dating of these records allows their correlation with changes recorded, for example, in the archives of former climates held within oceanic sediment piles far off our western shores. It is now a major goal of the Geological Survey of Ireland and Marine Institute's INFOMAR programme, in conjunction with NUIM's ICARUS Climate Change Institute and other Irish Universities, to extract this information by collecting cores of sediment from the deep sea bed and thus start to decipher any marine records of past climatic events in this region. There is much to be learnt about the links between the ocean and our landscape. A world of discovery in the reconstruction of our past environments awaits anyone interested in finding out. The unique times we live in are both a threat to our way of life but also should serve as an impetus to do what we do best as humans - learn about our environment and adapt and evolve our behaviour and society to cope with the change. Knowing more about *what* levels or scales of change might await us will only come by knowing how the climate system has worked over these last 'few' (~2.6 million) geological years of the Quaternary Period. This knowledge will leave us forewarned and thus forearmed.

References:

Kunzig, R. and Broecker, W. 2008 Fixing Climate, The Story of Climate Science – And How to Stop Global Warming, Green Profile/Sort of Books, London.

Walker, M. *et al.*, 2008 The Global Stratotype Section and Point (GSSP) for the base of the Holocene Series/Epoch (Quaternary system/Period) in the NGRIP ice core, *Episodes*, v31, no2, pp 264-267.

Postgraduate Research

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There are more than forty postgraduate research students in Geography in the current academic year. These students are undertaking a wide-ranging array of projects in Physical and Human Geography which may be explored on the Departmental website. Phd and MLitt research degrees are carried out under the supervision of a member of staff with an interest/ expertise in the research area. In many cases, students are encouraged to take a Masters degree before embarking on a PhD. Research degree programmes now also include a portfolio of taught/training courses which students will take throughout their postgraduate career in addition to the major primary research for their dissertations. These courses are designed to improve