

TIPPING POINTS

Annual Report

2011 – 2012

Institute of Hazard,
Risk and Resilience



The Leverhulme Trust

Tipping Points Annual Report 2011-2012

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INTRODUCTION

The Tipping Points project



Penny Hooper© Tipping Point

Tipping Points is currently pursuing a range of fascinating multidisciplinary studies through close collaboration between all researchers involved. Last year (2010-11),

researchers were aiming to develop connections and parallels within the project to build up our multidisciplinary perspective. This year, Tipping Points has delivered on targets needed to help answer some of the puzzling questions surrounding the use of the tipping point metaphor, and to illuminate aspects of the physical, social and biological systems it is used to describe.

Climate change research continues to be a highly topical area of interest for academia, governments, the private sector and media alike. The project has been proceeding with its fascinating investigation of past climate as well as a new exploration of how the tipping point metaphor itself is used to describe climate events such as a significant deterioration in climate that occurred about 5000 years ago across the North Atlantic region and which caused a growth of the Greenland Ice Sheet. A team of

researchers from WP1 travelled to Greenland, bringing back sediment and water samples collected from 25 lakes.

These sediments contain valuable records of past climate in the form of fossil non-biting midges (chironomids) and pollen grains. Currently, researchers are analysing the collected data in order to build new climate records from the North Atlantic region covering this important climate event.

The researchers into past climate from WP1 are working with the mathematicians from WP3, who are developing a statistical model that will incorporate information from both pollen and chironomid data sets. Together they will help shed light on whether the rapid cooling event that took place about 5000 years ago in the North Atlantic region involved a tipping point in the Earth's climate system(s).

This project is also examining how the public and scientific debate has developed through various printed media. Statistical information on the use of references to 'tipping points' in public debates and forums on the planet's changing climate are being analysed to show how the idea has emerged and helped to form our understanding of climate change. What is clear so far is that the tipping point metaphor has a fairly close relationship with 'climate change'. Tipping Points researchers discovered that 8.7 percent of all articles that use the term 'tipping point' are related to climate change. The idea of a 'tipping point' in the world's climate seems to come from non-academic sources as well as academic publications, raising interesting questions about how general opinions on the issue have been shaped by science or by other public discourses.

Important progress has also been made in understanding tipping points in Britain's banking system throughout history. The project's historians and social scientists provide detailed findings about the population of the banking sector in Britain, such as the creation and failure of around 3500 banks through time. Researchers have created a networking database of British banks throughout history, linking together datasets in a way that makes them highly searchable. This provides a method for understanding how banks have failed in Britain, examined at a scale never achieved before.

What emerges is a new way of looking at the lifetimes of banks in Britain that appear less as solid, stable, financial institutions and more like evolving organisms moving within a complex web of interactions similar to an ecosystem. The year 1810 was identified as the 'key tipping point' in British banking history and further investigation is needed to find out why this was the case. With regard to the behaviour of banks and other financial institutions, a better understanding of risk is essential for crafting future legislation. Trust was found to be an integral component to the welfare of financial markets and is essential to the resilience of the global financial system. Behaviours and attitudes of the different actors involved are very important to the success of governance and regulation of financial institutions.

Research in this programme also includes interdisciplinary collaboration between medical and social scientists and mathematicians. They are working to develop and test statistical models that can help us understand the diffusion of innovations, and the emergence of cultural and behavioural patterns in cities using a spatial agent-based modelling approach. Also, the

behaviours of people with smoking or drinking problems are being modelled mathematically to understand the complexity involved in their attempts to quit unhealthy behaviours. The results could have implications for future health policy.

These, together with a number of related research collaborations and projects that have spun off from Tipping Points so far, are being pursued diligently by all researchers involved and through engagement with partners from outside academia. However, the journey is far from over, as further interdisciplinary research is growing within the project as it continues. New initiatives are also starting to expand beyond the core 'Tipping Points' programme, as several new research intercollaborations have begun and could have the potential to continue beyond the lifetime of the project.

The Tipping Points project continues to disseminate findings from all its research activities online, in print and through the international network of the Institute of Hazard, Risk and Resilience at Durham University. Imaginative forms of dissemination and public engagement (for example debates linked to film screenings) are being used to make our research accessible to multiple audiences while promoting new ways to engage people from around the world with Tipping Points.

Prof Sarah Curtis

Principal Investigator, Tipping Points project, Executive Director, Institute of Hazard, Risk and Resilience

Brett Cherry

Research Writer and Dissemination Officer, Institute of Hazard, Risk and Resilience

WORK PACKAGE 1: Rapid Neo-glacial transits in the North Atlantic

*Professor Brian Huntley, Professor Antony Long,
Dr Eleanor Maddison & Dr Helen Ranner*

Tipping Point behaviour has been identified in past climate systems, for example, shifts from glacial to interglacial conditions, or short-lived excursions such as the 8200 years Before Present (BP) cold event¹. A majority of these documented changes has been attributed to external forcing mechanisms, such as orbitally-forced changes in insolation, solar activity, sea-level changes, ice sheet extent or volcanic aerosols.

A pronounced climatic cooling event, marking the transition from the generally warmer conditions of the Holocene Thermal Optimum to the cooler Neoglacial, is recorded across much of the northern Hemisphere in a range of sediment records, although the date for the event at individual localities ranges between 4000 and 6000 years BP. The signal is particularly clear in Greenland ice core borehole temperature profiles² and ice-rafted debris content of ocean cores from east of Greenland³. However, the underlying mechanism for this climatic transition remains undetermined.

Aims

The objective of WP1 research is to determine the cause(s) for the Neoglacial cooling event and to explore whether tipping point behaviour is exhibited in the climate system at this time. To achieve this, new, high temporal resolution palaeoclimatic records are being developed from the North Atlantic region, and existing palaeoclimatic evidence from global records is being collated and analysed.

Two complementary climatic proxies (pollen and chironomids (non-biting midges)) are being used to reconstruct specific climatic variables in order to characterise this event. To explore the spatial variability of this event new records are being developed from areas in southwest Greenland and in Finnmark, northern Norway (**FIGURE 1**). These areas have been selected using specific criteria (for example, optimal elevations, minimal influence from forest/woodland and anthropogenic factors) to maximise data recovery for both proxies.

FIGURE 1:

*Fieldwork areas: A = Greenland (2011);
and B = Finnmark, northern Norway (2012).*



- 1 Dakos V, Scheffer M, van Nes EH, Brovkin V, Petoukhov V, Held H. 2008. Slowing down as an early warning signal for abrupt climate change. PNAS 105: 14308-14312.
- 2 Dahl-Jensen D, Mosegaard K, Gundestrup N, Clow GD, Johnsen SJ, Hansen AW, Balling N. 1998. Past Temperatures Directly from the Greenland Ice Sheet. Science 282: 268-271.

- 3 Andrews JT, Jennings AE, Coleman GC, Eberl DD. 2010. Holocene variations in mineral and grain-size composition along the East Greenland glaciated margin (ca 67°N-70°N): Local versus long-distance sediment transport. Quaternary Science Reviews 29: 2619-2632.



FIGURE 2:

Greenland 2011 fieldwork participants. Left to right: Sarah Woodroffe, Holly Stewart, Helen Ranner, Rob Barnett, Eleanor Maddison, Antony Long.

for palaeoenvironmental investigations were recovered from three lakes from two different elevations. Temperature data loggers were deployed throughout the fieldwork area and will be collected in August 2012 by which time they will have recorded 12 months of 'real' climate that we will use to help interpret our field and laboratory data.

Chironomid and pollen data have been produced from the contemporary sediment samples (**FIGURE 4**) and the lake water samples have been analysed. Analysis of these collated data is currently being undertaken. The sediment cores have been logged and preliminary analyses have been conducted (**FIGURE 5**).

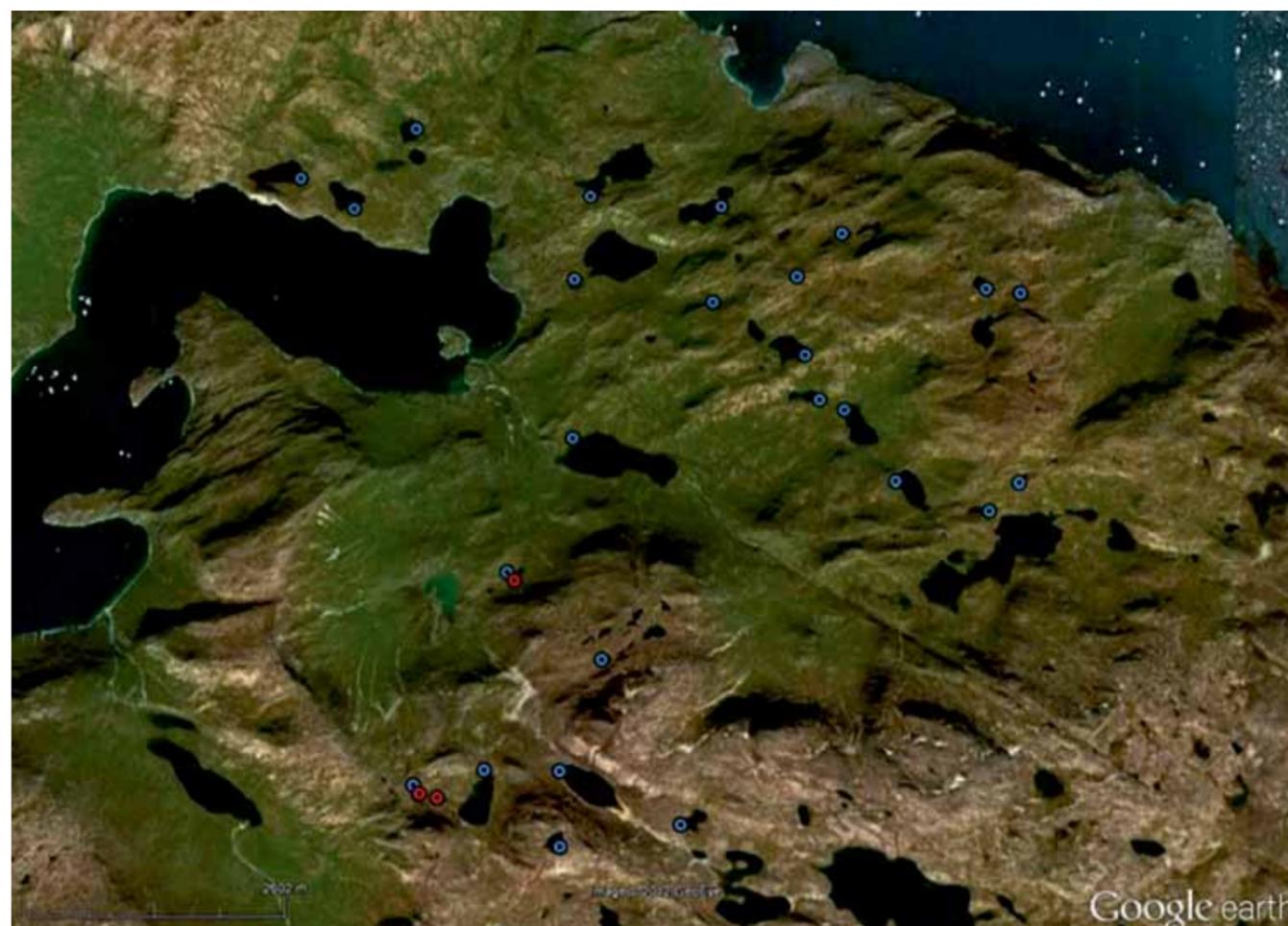
Progress and Results

Greenland fieldwork and associated analyses:

In August 2011 fieldwork took place in south-west Greenland (**FIGURE 1**). The WP1 team (**FIGURE 2**) undertook an intensive field campaign, based at a remote camping site, collecting contemporary lake sediment samples with complimentary lake water samples. Samples were collected from 25 lakes, which ranged in elevation from 50 to 830 m above sea-level (**FIGURE 3**). In addition, sediment cores

FIGURE 3:

*Locations of lakes sampled in Greenland:
Blue - contemporary samples; and Red - sediment cores.*



WORK PACKAGE 1: Rapid Neo-glacial transits in the North Atlantic *continued...*

Contemporary Samples from Greenland

Preliminary Relative Pollen Diagram for Selected Taxa (%)

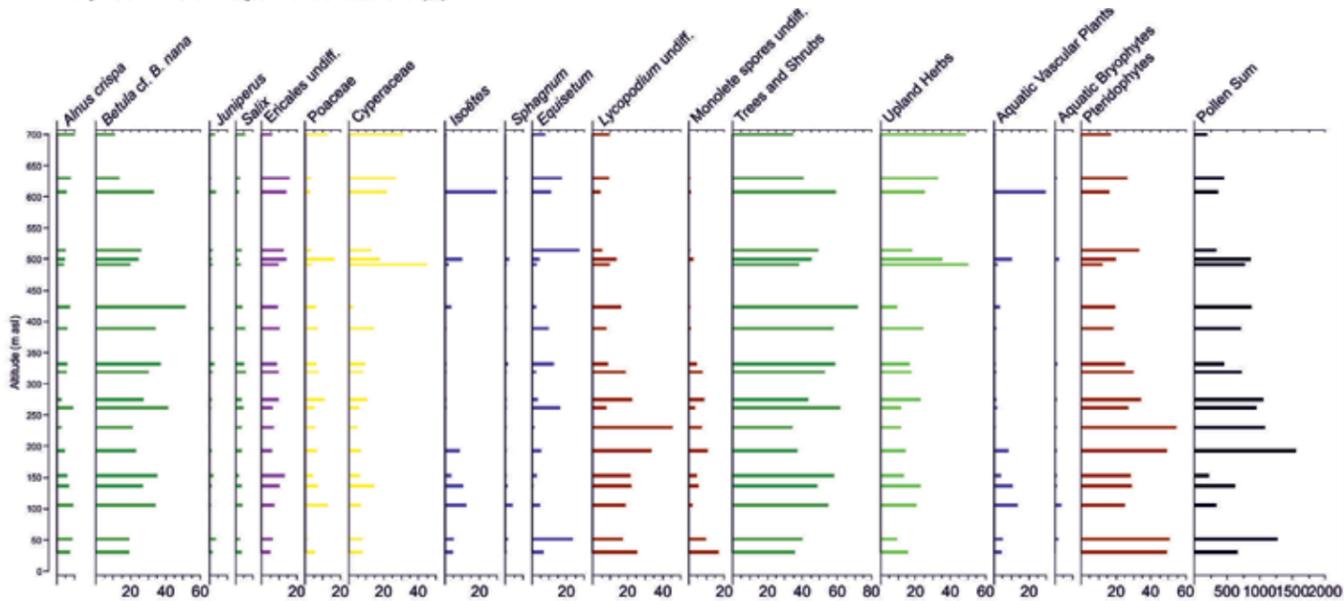


FIGURE 4a: Preliminary relative pollen diagram suggesting a mid-altitude peak in *Betula cf. B. nana*, with Pteridophytes becoming less dominant at higher altitudes and Ericales and Cyperaceae becoming more dominant at higher altitudes.

Preliminary Absolute Pollen Diagram for Selected Taxa (grains $cm^{-3} \times 0.001$)

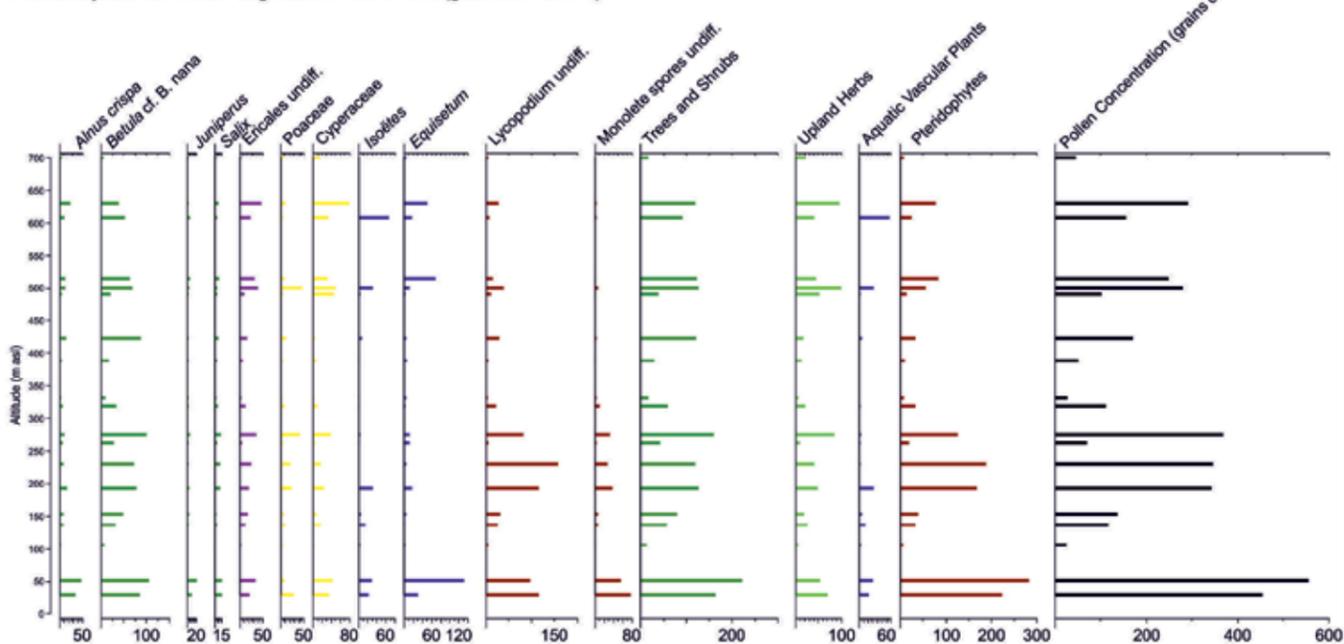


FIGURE 4b: Preliminary absolute pollen diagram (grains $cm^{-3} \times 0.001$) suggesting a general decrease in productivity with altitude.

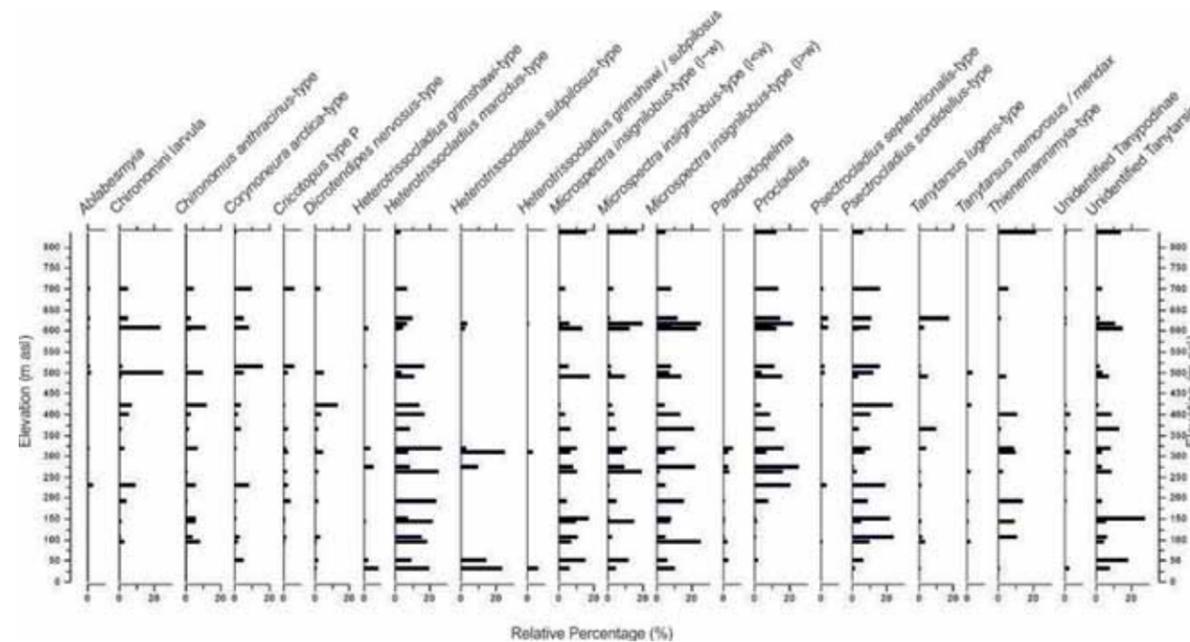
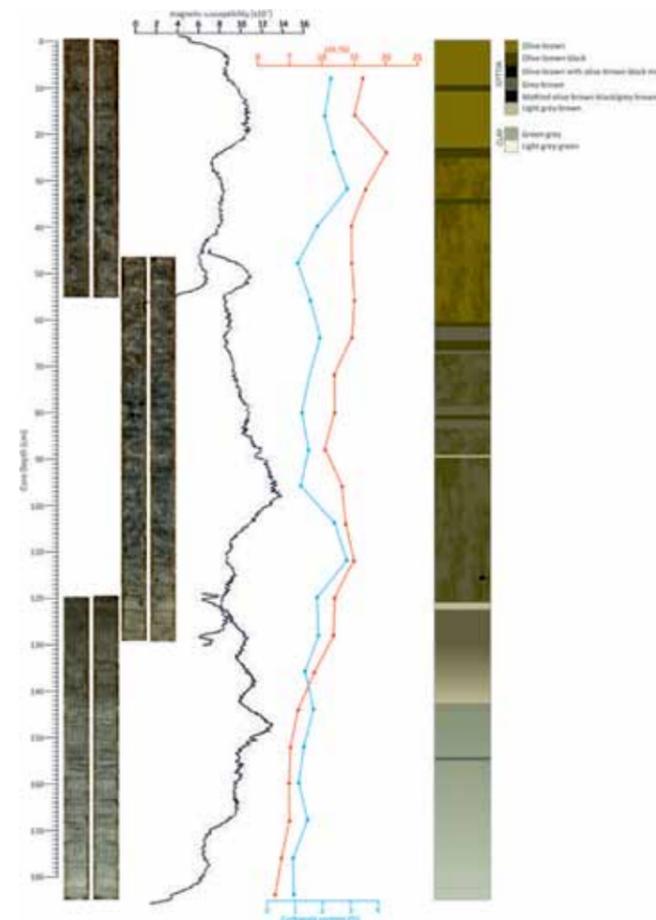


FIGURE 4c: (above) Relative percentage of chironomids (>2%).

FIGURE 5: (right) Lake 29A (Greenland) sediment core data: photographs; log; magnetic susceptibility; loss-on-ignition (LOI); and carbonate content.



Finnmark Fieldwork

Fieldwork in Finnmark, northern Norway (Figure 1), took place in July 2012. This site, on the opposite side of the North Atlantic to Greenland, will enable us to reconstruct regional patterns of climate and to investigate the role of the ocean and the atmosphere in causing change. Several sediment cores and approximately 25 contemporary lake sediment and water samples will be collected from lakes spanning a strategic range of elevations. At the time of writing, the field equipment has been shipped and the field team is preparing for departure.

WORK PACKAGE 2: Financial crises in the banking sector: past and present

*Professor Roman Tomasic, Professor Ranald Michie,
Dr Folarin Akinbami, Dr Matthew Hollow & Dr Simon Mollan*

Aims

The research has sought to explore significant transitions in financial systems, so as to understand the causes of such changes, the implications of those changes, and how to better deal with the effects of such changes.

Progress

We have completed a number of papers, some of which have been published, and some of which are currently under review. These papers tackle many of the substantive issues arising from the global financial crisis. The papers look at the following issues:

- Poor risk management within banks before, during and after the global financial crisis;
- The role of trust in maintaining the resilience of financial markets;
- The failure of shareholders to act as an effective check on their investee companies in the period before the global financial crisis;
- Failures in the supervision techniques adopted by the UK financial regulator, the FSA, in the period before the global financial crisis;
- Shortcomings in the mechanisms for detecting and punishing financial misconduct.

Results

Risk

The management of risk plays a central role in entrepreneurship generally, and in finance in particular. This is largely because of the particularly close relationship between risk and reward. Unfortunately the association between risk and reward can lead banks to take excessive risks in their pursuit of greater rewards. When such risks materialise the results can be catastrophic, not just for the particular risk-taking bank, but also for the financial system and the wider economy as a whole. Business decisions have significant implications with regard to risk. This was seen, for example, in the acquisition by RBS of ABN AMRO at the height of the global financial crisis; in hindsight, this proved to be an excessively risky acquisition, with catastrophic consequences for RBS itself and for UK taxpayers who had to bail it out.

Despite the potentially serious consequences of such decisions, the law often makes it difficult to effectively punish directors and senior managers of banks for negligent decisions, thus reducing the incentive for them to avoid excessively risky business strategies. There is often a resulting need for the law to be reformed so as to make it easier to hold senior managers accountable for excessively risky business strategies and risk management failures. Another corporate governance reform that can help in improving risk management is increasing both the competency and independence of boards of directors, and their risk management committees; this will help them greatly in tackling the enormous challenge of understanding risk information. Furthermore, the risk management function of banks must be given more support by the senior management, so that they can provide a better counter-balance to the risk-taking arms of the firm. Essentially, this refers to the type of corporate governance found within firms. The global financial crisis can, in a real sense, be seen as a failure in ensuring effective corporate governance. In one of our papers we call for new corporate governance, which draws upon more nuanced means of achieving the corporate objective.

Trust

The success of banks often depends essentially on levels of trust; trust is vital to whether banks succeed or fail in a highly competitive market, and it will continue to be vital when it comes to the effective functioning of financial markets and the governance of financial institutions. Trust strengthens the financial system by reducing the costs to institutions of doing business with each other, and this is because in an environment where there is trust the institutions comply with laws and with other ethical business standards even when such standards have not been specifically defined in the law. To this extent, finding ways to promote genuine trust within global financial markets may be instrumental in preventing or reducing the impact of future financial crises.

Although there are limitations to the ability of formal law to control corporate misconduct, the solution is not merely to allow corporations to regulate themselves. Instead we need to re-design the decision-making process within corporations and to change the cultures within corporations so as to bring about improved corporate accountability.

In our studies we also identified the need for a reappraisal of narrow law-and-economics views of corporate law because of the fundamental importance of behavioural factors in explaining economic decision-making in organisations. It is important to focus on human behaviour and to avoid excessive reliance on mathematical or economic models of markets.

Shareholder Activism and Litigation

Despite the fact that corporate law provides a range of mechanisms for shareholder activism (such as the power to elect and dismiss directors, and the power to bring legal actions against directors for breach of their statutory and fiduciary duties) shareholders made very little effort to constrain banks from taking more risky business strategies. This suggests that shareholder primacy is an ineffective means of holding managers and directors accountable, and is therefore an ineffective means of corporate governance.

It has become quite clear that in explaining aspects of the recent global financial crisis, shareholders failed in their responsibility as owners of corporations. One of these failures is simply the result of greedy shareholders who pressured managements to constantly seek to increase returns even when this meant that they were taking on excessive risk. Also shareholders did not engage with their investee companies in a meaningful way, thus representing a failure to play an effective stewardship role in the corporate governance of their investee companies.

When the shareholders did resort to the law, it was to protest the fact that they (in this case Northern Rock shareholders) felt that the bailouts of the banks adversely affected their own interests. This litigation was ultimately unsuccessful and the courts held that since the managements of banks were answerable to their shareholders, who could ultimately have removed the directors, the losses sustained by the shareholders arose due to their own fault and were not the fault of government or the regulator.

We reviewed the proposals in the UK's new Stewardship Code, and found this Code to be relatively modest, and potentially ineffective. Too much reliance should not be placed upon its capacity to prevent damaging conduct.

Haphazard Pursuit of Financial Crime

In his research on financial crime¹, Prof Tomasic looked at the Bernard Madoff Ponzi scheme and found shortcomings in the regulation carried out by the US Securities Exchange Commission (SEC)². Prof Tomasic argued that the Madoff case cannot be dismissed as merely the work of a rogue operator, because of the broader responsibility that many others shared for allowing this type of fraud to continue for as long as it did.

He also highlighted the effects of political ideologies in limiting the actions of regulatory agencies that might seek to intervene in markets. The regulatory philosophy was rooted within a political philosophy where the pressure was on the regulator not to scrutinise the business models of the regulated firms.

- 1 Tomasic, Roman. 2011. The financial crisis and the haphazard pursuit of financial crime. *Journal of Financial Crime* 18(1): 7-31.
- 2 The UK Stewardship Code. Financial Report Council. July, 2010.

He also concluded that in the pursuit of financial crime, law reform and enforcement have been slow to gain traction and powerful political and social forces have stood in the way of improved legal remedies. There is therefore much to be said for stronger consumer-oriented agencies to be set up to ensure oversight of financial markets.

The use of Meta-Regulation as a technique in UK Financial Regulation

In his research on the use of meta-regulation in UK financial regulation, Dr Folarin Akinbami examined the strengths and weaknesses of meta-regulation as a regulatory technique. Meta-regulation is a technique (or a method) of regulation where the regulator tries to harness the regulated firms' risk management tools directly into the regulatory process, thus enrolling the regulated firms into the regulatory process. It is largely about the regulated firms' managements and their internal control mechanisms for addressing the risks (to the regulator's objectives) created by their business activities.

Dr Akinbami used the failures in the supervision of Northern Rock and the Royal Bank of Scotland (RBS) to highlight how the problems associated with meta-regulation can lead to serious regulatory failures. He argued that the regulatory failure in both cases was largely a failure to supervise robustly, rather than a failure arising from problems with the institutional structure of the regulation or deficiencies in the regulatory rules. He therefore concluded that improving UK financial regulation will necessarily involve the regulator taking a more robust, intensive approach to supervision, rather than the superficial tinkering with the institutional structure of the regulation which the UK coalition government is currently in the process of doing.

Tipping Points and Interrelationships in Law, Business and Banking

Over the 13th/14th of July 2011 a conference hosted by the Institute of Hazard, Risk and Resilience was held in Durham on the theme of Tipping Points and Inter-Relationships in Law, Business and Banking. The idea of this conference was to explore the whole concept of tipping points as applied to law, banking and business and to establish whether there were common themes. What emerged was that financial crises are commonly treated as tipping points as they represent sudden change. That led to a discussion of the various responses to crises and whether that was best achieved through market forces or state intervention both to limit the consequences and prevent a repetition. However, both market forces and state intervention were also seen as contributing to crises, for example,

WORK PACKAGE 2: Financial crises in the banking sector: past and present *continued...*

through a lack of corporate governance and the demutualisation of the building societies.

The divorce between ownership and control that came with the growth of corporate enterprise was seen to have created a need for formal legal structures that governed the relationship between business and finance in new ways. Though it was the shareholders who owned the company, the day-to-day decisions were taken by the management, and a separation could exist between the interests of the two groups. This was seen to have been the case with the demutualised Northern Rock. From that basis the discussion moved on to the role played by auditors and how it changed over time, especially as the operation of banks became more complex. Finally, it was noted that financial crises were largely associated with banks as insurance companies generally avoided tipping points.

The conference concluded that there were an infinite variety of tipping points, which made it difficult to identify common causes, courses or cures. Nevertheless, a number of important themes did emerge from the conference. One is that risk is ever present and that crises can and do occur at regular intervals. The more complex the system the greater the probability that crises will occur because there are so many possible causes ranging from entrepreneurial failure through human greed to systemic collapse. Conversely, complex systems possess means of both coping with crises and creating ways of remedying weaknesses. In that way, crises can have positive outcomes if lessons are learnt from them.

In banking, the choice is not between downsizing and a return to

simpler systems or the inevitability of recurrent crises. Instead it involves an acceptance of the world that exists, a need to devise means that minimise the risks and provide ways of coping with them when they occur. That leads to providing another theme which is the importance of corporate governance. In a world in which companies play such a dominant role in business activities, two main issues emerge. The first is the relationship between the employees of the firm and its owners. The second is the relationship between the public company and society as a whole. In both cases the legal structure and the position of auditors is important in simultaneously safeguarding the interests of investors and the public.

A more general outcome of the conference was the recognition that academics in different disciplines have much to say to each other and can contribute valuable insights into common problems. The world is increasingly complex, making it necessary to call on the talents of specialists from different disciplines in order to both understand the problems and to put forward solutions. That cannot be done by generalists as they do not have the depth of knowledge and expertise required. Instead, it is through the collective actions of those with this specialist knowledge and expertise that resilient solutions can be suggested for the hazards and risks that exist in the world today. While the specific conclusions reached were important, especially in terms of recognising and coping with complexity, it was this general observation on the needs for greater co-operation across individual disciplines, which has been the lasting legacy of the conference.

It is helping to drive the remaining years of the Tipping Points project and has already started to bear fruit.

UK Bank Population

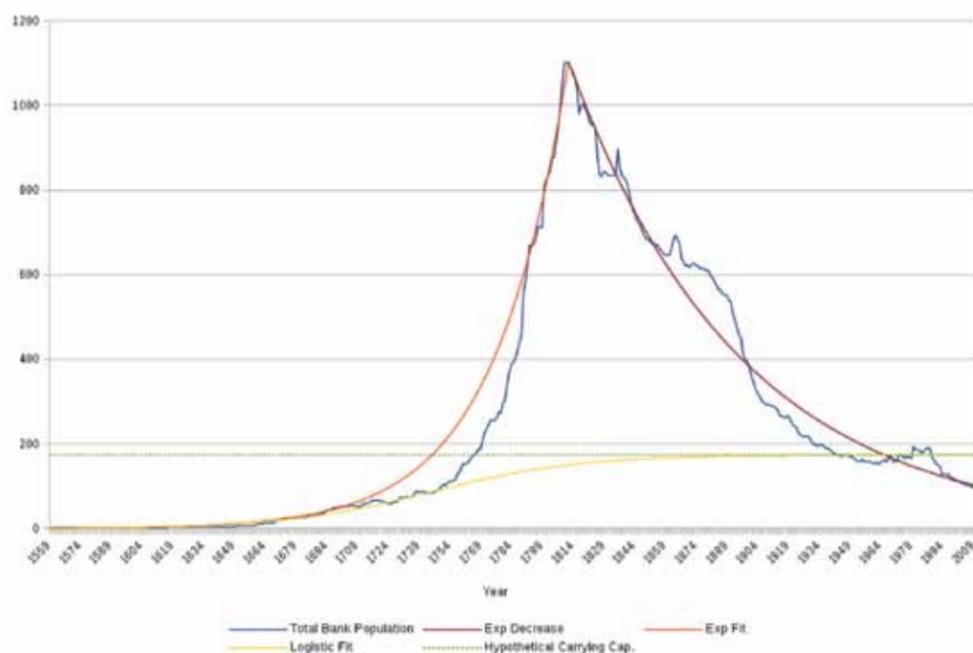


FIGURE 6
Historical data on population of UK banks. Notice the tipping point in 1810.

Banking Database

One valuable product of the conference was the comments made on the banking database that had been compiled by Dr Mollan. The database allowed the identification of Tipping Points in British banking history with the year 1810 emerging as the most significant, to the surprise of most (**FIGURE 6 ADJACENT**). Useful suggestions were also made on how this database could be improved and brought up to the present and these were subsequently carried out. The database now extends to 2008 and is believed to be as robust as the underlying sources permit. That subsequent work turned out to be much more time consuming than originally envisaged but has now been carried out through the collaboration between Dr Simon Mollan and a Research Associate on Work Package 4 of the project, Dr Philip Garnett. This collaboration has already led to one joint paper on the organisational ecology and population of UK banks at the New Business History meeting at York University in Easter 2012. More joint papers are being planned.

The database also allowed the identification of secondary Tipping Points, such as 1878 and 1890. One suggestion made was that these were related to the compulsory external auditing of bank balance sheets which was introduced in 1879 for banks registered with Limited Liability. External auditing of bank balance sheets for private banks then became widespread after the near failure of Barings Bank in 1890, as this was a private bank with no external scrutiny of its balance sheet. Professor Michie and Dr Danny Chow, from Durham University Business School, are to explore whether the introduction of external auditing is an important tipping point by visiting Barclays bank archives as this bank converted from a private to a joint stock bank in 1896. The intention is to compare and contrast the balance sheets drawn up pre- and post-conversion, and examine the role played by external auditors.

Another use of the database was to permit comparisons between the number of British and US banks. Data on the number of US banks are readily available, but there was no comparable database for the UK. One consequence of this is that the US banking experience is regularly used as a proxy for that of the UK. However, there are enormous differences between the banking systems of each country with legislation being the main explanation. In the 19th century, legislation was passed in the USA that restricted nationwide branch banking systems at the very time they were coming to dominate British banking. In the 1930s, the US government also passed an act that forced the separation of commercial and investment banking, but no such legislation was enacted in the UK. Both these pieces of legislation were then repealed towards the end of the 20th century, permitting a radical and rapid re-structuring of US banking. In a paper published online in *History and Policy* in December 2011, Professor Michie and Dr Mollan drew attention to these different histories through the presentation of comparable data for the first time.

1 Tomasic, Roman. 2011. The financial crisis and the haphazard pursuit of financial crime. *Journal of Financial Crime* 18(1): 7-31.

2 The UK Stewardship Code. Financial Report Council. July, 2010.

Finally, the identification of 1810 as the key tipping point in British banking history has created a need to investigate why this was so. This aspect of the project is being taken up by the new Research Associate Dr Matthew Hollow with the intention of writing a paper jointly with Professor Michie. The paper would attempt to explain why 1810 was a tipping point. In contrast, Dr Mollan had already begun archival research into why 1931 was not a tipping point for British banking. Virtually alone of all countries, Britain escaped a banking crisis at that time. However, one bank was saved through covert action by the Bank of England. The records of this bank, Williams and Deacon, exist in the archives of the Royal Bank of Scotland in Edinburgh as it was acquired by them in the 1930s, at the invitation of the Bank of England. In the light of what happened – and did not happen in 2007/08 – it was decided that this episode should be investigated. Dr Mollan intends to continue with this research even though now at Liverpool University, so it would become an output from the Tipping Points project.

Building Societies and Savings Banks

Largely neglected in the literature on the Financial Crisis of 2007/08 has been the role played by the building societies. The reason for this omission is because those at the epicentre of the crisis, most notably Northern Rock, had converted into banks. However, 2007/08 was not the first time that building societies had collapsed as there is a history of financial crises associated with the making of long-term loans on property using short-term deposits collected from retail savers. Even a preliminary glance at the available data reveals 1895 as a significant tipping point for the number of building societies. Finally, it was decided to add savings banks to the study as easily accessible data on their numbers also exist. This raises the question of what contribution did the disappearance of savings banks towards the end of the 20th century make to the destabilisation of the British banking system.

Titanic Moments

While focusing on Tipping Points it became evident that there were equally important non-tipping points to explain. These included events that were seen to be important at the time but produced no fundamental changes. Included among these were events that retain a strong media interest afterwards creating a greatly exaggerated view of their significance. To describe these, Professor Michie invented the term 'Titanic Moment'. This refers to an event that caught the media attention at the time and then has continued to resonate thereafter, but produced no lasting legacy. The sinking of the Titanic was due to an exceptional set of circumstances which were never repeated and produced no long-term consequences. A Titanic Moment is thus an once-in-a-lifetime event that lingers in the memory but does not change the course of history, apart from the effect it had on those directly involved.

WORK PACKAGE 2: Financial crises in the banking sector: past and present *continued...*

The problem is that today the media see every event as a tipping point without recognising that some are only Titanic Moments. As a result, there are constant calls for government intervention and the passing of new laws. If successful, these then change behaviour with far-reaching consequences. What is required is an ability to distinguish between Titanic Moments and tipping points as the former requires some modest reforms while the latter calls for radical change. One product of the Tipping Points project should be an increased awareness that some tipping points are only Titanic Moments, and the demands of the media for instance and far reaching change need to be resisted. The problem is how to catch the media's attention with the concept of a Titanic Moment as its very definition refers to something not happening. Is it possible to produce a book on Titanic Moments that would catch the public's imagination in the way that Gladwell's book on tipping points did?

Future plans

Since 1810 has been identified as the single most important tipping point in the history of British banking, the next step is to explain why. Researchers will focus on what was happening in British banking before and after 1810, which can be done from the published work, and research into the events of 1810. With the appointment of a new PDRA, Dr Matthew Hollow, to replace Dr Simon Mollan, we will be doing more collaborative work between WP 2.1 (History) and WP 2.2 (Law). Prof Ranald Michie and Dr Matthew Hollow are currently in the process of creating a database looking at the recent history of building societies in the UK, and there is scope to use this for collaborative research.

Dr Hollow has been given the task of discovering whether comparable tipping points exist in building societies. For that, easily accessible data exists as each building society had to make an annual return to the Registrar of Friendly Societies. Researchers will explore the question why did Building Societies emerge to challenge banks in the collection of savings and the making of loans? And do the building societies follow the same pattern as banks or do they differ? In continued collaboration with Dr Danny Chow at the Durham Business School, WP2 will also investigate the role of increased reliance placed on the use of professionally trained external auditors in the stability of the British financial system in the 20th century. In addition, there will be collaborative work looking at the evolution of the law on bank directors' duties in the UK.

WORK PACKAGE 3: The Mathematical Basis of Tipping Points

*Professor Brian Straughan, Professor Michael Goldstein,
Dr Camila Caiado & Dr John Bissell*

Aims

The mathematical modelling and risk assessment of tipping points in complex systems is an important topic. In this work package, we aim to explore the various mathematical interpretations of tipping points and assess the predictability and uncertainty of these events. Using deterministic and stochastic approaches, we plan to develop tools that use the strengths of both areas to tackle problems like the climate transition from the Holocene to present (WP1), prediction of financial crises (WP2), diffusion of innovation (WP4) and the dynamics of epidemic models, for example smoking tobacco and alcohol consumption.

Progress

In our study of compartmental models, we investigate examples related to the behaviour of individuals with smoking and drinking problems. Smoking is a serious problem throughout the UK, particularly in the North East. It is a costly problem to the UK government that persists even after the implementation of policies like the ban of smoking advertising and the open display of tobacco products in shops. This work is being undertaken by WP3 leaders Prof Goldstein and Prof Straughan, together with the postdoctoral research associates Dr Camila Caiado and Dr John Bissell. The novelty of the approach taken here is that we are looking at both deterministic and stochastic models and comparing the results with real data. This work is being undertaken with discussions involving Professor Jane Macnaughton (Deputy Head of the School of Medicine and Health), Dr Andrew Russell (Department of Anthropology), and Ailsa Rutter (FRESH, North East).

Prof Straughan is also developing and analysing models for dealing with alcohol problems in society, a topic of almost daily concern in the news, see e.g. Mulone & Straughan¹. In joint work with a PhD student Caroline Walters and Dr Jeremy Kendal (RCUK Fellow, Department of Anthropology) we have analysed a model which allows, but does not predict potential total recovery of a person with an alcohol problem. This has not been done in previous models, and may be useful in assessing the effect those who have given up alcohol can have in 'peer pressure' on those who currently have problems.

Jointly with WP4 members Professor Tim Clark and Dr Pojanath Bhatanacharoen, Prof Straughan is developing and analysing models for 'Diffusion of Innovation' to understand tipping points in this field. Straughan is also examining models for the tipping point in crowd behaviour, a subject which is of immense importance since crowding incidents have led to casualties. This is ongoing work being

WORK PACKAGE 3: The Mathematical Basis of Tipping Points *continued...*

discussed with Professor Bellomo of the Politecnico of Torino, and with Professor Lena Dominelli, School of Applied Social Sciences, Durham University.

In collaboration with Prof Alex Bentley and Dr Paul Ormerod, Dr Caiado is developing a model to study cultural patterns in cities by using a spatial agent-based approach. The objective is to develop tools to estimate the probability of innovations and the memory of the trends created by simulating possible scenarios of dispersion of ideas. Prof Straughan is further looking at tipping points in a mathematical system associated with an acceleration wave transforming into a shock wave². He is also modelling energy conservation tipping points in systems associated with thermal insulation³, and with his PhD student, Nicola Scott.

Prof Goldstein and Dr Caiado are working with WP1 to develop a Bayesian model that incorporates multiple proxies, like pollen and chironomidae datasets, to investigate climate patterns and their associated uncertainties and also assess the existence of possible tipping points. WP3 is preparing a two-day workshop 'Modelling Social Problems and Health', September 13-14, 2012, which will feature the researchers mentioned above together with others from industry and academia.

- Mulone, G. and Straughan, B. 2012. Modelling binge drinking. *Int. J. Biomathematics*, 5.
- Straughan, B. 2012 (in press). Thermo-poroacoustic acceleration waves in elastic materials with voids. *Encyclopedia of thermal stresses*. Springer.
- Straughan, B. 2011. Continuous dependence on the heat source in resonant porous penetrative convection. *Studies in Applied Mathematics*, 127, 302-314.

WORK PACKAGE 4: Metaphor and Agency

*Professor David Greatbatch, Professor Tim Clark,
Dr Philip Garnett, Dr Pojanath Bhatanacharoen
and Professor Alex Bentley*

Aims

The aim of this work package is to deepen our understanding of how words and discourse may have agency and impact on the way we think and act and thus contribute to tipping points in individual and collective behaviours. Building on last year's work on multiple access points to the spread of ideas, buzzwords and how labels enter into public and popular domains, we further explore the mechanisms which underpin the diffusion process in various social contexts. Our research areas range from the emergence of banks, the diffusion of management ideas, storytelling, and audience responses, phone-hacking scandals, to the usages of words and language in climate change discussions. The research on audience response, for instance, investigates models of standing ovations as a model system for tipping point behaviour in social systems. The work on the diffusion of management fashion similarly looks at how micro-behaviour might lead to topical changes: it investigates the waxing and waning of the individual gurus and the guru phenomenon as a whole to assess how fads and fashion may create tipping points in knowledge production systems. This includes citation analysis as well as content analysis of storytelling and the generation of audience responses to management ideas in management guru lectures.

We are currently examining how the tipping point concept has entered media coverage and culture in the UK and whether the use of the tipping point concept is changing the way events are reported by journalists. We are examining how journalists use the tipping point concept to depict changes in social behaviour and ideas, as well as physical and biological processes. The initial strand of this work is focusing on the use of the tipping point concept in newspaper coverage of the phone hacking scandal in the UK to depict significant moments of change in the evolution of the affair. This involves a comparison with the use by some journalists of alternative concepts such as 'nadir', 'gone toxic', 'catalyst for change' and 'erupted into crisis'. This work links in with our broader concerns with diffusion in that it is concerned not only with the use of the concept, but also whether or not it has spread in the context of journalism.

This research is conducted in parallel with how 'tipping point' is used in the context of climate change, which is linked to our broad concern in establishing the dynamics of climate change communication in general. In addition to climate change 'tipping points', we are also investigating its use in public works of scientific language, based on terms used in climate change research, but not restricted to tipping point, and how the use of scientific language by practitioners affects the impact of the research in the public domain. Overall, the research on climate change communication aims at exploring the selection and use of concepts by journalists as well as practitioners to characterize changes in social behaviour and ideas, as well as physical and biological processes. Below, we report in more detail on this research into climate change communication.

WORK PACKAGE 4: Metaphor and Agency *continued...*

Methodology and Results

A LexisNexis database search revealed that approximately 8.7 percent of all 'tipping point' articles in English language newspapers are related to climate change, indicating a high frequency of media attention in this area. There are two streams of this research. The first stream establishes the emergence of the tipping point metaphor in climate change discussions. The second stream examines the fashions of usage of scientific language in public works.

Climate change communication research explores the dynamics underpinning the diffusion of fashionable ideas with a particular focus on access points of ideas into academic and popular domains. We make distinctions between academic and media settings and explore how ideas may transmit and cascade between the two different communities. More specifically, we look at the discursive and textual variations in the usage of the tipping point metaphor in climate change discussions to identify thought leaders, assess how the issue of climate change is portrayed in different settings and impacts knowledge construction and policy-shaping in our society.

Using a combination of citation and content analysis, we trace the usage of tipping point in both academic and media settings. According to our ISI Web of Knowledge search, the first academic article on climate change which uses the term tipping point in its title and abstract is that written by Lindsay and Zhang (2005)¹. Yet, the first time the term 'tipping point' was used in the climate change context appeared in the editorial of a newspaper *The Atlanta Journal and Constitution* on 10 December 1998. At first glance, the first use of the tipping point concept in climate change discussions seems to

have originated from non-academic media. Surprisingly, however, the 1998 editorial article stated that a group of scientists '...point out that complex systems such as climate tend to stay relatively stable for a long time, absorbing pressure for change until it reaches a tipping point. Once that point is reached, major change occurs quickly, in a relative snap of the fingers'. Thus, although first appearing in the media, the usage of tipping point in the climate change context seems to have originated from a scientific community before Gladwell popularised the term in 2000 with his book².

Nevertheless, as Figure 7 shows, the usage of the term tipping point in the climate change context did not rocket until 2005, which indicates that neither the scientists who originally used the tipping point term in the climate change context in the 1998 newspaper article, nor Gladwell, may have been responsible for the exponential growth of the climate change tipping point usage. On the other hand, Russill (2008)³ suggests that Dr James Hansen's (a NASA scientist) shift to 'tipping point' forewarnings received prominent media coverage in early 2006, which is consistent with the trend indicated in Figure 7.

The next step in our research will investigate how the tipping point term gained popularity in the scientific research and public debates concerning climate change. We will identify the thought leaders by examining key actors who frequently feature in these articles such as the International Panel on Climate Change, James Hansen, Greenpeace, as well as the World Wildlife Federation. We will then conduct a discursive analysis on how they have used the tipping point metaphor and assess Russill's (2008) propositions that scientists such as James Hansen or politicians like Tony Blair have used the tipping point metaphor at the more apocalyptic end of its meaning

spectrum to attract public attention, raise debates and motivate public action. This raises another set of questions concerning the symbiotic relationship between public discourse and scientific discourse, which is explored in the second stream of climate change communication research.

There are frequently substantial disjoints between the findings of scientific research and the effect (or impact) that it has on the public. For example, climate change as a man-made phenomenon is now widely accepted in the scientific community, but remains a contentious topic in the wider public domain. For this stream of research, we use the extraordinary new dataset provided by Google that includes word frequencies in approximately four percent of all books published up to the year 2008, to consider the role of scientists in the information-dissemination process as a potential cause for this disjoint. As the Google data represents public works, it allows us to understand the frequency of use of words in the public domain that are considered to be of importance to a particular scientific field. We focus our investigation on the top keywords used in climate science research and much discussed by the public, media and government. The Google data allows us to view the comings and goings of the keywords over years, and in some cases centuries, giving us insight into when words have gone through a tipping point in their use.

The keyword data shows that the keywords have changed in popularity significantly through time. We are able to fit a classic two-parameter social diffusion model to the keyword data, indicating that scientific language is subject to fashion in public works. We also find that almost all of the keywords are on the downside of the wave (shown in Figure 1), suggesting that their popularity is on the wane. This waning suggests that the continued use of passé language by scientists may diminish the impact of important scientific research in the public domain, despite the keywords still being relevant to the scientific field which uses them. If this effect is real then it opens up many interesting ethical questions. For example, is it legitimate to use 'scientific spin' in order to keep important science in the public eye? Who should be responsible for this (surely not the scientists)? Finally, are the results of scientific research already the subject of spin?

- 1 Lindsay, R.W. and Zhang J. 2005. The thinning of Arctic sea ice, 1988-2003: Have we passed a tipping point? *Journal of Climate* 18, 22: 4879-4894.
- 2 Gladwell originally first used the 'tipping point' term in a *New Yorker* article in 1996, so we do not know yet whether scientists may have picked up the tipping point term from this article, which is subject to further investigation. But it was Gladwell's book *The Tipping Point: How Little Things Can Make a Big Difference* published in 2000 which popularised the term.
- 3 Russill C. 2008. Tipping Point Forewarnings in Climate Change Communication: Some Implications of an Emerging Trend. *Environmental Communication-A Journal of Nature and Culture*, 2, 2:133-153

Articles using the terms 'tipping point' and 'climate change' compared to the articles using the term 'tipping point' LexisNexis Database, 1999-2011

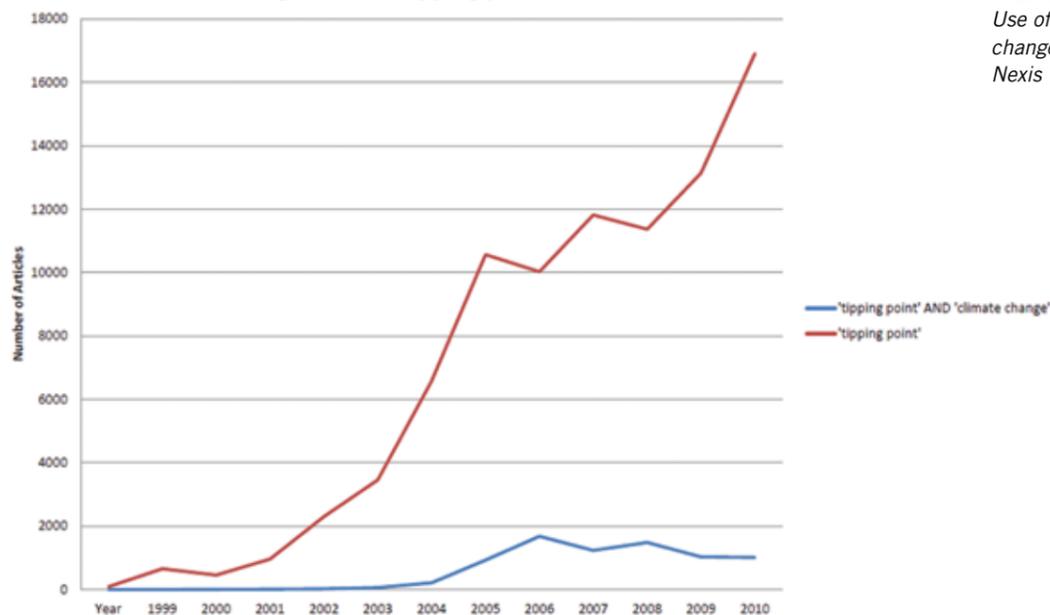


FIGURE 7
Use of 'tipping point' and 'climate change' in article searches on Lexis Nexis 1999-2011.

Collaborations

WP2 & WP4: The development of the UK Banking Sector

WP2 and WP4 have collaborated on the development of a unique dataset tracking the development of the British banking sector since 1750. Not only does this dataset provide detailed information about the population of the banking sector in general (including the creation and failure of approximately 3500 banks through time) it also contains relationship data between banks (which banks have merged with other banks and what organisation was formed, if a bank has changed its name, if it has been acquired, etc). In order to extract the most from the data they are stored in a network database.

Network databases store information as nodes in a graph, and the relationships between data points as links between the nodes (known as edges). In our dataset the banks are nodes (node attributes include bank name and creation date), and the relationships between the banks are edges (edge attributes include the relationship type, such as 'merged with'). Storing the data in this way allows us to track the development of any bank in the database. For example, it is possible to select a bank in the dataset and then look at all the interactions between all the banks in the past that lead up to the formation of the selected bank at a particular time. This development can be viewed as a graph. Figure 2 shows a small part of the graph for the development of Lloyds Bank PLC. Down the left hand side is the timing of the events and the banks are shown as coloured nodes. In this visualisation, the nodes are coloured to indicate the type of event (green indicates merger) to avoid cluttering the graph with edge attributes. The graph shows the flow of banks into the yellow node at the bottom.

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WORK PACKAGE 4: Metaphor and Agency *continued...*

FIGURE 8

Snapshot of the network database of the UK banking sector showing the development of Lloyds Bank PLC.

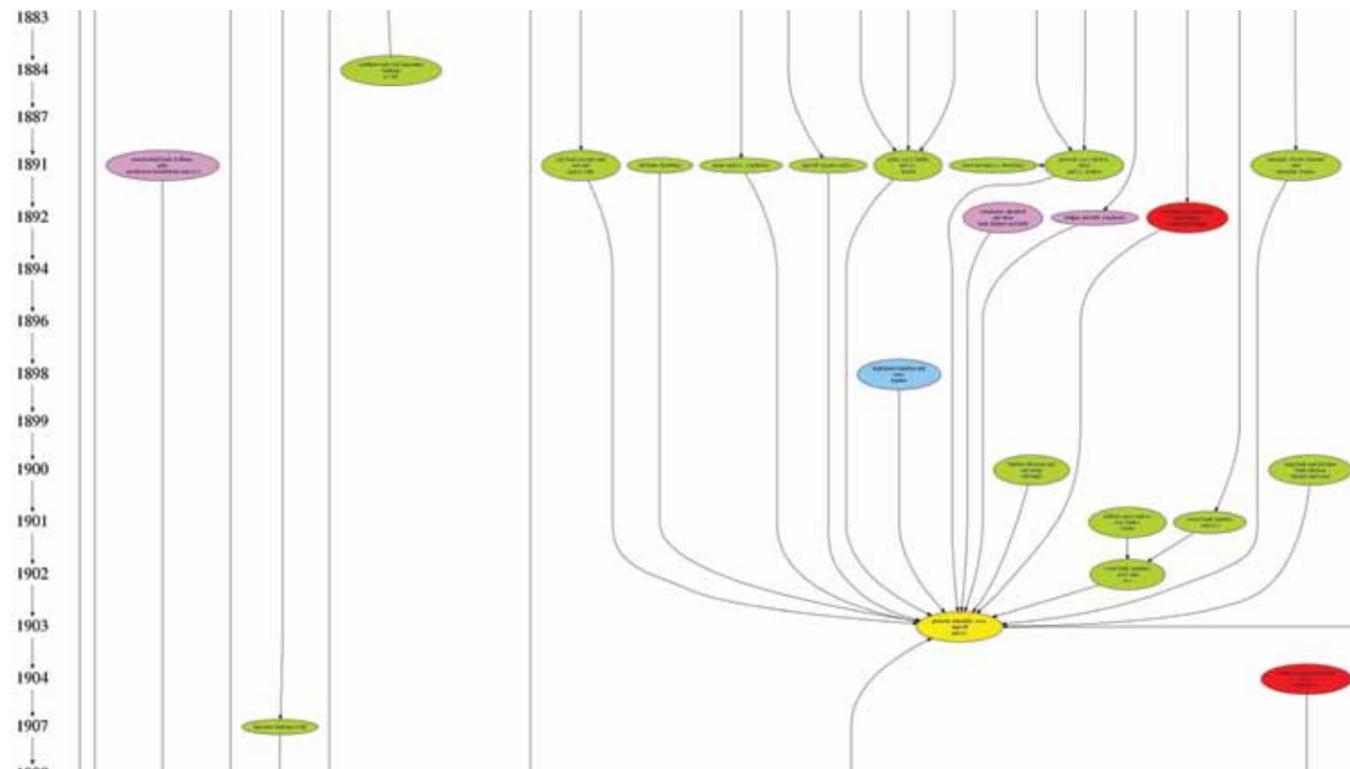


Figure 8 shows a small part of the graph for the development of Lloyds Bank PLC. Down the left hand side is the timing of the events and the banks are shown as coloured nodes. In this visualisation, the nodes are coloured to indicate the type of event (green indicates merger) to avoid cluttering the graph with edge attributes. The graph shows the flow of banks into the yellow node at the bottom.

Storage of historical banking data in this way allows us to challenge the accepted view on how the British banking sector developed. History is often written from the viewpoint of the winners, and banking history is no different. A number of the project's conference presentations and papers will provide an alternative view on the development of the banking sector where banks seem to be responding more to external drivers, and that today's victors could easily have been a number of different banks. Network databases are very powerful as they allow rich datasets of information to be linked and searched in very sophisticated ways.

WP4 Collaboration with Procter & Gamble

WP4 is leading a collaboration with Procter and Gamble to investigate the possibility of identifying new technologies that show potential in the pharmaceutical industry. The aim of this project is to develop a framework for the identification of technologies that might be about to go through a 'tipping point'. Specifically we are interested in technology that is showing the possibility of commercialisation, at the point of moving from basic science to industry. Once identified, these technologies can then be nurtured through the process of industrialisation. The methods being used are to link the various outputs of the scientific process to see if there are patterns in the outputs from successful research. If it is possible to identify patterns, can they be used as signals indicating that a technology is about to go through a tipping point? This collaboration applies outputs from all areas of the Tipping Points project. The techniques developed to store the historical data (collected by WP2) as a network can be applied here and are particularly useful. The different outputs and agents of the scientific process (such as people, papers, patents and clinical trial data) can be linked together on a multi-layered network. This network can then be analysed to look for signal patterns in the data.

Future Plans

In the coming year, we are going to pursue interrelated themes using a range of methodological/analytical approaches, notably bibliometric analysis, interviews and discursive analysis. This will enable us to look at the use of the 'tipping point' term and related concepts in different contexts. In doing this, we are assessing both the trends and diffusion of ideas at a macrolevel as well as examining specific usages by thought leaders and public debates. The findings should generate models and computer simulations of decision-making in relation to collective behaviours and whether tipping point type processes occur in the social world. By assessing the discursive dimension, this research is being extended to public speaking contexts to ascertain the occurrence of tipping point phenomena/processes or threshold behaviours in the context of collective behaviour.

WP5: Deep Thinking

Prof Patricia Waugh

WP5, officially launched this year, will explore the general significance and applicability of the idea of tipping points in human societies. One of its distinctive features is that it will incorporate and bring to bear perspectives from the humanities, including the literary and medical humanities, as well as the social sciences, to consider to what extent tipping points really are common features of physical and social systems, or whether they are simply a metaphor to represent sudden change across a variety of complex systems. From a humanities' perspective, the tipping point implies a narrative as well as a metaphor and therefore engages questions of historicity and change.

Historicity, understood as interconnected processes of intellectual, cultural and social change, is at the heart of the humanities. One important focus of this work will be to consider some of the ways in which the research of WPs 1-4 might illuminate, challenge or complexify the more familiar accounts of change traditionally at the heart of humanistic disciplines, and also to consider whether humanistic accounts of change – which tend to be hermeneutic as much as causal and explanatory – might have insights to offer to researchers in the other work packages of the project. WP5 will begin to draw on and bring together the research from all Work Packages of Tipping Points as part of its remit to consider and examine the implications of living in and beyond a 'tipping point world'.

CONCLUSION

As Tipping Points researchers and our partners beyond Durham University continue to collaborate closely, our understanding of the idea of tipping points and its relevance to human and natural systems can potentially help us deal with problems ranging from major environmental impacts caused by past and future climate change in the future, to questions concerning health resilience and well being, and to ways of understanding processes of cultural and intellectual change in society and the resistance to and/or take up and dissemination of innovative thinking. As is true for other popular terms in wide use today, the context in which tipping point is used is important for understanding how it is defined in society. The challenge ahead is finding out if there is indeed any similarity between tipping points in the systems studied and, if that is proved to be the case, how we can better understand the implications they may have for the future as well as our knowledge of the past.



Penny Hooper© Tipping Point

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CONFERENCE PRESENTATIONS, SEMINARS AND LECTURES 2011-2012

Bhatanacharoen, P. Exploring Multiple Access Points to the Diffusion of Innovative Ideas. Chulalongkorn University, Bangkok, Thailand, September 2011.

Bhatanacharoen, P. and Clark, T. The Birth and Rebirth of the Tipping Point Metaphor: Exploring Multiple Access Points to the Diffusion of Innovative Ideas. Durham Business School, November 2011.

Bentley, R.A. Networks, complexity and the archaeology of complex social systems. "Connected Past" Conference (Keynote Lecture). Southampton University, March 2012.

Bentley, R.A. An anthropologist's view on vaccination. European Society for Paediatric Infectious Diseases, Thessaloniki, Greece, May 2012.

Bentley, R.A. Social influence and drift in collective behaviour. Santa Fe Institute, November 2011. Bristol University, January 2012. Bath University, March 2012. Oxford University, March 2012

Bentley, R.A. Complexity approaches to creative economy data. Panel at the Complexity and Creative Economies Workshop. NETSTA, London, June 2011.

Bentley, R.A. Tipping points and unpredictability in complex social systems. University College London, June 2011.

Bentley, R.A. Does the Internet really change how we interact and decide? Google Social Media Week, London, February 2012.

Garnett, P. and Mollan, S. A population analysis of British Banking over time. *New Business History*, York, May 2012. Huntley, B. The Neoglaciale transition - a 'tipping point' in the climate system? Irish Quaternary Association Symposium: Quaternary tipping points: Exploring the dynamics of human and environmental change, Dublin, December 2011.

Long, A.J. PALSEA Ice sheet climate interactions – implications for human responses. (Invited Keynote) University of Maddison-Wisconsin, June 2012.

Long, A.J. Late Holocene Greenlandic and Antarctic Ice-Climate-Sea-level Interactions and Past and Present Sea Level Rise and Ice Sheets (Invited Panel Discussant) Planet Under Pressure, London, March 2012.

Long, A.J. Sea-Level and Adjustment of the Land Observations and Models (SLALOM) and Sea-level indicators. EU COST Action Conference, Athens, March, 2012.

Long, A.J. New relative sea-level-based constraints on ice sheet history in the SE sector of the Greenland Ice Sheet. (Invited Keynote) INQUA Congress, Berne, July, 2012.

Long, A.J. Life and science in the Arctic, Marton cum Grafton Women's Institute, North Yorkshire, January 2012.

Long, A.J. Greenland: the climate of science. Geography Teachers Conference, Durham University, March 2012.

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Michie, R. British Bank Stability and Financial Crises since 1945. Economic History Society Conference, Oxford University, March 2012.

Michie, R. Too Big to Fail: UK Financial Services Reform in History and Policy. Economic History Society Conference, Oxford University, March 2012.

Michie, R. British Bank Stability and Financial Crises since 1945. Financial Crises and the Transformation of the Financial System since 1945. European University Institute, Florence. May 2012.

Straughan, B. Modelling binge drinking. Brunel University, London, February 2012.

Straughan, B. Thermal convection with second sound. University of Birmingham, March 2012.

Straughan, B. Thermal convection in nanofluids. Basque Center for Applied Mathematics (BCAM), Bilbao, Spain, March 2012.

Straughan, B. Mathematical Models and Analytical Problems in Special Materials. Local thermal non-equilibrium and convection in a vertical porous channel (Invited plenary speaker). Rome, April 18, 2012.

Tomasic, R.A. and Akinbami F. Achieving More Effective Risk Management through Improved Corporate Governance. 29th Cambridge International Symposium on Economic Crime, University of Cambridge, September 2011.

Tomasic, R.A. and Akinbami F. Trust and the Regulation of Public Companies: Reconceptualising Company Law Theory. Society of Legal Scholars (SLS) 102nd Annual Conference, September 2011.

Tomasic, R.A. Regulating Financial Innovation after the Global Financial Crisis. Herding, Innovations and Tipping Points in Financial Systems, Durham University, July 2011.

PUBLIC ENGAGEMENT, ONLINE AND MEDIA DISSEMINATION 2011-2012

Prof Dave Petley, Prof Antony Long, Dr Pojanath Bhatanacharoen and Prof Pat Waugh were members of a panel that led a discussion on the use of the tipping point metaphor in portraying climate change and political action after the film screening of 'Beyond the Tipping Point' 2 May 2012 that was attended by ~100 members of the public at Durham University. <http://wp.me/p13wbQ-c8>

Dr Helen Ranner, Dr Eleanor Maddison and Brett Cherry, in collaboration with Durham University's Science Learning Centre's Climate Change Schools Project, organised a science public engagement event with students from St Anthony's Girls' School in Sunderland and All Saints VA Church of England School in Stockton to explore past climate change through hands-on activities and interactive lessons. The event in March 2012 attracted attention from the local media that was arranged by Brett Cherry and the Durham Media Relations team. This event will run again in March 2013 for KS2 teachers. <http://wp.me/p13wbQ-bB>

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'Tipping Points – uncovering the climate of the past in Greenland'. Part 1 of an ongoing series of videos about the research of WP1 (forthcoming video in July 2012). Produced by Brett Cherry and the WP 1 team. <http://wp.me/p13wbQ-aX>

The first of a series of Research Briefs from the project is on 'Restoring Trust in order to Increase Market Resilience after the Global Financial Crisis'. It is available on the Tipping Points website, IHRR's website, the Tipping Points blog and on the online media dissemination platform Issuu. It provides policy recommendations and video interviews about the research with Dr Folarin Akinbami and Prof Roman Tomasic from WP2. <http://bit.ly/yf7hZp>

The first issue of IHRR's magazine Hazard Risk Resilience featured a popular article on the project suitable for non-academic audiences, 'In Search of Tipping Points', by Brett Cherry. <http://issuu.com/s/7b2>

BBC Radio 4's programme 'Thinking Allowed' featured guests from the project Prof Pat Waugh (WP5), Prof Tim Clark (WP4) and Prof Alex Bentley (WP4) on a special broadcast focused on 'tipping points'. http://www.bbc.co.uk/iplayer/episode/b0184s2x/Thinking_Allowed_Tipping_points/

The Tipping Points project's blog has 151 followers so far and a readership from around the world, including countries in North America, Asia, Europe, the Middle East and South America. <http://tippingpointsproject.org/>

A series of audio programmes about different aspects of the project are available via the Tipping Points website. <http://www.dur.ac.uk/ihr/tippingpoints/resources/>

A Tipping Points research feed has been created in collaboration with Durham University Library to make available all published papers from the project publicly available for free. <http://feeds.feedburner.com/tpresearch>

The 2010-2011 Tipping Points annual report is publicly available via the Tipping Points and IHRR websites and blogs and is downloaded regularly (~700 downloads to date). <http://bit.ly/pfTmnM>

APPENDIX

Tipping Points Publications 2010-12

2010

Akinbami, F. 2010. The global financial crisis: Causes, effects and issues to consider in the reform of financial regulation. *International Finance Review* 11, 167-190.

Bentley, R.A. and Ormerod P. 2010. A rapid method for assessing social versus independent interest in health issues. *Social Science and Medicine* 71: 482-485.

Byers, B.E. Belinsky K.L. and Bentley, R.A. 2010. Independent cultural evolution of two song traditions in the chestnut-sided warbler. *American Naturalist* 176, 476-489.

Straughan, B. 2010. Structure of the dependence of Darcy and Forchheimer coefficients on porosity. *Int. J. Engng. Sci*, 48, 1610-1621.

Tomasic, R.A. 2010. Establishing a UK rescue regime for failed investment banks. *Corporate Rescue and Insolvency*, 3 (2) 60-64.

Tomasic, R.A. 2010. 'Beyond 'Light Touch' Regulation of British Banks after the Financial Crisis', (pp. 103-122), in *The Future of Financial Regulation*, edited by Iain G MacNeil and Justin O'Brien, Oxford, Richard Hart Publishers, 2010.

Tomasic, R.A. 2010. 'Creating a Template for Banking Insolvency Law Reform after the Collapse of Northern Rock', (pp. 59-83) in Wessels, B and Omar PJ (eds), *Insolvency Law in the United Kingdom: The Cork Report at 30 Years*, (INSOL Europe Academic Forum), Nottingham, INSOL Europe.

2011

Bentley, R.A. and Ormerod P. 2011. 'Agents, intelligence, and social atoms' in M. Collard & E. Slingerland (eds.) *Creating Consilience: Science and the Humanities* OUP.

Bentley, R.A. Ormerod, P and Shennan, S.J. 2011. Population-level neutral model already explains linguistic patterns. *Proceedings of the Royal Society B*, 278, 1770-1772.

Bentley, R.A. Ormerod, P. and Batty, M. 2011. Evolving social influence in large populations. *Behavioural Ecology and Sociobiology* 65, 537-546.

Bentley, R.A. and O'Brien, M.J. 2011. The selectivity of social learning and the tempo of cultural evolution. *Journal of Evolutionary Psychology* 9, 1-17.

Clark, T. and Greatbatch, D. 2011. Audience perceptions of charismatic and non-charismatic oratory: The case of management gurus. *The Leadership Quarterly*, 22 (1), 22-32.

Ormerod, P. & R.A. Bentley 2011. Modelling creative innovation. *Journal of Cultural Science* 3, 1-15.

Straughan, B. 2011. Tipping points in Cattaneo-Christov thermohaline convection. *Proceedings of the Royal Society A*. 467 (2125) 7-18.

Tomasic, R. 2011. The financial crisis and the haphazard pursuit of financial crime. *Journal of Financial Crime*. 18 (1), 7-31.

Tomasic, R.A. 2011. The emerging EU framework for bank recovery and resolution. *Corporate Rescue and Insolvency* 40-42.

Tomasic, R.A. 2011. The Financial Crisis and the Haphazard Pursuit of Financial Crime. *Journal of Financial Crime* 18, 1:7-31.

Tomasic, R.A. 2011. 'The Failure of Corporate Governance and the Limits of Law: British Banks and the Global Financial Crisis' in W Sun et al (eds) *Corporate Governance and the Global Financial Crisis: International Perspectives*, Cambridge University Press.



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