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Professor Sir Brian Hoskins, CBE FRS
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Jon Freeman
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Room 108, 55 Whitehall
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Dear John

RCEP STUDY ON ADAPTING THE UK TO CLIMATE CHANGE

Please find attached a submission of evidence from the Grantham Institute for Climate Change at Imperial College for consideration by the Commission in connection with their study of "Adapting the UK to Climate Change".

The submission was prepared by myself and Dr Simon Buckle at the Institute, with inputs from Professor Georgina Mace, CBE FRS, Chair in Conservation Science and Director of the NERC Centre for Population Biology, Professor Howard Wheater, FREng, Professor of Hydrology and Dr Robert Ewers, Department of Biology.

Yours sincerely

Brian Hoskins

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Director

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SUBMISSION BY THE GRANTHAM INSTITUTE FOR CLIMATE CHANGE FOR CONSIDERATION BY THE RCEP IN CONNECTION WITH ITS STUDY ON "ADAPTING THE UK TO CLIMATE CHANGE"

Key Overarching Points

1. Global climate models as assessed by IPCC, suggest little dependence of climate change on the actual emission scenario until after 2030. Therefore further climate change is inevitable and adaptation to it is essential.

2. Moving adaptation higher on the agenda must not deflect from the priority for mitigation, and indeed the two should often be linked. The local adaptation to climate change must be considered in the context of the global requirement to mitigate the change. Hotter buildings in summer must be countered through better design rather than more air conditioners!

3. There is a dangerous perception in the impacts and policy communities that the climate projection problem is essentially solved and that downscaling from current global climate models provides a firm basis for determining impacts and the requirements for adaptation at a regional level.

4. There is indeed confidence on the general nature of planetary scale trends in temperature, and some confidence in trends for precipitation on the same scale. However, because of the current inability of climate models to represent well the statistics of the weather regimes that affect the UK, there can at present be little confidence in projections for UK regions on decadal time-scales. For example, for the UK there is currently little confidence in likely changes in the frequency of extreme precipitation events or persistence of droughts. Downscaling cannot solve this problem.

5. There is much research into the understanding, techniques and measurements that will enable climate models to forecast the behaviour of slow, decadal time-scale modes of variability in the climate system, for example the Atlantic Multi-decadal Oscillation. However the climate model projections which

provide the current basis for the determination of impacts and the requirements for adaptation for the next few decades do not contain good representations of the variability on those time-scales.

6. Thus the quality of information available for adaptation decisions in the UK is not currently high. Given the level of confidence that can at present be had in regional projections over the next few decades, the best adaptive response can often be to build in more resilience.

7. The big challenge for climate science in the next decade is to provide useful predictions of regional climate change statistics for the next few decades so as to provide a basis for more advanced adaptation strategies.

8. Climate change generally impacts on the natural environment in consort with other pressures on it. Adaptation should consider a portfolio of measures on the range of multiple pressures.

9. These uncertainties in climate projections are compounded by uncertainty about the specific responses of biogeochemical cycles, species and ecosystems to climatic stress and novel climatic conditions and the impact of feedbacks between the different components of the entire system. This raises questions about the extent to which species and ecosystems are able to adapt without anthropogenic assistance.

10. Much UK and European planning for land use (including for biodiversity conservation, water management and agriculture) is based on 1970s climates. Under realistic regional climate change projections these plans may range between sub-optimal to unrealistic. A more wide-ranging, holistic approach is required.

11. To meet economic and social goals, land use planning may need to be undertaken at larger spatial scales: the European context will be important.

12. In order to maintain ecosystem functions in an uncertain future, we should ensure that ecosystems are as resilient as possible. Those systems that are

restricted, homogeneous and isolated are likely to be less resilient. It follows that UK management should facilitate key habitats and ecosystems to remain interconnected and diverse.

13. Overall, and given the uncertainties stated above, we suggest that plans for adapting the UK to climate change should remain as flexible as possible.

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Annex

COMMENTS ON SOME OF THE SPECIFIC QUESTIONS POSED BY THE RCEP

Q1. The IPCC definition of adaptation is useful shorthand. But capacity for adaptation is constrained by a variety of factors including: the inherent characteristics of the species and systems under consideration; linkages and interdependencies across spatial scales and systems; by political and institutional hierarchies; and by resource availability. There can also be mal-adaptation, i.e. adaptations that might relieve a problem in the short term but exacerbate the problem in the longer term, e.g. air conditioning to deal with increased risks of heatwaves.

Q2 (a) The lagged nature of the climate system means that we are already committed to significant change over the next 30 years, whatever mitigation we undertake now. The current inability to stem the rapid rise in anthropogenic greenhouse gas emissions means that the adaptation challenge is likely to grow in the next century. It is therefore important to consider adaptation on all these timescales, avoiding to the extent possible mal-adaptation or decisions for action in the first part of the century that limit more extensive adaptation options that might be needed in later years. This is made more difficult and potentially much more costly by the inherent uncertainty we face in terms of potential climate impacts post-2020.

Species and ecosystems will not have instantaneous responses to climate change: many will have significant time lags before the full effects of climate change are manifested. Ideally, climate change should be considered over a period that: (1) extends until the climate has stabilised in its new form, which may be a century or more; and (2) allows species and systems to adjust to the new conditions. These requirements imply that we need to take a long view.

In terms of planning adaptation for freshwater, 2020 is too soon. For example, large water resource schemes typically have 20-year planning and construction periods, and developing and implementing suitable policies may take significantly longer. Although uncertainty in predictions is very high, accounting for the range of plausible scenarios in 2100 will allow the scale of the water resource/flooding problem to be envisioned.

Q3 (a) High.

Q3 (b) We are highly aware of what *could* be done in terms of freshwater and ecosystems and in terms of managing water to balance future societal and environmental needs. What *should* be done is not clear at present due to the complexity of the interactions between climate, society and ecosystems. Far-sighted research is needed which explores potential interactions and their implications for adaptation.

Flooding: We are aware of the general options for adapting the environment so that it is both of value in itself, and a value for flood risk management. Again, the best specific options are unknown. This is evident in current strategic flood risk planning, which almost completely neglects environmental change except for direct impacts of climate change (increased rainfall intensity).

Q3 (c) Water resources: The government (OFWAT) requires water companies to consider climate change in their water resource planning. In cases, particularly SE England, the allowance for climate change implies that new resources are needed combined with demand management. For example, climate change is one of the justifications for the recently approved desalination plant on the Thames Estuary.

The Environment Agency of England and Wales have published Catchment Abstraction Management Strategies (CAMS), which describe strategies for managing abstractions of water over England and Wales. These strategies are reviewed every few years, to allow for uncertainties including climate change. New abstraction licenses are time-limited, so may be withdrawn due to climate change pressures.

Flooding: UK Government (DEFRA) guidelines for local government is that new developments must consider flood risk including allowance for future climate change; and developments on flood plains, if allowed, must be flood resilient and developers usually must provide compensatory flood water storage. The allowance for climate change is currently up to 20% increase in peak flows for a 2100 horizon, based on UKCIP2002 scenarios.

Flood risk management plans are currently being developed by the Environment Agency of England and Wales, due to be published in 2008-2009. These specify general policies for flood risk management in each river basin in England and Wales, allowing for climate change over the next 100 years. Recognising the high uncertainty, these will be updated every five or so years.

Q4 Mitigation and adaptation actions are, to a great extent, economic substitutes; the more of one that is purchased, the less the other is needed. An exception is where adaptation could be used as a means to buy time for the development of more effective mitigation options.

Consequently, optimal mitigation and adaptation policies should theoretically be co-determined, reflecting the most cost-effective and equitable mix of these two different approaches. However:

- There is already significant change built into the system that makes some level of adaptation essential irrespective of the scale of future mitigation actions;
- Mitigation action is by its nature global, i.e. what matters is the cumulative stock of greenhouse gases in the atmosphere, not the annual or even cumulative emissions of a single country. By contrast, adaptation is to a

far greater degree influenced by local or national level decisions, where the bulk of adaptation costs and benefits fall.

- The time dimension of mitigation and adaptation actions must be considered carefully, for example in terms of the timing of their costs and the flow of their benefits, both of which remain subject to considerable uncertainties.
- Given this, we need to pursue both mitigation and adaptation policies, aiming iteratively to determine an appropriate mix of mitigation and adaptation over time, informed by new information about rates of change and impact and from current and future research programmes.

There are however also important examples of externalities in adaptation – both potentially positive and negative, e.g. from risk shifting due to a particular approach to minimizing flood risk or enhancing coastal defence in certain areas that have knock on effects elsewhere.

Water resources: The water industry is a major user of energy in the UK. This energy use is expected to increase due to climate change, for example due to energy intensive drought adaptation measures such as desalination, long distance pumped transfers, and potentially increased treatment costs associated with increased chemical/biological pollution.

There should be a revised UK regulatory framework which encourages the water industry to be energy and carbon efficient. This needs to be in parallel with research programmes which allow the management and technological solutions to be identified.

Flooding: Flood risk adaptation to increased fluvial flooding and sea level rise involves retreating from rural areas which are costly to defend against flooding. For example, agricultural land on flood plains will be allowed to flood with higher frequency to increase flood storage and allow resources to be focussed on high-risk urbanised areas. This is already integral to government policy (Making Space for Water). Also, agricultural use of upland areas may in future be de-intensified to mitigate flood generation and to improve ecosystems.

However, these adaptation options assume that we will have spare agricultural productivity in the future and that we can continue relying on imported foods. Such adaptation policies must be combined with a far-sighted approach to the world food and energy markets under climate change and associated mitigation issues.

Large-scale land use change, associated with flood risk and water quality management, also may have implications for climate feedbacks, for example release of carbon from drained peatlands.

Q5 a) Water resources: Overall, the future balance of water supply and environmental needs for water is complex, depending on interacting social, political, economic and technological factors as well as climate change. Relevant factors in the water industry include: social acceptability of non-potable water supply; social acceptability of water recycling; social attitudes towards cheap water supply versus environmental protection; effects of water metering and other demand management measures; cost of energy; trends in water pollution and associated treatment costs; population growth and distribution; desalination technology (at present high energy cost, although potential for renewable sources).

The complexity of the problem requires future scenarios to be developed which account for the interactions. This has been already been done for flood risk to some degree (Foresight), but not for water resource and environmental planning.

Q5 (b) Water resources: in the UK, there is wide scope for environmental damage and increased carbon footprint due to water supply adaptation options. In particular, ecosystems are sensitive to water availability (water levels in rivers, lakes and wetlands, and soil moisture) and rely on the natural variability of the hydrological cycle.

There are abundant examples in the UK of degraded ecosystems due to over-abstraction of water (and also due to flood protection).

However, the UK as a whole, under current climate, has surplus freshwater; furthermore, nationally we remain one of the least efficient water users in the developed world. We believe there is significant scope to improve the UK freshwater environment, and adapt to and mitigate climate change simultaneously. However, doing so with current knowledge is not possible – investment in research should be the current priority.

Biodiversity: The interaction of climate change with habitat loss and land use intensification will be crucial for the persistence of species and ecosystems. In previous episodes of climate change in the Earth's history, species and ecosystems responded with shifts in altitude and/or latitude. In the modern UK where landscapes are dominated by anthropogenic land uses, this option is no longer available. Even species that are able to disperse across modified landscapes are not guaranteed to persist under new climatic conditions because, in many cases, there will be no habitat for them to disperse to. In general the landscape has become more homogeneous but with barriers to movement and dispersal which will severely compromise natural adaptive responses.

Under climate change we are also likely to see dramatic increases in invasive species and pathogens. Many or most of these will be deleterious to UK native species and habitats. But some potential exists for recovery or the establishment of new biodiversity which could be advantageous overall. It is important not to see change as always an undesirable outcome.

There is also potential that interactions and feedbacks will occur among the three exemplar systems. For example, alterations to the Freshwater systems may have strong impacts on terrestrial protected area systems by increasing the frequency of floods and/or droughts, and through long-term changes to water table levels.

Q6 (a) Resilience of the freshwater environment to climate change: In general, natural surface water systems in the UK provide habitats (shelter, pathways, water storage, nutrient supply) and have good ecosystem value. However, ecosystems will change in response to significant climate change, and although this is expected to be gradual, effects on ecosystem value are uncertain. Some UK freshwater bodies have been significantly degraded by human intervention (channel straightening, cattle poaching of banks, pollution sources, etc) and recovery of these systems remains a priority irrespective of climate change.

In cases, there is large scope for engineered resilience to climate change, for example by simulating natural flow regimes and augmenting low flows by reservoir releases.

Although there is currently little research on how society values the natural freshwater environment (versus quality and cheapness of water supply and other human uses), increasing directives on environmental protection (notably the Water Framework Directive and all the daughter Directives which it covers) imply that environmental protection will be a primary objective of climate change adaptation. Although the WFD is clear on the fact that good ecological status should be aimed for in general, what constitutes ‘good’ is not clear. There is no widely applicable guidance on whether freshwater systems should be encouraged to return to historic conditions, or be encouraged to naturally adapt to climate change as a more sustainable goal.

Q7 The freshwater environment should be allowed to adapt naturally to climate change, as far as possible given the human needs for water. This does not mean “do nothing”; rather it means minimising effects of direct human influences to allow more natural conditions (e.g. abstraction management, development control); or in some cases controlling direct human influences to simulate natural conditions (reservoir releases to simulate natural flow regime; wetland creation as part of flood management).

Q8 (a) There has been significant research into identifying thresholds (e.g. of flow velocities, inundation frequency and duration, nutrient concentrations), for certain freshwater species. However, these have been generalised (over space, time and sometimes over species) based on limited research. The ability to predict where, when and how often thresholds will be passed for both terrestrial and freshwater ecosystems under climate change is beyond our current knowledge and the current generation of models.

Q8 (b) This is a societal question, albeit one that can be informed by research. For example, how much biodiversity will the public be willing to lose, and how much will the public be willing to pay to retain biodiversity? What is the public's tolerance of a significantly reduced level of ecosystem services?

Q9 Agricultural land management is central to climate change adaptation. For example, current activity in the water industry is looking into manipulating land use to improve river water quality and ecology, to reduce flood water generation and to increase flood water storage. The potential gains to be made, in terms of balancing human needs and environmental needs under pressures of climate change, are clearly large.

However, climate change introduces complexity which has not yet been tackled adequately: research has focused on direct effects of climate change (i.e. changes in river flows due to rainfall and temperature changes). Less direct effects, such as impacts of the hydrological cycle due to vegetation and soil structure, are potentially crucial, but have not yet been studied.

Land management will also play a crucial role in the persistence of biodiversity under climate change. Patterns of land use determine the isolation of natural ecosystems and greatly influence the ability of species to disperse from one habitat to another, a process that will be needed if climate change results in the movement of species' climatic niches. Designing landscapes to maximize connectivity should be an important component of climate adaptation measures.

Q13 In terms of freshwater resources and flood management, the dependency on the natural environment is widely recognised. This is evident in the legislation and strategy which have dual or triple purposes of protecting the natural environment, protecting the quality and continuity of water supply, and managing flood risk (the Nitrates Directive, WFD, Flood Risk Directive, CAMs, CFMPs, etc). However, the understanding behind this recognition is low-level, with only general understanding of first order effects, not the non-linearities and interactions. Furthermore, there is no knowledge of environmental functioning in extreme droughts, which is critical in terms of identifying adaptation options under future climate change.

Q16 (a) For freshwater: Continue to improve the natural freshwater environment assuming that climate change may gradually change ecosystems; while providing an acceptable (continuous, clean, and cheap) water supply and other societal value through adaptation.

Q16 (b) Ecosystem criteria are not easily defined because of uncertainty about future ecosystem responses due to climate change. Acceptability of water supply can be measured using metrics of continuity, pressure, quality and cost (which must account for carbon footprint).

Q17 All levels of decision-making are going to be required. Climate change is an issue that is much wider than the UK alone and *for some issues* a European-scale response will be required. For example, species currently within the UK may no longer be able to survive here, but may be able to survive in areas of Europe where they were never historically present. Similarly, some European species may be forced from their historic ranges, but find a new home in the UK. Such cross-border effects of climate change cannot be effectively managed at the national scale. Cross-European collaboration presents opportunties for planning and implementation at a much broader scale which can be extremely beneficial. However, effective adaptation at the European scale will involve compromises at the national scale and it is clear that this needs to be discussed and understood within and among all EU states before such an approach is adopted and implemented.

Within the UK, the strategy for adapting to climate change must fit within the wider policy of the EU and encompass initiatives to mitigate the impacts across nations, rather than focus solely on UK issues. Regional and local governments will need to take action at the smallest scale to enact the policy decisions being determined at the national and international level.