Institution: The University of Edinburgh

Unit of Assessment: 18 Economics and Econometrics

Title of case study: Planning for Adaptation to Climate Change

1. Summary of the impact

The Edinburgh-based research (2009-) of Gordon Hughes underpinning this case study has influenced the development of World Bank policies and advice concerning the response to climate change. It has done so by providing a measure of the financial costs of adapting our infrastructure to climate change. His work shows that the financial burden is unevenly spread across countries and sectors, but it can often be substantially reduced by better managing natural resources and weather risks. These findings were given a worldwide reach as they formed the factual basis for the signing of international agreements (worth $80bn) on reducing greenhouse emissions by the 2010 Conference of Parties (all the UN member states).

2. Underpinning research

Context: *Hughes's research agenda on energy and environmental change was started at the University of Edinburgh in the period between 1988 and 1991 when he was also Head of the Department of Economics. During the 1990s he extended this work as a Senior Adviser at the World Bank while retaining his connection with the University as a part-time Professor (since 1995 he has taught the Honours option course* Natural Resource and Environmental Economics *every year; he has had an office, has supervised PGRs, attended seminars and informal discussions and participated in recruiting decisions). In 2001 he left the World Bank and since then he has been based in Scotland with the University of Edinburgh as his sole academic base, along with a mix of public roles and consultancy on policy issues. This combination of academic rigour combined with applied policy research has led to powerful synergies, making his advice highly sought after in policy circles.*

This case study deals with Hughes's latest research on the economics of adaptation to climate change. Underlying it is the general theme he has championed in earlier work that successful policies to address climate change must be based on carefully thought through empirical economics.

As of 2009 there were no reliable estimates of the cost of adapting the infrastructure to climate change, notwithstanding the existence of the 2007 Bali Action Plan agreed by the UN. In order to progress with this plan, a thorough cost measurement was required. To achieve this, the World Bank commissioned a series of reports called the *Economics of Adaptation to Climate Change* (EACC). As well as being effectively the lead author on the main document, Hughes was personally responsible for the detailed infrastructure parts (World Bank, 2010b) [see 5.1 below]. Parallel to these applications, Hughes (and co-authors) developed and applied a framework for projecting and analysing the costs of adaptation for the water, energy and infrastructure sectors for different alternative projections of climate change over the 21st century, published in scholarly articles. The method provides a tool for estimating broad costs at the global and regional scale; such information is of key importance in international negotiations. For example, in the case of water infrastructure the analysis separates (a) the costs of maintaining service standards for a baseline projection of demand, and (b) the costs of changes in water use and infrastructure as a consequence of changes in climate patterns. The engineering estimates focus on the direct capital and operating costs of adaptation without relying upon economic incentives to affect patterns of water use. Adopting an economic approach under which water levies are used to cap total water abstractions, leads to a large reduction in the burden of adaptation and generates savings of US$6-12 billion per year. Globally, these adaptation costs are low compared to baseline costs (US$73 billion per year), which supports the notion of mainstreaming climate change adaptation into broader policy aims.

3. References to the research

Hughes, G.A, Chinowsky, P. & Strzepek, K. (2010a) "The Costs of Adapting to Climate Change for Infrastructure", Economics of Adaptation to Climate Change Discussion Paper No. 2, Washington, DC: The World Bank, 51 pp. http://siteresources.worldbank.org/EXTCC/Resources/407863-1229101582229/DCCDP_2Infrastructure.pdf

Hughes, G.A, Chinowsky, P. & Strzepek, K. (2010b) "The Costs of Adaptation to Climate Change for Water Infrastructure in OECD Countries", *Utilities Policy*, 18, 142-153. http://dx.doi.org/10.1016/j.jup.2010.03.002

Ward, P.J., Strzepek, K.M., Pauw, W.P., Brander, L.M., Hughes, G.A. & Aerts, J. (2010) "Partial costs of global climate change adaptation for the supply of raw industrial and municipal water: a methodology and application", *Environmental Research Letters*, Volume 5, 10 pp. http://dx.doi.org/10.1088/1748-9326/5/4/044011.

World Bank (2010a) *The Costs to Developing Countries of Adapting to Climate Change: New Methods and Estimates*, Washington, DC: The World Bank, 84 pp. http://siteresources.worldbank.org/EXTCC/Resources/EACC-june2010.pdf

World Bank (2010b) *Economics of Adaptation to Climate Change: Synthesis Report*, Washington, DC: The World Bank, 100 pp. http://climatechange.worldbank.org/sites/default/files/documents/EACCSynthesisReport.pdf

Hughes, G.A. (2011) "Adapting to Climate Change for Infrastructure in China", Background Paper for China Greener Growth Study, Washington, DC: The World Bank, 58 pp. http://tinyurl.com/ogjvq8u

4. Details of the impact

Hughes's research was originally funded and developed in order to provide a direct contribution to the formulation of policy at an international and national level. It formed a large element of a study undertaken by the World Bank which was funded by the Governments of the United Kingdom, the Netherlands and Switzerland. This study was **specifically commissioned as the primary background document** for the negotiations at the Copenhagen Conference of Parties (COP15) for the UN Framework Convention on Climate Change in 2009. [see 5.1 below] Agreement was not reached in Copenhagen, so it was subsequently used in reaching an international agreement on funding for adaptation to climate change in 2010 at the COP16 held in Cancun, Mexico. The final agreed funding (of approximately US$80bn) was closely in line with the report's recommendations. In addition to the specific research on infrastructure and the main EACC report, Hughes also co-authored several sector (infrastructure) and country (Samoa, Vietnam) reports – all published by the World Bank – which drew upon the original research. These reports have, in turn, been used by developing countries and international organisations for assessing the risks and in formulating national strategies for adaptation to climate change. [5.2]

Hughes has applied and extended this research in a number of follow-up studies, including being the lead author on a study of the costs of adaptation to climate change (by regions) in China undertaken in 2011 as part of a program of research on green growth in China. This research was co-sponsored by the World Bank and the Development Research Centre of the State Council of China, **resulting in a policy statement** on greener growth, describing how China should respond to the challenges of climate change. As the State Council is the Cabinet of the People's Republic of China the results of the study have been incorporated into China's current development strategy and plan. *The Economist* has referred to the report as

"This rare joint study, produced with the strong backing of Li Keqiang (who is expected to

take over from Mr Wen as prime minister next March), also raised the possibility of a "middle-income trap" and called for wide-ranging economic reforms." [5.3]

Building on the same research methodology, Hughes has directed a study (through the Asian Development Bank) that examines how policies for adaptation to and mitigation of climate change in North East Asia can be combined. This is sponsored by the Government of South Korea and with the direct involvement of senior officials from China and Japan. In these and other cases (Samoa, Vietnam, Western Balkans), the results of the research have been or are being used as the basis for developing strategies for adapting to climate change over the next one or two decades. [5.4]

Hughes's research also informs his work as Chairman of the Water Industry Commission for Scotland, where he can have a direct impact on how the Scottish water industry prepares for the effects of climate change. A case in point is how the Commission assigns investment priorities based on the risk assessment methods that Hughes has developed. For example, to manage the increased risk of droughts they prioritise investment in water storage and transport as well as upgrades to pipeline networks. [5.5]

5. Sources to corroborate the impact

Archived links available at www.wiki.ed.ac.uk/display/REF2014REF3B/UoA+18

5.1 Former Lead Environmental Economist, The World Bank. Can corroborate Hughes's role in writing the main EACC reports, and the relevance of these in the COP15-16 negotiations.

5.2 Senior Environmental Economist, The World Bank. Can corroborate Hughes's role in writing the country EACC reports, and how these have been used.

5.3 "Vaunting the best, fearing the worst" *The Economist*, 17 October 2012. http://www.economist.com/news/briefing/21565132-china%E2%80%99s-communist-party-preparing-its-ten-yearly-change-leadership-new-team or http://tinyurl.com/lnk2jd6

5.4 Director General for East Asia, Asian Development Bank, Manila, Philippines. Can corroborate Hughes's contribution to the North East Asia study and that it has been a basis for discussion in the relevant governments.

5.5 Chief Executive, Water Industry Commission for Scotland. Can corroborate Hughes's research-based contribution to water policy in Scotland.