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# Delivering organisational adaptation through legislative mechanisms: Evidence from the Adaptation Reporting Power (Climate Change Act 2008)

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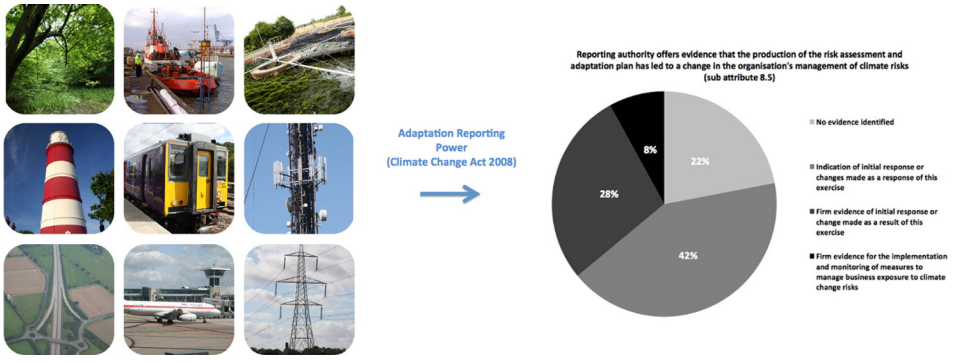
## HIGHLIGHTS

- We present an extensive analysis of the Climate Change Act (2008) Adaptation Reporting Power
- The process has triggered engagement, organisational change and adaptation actions across key business sectors vulnerable to climate change
- Supporting and engaging with reporting authorities during the reporting process and evaluating the adaptation reports represent challenges
- The Adaptation Reporting Power potentially provides the basis for similar initiatives in other countries for delivering organisational adaptation
- Research exploring its long-term legacy and alternative reporting strategies is required

## GRAPHICAL ABSTRACT

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## ABSTRACT

There is increasing recognition that organisations, particularly in key infrastructure sectors, are potentially vulnerable to climate change and extreme weather events, and require organisational responses to ensure they are resilient and adaptive. However, detailed evidence of how adaptation is facilitated, implemented and reported, particularly through legislative mechanisms is lacking. The United Kingdom Climate Change Act (2008), introduced the Adaptation Reporting Power, enabling the Government to direct so-called reporting authorities to report their climate change risks and adaptation plans. We describe the authors' unique role and experience supporting the Department for Environment, Food and Rural Affairs (Defra) during the Adaptation Reporting Power's first round. An evaluation framework, used to review the adaptation reports, is presented alongside evidence on how the process provides new insights into adaptation activities and triggered organisational change in 78% of reporting authorities, including the embedding of climate risk and adaptation issues. The role of legislative mechanisms and risk-based approaches in driving and delivering adaptation is discussed alongside future research needs, including the development of organisational maturity models to determine resilient and well adapting organisations. The Adaptation Reporting Power process provides a basis for similar initiatives in other

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countries, although a clear engagement strategy to ensure buy-in to the process and research on its long-term legacy, including the potential merits of voluntary approaches, is required.



## 1. Introduction

It is increasingly recognised that organisations need to adapt to climate change, adopting risk and resilience approaches and incorporating climate change and extreme weather events into their corporate strategies and decision making (Linnenluecke and Griffiths, 2010; Tompkins et al., 2010; Beermann, 2011; Winn et al., 2011; Linnenluecke et al., 2012; Weinhofer and Busch, 2013). The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as *'adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities'* (McCarthy et al., 2001, p.982). Adaptation may be technological, behavioural, financial, institutional or informational in nature, and occur in a variety of forms, including anticipatory, passive, reactive, proactive, autonomous, spontaneous or planned/purposeful (Carter et al., 1994; Smith, 1997; Smit et al., 2000; Fankhauser et al., 1999; Smith and Lenhart, 1996; Smit et al., 2000). In addition, Tompkins et al. (2010, p.630) have classified adaptation actions as a) building adaptive capacity - where activities may include research, planning, networking, awareness raising, training and advocacy; b) implementing adaptation, and c) developing supportive legislative and policy frameworks. Elsewhere, Hertin et al. (2003, p.287) have identified flexible risk management processes, effective internal communication and external relationships and strong in house expertise as key features of adaptive capacity. Early and precautionary adaptation is important, as are iterative risk management processes and flexible adaptive responses, accounting for uncertainty to prevent the potential risk of maladaptation (Fankhauser et al., 1999; Willows and Connell, 2003).

Numerous adaptation drivers have been identified in organisations including real or perceived climate change, legislation, regulation and policy, flooding, risk management and cost savings, and population pressures (Tompkins et al., 2010; Wilby and Vaughan, 2011). Experience of stimuli, such as extreme events, has been recognised as providing the impetus for adaptation actions (e.g. Smit et al., 2000; Berrang-Ford et al., 2011; Wilby and Vaughan, 2011). However, it is also acknowledged that attributing tangible actions to broader motives or adaptation goals is challenging (Fankhauser et al., 1999; Tompkins et al., 2010; Dupuis and Biesbroek, 2013). Tompkins et al.'s (2010) review of adaptation activities in the UK highlighted that many observed adaptations are not planned as adaptive responses to climate change. Indeed, many are not climate change specific; instead representing unintentional or secondary benefits arising from activities unrelated to climate change (e.g. planned infrastructure investment), with co-benefits, such as cost savings, frequently used to justify them (Tompkins et al., 2010; Smit et al., 2000; Smit and Wandel, 2006). Elsewhere, the risks extreme weather events pose to organisational survival have been highlighted (Linnenluecke and Griffiths, 2010; Linnenluecke et al., 2012), with Wilby and Vaughan (2011) noting how organisations have traditionally responded to weather and climate shocks rather than implementing long-term measures to reduce climate risks.

Detailed evidence of how adaptation is facilitated, implemented and reported is lacking, as are examples of practical adaptation actions (Arnell, 2010; Berkhout, 2012; Berrang-Ford et al., 2011; Ford et al., 2011; Linnenluecke et al., 2013). Where studies do exist, they are predominantly constrained to small numbers of organisations or sectors (Arnell and Delaney, 2006; Berkhout et al., 2006; Hertin et al., 2003; Weinhofer and Busch, 2013), or they consist of literature and document reviews (Tompkins et al., 2010; Berrang-Ford et al., 2011; Linnenluecke et al., 2013). Whilst Wilby and Vaughan (2011) identified a series of hallmarks potentially associated with adapting organisations, there is a paucity of research investigating whether and indeed if adaptive capacity is translating into actual adaptation action (Berkhout, 2012; Berrang-Ford et al., 2014) at all levels from individual organisations to whole sectors. Furthermore, studies such as Tompkins et al. (2010), who argued that a climate change adaptation transition has commenced in the UK, with niche activities starting to be mainstreamed, are now out-dated due to rapid changes in policy and associated organisational response.

Significant research questions remain and challenges exist with comparing and measuring adaptation actions and effectiveness within and across cases (Dupuis and Biesbroek, 2013; Berrang-Ford et al., 2014). Thus research investigating how adaptation activities are being facilitated at all levels from individual organisations to whole sectors is needed (Arnell, 2010). In particular, practical evidence of, and insights into, the adaptive capacity and corporate adaptation actions being undertaken by organisations (e.g. mainstreaming (Smit and Wandel, 2006), long term investment, climate proofing of assets and monitoring), any associated challenges and barriers (e.g. regulatory), and whether they exhibit the hallmarks of adapting organisations (Weinhofer and Busch, 2013; Wilby and Vaughan, 2011) would be beneficial. For example, Tompkins et al. (2010) and Weinhofer and Busch (2013) have postulated that framing climate change through a risk management rather than sustainability lens may prove effective, whilst Fankhauser et al. (1999) emphasise the need for investment decisions to account for climate change and its associated uncertainties. Furthermore, questions remain in relation to the extent to which organisations have appropriate and adequate skills, knowledge and expertise to guide and implement adaptation actions (Fankhauser et al., 1999). Here the extent to which individualistic or collective capacity building is occurring, particularly with regards sector specific and cross-sector guidance and engagement is occurring would benefit from further exploration (Wilby and Vaughan, 2011). Finally, alongside risks, the potential benefits and opportunities that climate change offers organisations require investigation (Smit et al., 2000; Weinhofer and Busch, 2013; Winn et al., 2011). However, very little is currently known about these fundamental issues in practice.

The authors are interested in evidence of practical adaptation. In this paper, we directly address such knowledge gaps, using the first round of the Adaptation Reporting Power (ARP) – part of the Climate Change Act (2008) (United Kingdom, 2008) – to explore the insights that the ARP process has provided into the range of climate change risk and adaptation activities that organisations across key critical sectors are undertaking, and consider the benefits and challenges encountered during the ARP process and their implications for those considering implementing similar climate change risk and adaptation reporting initiatives. We examine whether legislative mechanisms for corporate climate change risk and adaptation reporting, and the framing of climate change as a business risk, offer a means for driving greater consideration of climate change risk, adaptation within organisations, including organisational change, the development of adaptive capacity, and the delivery of practical adaptation outcomes. Thus the paper will help to inform pragmatic strategies for organisational adaptation and resilience.

### 1.1. The Adaptation Reporting Power

The UK Climate Change Act (2008) (United Kingdom, 2008) introduced legally binding frameworks for reducing greenhouse gas emissions and for adapting to climate change, through the introduction of a legal requirement to undertake a Climate Change Risk Assessment (CCRA), develop a National Adaptation Programme (NAP), and an

Adaptation Reporting Power (ARP). The ARP introduced a requirement for 'reporting authorities' to report on how they are addressing and acting on the risks and opportunities from a changing climate, in the context of their business risks. Reporting authorities are organisations with functions of a statutory nature and statutory undertakers, such as water companies and electricity distribution network operators (Department for Environment, Food and Rural Affairs (Defra), 2009a). The ARP aims to assist reporting authorities to take appropriate action to adapt to the future impacts of climate change, raise awareness, build capacity in organisations, and provide examples of good practice (Defra, 2009a).

Between October 2010 and March 2012 reporting authorities from nine business sectors (aviation, electricity distribution and transmission, electricity generation, gas distribution and transportation, ports and lighthouses, public bodies, regulators, road and rail, and water) reported during the first round of the ARP (Defra, 2012a). Whilst no prescribed format for reporting was specified, reporting authorities were required to follow the requirements outlined in the Direction to report and the associated Statutory Guidance (Defra, 2009b), which set out the process that organisations need to undertake to assess their risks from climate change and to draw up adaptation plans.

This paper presents an analysis of the benefits and challenges associated with the ARP, based on analysis of the ARP reports (Drew et al., 2010; Defra, 2011; Defra, 2012a; Centre for Environmental Risks and Futures, 2012), presenting examples of how organisations are assessing their climate change risks and vulnerabilities, and implementing adaptation actions. The ARP's role in driving such activities is also considered, and recommendations are provided for other countries considering introducing requirements for corporate climate change risk and adaptation evaluation. This is particularly valuable as Fankhauser et al. (1999) have emphasised the need to provide conducive environments for adaptation, which they note is the role of the State, and adaptation reporting may provide a role in this process. Similarly, it provides an opportunity to consider the effectiveness of UK adaptation legislation and policy, which Tompkins et al. (2010) highlight as a research need. The paper provides new academic insights into the practical adaptation activities and development of adaptive capacity, including good practice and levels of maturity, both within organisations and across key sectors, and the application and effectiveness of legislative mechanisms to drive and deliver adaptation activity. Thus it is of interest to those developing climate change adaptation legislation and policy in governments and their agencies, providers of climate change support services, and organisations wishing to assess their potential climate change vulnerabilities and embed climate change risk management and adaptation within their activities.

## 2. Materials and methods

The analysis presented is based on the authors' key roles in the first round of the ARP, between September 2009 and March 2012, directly supporting the Secretary for State and the Department for Environment, Food and Rural Affairs' Adapting to Climate Change Programme during its implementation. As described in detail later, this unique contribution to implementing the first type of legislation of its kind, included supporting the formulation of the Statutory Guidance for reporting authorities, and critically the development of an evaluation framework, based on the Statutory Guidance, which was used by the Cranfield authors to provide an independent and objective review of each of the adaptation reports to ensure that they met the direction to report, and the production of sector summaries (Defra, 2009b; Drew et al., 2010). The independent nature of the review team was chosen to build trust in the review process and achieve buy in and support from reporting authorities. This support included the lead author being embedded within Defra's Adapting to Climate Change Programme's team. In addition, the UK Climate Impacts Programme (UKCIP) provided advice and training on the use of the UK Climate Projections and climate risk assessment and adaptation issues to Defra and reporting authorities.

The evaluation framework (Drew et al., 2010), used to objectively review the reports, assesses eight 'key attributes' that the Statutory Guidance (Defra, 2009b) for reporting authorities identifies as essential components of the adaptation reports. The key attributes comprise:

1. Climate change risk assessment is a clear component of corporate risk appraisal
2. Climate change risk assessment enables the reporting authority to make evidence based decisions on adapting to climate change
3. Demonstrable use of relevant and appropriate data, information, knowledge, tools and methodologies
4. Climate change risk assessment and adaptation measures explicitly consider uncertainties
5. Climate change risk assessment generate priorities for action
6. Climate change risk assessment identifies opportunities (where applicable)
7. Clear demonstration of flexible adaptation measures
8. Monitoring and evaluation of adaptation effectiveness

The evaluation framework builds on similar 'maturity models' that have been developed to evaluate risk management capability within organisations and between sectors (MacGillivray et al., 2007; Curtis et al., 2009; International Association for Contract and Commercial Management (IACCM), 2003). Maturity models allow organisations to assess and establish their current levels of process or organisational maturity and comprise of a series of maturity levels, relating to organisational competence, for example from novice to expert (IACCM, 2003) or best practice (MacGillivray et al., 2007), against which process or organisational attributes are assessed (e.g. culture, process, experience and application (IACCM, 2003)). They allow organisations to assess their current level of maturity, identify strengths and weaknesses, and importantly, actions that may be required to enhance organisational maturity (MacGillivray et al., 2007). With regards the ARP process, maturity models facilitate the benchmarking of organisations (MacGillivray et al., 2007). Within the evaluation framework each 'key attribute' consists of a series of specific 'sub attributes', drawn directly from the Statutory Guidance (Defra, 2009b) for reporting authorities. Each sub attribute comprises of four discrete descriptors, against which tangible evidence within the reports can be identified and evaluated on a scale of 1–4 (Table 1):

- Not present (1); meaning there is no evidence of this aspect having been addressed.
- Partially complete (2); meaning preliminary evidence is available but there are some concerns with the method used, or the evidence gathered is not comprehensive.
- Complete (3); meaning this attribute is comprehensively addressed.
- Complete and fully integrated (4); meaning this attribute is addressed in full and there is clear evidence of the thinking being woven into other business processes and/or strategic plans accordingly.

The 'key attribute' evaluation, which uses the same scale of 1–4, is subsequently calculated using the average evaluation for each of its 'sub attributes' (Table 1). A series of Microsoft Excel spreadsheets were created to tabulate, analyse and visualise the results of the evaluation framework analysis at the organisational, sector and whole sample level, with SPSS used to produce descriptive statistics.

In total, 88 adaptation reports (a number of joint reports were submitted by organisations, such as port operators, who received multiple directions to report on a number of ports under their ownership) from nine key sectors (Fig. 1) were evaluated. Approximately 6700 pages of adaptation report were reviewed using the evaluation framework, with 20% of reports being reviewed by two reviewers to ensure report consistency and offer a triangulation of report attributes (Drew et al., 2010).

**Table 1**
The evaluation framework used to objectively identify and evaluate tangible evidence in each of the adaptation reports (Drew et al., 2010).

| Sub-attribute | Not present | Partially complete | Complete | Complete and fully integrated |
|---|---|---|---|---|
| Climate change risk assessment is a clear component of corporate risk appraisal (key attribute 1) | | | | |
| 1.1 Climate change demonstrably a key consideration in corporate planning and processes of the reporting authority | No evidence identified | High level statement that climate change risks will require management by reference to strategic objectives | Formal consideration and analysis of climate change impacts at a strategic level | Strategic analysis of climate change risks alongside other business risks and consideration of resource requirements to manage priority risks |
| 1.2 Reporting authority presents a clear analysis of climate risks on business operations for specified periods into the future and includes high priority climate related risks and timescales | No evidence identified | Indicative recognition of scale and extent of climate change risks to business | Formal analysis of climate change risks within a business risk matrix | Formal analysis and presentation of climate change risks in the content of other business risks by reference to expected future trend and review timescales |
| 1.3 Adaptation plan is clearly embedded in the core of the reporting authority's business | No evidence identified | Indicative plan to continue assessment of climate change risks, and/or indication of an initial response as a result of this exercise | Summarised plan for continued assessment of climate change risks, and/or clear evidence of risk management actions following risk assessment | Active engagement with key relevant stakeholders in the assessment and management of prioritised climate change risks |
| 1.4 Reporting authority includes some prior evaluation of how its climate change risks impact upon or are affected by stakeholders | No evidence identified | Identification of key relevant stakeholders associated with climate change risks | Consultation with key relevant stakeholders associated with climate change risks | Active engagement with key relevant stakeholders in the assessment and management of prioritised climate change risks |
| 1.5 Reporting authority considers the existing policies and procedures related to climate impacts, and the effect the weather has on operations and the achievement of the organisation's strategic objectives | No evidence identified | Indication that key strategic priorities and functions may be affected by climate change and the weather | Evidence that key strategic priorities and functions may be affected by climate change and the weather, and use of this in the risk assessment report | Evidence that business is mindful of the impact of climate change and the weather, and there is evidence of active, ongoing consideration of their influence and impact on business decisions |
| Climate change risk assessment enables the reporting authority to make evidence based decisions on adapting to climate change (key attribute 2) | | | | |
| 2.1 Reporting authority adopts a conceptual risk management framework for organisational, rather than locational risks | No evidence identified | Identification of key organisational risks within a business risk management framework | Structured analysis of climate change risks within a business risk management framework | Evidence for the identification of key drivers of climate change risk within the organisation, of an adaptation plan and forward risk assessment programme that addresses these key features |
| 2.2 Reporting authority identifies the key climate variables and their potential impact on the organisation | No evidence identified | Identifies some climate variables specific to organisation, but list is limited or method used to evaluate variables is not deemed fit for purpose | Analyses and evaluates all relevant climate variables specific to organisation, using a method that is fit for purpose | Evaluates key climate variables and thresholds specific to organisation, above which impacts will affect organisation |
| 2.3 Reporting authority provides clear criteria for likelihood and consequence that are appropriate and specific to their organisation | No evidence identified | States risk appetite and vulnerability, without sound methodology | Evidence of formal consideration of risk appetite and organisational vulnerability, with sound methodology for evaluating likelihood and consequence criteria specific to organisation | Likelihood and consequence criteria actively employed to evaluate risk acceptability for climate change risks alongside other business risks using sound methodology |
| 2.4 Reporting authority's risk assessment quantifies, or otherwise estimates or characterises the impact and likelihood of risks occurring at various points in the future | No evidence identified | Generic estimates of impact and likelihood, without sound methodology | Evidence of formal consideration of risk appetite and organisational vulnerability, with sound methodology for evaluating likelihood and consequence criteria specific to organisation | Likelihood and consequence criteria actively employed to evaluate risk acceptability for climate change risks alongside other business risks using sound methodology |
| 2.5 Reporting authority presents all the organisation's strategic risks from climate change on a likelihood/consequence matrix, where possible including the climate thresholds above which climate change poses a threat to the organisation[a] | No evidence identified | Matrix of likelihood/consequence, without methodology | Semi-quantified matrix of likelihood/consequence, with supporting methodology | Comprehensive matrix of likelihood/consequence, with appropriate timescales, risk acceptance thresholds and detailed methodology |
| 2.6 Reporting authority considers short, medium and long term risks of climate change disaggregated into different locations where appropriate, and includes an assessment of the level of confidence in these calculations | No evidence identified | Separation of short, medium and long term risks but without sound estimation of confidence | Separation and prioritisation of short, medium and long term risks by location, recognising that risks are unevenly distributed temporally and spatially, with a sound calculation of confidence | Separation and prioritisation of short, medium and long term risks by location with assessment of confidence level, recognising that risks are unevenly distributed temporally and spatially |
| Demonstrable use of relevant and appropriate data, information, knowledge, tools and methodologies (key attribute 3) | | | | |
| 3.1 Reporting authority adopts the latest set of UK Climate Projections (currently UKCP09) or other appropriate scenarios or climate information | No evidence identified | Use of climate information within the organisational context, but methods or data chosen is inappropriate | Correct and justified use of climate information within the organisational context with an accompanying rationale for use | Full and appropriate use of climate information with justification and demonstrable understanding of implications over the choice of scenarios for the risk assessment |
| 3.2 Reporting authority demonstrably assesses using the best evidence suitable to organisational need | No evidence identified | References and links supporting evidence to risk assessment | Discusses the selection of relevant supporting evidence used in the risk assessment by reference to organisational context | Discusses the selection of supporting evidence used in the risk assessment by reference to organisational context, identifying where risks are particularly |

(continued on next page)

**Table 1** (*continued*)

| Sub-attribute | Not present | Partially complete | Complete | Complete and fully integrated |
|---|---|---|---|---|
| | | | | sensitive to the selection of specific lines of evidence |
| 3.3 Reporting authority's risk assessment includes consultation with interested parties or stakeholders | No evidence identified | Identification of stakeholders associated with climate change risks | Consultation with key relevant stakeholders on the scoping and methodology of the risk assessment | Ongoing engagement with key relevant stakeholders on the outcome of the risk assessment and associated adaptation plan |
| Climate change risk assessment and adaptation measures explicitly consider uncertainties (key attribute 4) | | | | |
| 4.1 Reporting authority's risk assessment includes a statement of the main uncertainties in the evidence, approach and method used in the adaptation plan and in the operation of the organisation | No evidence identified | Identification of main uncertainties in the evidence, approach and method, but little/no consideration of how this affects the overall risk assessment | Explicit discussion of the key uncertainties in the evidence, in the risk assessment approach, with implications for the risk assessment findings | Exploration of the sensitivities of the risk assessment to key uncertainties, with alternative actions for priority risks that are vulnerable to underlying uncertainties |
| 4.2 Reporting authority's adaptation responses explicitly account for uncertainties and interdependencies of actions, including the actions of others on the adaptation plan | No evidence identified | Some indication of how the adaptation response can deal with uncertainty, and identification of other organisations that may impact on adaptation response | Good coverage of how the adaptation response is robust to uncertainties, and discussion of the extent to which management of the reporting authority's risks are contingent on other organisations' actions | Full coverage of how the adaptation response is robust to uncertainties, and exploration of the sensitivities of others' actions on the reporting authority's risks, together with plans to address these |
| 4.3 Reporting authority's adaptation plan includes a clear statement of assumptions which are well evidenced and justified | No evidence identified | Statement of assumptions within adaptation plan but not how these impact on the resulting actions | Rationale for the assumptions made, set within an organisational context, so establishing the credibility of assumptions, and discussion of how they impact on the findings and how they can be addressed | Exploration of the sensitivity of adaptation plan to underlying assumptions |
| Climate change risk assessment generate priorities for action (key attribute 5) | | | | |
| 5.1 Reporting authority provides priority areas for action that are demonstrably linked to the development of a risk-based adaptation plan | No evidence identified | Risk assessment classifies risks according to their priority, but method or coverage is limited | Evidence of a sound and demonstrable prioritisation of risks, with clear links between priority risks and the subsequent adaptation plan | Adaptation plan is targeted towards the key features of the priority risk |
| 5.2 Reporting authority's adaptation plan includes a detailed action plan covering its priority areas. This should ideally include timescales, resources and responsibilities and be included in the report[b] | No evidence identified | Priority risks are linked to adaptation response but there are gaps | Adaptation action plan includes timescales, resources and/or general responsibilities | Full detailed adaptation action plan, with timescales, resources, responsibilities and monitoring provided for |
| 5.3 Reporting authority's risk management actions are targeted to demonstrably reduce risks to a defined (by the organisation) level of residual risk | No evidence identified | Aims to reduce priority risks but proposed targets are limited or unsupported | Clear target to reduce priority risks with timescale | Clear target to reduce priority risks to specified level of acceptable residual risk with timescale, with justified selection of risk management measures |
| 5.4 Reporting authority's adaptation plan is subject to appraisal against sustainability principles, and specifically to an appraisal of costs and benefits | No evidence identified | Adaptation plan provides a narrative of economic, social and environmental benefits, but coverage or treatment of these is limited | Qualitative appraisal of economic, social and environmental benefits | Sound and structured sustainability appraisal with supporting cost-benefit analysis |
| Climate change risk assessment identifies opportunities (where applicable) (key attribute 6) | | | | |
| 6.1 Reporting authority's risk assessment allows an evaluation of net benefits and/or opportunities arising from the impacts of climate change | No evidence identified | Correct identification of easily secured benefits from climate change, with a plan for securing these, but no/incomplete justification | Sound justification, where possible, of benefits from climate change with plan and timescale for securing and exploiting these | Exploration of strategic business and/or reputational advantage gained by securing net benefits, as evaluated |
| Clear demonstration of flexible adaptation measures (key attribute 7) | | | | |
| 7.1 Reporting authority's adaptation plan includes strategies to deal with the level of quantified risk and retains flexibility over which future course of action to follow as knowledge improves and projections change | No evidence identified | Adaptation plan identifies need for flexibility to respond to change, but no/incomplete actions | Adaptation plan identifies areas where flexibility is necessary to respond to future changes | Adaptation plan identifies areas where flexibility is necessary to respond to future changes, along with plan to monitor potential changes |
| 7.2 Reporting authority's adaptation plan includes a statement of the barriers to implementation and a means for overcoming these | No evidence identified | Barriers to implementation are listed, but list incomplete/unjustified | Barriers to implementation are identified and justified | Barriers to implementation are identified and justified, with a plan to overcome barriers where possible |
| Monitoring and evaluation of adaptation effectiveness (key attribute 8) | | | | |
| 8.1 Where possible, the Reporting authority's report shows progress already made against its adaptation plan | No evidence identified | Indication that previous climate change risk assessments undertaken, or of existing policies/procedures in place to adapt to climate change risks | Evidence for the iterative updating of previous climate change risk assessments, by reference to existing policies/procedures in place to adapt to climate change risks | Evidence for a reduction in organisational exposure to climate change risks by reference to active implementation of adaptation plans |
| 8.2 Reporting authority makes clear provision for the evaluation of the | No evidence | Indicates plan to evaluate adaptation plan | Summarises plan to evaluate adaptation plan | Clear structured plan to evaluate adaptation plan with review timescales |

**Table 1** (*continued*)

| Sub-attribute | Not present | Partially complete | Complete | Complete and fully integrated |
|---|---|---|---|---|
| effectiveness and viability of its adaptation plan | identified | | | and actions |
| 8.3 Reporting authority makes clear provision for monitoring thresholds, above which climate change impacts will pose a risk to the organisation, and their incorporation into future risk assessments[c] | No evidence identified | Indicates plan to monitor climate change thresholds and availability of climate change projections for the inclusion in future risk assessments | Summarises plan to monitor climate change thresholds and availability of climate change projections for the inclusion in future risk assessments, with timescales | Clear structured plan to monitor climate change thresholds and availability of climate change projections for the inclusion in future risk assessments, with timescales |
| 8.4 Reporting authority makes clear provision for the monitoring of residual risks from climate change on the organisation and its stakeholders | No evidence identified | Indicates plan to continue assessment of climate change risks | Summarises plan for continued assessment of climate change risks | Clear structured plan for continued assessment of climate change risks as adaptation plan proceeds |
| 8.5 Reporting authority offers evidence that the production of the risk assessment and adaptation plan has led to a change in the organisation's management of climate risks | No evidence identified | Indication of initial response or changes made as a result of this exercise | Firm evidence of initial response or changes made as a result of this exercise | Firm evidence for the implementation and monitoring of measures to manage business exposure to climate change risks |

[a] Where it is not possible, the reporting authority should set out how it will investigate thresholds.
[b] Where this is not possible, (e.g. to avoid duplication with your corporate risk register or for commercial/confidentiality issues) this should be explained and the action plan made available for Cranfield to review during the evaluation process if necessary.
[c] Where thresholds are not known, a clear commitment to address this should be made.

The individual reviews contained the results of the review using the evaluation framework together with an accompanying narrative covering functions impacted by climate change, approach, summary of risks, actions proposed to address risks, uncertainties and assumptions, barriers to adaptation and interdependencies, monitoring and evaluation, good practice examples in the report, and areas for further work. These were used by Defra's Adapting to Climate Change Programme team and policy leads within relevant government departments to provide feedback to reporting authorities on their reports via the Secretary of State. Further details of this process are available in Drew et al. (2010), with sector level findings available in Defra (2012a). In addition, a benchmarker review was published (Defra, 2011), outlining the analysis of an initial set of 7 benchmarker reports that were submitted in October 2010 to enable the evaluation process to be piloted and refined. This highlighted both areas of good practice and aspects of the reports where further work or research may be required in the future by the benchmarker reporting authorities and those reporting later in the ARP process. Likewise, a series of individual sector summaries outlining common key risks, adaptation measures, barriers, interdependencies, information gaps, emerging issues and areas for further research were produced. These formed the basis of Defra's report presenting the sector summaries and overall findings from the ARP (Defra, 2012a), which directly supported the development of the National Adaptation Programme (Defra, 2013a), and will enable future adaptation policy, and the provision of climate change risk and adaptation support services (e.g. climate projections, Environment Agency Climate Ready service), to be tailored to specific organisational and sectoral needs. Finally, a report summarising our analysis of the ARP process was produced (Centre for Environmental Risks and Futures, 2012), which provided supporting evidence for the Government's consultation on the second round of the ARP (Defra, 2012b).

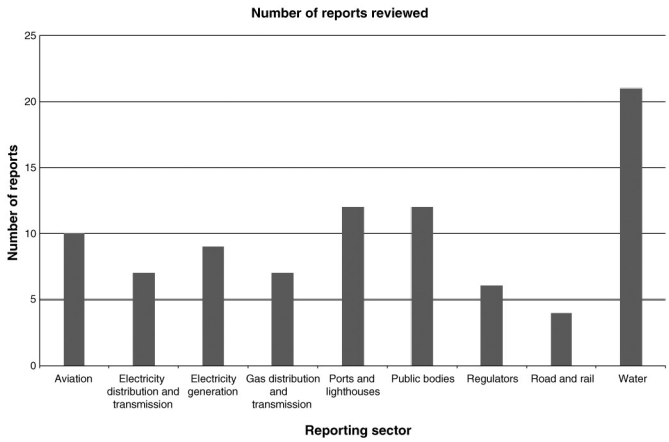


**Fig. 1.** The number of reports reviewed per sector.

Throughout this process the authors engaged with approximately 100 organisations involved in the ARP including government departments, regulators, reporting authorities, industry associations and consultants, participating in over 50 meetings, workshops, field visits and webinars. These ranged from meetings with individual reporting authorities, industry associations, working groups, and specialist consultants supporting reporting authorities with their ARP activities, to site visits to discuss ongoing adaptation activities as well as the sector workshops. In addition, UKCIP hosted two workshops for reporting authorities, including one to support the benchmarker reporting authorities, representing 'early reporters', and a subsequent event where all reporting authorities were invited to hear from their experiences, with around 60 representatives from the reporting authorities in attendance.

Detailed analyses of the quality of individual reports were undertaken using the evaluation framework (Drew et al., 2010; Defra, 2011; Defra, 2012a). This paper presents insights into the wider ARP process and is based on evidence from our experiences and our analyses, and examples of key findings from the evaluation of the reports. Full results from the analysis of the individual reports will form the basis of a further paper and extensive details of the wide ranging climate change risks, vulnerabilities, interdependencies and adaptation barriers identified by this analysis are available in the Government report on the Adaptation Reporting Power (Defra, 2012a). Examples of specific issues from individual reports and the sector summaries are presented. This supports the evidence garnered from our unique perspective of being directly involved in the ARP process and the in-depth knowledge it provided on the adaptation challenges facing key sectors and policymakers – insights that would not be possible from solely reviewing the published reports.

## 3. Benefits identified during the first round of the ARP

### *3.1. Greater consideration of climate change and adaptation by organisations*

Possibly the ARP's greatest legacy has been providing the catalyst behind many organisations' formally considering their business exposure

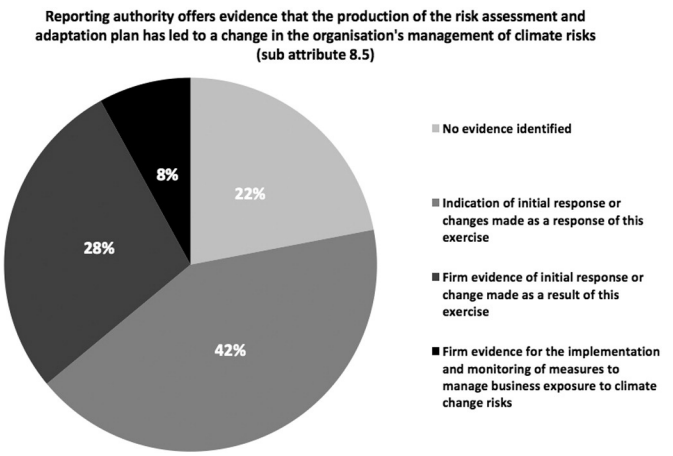


**Fig. 2.** Changes in organisation's management of climate risks as a result of the ARP process.

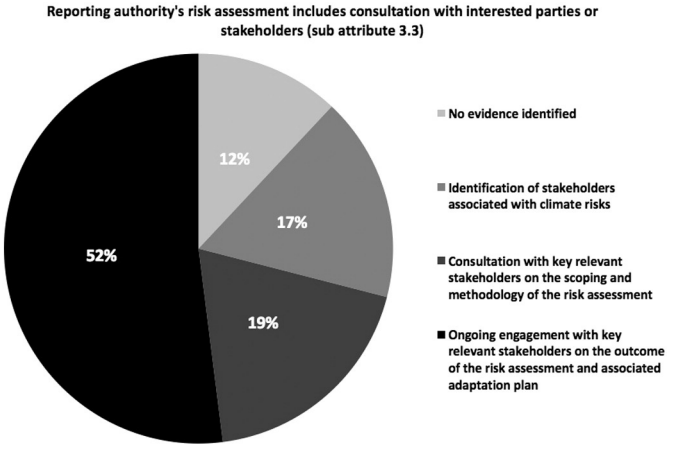


**Fig. 3.** The ARP has triggered engagement between interested parties or stakeholders on climate change risk and adaptation issues.

to climate change risks and possible adaptation responses for the first time. As Fig. 2 illustrates, 78% of adaptation reports contained evidence of a change in an organisation's management of climate risks. A common outcome, highlighted in the adaptation reports and during sector workshops, was that for many organisations, the ARP has afforded greater visibility of climate change risks at the organisational and board level, with climate change risks being embedded within corporate risk management processes for the first time (Table 2). A clear example of this is provided by SP Energy Networks (2011) who noted that other than working with the Energy Networks Association (ENA) to develop an understanding of the likely climate impacts on the business, it had not explicitly considered climate change risk before being directed to report. This was also true at a sector level where early engagement activities highlighted that some sectors, particularly gas transportation and aviation, were new to climate change risk and adaptation issues. These sectors subsequently exploited the reporting process, developing collaborative working groups and enhancing their understanding of climate change. Importantly, many groups planned to continue their work on climate change risks and adaptation (Table 2).

### 3.2. Engagement

The promotion of widespread engagement on climate risks and adaptation, at all levels, has been a significant outcome arising from the ARP process. Many reporting authorities, including the Port of Dover (2011), described how their ARP risk assessments involved internal engagement with relevant experts from across their organisation, covering both technical and management (including operations, engineering, human resources, estates, finance and insurance) experts. Reports frequently described the success of internal workshops and other activities informing their risk assessment process and raising awareness of climate change risk and adaptation issues.

The adaptation reports also illustrate active engagement with stakeholders, with reporting authorities conscious of the need for partnership approaches when addressing climate change risks. For example, Cardiff Airport's (2011) risk assessment process involved consultation with numerous stakeholders, including NATS (National Air Traffic Services), airline operators and the Welsh Assembly, and the airport is considering holding an awareness-raising seminar with airlines in the future. Similarly, Severn Trent Water Ltd (2011) conducted a workshop with public bodies, raising awareness of its climate change adaptation work and exploring interdependency issues. Such activities have galvanised closer engagement on climate change issues, with Birmingham Airport (2011) planning to share climate change information with local authorities in future. Activities such as these were reflected in the analysis of the adaptation reports, with 71% containing evidence of either consultation or ongoing engagement with relevant stakeholders (Fig. 3).

The reporting process has resulted in engagement and the development of closer relationships with industry associations, including the Airports Operators Association (AOA), the Energy Networks Association (ENA), Association of Energy Producers (AEP – now Energy UK), Association of Independent Gas Transporters (AIGT), UK Major Ports Group and WaterUK, fostering a greater appreciation of the climate change risks and adaptation issues facing many sectors. Furthermore, industry association involvement drove sector-level collaboration, with a number of sectors working together to undertake sector-level risk assessments and identify common risks and adaptation issues. For example, the Energy Networks Association and its members coproduced a

**Table 2**
Examples of greater visibility of climate change within reporting authorities as a result of the ARP process.

| Organisational change as a result of the ARP process | Example |
|---|---|
| Driver for considering climate change risks for the first time | *"The development of this Adaptation Report is the start of a process of a more formal consideration of climate change risk within SP Energy Networks"* (SP Energy Networks, 2011, p.4). |
| Greater visibility of climate change risks amongst staff | Luton Airport held a workshop with senior departmental managers and directors. Organised by their environmental manager, it introduced the reporting process, with sub-groups based around key business functions subsequently formed to assess risks facing their business areas (Luton Airport, 2011). |
| Formal reporting | Climate change adaptation reporting and progress will be formally included in the Harwich Haven Authority's Annual Report (Harwich Haven Authority, 2011). |
| Embedding in Health, Safety and Environment (HSE) risk register and business risk process | Embedding of climate change within Northern Gas Networks' HSE risk register (Northern Gas Networks, 2011). |
| Embedding in Environmental Management System (EMS) | Climate change added to Birmingham Airport's Environmental Management System (Birmingham Airport, 2011). |
| Monitoring | Monitoring of adaptation responses through its existing Sustainability and Risk Governance Forums at Stansted Airport (BAA Airports Limited, 2011). |
| Expansion to other activities | Manchester Airports Group extended its climate change risk assessment work to include Bournemouth and Humberside Airports (Manchester Airports Group, 2011). |

common risk assessment framework, assessing common sector-level risks and identifying unified adaptation responses (Energy Networks Association, 2011).

### 3.3. Assessing and monitoring climate risks

The analysis of the adaptation reports (Drew et al., 2010; Defra, 2011; Defra, 2012a; Centre for Environmental Risks and Futures, 2012) provides extensive evidence of reporting authorities' potentially significant risks and vulnerabilities at a range of spatial scales, from individual sites to the international level. Furthermore, it provides detailed insights into the work that reporting authorities are undertaking to assess and monitor their climate change risks. For example, the energy sector has a history of ongoing industry-level research, through the UK Meteorological Office EP1 and EP2 – Impacts of Climate Change on the Energy Industry studies (Met Office, 2014), and the development of a common approach for assessing flood risk to substations. Elsewhere, Network Rail, with the Railway Safety and Standards Board (RSSB) has explored specific thresholds, the spatial distribution of risks, and implications for adaptation strategies (Network Rail, 2011; RSSB, 2014). Likewise, some reporting authorities are engaged in international projects and initiatives, with Forestry Commission England (2011) involved in numerous European Union funded research projects. Research is also underway to explore knowledge and information gaps, and emerging risks of concern. For example, several electricity Distribution Network Operators (DNOs) are funding research quantifying the impact of vegetation growth around overhead lines, with initial predictions suggesting a potentially substantial impact on vegetation growth necessitating increased vegetation management expenditure (Western Power Distribution, 2011).

Alongside ongoing research, the ARP process provided the incentive for some reporting authorities to enhance their climate risk assessment activities. For example, Anglian Water Services Ltd (2011) developed a quantitative risk assessment tool, whilst Forestry Commission England (2011) assessed climate change risk to trees and woodland in the forestry estate. The findings suggest that *'there is a risk that nearly two thirds of the public forest estate would be considered unsuitable for commercial timber production by the end of the century, under current expectations of timber yield'* (Forestry Commission England, 2011, p.55), highlighting both the significant implications that climate change poses for forest management and Forestry Commission England, and the ARP's role in triggering such research. Similarly, evidence of ARP-driven improvements in climate change risks monitoring exist. For example, Milford Haven Port Authority's (2011) ARP activities and internal risk assessment workshop identified requirements for collating meteorological data and the monitoring of trends, particularly those emerging from climate change, with adaptation actions planned shortly.

### 3.4. Greater awareness of barriers and interdependencies

One of the successes from the reporting process has been to trigger greater awareness of barriers and interdependencies and their potential implications for organisations. Indeed, evidence from both the adaptation reports and sector workshops highlights that the ARP has both led to the identification of potentially significant issues relating to barriers (e.g. misalignment of regulation or policy), and provided the impetus for cross-sector engagement on such issues. As Fig. 4 illustrates, this is reflected in the adaptation reports. For example, the Joint Regulators Group, involving senior representatives from sectoral and competition regulators, met following the ARP to learn from their reporting experiences and to identify a coordination framework for further cross-sector engagement on adaptation and interdependencies. Similarly, whilst difficult to directly attribute to the ARP, it has fostered dialogue and collaboration, subsequently enabling the Environment Agency's Climate Ready service to establish the Infrastructure Operators' Adaptation Forum. Furthermore, reporting authorities are developing their

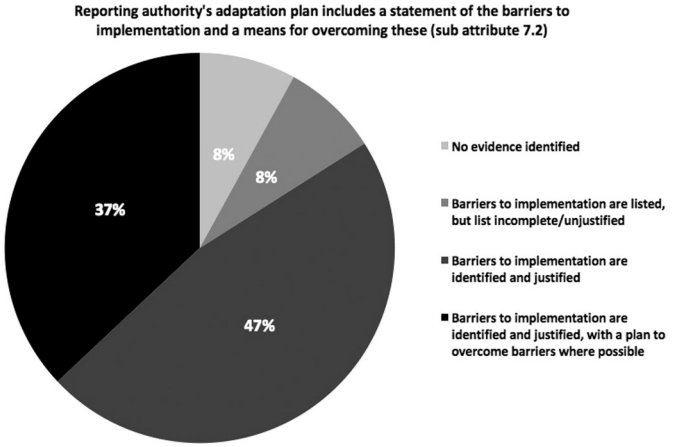


**Fig. 4.** The ARP has resulted in the identification of adaptation barriers, as illustrated by the findings for the sub attribute 'Reporting Authority's adaptation plan includes a statement of the barriers to implementation and a means for overcoming these'.

awareness of interdependencies, particularly with regards energy, water, transport and information communications technology (ICT). For example, Transport for London (2011) describe ongoing engagement with EDF Energy to ensure electricity supply resilience, using the ARP process to cross check common issues identified. These include substation flood risk and also processes for managing electricity demand surges, such as those related to the use of air conditioning during summer heat wave events, which have the potential to cause 'brownouts' during which electricity supply voltages drop.

### 3.5. Adaptation and adaptive capacity

It is evident that many reporting authorities are beginning to adapt to climate change with the ARP providing the stimulus for such activities in some organisations (Fig. 2; Table 3). The analysis provides considerable evidence of organisations climate-proofing new infrastructure and modifying design standards and operational and organisational practices to accommodate future climate change. Furthermore, emerging awareness of flexible adaptive management approaches to prevent the risk of maladaptation is apparent. Table 3 presents examples of such adaptation responses. The reports were however influenced by the proximity of particular weather events, notably the significant disruption caused by snow and cold weather, which particularly affected the aviation sector during the reporting process (BAA Airports Limited, 2011; Birmingham Airport, 2011; Cardiff Airport, 2011; Luton Airport, 2011), and it is anticipated that the second round of reports, produced between 2013 and 2016, will be strongly influenced by the 2013/14 winter flooding. Similarly, it was evident that the 2007 floods had triggered substantial investment in flood protection measures in many sectors (Table 3). Such findings highlight the requirement for organisations to adopt flexible adaptation measures and to consider a range of climate change and weather impacts, which can pose significant business risks.

### 3.6. Training and awareness

As Table 3 illustrates, considerable evidence of the ARP's role in increasing organisational awareness of climate change exists, with many reporting authorities working to raise employee awareness of climate change. Additionally, developing awareness amongst regulatory bodies regarding their potential role in enabling adaptation is apparent, with some identifying the possible future requirement for flexible regulatory frameworks and incentives to facilitate adaptation (Table 3). Similarly, the ARP complements the UK CCRA's top-down, strategic overview of climate change risks, by providing policymakers with insights into the

**Table 3**
Examples of adaptation responses identified from the adaptation reports submitted by reporting authorities.

| Adaptation response | Examples |
|---|---|
| Climate proofing new assets | Arboriculture consultants are supporting the Port of London Authority's (2011) towpath tree management plan, advising on species that can adapt to the likely impacts of likely impacts of climate change as identified in its climate change risk assessment. The first tranche of replanting following this new approach is already underway.<br>To mitigate potential high temperatures on buses, Transport for London (2011) has set a specification for all new buses to have white roofs, opening, tinted windows, upper deck ventilation systems and air conditioning in drivers' cabs. This was introduced four years ago so the majority of buses in service now have these features. |
| Design standards | The Highways Agency (2011) has adopted French temperature standards for road surfaces (EME-2).<br>The Energy Networks Association (2011) intends to review engineering documents likely to be affected by climate change, enabling changes to standards to be proposed. It is also planning to consider revising design standards for wooden poles supporting overhead lines. |
| Resilience of existing assets | Wales and West Utilities (2011) are now ensuring that that all retrospective gas site refurbishments are constructed to account for current and future climate change impacts over the assets lifetime.<br>Western Power Distribution (2011) is investing £31 million in flood protection at susceptible major substation sites. |
| Changing working practices and internal policies | Birmingham Airport (2011) intends to include climate change within its staff induction process and employee pocket handbooks.<br>Natural England (2012) has developed a bespoke web-based training course introducing climate change science. It includes modules on adaptation, mitigation and communicating climate change. |
| Changing policy and regulation | The Civil Aviation Authority's adaptation report discusses how future changes in its regulatory regime may enable incentives for adaptation (Civil Aviation Authority, 2011).<br>Energy sector reporting authorities are using Ofgem's Innovation Funding Incentive (IFI), with SSE Power Distribution (2011) using such funding to trial real time monitoring of conductor temperatures to facilitate dynamic line rating and mitigate against temperature related conductor clearance issues.<br>Ofgem's Distribution Price Control Review 5 (DPCR5), running between 2010 and 2015, provides electricity Distribution Network Operators with allowances of approximately £110 million for flood risk measures (Ofgem, 2011). |

climate change risks and adaptation challenges facing individual organisations, both within and across key sectors for the first time (Defra, 2012c).

## 4. Discussion

### 4.1. Challenges identified during the first round

#### 4.1.1. Support, communications and engagement

The ARP included numerous meetings, workshops and online communications with industry associations and individual organisations (Centre for Environmental Risks and Futures, 2012). Our experience is that such engagement proved invaluable, resulting in a noticeable change in attitudes towards the ARP process and climate change from initial reluctance and scepticism to support and buy-in. Furthermore, framing climate change as a business and reputational risk proved effective in shifting attitudes amongst reporting authorities and those involved in the ARP process. Likewise, engagement proved crucial when supporting organisations new to climate change issues, assisting in developing their awareness of climate risk. Therefore, a formal communications and engagement strategy is an essential element of any similar initiatives, and Table 4 provides a suggested structure for this.

**Table 4**
Suggested communications and engagement strategy for a future round of adaptation reporting.

| Strategy | Description/principles/recommendations |
|---|---|
| Early and sustained engagement | • Clear strategy from the onset<br>• Open dialogue<br>• Transparent processes<br>• Engagement through industry associations<br>• Mid process engagement activities |
| Meetings | • Access to experts, Defra and lead Government departments to discuss the reporting process and specific challenges for organisations |
| Workshops | • Facilitated workshops<br>• Access to experts<br>• Question and answer sessions<br>• Discussion of common issues<br>• Promotion of cross-sector engagement<br>• Collaborative approach to producing the sector summaries<br>• Disseminate and discuss the findings (at later events) |
| Briefing notes | • Concise notes each with a clear, defined purpose<br>• Provides the necessary guidance in a single location<br>• Clear explanation of how the ARP links to other activities such as the Climate Change Risk Assessment and National Adaptation Programme |
| Newsletters and e-mail updates | • Updates on current progress<br>• Seek views on the production of sector summaries or next steps for the reporting process |
| Short courses, webinars and e-learning | • Access to experts<br>• Online question and answer sessions for those unable to attend workshops<br>• Understand requirements of the Adaptation Reporting Power<br>• Introduce methodologies<br>• Introductory training on climate change risk assessment methodologies<br>• Use of more advanced climate projection tools such as the UK Climate Projections (UKCP09) Weather Generator and Threshold Detector |
| Targeted support | • Catering for different levels of experience/expertise<br>• Relevant to specific sectors or industry |
| Web-based directory of case studies | • Available from the first round |

Importantly, this should include mid-process engagement activities to facilitate shared learning and contextualise the reporting process. However, our experience suggests that this may prove challenging for a number of reasons. In particular, the wide range of organisations and sectors, each at differing stages of climate change risk and adaptation process, and with differing operational activities and/or assets, potentially require tailored support (e.g. training in the use of the UK Climate Projections UKCP09 Weather Generator (UK Climate Projections, 2016)), which is both time-consuming and expensive to provide. Similarly, the tight reporting timescales, with reporting staggered by sector, pose time and resource issues for all involved in the reporting process. Finally, as encountered during the ARP process, organisations and sectors may simply wish to produce their reports without seeking support.

With regards engagement, producing sector summaries (Defra, 2012a) and holding sector workshops both enabled the identification of key issues facing sectors and facilitated cross-sector comparisons. These activities proved highly valuable, providing detailed information to aid the development of adaptation policies, and a forum for engaging and developing working relationships with different sectors. Thus, any future round of the ARP or similar reporting process should try to further develop the sector summaries and workshops.

#### 4.1.2. The report evaluation process

The decision to independently review the adaptation reports represented a key challenge, with the evaluation framework (Drew et al., 2010) being developed to provide a common objective methodology based on the Statutory Guidance (Defra, 2009b). Some criticisms of the evaluation framework were raised, especially regarding its applicability to particular circumstances, notably regulatory bodies, and the risk of organisations adopting a 'tick box' approach to their risk assessments and reports. In response, considerable effort was made to emphasise that the evaluation framework may not be entirely suitable for some organisations and that the evaluation process was not a 'tick box' or 'scoring' exercise, with organisations not being compared against each other (Drew et al., 2010). However, in practice, the evaluation framework proved valuable, facilitating objective, standardised assessments of the reports within and between sectors.

The Statutory Guidance's non-prescribed methodology for assessing risks and identifying adaptation measures (Defra, 2009b) had benefits and drawbacks. In particular, it enabled reporting authorities to adopt an individualised, appropriate risk assessment methodology and tailor their reports to their needs, although some organisations struggled with the open reporting process, preferring a directed structure and framework. A key legacy is that many reporting authorities utilised existing corporate risk assessment processes enabling the embedding and management of climate change risks alongside existing corporate risks. Despite affording flexibility to reporting authorities, this complicated the analysis of reports, notably the cross organisation and sector comparisons. Here, the diversity of sectors, and organisations, each with differing locations, activities and circumstance specific risks, together with alternative risk assessment and prioritisation methods, proved challenging, making direct comparisons of risks virtually impossible. As a result, the sector summaries (Defra, 2012a) presented an overview of sector-level risks rather than identifying specific key risks. Furthermore, classifying risks also proved problematic for the same reasons, and used climate variables rather than risk type. This raises questions regarding the value of a broad overview of sectoral risks versus specific key risks, which would potentially require formalised criteria for risk identification and quantification, and be at odds with the open approach to reporting.

Unsurprisingly, the online publication of the reports and sector summaries (Defra, 2012a) triggered inevitable concerns from reporting authorities, and developing trust between reporting authorities and those reviewing the reports proved vital to the ARP's success. Here, dialogue, safeguards regarding confidentiality issues, and allowing redacted reports to protect commercial interests, nurtured trust in the process. Such were the sensitivities that concerns regarding sector composition and naming even arose when producing some sector summaries, notably the road and rail and ports and lighthouses sectors.

Whilst such issues should not come as a surprise, part of the rationale behind the reports and their analysis was to help inform the development of the UK CCRA (Defra, 2012c) and the NAP (Defra, 2013a). Alongside the challenges associated with identifying and comparing risks across organisations and sectors, reporting authorities commonly expressed concerns regarding the poor timing and synchronisation of these activities and ARP's role in informing the CCRA and NAP. In particular, the implementation and timing of the ARP and CCRA meant that only the evidence from the water sector reports – the first sector to report – was able to be fed into the CCRA evidence report. Here it is apparent that a clearer vision of the ARP's role in providing evidence to support the development of the CCRA and NAP, and communication of the interrelationship between such processes is necessary to foster support and buy-in from reporting authorities.

### 4.2. Insights into adaptation activity

Our experience clearly illustrates that climate change adaptation is being mainstreamed and embedded within organisations in the UK. Furthermore, whilst organisations are responding to weather and climate shocks (e.g. 2007 floods and winter snow events) and introducing reactive adaptation measures, many are proactively implementing longer-term adaptation and resilience measures, particularly as part of long-term investment activities (e.g. Port of London Authority's climate proofing of tree species in its towpath tree management plan). Many examples illustrating the features of adaptation actions and adaptive capacity (Carter et al., 1994; Smith, 1997; Smit et al., 2000; Fankhauser et al., 1999; Smith and Lenhart, 1996; Smit et al., 2000; Hertin et al., 2003; Tompkins et al., 2010) are evident, with many organisations exhibiting Wilby and Vaughan's (2011) hallmarks of well adapted organisations (Tables 2 and 3). These include visible climate change champions, commonly environmental and climate change managers (e.g. Luton Airport's Environment Manager), incorporating climate change adaptation objectives in organisational processes and strategies, as typified by Northern Gas Networks embedding climate change within its HSE risk register (Northern Gas Networks, 2011), and risk and vulnerability studies, including the UK Meteorological Office EP1 and EP2 – Impacts of Climate Change on the Energy Industry studies (Met Office, 2014) (Wilby and Vaughan, 2011). Furthermore, many organisations are actively producing guidance and training for staff (Birmingham Airport, 2011), with others, such as Natural England (2012) introducing flexible structures promoting organisational learning, training and mainstreaming of climate change across their activities (Wilby and Vaughan, 2011). Precautionary low-regrets anticipatory adaptation is also apparent, such as the Highways Agency's (2011) work to modify design standards, whilst organisations including Harwich Haven Authority (2011) have introduced measures to monitor and report their climate risks and adaptation progress (Wilby and Vaughan, 2011). It is also evident that multi-partner approaches are clearly important given the complexity of climate risk and adaptation challenges facing organisations, with examples including Cardiff Airport (2011) engaging with local stakeholders, and Forestry Commission England (2011) engaging internationally on large research projects (Wilby and Vaughan, 2011). Significantly, organisations are also developing both internal and external collective capacity building activities, particularly at the sectoral level, as evidenced through the involvement of numerous industry associations, including the Energy Networks Association (ENA) and WaterUK, which Hertin et al. (2003) and Wilby and Vaughan (2011) highlight as being of importance. However, as noted by previous studies (Tompkins et al., 2010; Smit et al., 2000; Smit and Wandel, 2006), whilst some adaptation actions represent planned responses to climate change, many are secondary to other organisational activities. Investigating the relative merits and effectiveness of this approach to

implementing adaptation actions is clearly an area ripe for further research.

Whilst studies such as Tompkins et al. (2010) have presented a typology of adaptation drivers our experience suggests that this should include commercial advantage and reputational risk, which represented key drivers during the ARP process. Furthermore, whilst attributing motivation for adaptation actions is difficult (Fankhauser et al., 1999; Tompkins et al., 2010; Dupuis and Biesbroek, 2013), it is apparent that the ARP process has triggered the mainstreaming and embedding of climate change adaptation, and the implementation of adaptation actions and development of adaptive capacity in many organisations. In particular, whilst not perfect, the ARPs promotion of adaptation from a risk management perspective appears to have been highly effective as a means of embedding climate risk and adaptation within existing risk management processes, thus enabling risks to be prioritised and managed effectively. Indeed, it is evident that for some organisations, climate change represents a key organisational risk, included in corporate risk registers and embedded within organisational processes and board level decision making, whilst for others it is more pervasive, cutting across and potentially exacerbating existing organisational risks. Thus, the ARP process confirms the value of adopting a risk-based approach to managing climate risks, which has been highlighted elsewhere (Tompkins et al., 2010 and Weinhofer and Busch, 2013). Furthermore, whilst this case study involves mandatory climate change risk and adaptation reporting, it is clear that responsible boards within organisations whose operations may be affected by climate change should be taking steps to consider their exposure to climate change and to identify potential steps to manage and mitigate such risks. Initially this may not necessarily require detailed risk assessments and adaptation plans but instead the scoping of potential risks and vulnerabilities, and the development of adaptive capacity, is particularly important for the types of organisation operating in critical sectors, such as those involved in the Adaptation Reporting Power. However, further detailed analysis of the adaptation reports, accompanied by interviews exploring these issues with reporting authorities would prove beneficial.

The ARP process provides clear evidence of a wide array of adaptation activities that are underway and highlights that the adaptation transition highlighted by Tompkins et al. (2010) is now well underway and reaching maturity in some organisations – reflecting the time that has elapsed since their research. However, the challenges associated with measuring and evaluating the effectiveness of such activities (Tompkins et al., 2010; Wilby and Vaughan, 2011), and the role of maturity models to support such analyses, requires further consideration. In particular, whilst the preliminary results from the analysis of the adaptation reports provide clear evidence of adaptation within and across key organisations and sectors in the UK, levels of organisational and sectoral maturity are less clear. Thus questions regarding how organisations are making decisions regarding their climate change risks and adaptation, and the quality of the information, knowledge, tools, methods and motivations underpinning such decisions remain. Similarly, adaptation barriers, interdependencies and enabling mechanisms warrant further exploration. Whilst further detailed analysis of the results from the assessment of the adaptation reports using the evaluation framework is needed to investigate these issues, there is clearly a need to build upon the evaluation framework and Wilby and Vaughan's (2011) hallmarks of well adapting organisations, for example, to develop organisational maturity models and undertake detailed research focussing on organisational adaptation and resilience to climate change. In particular, difficulties in determining the timeliness and effectiveness of adaptation measures, particularly flexible adaptive management approaches, accounting for uncertainty, and the potential link between the level of adaptive capacity, adaptation activities and whether they deliver more resilient organisations, infrastructure and services exist. Similarly, it is unclear whether an adaptation deficit (Tompkins et al., 2010) or resilience deficit exists within organisations and sectors, and whether organisations have the required skills, knowledge and expertise to deliver effective adaptation (Fankhauser et al., 1999) and resilience. Thus, the practicalities of determining resilient and well-adaptive organisations remains open to question, with our experience from the ARP process suggesting that this may prove difficult given the diversity of organisations in the UK.

### *4.3. Future application of the Adaptation Reporting Power and corporate reporting processes*

In terms of the future use of the ARP, it is evident that opportunities for improving future rounds or reporting or similar initiatives exist. The ARP could be exercised differently, for example seeking sector-level reports, similar to that produced for the electricity DNOs by the Energy Networks Association (2011), to provide a broad picture of the risks and adaptation plans of individual sectors. Furthermore, whilst limited to specific sectors, proactive application of the reporting powers could include targeting specific sectors and organisations where concerns regarding climate change preparedness exist, or to investigate specific issues including barriers and interdependencies or specific events affecting key sectors (e.g. floods). For example, the first round highlighted local authorities, emergency services, the Information Communications Technology (ICT), food and petrochemicals sectors, as representing key interdependencies for many organisations, yet lacked detailed attention because their potential exposure to climate risks and vulnerabilities is currently unclear, partly because they have not reported under the ARP. Such sectors therefore represent potential candidates for more targeted application of the ARP. Alternatively, mandatory reporting of quantified adaptation metrics/indicators, such as those used by the Adaptation Sub-Committee of the Committee on Climate Change to assess the UK's climate change preparedness (Committee on Climate Change, 2016) (for example the amount of actual and planned investment in resilience measures by water companies), could also be introduced, enabling the effectiveness of both specific adaptation activities at the organisational level and government policy and legislation at the national level to be evaluated.

The adaptation reports have potentially wide-ranging applications, from individual organisations to policy makers, regulators and academics, with the ARP sparking cross-sector engagement on climate risk, interdependency and adaptation issues. Reporting authorities are using the reports to identify vulnerabilities associated with their interdependencies (e.g. energy, water, transport, ICT), subsequently exerting pressure on such organisations to assess and address their exposure to climate change. Thus current and future report usage, for example by the financial sector, in driving awareness of climate risks and adaptation issues through investment and insurance decisions, requires greater consideration. Furthermore, the long-term implications and legacy of the first round, including cross-sector engagement on adaptation, the ARP's role formulating the NAP and whether it provides any additional information over the CCRA merits detailed evaluation. With an independent evidence report, based on an open call for evidence, produced by the Adaptation Sub-Committee of the Committee on Climate Change, underpinning the underway 2017 CCRA (Committee on Climate Change, 2014), this is vitally important. Here the adaptation reports and sector level risk assessments arising from the ARP may assume greater importance.

Following a Defra consultation, the current second round of the ARP shifts from statutory to voluntary reporting without an independent evaluation of the reports (Defra, 2012b; Defra, 2013b). This reflects lobbying from round one reporting authorities who cite reporting costs and the desire to provide progress updates rather than repeated formal risk assessments, and the Government's shift from formal to voluntary regulation (Defra, 2013c). Clearly opportunities to investigate the relative merits of voluntary reporting exist with proponents to both approaches. In particular, some involved in the first round argue that a voluntary approach, seeing organisations being 'invited' rather than 'directed' to report, will result in insufficient support at the board level. Indeed, this

was apparent during the first round of the ARP where key sectors including electronic communications, petroleum and food declined to report voluntarily. Furthermore, they argue that light touch regulation is inappropriate given the potential risk that climate change poses to reporting authorities who have responsibilities for critical infrastructure, regulation, and environmental protection for example. Such a stance also raises issues regarding the levels of disclosure and transparency in the adaptation reports and whether validating organisational risk assessments and adaptation actions may prove beneficial. Additionally, the lack of a formal independent review process could affect the report quality and value to users. Similarly, the reporting cost arguments warrant further critical analysis. Here some reporting authorities have claimed that the reporting process is costly and time consuming, despite highlighting potentially significant financial and reputational costs associated with their potential exposure to climate risks, and in some cases receiving significant regulatory allowances to fund adaptation measures. Such insights suggest that it may prove difficult to establish similar initiatives to the ARP in other countries without the introduction of formal statutory reporting processes. However, the potential role of voluntary reporting processes will become clearer as the second round of the ARP (2013–16) progresses, with organisations reporting during 2015–16 (Defra, 2013b).

## 5. Conclusions

Our analysis suggests that the ARP has achieved its aims, and has provided new academic insights into the role of legislative mechanisms and risk-based approaches for driving and delivering improved awareness and understanding of climate change risks and vulnerabilities, and the development of adaptive capacity and adaptation. In particular, the statutory nature of the reporting process and the independent evaluation and publication of the reports has proved extremely powerful, raising awareness of climate risk and adaptation at the highest level within reporting authorities and resulting in the embedding of a wide variety of capacity building and adaptation activities throughout organisational activities. In parallel, the ARP has provided new detailed insights into the climate risk and adaptation activities and challenges facing both individual organisations and key sectors for the first time. These both complement the findings from the CCRA and have supported the development of the NAP, thus illustrating the value of combining both national level 'top down' and organisational/sectoral level 'bottom up' assessments of climate change risks, thus enabling policymakers and reporting authorities alike to identify and target key risks and vulnerabilities (e.g. infrastructure flood risk), and to address information gaps (e.g. limited projections for specific climate variables such as wind) and adaptation barriers (e.g. regulatory mismatch). As such, the ARP process is extremely valuable and could provide a basis for similar initiatives in other countries, although a clear engagement strategy to ensure buy-in to the process is required. Indeed, we are aware of a number of countries that are interested in adopting processes similar to the ARP. Furthermore we strongly believe that interest in adaptation reporting will increase following the United Nations Framework Convention on Climate Change signed in Paris (United Nations Framework Convention on Climate Change, 2015). The Agreement not only requires Parties to report adaptation actions, but to promote cooperative action on climate change adaptation through the provision of enabling environments, sharing of information, good practice and lessons learned (United Nations Framework Convention on Climate Change, 2015) – activities that ARP type initiatives would be ideally placed to support. However, further research, employing a mixed methods approach, including both quantitative analysis of the adaptation reports, from both the first round and subsequent reporting rounds, using the evaluation framework, and qualitative methods, such as interviews with individuals involved in the reporting process, are required to determine the longer-term legacy of the process, not only for reporting authorities but policy-makers, regulators and wider users. Such research would also help to evaluate alternative strategies for using the ARP, notably the relative merits of statutory versus voluntary forms of reporting. Furthermore, whilst the analysis has highlighted the merits of framing climate change through a risk management lens, there is an urgent need to investigate organisational decision-making and responses to climate change risks and vulnerabilities. This includes a deeper analysis of the quality of the adaptation reports and adaptation actions, the development of maturity models to help determine the characteristics of resilient and well adapted organisations, and research exploring organisational motivations and challenges, all of which will help to investigate whether adaptation/resilience deficits exist. It will also aid the testing and further development of existing typologies of adaptation responses and motivations, which from our ARP experiences should be expanded to include commercial advantage and reputational risk. Critically, key questions regarding the possible links between risk-based approaches, adaptive capacity and adaptation activities in delivering resilient organisations require investigation. Finally, our analysis provides clear evidence that climate change represents a corporate risk to many organisations and we strongly believe that that responsible boards should be proactively assessing and managing their potential exposure to climate change vulnerabilities.

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All adaptation reports and supporting documents from the ARP are available online at http://webarchive.nationalarchives.gov.uk/20130123162956/http:/www.defra.gov.uk/environment/climate/sectors/reporting-authorities/reporting-authorities-reports/.

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