Incorporating climate change mitigation and adaptation into environmental impact assessment: a review of current practice within transport projects in England

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Abstract

Climate change mitigation and adaptation can be perceived as neglected in Environmental Impact Assessment (EIA). In the light of amendments to the European Union EIA Directive (2014), we developed a novel criteria-based review package to assess climate change mitigation and adaptation as documented in Environmental Statements, and applied this to a sample of ten transport developments from England. Justifications relating to climate policy, climate science, the effect of climate change on the development, and its vulnerability to climate risks were well explained in most projects. Many projects lacked detail of climate change mitigation and adaptation measures and their benefits, whilst evidence of commitment to mitigation and adaptation or to post-decision monitoring was poor or non-existent; reportedly due to costs, time constraints and absence of mandatory requirements. It is recommended that to improve the effectiveness of the consideration of climate change mitigation and adaptation in EIA, the production of guidelines, change of behaviour of EIA practitioners, more holistic consideration of climate change issues, rigorous post-decision monitoring and use of climate change terminology are more widely adopted.

Key words: Adaptation; Climate change; mitigation; Review; Transport projects

1. Introduction

1.1 Background

Climate change has become a key environmental issue in the past decade, with a growing attention towards mitigating and adapting to the potential effects of extreme weather events, increased global temperatures and rising sea levels (IPCC 2014). Stand-alone methodologies and tools have been developed to help major activities consider the risks posed by climate change such as the World Bank ‘climate risk screening’ and ‘greenhouse gas accounting’ tools. However, it has been suggested that a more effective approach is to incorporate the consideration of climate change
Recently there have been steps to formalise its inclusion in the decision making process for major developments, for example in Spain (Enriquez-de-Salamanca et al 2016) and China (Chang & Wu 2013).

EIA is a systematic process that examines the environmental consequences, positive or negative, of development actions (Glasson et al 2012). EIA is a multi-step process involving project screening, the scoping and identification of significant impacts, development of mitigation measures and the production of an Environmental Statement (ES). As EIA is a well-established and legally required environmental decision-making tool for certain project types in most countries (Glasson et al 2012; Yi & Hacking 2012), it can potentially play a key role in assisting efforts to minimise greenhouse gas emissions and adapt to the changing climate (Institute of Environmental Management and Assessment (IEMA) 2015). Furthermore, there is scope for using EIA to enhance a project’s resilience to climate change impacts and several entry points in the EIA process have been suggested in which climate change can be included (Agrawala et al 2012).

1.2 The European Union EIA Directive and revisions

Climate change is not explicitly included in the formal requirements of the EIA Directive (2011/92/EU) in that ‘climatic factors’ is listed along with soil, water, air and landscape as a factor that should be assessed. For this reason, along with issues of availability of historical climate information and uncertainty in climate predictions, it is not current practice to explore climate change in the EIA for the majority of project types (Chang & Wu 2013). Additionally, in Europe there is still little practical experience integrating climate change mitigation and adaptation into EIA, and a general uncertainty surrounding how to tackle the problem amongst the actors involved (Jiricka et al 2016). Currently, the consideration of climate-related impacts is typically limited to assessments of flood risk, carbon dioxide and greenhouse gas emissions.
Despite this, the demand for the inclusion of climate change in EIA is growing (Ncube 2011; Yi & Hacking 2012). Reasons include its growing environmental and economic importance; the long timescales of certain projects, meaning they are likely to be affected by the changing climate; the emergence of Government strategies such as the *HM Government (2011): Climate Resilient Infrastructure: Preparing for a Changing Climate* and upcoming revisions to European Union legislation. Revisions to the EU Directive (2014/52/EU), effective by 2017, focus on improving the consistency and quality of EIA content. The Directive amendment states the need to explore ‘the impact of the project on climate and the vulnerability of the project to climate change’ (annex IV 5. (f)), confirming the need to consider climate change at greater detail and specificity than current practice.

Appropriately and effectively including climate change mitigation and adaptation in EIA is particularly important in accounting for climate impacts of new developments (Agrawala et al 2012). In this paper, mitigation in EIA refers to, "measures to avoid, minimise, remedy or compensate for the predicted adverse impacts of the project" (Morris & Therivel eds 2009), and we focus on climate change mitigation (i.e. the reduction in the causes of climate change), and climate change adaptation (i.e., adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities). We generally use the phrase ‘climate mitigation and adaptation’ for brevity. Various guidance documents exist on integrating climate change into EIA in the UK such as the European Commission ‘Guidance on integrating climate change and biodiversity into EIA’ (2013) and sections of the Design Manual for Roads and Bridges (Department for Transport 2015). Additionally, there has been international considerations on integrating climate change into EIA (The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment 2003; Nova Scotia’s Climate Change Adaptation Initiative 2003; Sok et a; 2011; Enríquez-de-Salamanca et al 2016; Jiricka et al 2016). Despite this, guidelines providing specific advice on accounting for climate mitigation and adaptation in the UK are lacking (Yi & Hacking 2012; IEMA 2015). Therefore, there is scope to assess current practice of
including climate change mitigation and adaptation in EIA to develop recommendations for its impending future inclusion.

1.3 Consenting process for transport projects in England

In England, there are various consenting processes for transport projects which could determine if and how climate mitigation and adaptation are included. The Planning Act 2008 introduced nationally significant infrastructure projects (NSIPs), a system for consenting major infrastructure which encompasses three elements:

1. the designation of National Policy Statements;
2. the creation of the National Infrastructure Directorate where the Planning Inspectorate is the examining authority; and,
3. the creation of Development Consent Orders to authorise NSIPs.

For projects to be considered as a NSIP, they must fall within the various thresholds as outlined in the Planning Act 2008. For example, a motorway exceeding 15 hectares would be considered a NSIP. For railway or tramway Schemes that do not fall under the Planning Act’s NSIP consenting infrastructure, an order is made under the Transport and Works Act 1992 (Transport and Works Act Order).

For smaller projects that do not meet the thresholds to be considered a NSIP, the project would fall within Permitted Development rights and therefore does not require planning consent. The consenting process lies with the Local Planning Authority.

1.4 Climate Change Policy

Within the last few decades, there have been various climate change related policies and programmes in the UK such as the Climate Change Levy introduced in 2001, the Renewables Obligation (2002) and the EU Emissions Trading System (2005). Most notable is the 2008 Climate Change Act which sets a legally binding target of an 80% reduction in 1990 emissions by 2050.
In regards to mitigation and adaptation, as of yet there are no climate change mitigation and adaptation policies however in 2013, the National Adaptation Programme was published as the Government’s long term strategy to address the risks identified in the first UK Climate Change Risk Assessment (2012). In addition, the National Planning Policy Framework outlines the need to ‘adopt proactive strategies to mitigate and adapt to climate change’.

1.5 Review methods for EIA evaluation and quality assurance

The effectiveness of EIA is dependent on the manner and detail in which the EIA Directive requirements are followed (Barker & Wood 1999). Furthermore, the quality of ESs is important in the overall performance of the EIA process (Lee et al 1994). A poor quality ES may result in project rejection, loss of time and money and the misidentification or non-identification of environmental impacts. When EIA was first introduced in the UK in the 1980s, the quality of ESs was often unsatisfactory (Barker & Wood 1999) therefore there was significant need to review and identify the issues. The development of the Lee and Colley review package (1992) was the catalyst to an increase in EIA assessment (Emmelin 1998), for which many studies have adopted or adapted their review checklist and scoring system (e.g. Bruhn-Tysk & Eklund 2002; Sandham & Pretorius 2008).

Furthermore, there has been increasing attention towards the evaluation of EIA effectiveness using more substantive review process specifically developed for assessing a particular aim (e.g. Jay et al 2007, Briggs & Hudson 2013) or project type (e.g. wind farms in Germany and the UK: Phylip-Jones et al 2013)

There are a small number of existing studies reviewing climate change mitigation and adaptation in EIA which have taken a case study approach, evaluating a specific project type. Yi and Hacking (2011) considered urban development projects in South Korea, exploring specific assessment methods; and Ncube (2011) reviewed a sample UK urban regeneration projects studying resilience and adaptation, with a detailed survey of consultants involved in the projects. This approach is best suited to
considering ‘how’ and ‘why’ type questions as opposed to experiments and surveys which provide data for analysis (Schell 1992).

1.6 Aims of this study

As the consideration of climate change is a new inclusion in EIA and guidelines for accounting for climate mitigation and adaptation are lacking, this paper aims to assess the quality of current inclusion of climate mitigation and adaptation in ESs in order to evaluate current practice and suggest recommendations to move forward. This will be achieved through the development of a specific climate change mitigation and adaptation review method, incorporating criteria-based review approaches adapted from existing methods and wider literature. As current review methods are not specific towards this research aim, the development of a new review package is needed. Furthermore, the development of the method involves stakeholder input to ensure the approach is accurate, useful and achievable. The review package is applied to a sample of UK transport projects—a sector responsible for 21% of total emissions in the UK (DECC 2013). Furthermore, transport projects are highly vulnerable to the effects of climate change (Eisenack et al 2012), therefore such projects would benefit from effective consideration of climate change mitigation and adaptation.
2. Method

In order to develop a review package that addressed the current knowledge gap, this research evolved through three phases. The phases comprised of an initial audit of recent environmental statements; literature review and interviews with expert consultants; and development and application of the review package to a sample of transport projects (Fig. 1).

2.1 Phase one: initial research

The initial focus of this research was to audit ESs for their extent and quality of climate change inclusion. This was carried out on 25 publicly available ESs within the UK energy and transport sectors. For each ES, key climate change related terms including: climate change, Climate Change Act, global warming, greenhouse gas, low carbon, carbon dioxide, extreme weather, climate change mitigation, carbon footprint, carbon budget and flood control were searched for. For each term, its context of use was categorised (Table 1). A fuller extent of terms such as ‘temperature change’, ‘flood-risk’, ‘drought’, ‘erosion’ etc. would have been assessed however due to complexity issues, the assessment was limited to the above terms.

This preliminary audit (Appendix A) revealed that climate change appeared in 23 of the 25 ESs. The majority of mentions were in the policy context and in the rationale for the development. Whilst this approach identified the areas that climate change was generally mentioned, the results proved very little regarding the quality of the assessment of climate change. Furthermore, as all ESs included climate change to varying extents, to gain a higher level of analysis, a more focused approach was required. One finding of the audit was that climate mitigation and adaptation was inconsistently included. This is consistent with IEMA’s recognition of a current lack of guidance of accounting for climate change mitigation or adaptation in EIA practice (IEMA 2015). This led the research to focus on assessing how climate mitigation and adaptation is currently incorporated in EIA.
2.2 Phase two: development of a new climate change assessment method for evaluation of Environmental Statements

To assess climate mitigation and adaptation in more detail than phase one, the development of a criteria-based method was required (Appendix B). The review approach was adapted from three established methods: the Lee and Colley (1992) review package, the Oxford Brookes review package (Glasson et al. 2012) and the UK Department of the Environment Transport and the Regions (DETR) (1997) review pro-forma of mitigation measures in environmental statements (Table 2).

The review process was split into three sections of which the first and second gathered information on the project and its climate-related mitigation and adaptation without allocating grades. This was in order to gain a background understanding of the project and mitigations. The third section evaluated and graded the mitigation and adaptation (Table 3). Outputs from section 1 and 2 are essential for the criteria-based review and grading process in section 3 but only give context rather than establish the quality of delivery, so the results section focuses on section 3. Section 3 (included in full in Appendix E) focuses on evaluation of the proposed climate mitigation and adaptation, with six criteria: justification of need (3.1, including sub-criteria for policy context, development context and climate change context); justification of chosen approach(es) (3.2); level of detail of proposed measures (3.3); effectiveness, benefits and uncertainties surrounding the approaches (3.4); evidence of commitment (3.5) and evidence of plans for monitoring (3.6). Although 3.2-3.6 did not include a further tier of sub-criteria, each assessed more than one related topic and the overall commitment grading was judged on those topics combined. For example 3.5 (commitment) includes consideration of timelines, budgets, involvement of other organisations, and focus on specific tasks. Where all of those topics (if relevant to the particular project) were dealt with in comprehensive detail - an A grade would be given; at the other end of the scale, if they were not considered at all an E grade was given, or a D grade was given for minimal consideration only.
The Lee and Colley review package scoring system was broadly used for the grading of questions but with scores of A-E used to marginally simplify the grading. The grading criteria for each question were individually established as they each assessed a different aspect of the climate mitigation and adaptation (Table 4). Additionally, this provides more informed guidance when repeating the criteria.

Draft review criteria were circulated to UK and international professionals from a variety of global engineering and environmental consultancies for validation. The professionals were contacted via email to personal contacts, a post on the LinkedIn EIA group and circulation within the UK IEMA EIA Quality Mark author group. Eight professionals from a range of environmental consultancies and an educational institution supplied feedback on the criteria and have been given representative codes in this assessment (P1, P2 etc.) to allow them to remain anonymous. The comments from professionals (Appendix C) influenced several amendments to the criteria (Appendix D).

2.3 Phase three: application of review package

The amended review criteria (Appendix E) were piloted on an ES which contained a specific section on climate mitigation and adaptation. The application of the review package and the findings were sent to two consultants (one of whom had worked on the project) for feedback. The criteria received positive comments regarding its accessibility and the detailed analysis it enabled.

Ten projects were chosen as case studies for this research. These were obtained via an extensive online search. The criteria for project selection were those in the transport sector that contained a chapter specifically considering climate change (Table 5). The reasons for project selection within the transport sector are as outlined in 1.4. In addition, whilst energy projects were additionally studied in the initial stages of this research, as transport emissions are rising faster than from other energy-using sectors (Woodcock et al 2009) and to focus the assessment, the assessment of energy projects was omitted from further assessment. In addition, whilst the location for the initial project selection were those within the UK, the ten case study projects were chosen within England in order to focus
the assessment. The time window for project selection were those produced within the past ten years as these projects would fall into the EIA Directive (85/337/EEC) requirements for which all of the projects would have adhered to the same EIA regulations, as no changes were made to ‘climate’ inclusion in the Directive amendment 2009/31/EC or Directive 2011/92/EU.

The review process was applied to all ten projects consistently by reading through the ES and any relevant supporting documents referred to therein, and publically available online. The criteria questions were methodically answered as fully as possible from the ES and relevant documents. When grading the mitigation and adaptation, a justification and evidence were provided for each allocated grade where possible. Where various information within the same question were given differing grades, an average was taken to obtain the overall grade. Overall grades for each ES were not allocated as this portrays very little regarding each individual question and defeats the aim of this study which considers each question as individually important. Once all projects were initially reviewed, they were graded again several days later by the same researcher, blind of the initial grades allocated to ensure accuracy in grading. The grades allocated were moderated by a second experienced researcher with discussion of any grading uncertainties or ambiguities.

Following recommendations from the professionals, each case study was also evaluated for inexplicit climate related mitigation and adaptation. This is an area that has not been subject to much scrutiny in the context of EIA to date, but, for example international aid projects can comprise a major factor in addressing climate related issues (Donner et al 2016); where there are overlaps between direct climate-related activities and those which may have other primary objectives (Pickering et al 2015).

In the absence of an established framework, we considered that these inexplicit components consist of mitigation or adaptation that contains benefits contributing to mitigating or adapting to climate change, but their climate benefits are not directly referred to in the ES. Mitigation or adaptation which has inexplicit climate change benefits can include: the recycling or reusing materials, traffic management through using low emission vehicles, site and office based energy saving measures or
the planting of trees. For this assessment, all mitigation and adaptation within each chapter was thoroughly reviewed and any climate-related mitigation or adaptation not referenced to climate change was documented into a table containing the mitigation or adaptation measure and the chapter in which it was included.

On completion of the review and inexplicit climate change assessment against all ten projects, the grade justifications for each project were tabulated against the criteria questions (Appendix F) in order assist comparison and analysis of the results.
3 Results

This section details the results of section three of the review process (Table 6 - for full details see Appendix F) and the findings from the assessment of the inexplicit climate mitigation and adaptation. Sections one and two of the review, used for informative purposes, are not discussed.

3.1. Justification for the need for mitigation and adaptation

This question was split into three parts regarding the justification given for the climate mitigation and adaptation in the policy context, development context and climate change context. Grades were dependent on the level of justification given (Table 4).

3.1.1 Justification: policy context

The first part assessed the presence of climate related policies at the global, national, regional and local level that influenced the inclusion of climate change in the ES. Seven projects gained a grade A and three a grade B. Grade A was given where at least three of the levels of policy were mentioned and explained whereas, grade B was given where only two policy levels were mentioned. For example, the Northern Line Extension (NLE) received an A as it referred to the Climate Change Act, The London Plan and local planning policies, whereas Luton Airport referred to the Climate Change Act and local policies, but only gained a B due to the absence of global or regional policies.

3.1.2 Justification: development context

The second part of the question focused on the justification for the climate change effect(s) on the development or the project’s contribution toward climate change. Eight projects were awarded an A and the remaining two either a B or C. Those that achieved an A detailed the specific risks to the project along with data, predictions and evidence where available. There was also reference to the specific areas of the project that would contribute to climate change. For example, High Speed 2 (HS2) outlined where increased greenhouse gas emissions would originate (from the construction phase in embedded materials and activities and from the operational phase through the use of
electricity and freight). This was supported by emissions data and an extensive greenhouse gas assessment. Ashford Airport gained a B as the impacts on the development were discussed, but there was a lack of data, despite specific discussion of increases in greenhouse gas emissions. Mersey Gateway gained a C as detail of the project’s contribution to climate change was limited to the statement: ‘traffic during the operational and construction phase will result in emissions’. Furthermore, the Mersey Gateway chapter ‘air quality and climate’ mainly focused on the impacts to air quality with little reference to climate change throughout, despite the importance of carbon dioxide emissions to climate change being stated in the chapter introduction.

3.1.3 Justification: climate change context

The final part of this question assessed the project’s reference to the climate change science from which its mitigation and adaptation was established. An explanation of the climate science could include future impacts and predictions of climate change. Additionally, for projects that focused on carbon dioxide emissions, an explanation of carbon dioxide as a potent greenhouse gas was desired. Grades ranged from A-E with eight projects gaining an A or B and two achieving either a D or E. The A grade projects gave a comprehensive explanation of the climate science affecting their project along with predictions and data from the UK Climate Impacts Programme. Those with a B grade lacked reference to data or predictions. The projects that gained a D and E had either a basic incomplete statement relating to climate science or a complete lack of climate context.

3.2 Justification for mitigation and adaptation

This question evaluated the justification given for the climate mitigation and adaptation measures. The gradings allocated were dependent on the level of detail given. Grades awarded ranged from A-C with only one project receiving an A, six a B and three achieving a C. HS2 received the A grade because each measure was systematically stated, along with the resource or receptor affected and the climate change impact on the receptor. Projects that achieved a B grade justified the measures, however some explanations remained brief. The projects that gained a C did not always explain each
element of the mitigation or adaptation or instead provided a general statement as the justification.

For example, Luton Airport’s justification was limited to: ‘these measures are to mitigate emissions during construction and demolition phases’.

3.3 Detail given in mitigation and adaptation description

This question assessed the detail given in the description of the mitigation and adaptation measure. This was assessed according to the discussion of: specific actions required for the measure, timelines, targets and personnel or organisations involved.

All projects achieved either a grade B or C. Three projects achieved a B as good detail was given with reference to specific actions, organisations involved and targets for the measure. For example, Mersey Gateway gave great detail in the mitigation measures to control traffic emissions: ‘all non-road mobile machinery with power outputs greater than 37kW should be fitted with suitable after-treatment devices on the approved list managed by the Energy Saving Trust’ (the exact devices are not stated). For the seven projects that achieved a C, there was some detail in the mitigation and adaptation description however this was often limited to a basic description of the measure and no further in-depth information. For example, the extent of the mitigation description for the NLE and Luton Airport was to: ‘use building materials with a high capacity to store heat which reduces variation in temperature’ and ‘for energy efficiency, use of cladding and walling systems with high-specification insulation, and using high efficiency lighting’ respectively.

3.4 Inclusion of the effectiveness or benefits of the mitigation

Question 3.4 assessed the level of justification given of the effectiveness or benefits of the measure (Table 4). Grades ranged from A-D with eight of the projects receiving either a C or D. The Northern Distributor Road was the only project to achieve an A. This was due to the project containing a full assessment of the benefits of the tree and shrub planting mitigation. The benefits of the remaining mitigation measures were explained and where this was not possible, this was stated. In addition to
This project presented a table measuring the overall performance of each mitigation and adaptation measure, grading them from moderate to high. Furthermore, the table described ‘management of impacts to the scheme’ and ‘management of impacts to the wider environment’. The mitigations were additionally appraised in the project’s appendices however not all measures were included therefore the project was limited to a B.

Of the remaining eight projects, four achieved a C grade and four a D grade. Those that received a C stated the climate mitigation or adaptation benefits however lacked explanation. For example, HS2 stated that a green infrastructure approach would result in a multi-functional landscape, reducing vulnerability and increasing resilience to climate change however this was not explained further. This was similar to Luton Airport which stated that the initial climate change effect on the project pre-mitigation would be ‘minor adverse’ however post-mitigation, the effect was ‘insignificant’. This suggests that the mitigation would be effective however there was no explanation of the reasons for it.

The projects that achieved a D contained very brief mention of the benefits and an absence of explanation. For example, Birmingham Airport only mentioned the estimated carbon dioxide savings, Ashford Airport stated the low impact of biomass burners and North Doncaster Chord indicated how the mitigations can play a major role in reducing the embodied carbon however none of the points were explained further.

3.5 Evidence of commitment

This question evaluated the commitment to implementing the climate mitigation or adaptation measures through assessing monitoring measures, timelines, budgets, specific tasks and organisations involved.

Grades ranged from B-D with two projects achieving a B, two a C and the remaining five a D. The Northern Line Extension was not given a grade as the document that contained information of
commitment to the mitigation and adaptation could not be located. North Doncaster Chord and
Luton Airport gained B grades as these projects stated their commitment to the mitigation along
with actions to achieve their commitment. For example, Luton Airport outlined a three year carbon
management plan, managed by British Gas, and a target to save 3000 tonnes of carbon by December
2013 compared to 2010. North Doncaster Chord outlined Network Rail’s sustainability policy and
steps to achieve this which included a detailed consideration of embodied carbon, engaging with
suppliers, a sustainable construction strategy and maximising opportunities for sustainable materials
transport. These projects were not awarded an A because the evidence of commitment was not
comprehensive with both lacking budgets, North Doncaster lacking targets and organisations
involved, and Luton Airport lacking detail in specific tasks.

Leeds New Generation and the M1 Junction Improvement gained C grades as both exhibited some
evidence of commitment to climate mitigation in the form of reference to the project’s construction
environmental management plans (CEMP). Leeds New Generation stated: ‘The CEMP will include a
number of mitigation measures which will minimise the effects from construction traffic’. This
suggests some commitment to the mitigation, however the lack of additional information led this
project to be awarded a C. The M1 Junction Improvement similarly set out the contents of the CEMP
but with little additional information.

The six projects that achieved a D had vague or brief information regarding commitment to the
climate mitigation and adaptation. For example, Ashford Airport stated that mitigation would be
‘implemented as part of a long term strategy to minimise the impact of the airport expansion on air
quality’. Birmingham International Airport stated they had ‘the opportunity to develop a carbon
management plan for the rest of the airport activities’ and Mersey Gateway described the
mitigations as ‘likely to be’ or ‘would probably be’ implemented, suggesting a lack of clear
commitment.

3.6 Evidence of measuring or monitoring
This question assessed the existence of monitoring or measuring of the climate mitigation and adaptation measures (Table 4). Grades ranged from B to E with only Mersey Gateway achieving a B, the NLE achieving a C, six projects receiving a D and two an E.

Mersey Gateway outlined a monitoring regime with the council along with proposed continuous and non-continuous monitoring methods. The NLE exhibited evidence of monitoring within external documents such as the ‘energy management plan’ which outlined audits for all energy using processes to identify high energy demand areas that could be targeted for reduction measures.

Projects that achieved a D had vague mentions of monitoring, such as the Northern Distributor Road which, in the section ‘how the measures will be implemented, measured and monitored’, mentioned the CEMP but gave no further information. Leeds New Generation contained a section on monitoring and evaluation however there was an absence of specific monitoring measures.

Finally, HS2 and Ashford Airport achieved E grades as there was no indication of monitoring measures.

3.7 Inexplicit climate mitigation

All projects contained forms of inexplicit climate mitigation and adaptation in various chapters other than those concerning climate change (Tables 6 and 7).

The Northern Distributor Road and North Doncaster Chord contained the highest number of chapters with inexplicit climate related measures of seven and six chapters respectively. In comparison, the airport projects and Mersey Gateway contained the lowest number with only three or four chapters including inexplicit climate measures. Inexplicit climate mitigation and adaptation appeared in eight of the ecology chapters and seven landscape and visual and water resources chapters. Waste and traffic and transport were also included in six and five chapters respectively (Table 7 and 8).

Other various climate mitigation and adaptation measures present in the socio-economics, materials, cultural heritage and geology chapters included: increasing the proportion of open space,
using waste products where applicable, planting trees, shrubs and woodland to screen views and works not to be carried out in extreme weather respectively.
4 Discussion
The discussion addresses the key findings from the application of the review package. It focuses on the reasons for a lack of commitment to climate mitigation and adaptation and post-decision monitoring and the many forms of inexplicit climate mitigation and adaptation measures that are not referenced directly to climate change. The review method and its limitations are assessed and the discussion concludes by evaluating if EIA is a good platform to consider climate change.

4.1 Lack of evidence of commitment, monitoring or measuring
It is evident that currently lacking in ESs is commitment to implementing climate mitigation and adaptation measures, and to post-decision measuring or monitoring (Table 7). From the criteria assessment, these two questions received the lowest grades, with D grades the most common for the projects assessed.

Post-auditing, i.e. the monitoring of individual plans or projects from the ES are recognised in the EIA community as important (Arts et al 2001) but are seen as weaknesses in the EIA process and have been lacking in practice for some years (Dipper 1998; Wasserman 2011). Post-auditing has many benefits such as being able to learn from experience, monitor expected impacts, improve resource targeting, suggest appropriate mitigation and adaptation measures and ensure better environmental protection for future developments (Wood et al 2000; O’Faircheallaigh 2007).

It is suggested that the lack of commitment to measures in the EIA is intrinsically linked with the absence of post-auditing. Dipper (1998) suggests that post-auditing may highlight shortcomings which will improve the commitment to mitigation whilst Jay et al (2007) argues that commitments made in the ES will lead to post-auditing. Nevertheless, this link, or lack thereof, is evident in this study as the grades for commitment and monitoring are generally similar for each project (Table 6).

Following consultation with professionals, P6 explained that “when producing the ES, if aspects, such as post-auditing and evidence of commitment, are not required, they are not further explored despite..."
being best practice”. Reasons for this neglect include the cost and time of monitoring, vague impact predictions and the absence of mandatory or auditable requirements (Wood et al 2000; Wang et al 2003), and a more recent review identified implementation costs, lack of enforcement and a lack of appropriate legislation as the three main barriers to EIA follow-up (Jones & Fischer 2016). In reference to the latter, fundamental to EIA is explicitly incorporating requirements into legislative frameworks (Wood et al 2000; Jay et al 2007) however the requirement for post-decision auditing is not explicit in the current EIA regulations. Revisions to the Directive (2014/52/EU) move towards a clearer requirement for monitoring and commitment, by stipulating that Member States shall implement mitigation measures and subsequent monitoring procedures for the significant adverse effects (Article 8a (4)).

To improve commitment to climate mitigation and adaptation, and to post-auditing following the Directive amendments, stronger links between the EIA process and its ongoing environmental management is required (Morrison-Saunders & Bailey 1999). EIA needs to advance beyond its conventional and linear process of identifying and mitigating chapter-specific impacts towards encouraging environmental enhancement and delivering more sustainable outcomes through post-auditing (Jay et al 2007; Morrison-Saunders & Retief 2012). The conventional nature of the EIA process reflects the higher grades obtained for the questions outlining the policies, need and justification for the mitigation and adaptation, aspects typically included in all EIAs. The decline in grades for the questions relating to the commitment, monitoring and detail of the measures exhibits how this conventional nature of EIA does not appropriately consider the follow-up and sustainability of mitigation measures (Morrison-Saunders & Arts 2005). The 2014 Directive amendment has addressed sustainability by stating that the original EIA Directive should be revised in a way that improves environmental protection and supports sustainable growth, however the ongoing challenge will be addressing sustainability within the bounds of the conventional nature of the EIA process (Cashmore 2004).
4.2 Commitment to climate change

Whilst there is considerable literature addressing post-auditing in the EIA process, specific references to climate change mitigation and adaptation commitments and post-auditing are sparse. Similar to the EIA process, this is due to the absence of legislative requirements. However, specific commitment to climate mitigation and adaptation is additionally challenging due to uncertainty in the climate change effects, timescales, the evolving baseline, difficulty in distinguishing the magnitude and significance of impacts, and the complexity of the climate change issue (Byer and Yeomans 2007; EC 2013).

A key feature of the management of climate change is continually assessing and updating knowledge regarding the changing trends and baselines (Peterson et al 1997) therefore monitoring is particularly important for climate change. Furthermore, the uncertain nature of climate change means that monitoring could be a form of mitigation in itself as this could identify unforeseen adverse effects and ensure subsequent appropriate remedial action (EC 2013). There is currently a lack of monitoring of climate change mitigation and adaptation, as EIA practitioners fail to consider climate change with the principles of adaptive management, and as a changing, holistic process (Wende et al 2012). A reason for this could be that the EIA regulations were developed in an era where climate change was not widely considered and the main focus of EIA was to achieve development consent. However, the consideration of climate mitigation and adaptation needs to be a pathway of change and response (Wise et al 2013), working toward environmental management through measuring, monitoring and commitment.

Ways to strengthen the link between EIA and environmental management outcomes have been suggested as improving the EIA process, changing the behaviour of individual professionals and ensuring that sustainability concepts are more explicitly included in the ES (Ramanathan 2001; Jay et al 2007; Morrison-Saunders & Retief 2012).

4.3 Inexplicit climate mitigation
When reviewing the case studies, many chapters contained inexplicit climate mitigation and adaptation (Table 7). Consulting with P5, it was explained that “whilst mitigations or adaptations may relate to climate change, to keep chapters consistent and focused, it is not necessary to relate them to other impacts”. This outlines the issue of reductionism in the EIA process where complex issues are broken down into component parts rather than considered as a whole system in a holistic approach (Bond & Morrison-Saunders 2011). However, when considering climate change and sustainability, the context and numerous sectors involved in these issues require an integrated and holistic approach to reasonably consider them (Swart et al 2003).

To improve the holistic consideration of climate change in EIA, more explicit use of sustainability concepts is required as this would draw attention to these wider concepts and enable their cumulative consequences to be pursued (Jay et al 2007). Furthermore, as climate change interacts with many chapters in an ES (Table 7) this identifies the need to explicitly address these interconnections (Lawrence 1997). These interconnections can be addressed either within each chapter or through a single chapter concerning ‘combined and cumulative issues’ such as observed in the M1 Junction improvement project which contained a table outlining the interactions between topic areas. However, similar to post-auditing, the challenge is due to the nature of EIA as a methodological and process-based tool. Morrison-Saunders and Retief (2012) suggest that rather than legislative reform or change in the EIA process, the bigger issue is changing the behaviour of individual professionals. Professionals should recognise that climate change cannot successfully be incorporated into EIA in its current pro-forma but instead should be considered holistically and as an integrative part of the EIA. Posas (2011) suggests that in order to do this, a guiding framework for action is required at strategic level; and specific targets for key issues such as carbon emission reduction are recommended (Fischer et al 2011).

4.4 Assessment of the review process
Whilst EIA review is common, not all are necessarily successful as this is dependent on the review package. The criteria should maintain a balance over the aspects the ES ‘must’ contain, ‘could’ contain and ‘can reasonably be expected to contain’ (Glasson et al 2012). The first two questions of the criteria (3.1 and 3.2) which justify the reasons and need for the mitigation and adaptation are features the ES ‘must’ contain according to the EIA Directive (schedule 4 part 1 – points 3 and 4). Question 3.3 inquires into the level of detail of the measure, and is an aspect the ES ‘could’ contain as the EIA regulations require a description of the measures however the level of detail is not specified. The final questions regarding the evidence of commitment, monitoring and the effectiveness of the measure should be reasonably expected to be contained in EIA as this is considered best practice (Lee 1983; Dipper 1998). Their modal grades of Cs and Ds suggest these questions may have been too expectant, however their presence in the criteria has drawn attention to the issue that these areas, though best practice, are not widely explored in EIA.

Climate change in itself, is an aspect EIA should be ‘reasonably expected to contain’ (IEMA 2010; EC 2013) however as current practice has identified that climate change issues are not yet coherently explored, asking expectant questions is an important step to advance knowledge in climate change and EIA and expose the areas that are not adequately being addressed. The development of a novel review method exploring new aspects of EIA is also important. Whilst there is variable literature surrounding climate change in EIA, very few studies have reviewed climate mitigation and adaptation, let alone developed a unique assessment method.

4.5 Limitations in method

Developing a review package requiring judgement on specific grade allocations can be subjective and is dependent on the experience of the reviewers and their ability to judge the ES against the assessment criteria (Glasson et al 2012). Furthermore, the criteria need to be as transparent as possible for which it may be possible to refine our review package to include a further level of sub-criteria in order to achieve this (see Methods Section 2.2 and Appendix E).
As this study exclusively evaluated climate change mitigation and adaptation within a small number of transport projects that contained a chapter focusing on climate change, this could give an incorrect impression of climate mitigation and adaptation within all ESs. For example, in the implicit climate mitigation and adaptation assessment, the ecology and landscape chapters contained implicit climate measures in the highest number of projects. This is expected within transport projects as they are likely to adversely impact ecology and landscape features whereas impacts to air quality and traffic are likely to be reduced following mitigation. This is a characteristic inherent to transport projects but unlikely for some other project types. Despite this, the evaluation of climate mitigation and adaptation within transport projects remains important as transport is increasingly vulnerable to climate change and its emissions are major contributors to climate change (Nagurney et al 2010). In addition, the wider impacts of the transport sector go beyond assessment of projects and lie in changing transport modes, fuels and demands (Pathak and Shukla 2016).

Furthermore, as phase one of the method revealed that a more focused approach was required for a higher level of analysis, evaluating specific ESs considering climate change was necessary for the aim of this study.

Another limitation was that relevant documents relating to two of the ESs were not available online. For example, the NLE referred to commitment to the mitigations within the document ‘transport and works act order’ however as this document could not be located, the question regarding commitment was not graded. A carbon footprint assessment relating to the North Doncaster Chord was the other document that was mentioned in the ES but could not be accessed. Unlike the NLE, this did not affect the grades allocated to this project as the assessment findings were summarised when justifying the mitigation and were not referenced to regarding mitigation commitment.

4.6 Is EIA a good platform to evaluate climate change?

Given the regulation amendments and increasing concern over how to consider climate change in EIA, it is important to address whether EIA is a good platform to evaluate climate change. Including
climate concerns in EIA only accounts for climate change impacts from new developments required
to undertake EIA. This excludes climate impacts from ongoing activities and from new developments
not requiring an EIA. As very small proportions of developments require an EIA (Department for
Communities and Local Government 1999), the impacts mitigated or adapted to within new
developments compared to those from existing developments will be very small. Additionally, as EIA
primarily identifies the impact of a project on the environment rather than the impact of
environmental change, EIA may not fully evaluate climate change (Agrawala et al 2011).

It has been questioned if EIA is as effective as its originators expected (Cashmore et al 2004) and if it
offers more in theory than in practice (Lawrence 1997). This concurs with the findings of this study,
which demonstrate that climate change is only included in ESs following the requirements of the EIA
Directive, with the absence of best practice commitment, post-auditing and explicit inclusion of
climate change. It appears that currently, EIA is not a platform fit to address climate change for three
main reasons (Jay et al 2007; Morrison-Saunders & Retief 2012; Chang & Wu 2013):

(1) To date, climate change is yet to be required by EU legislation (but will be when the 2014
Directive is implemented);

(2) There is a lack of guidance and understanding of how climate change should be included in
UK EIA assessments; and,

(3) Current practice in EIA is to achieve development consent with lesser focus on the post-EIA
impacts and sustainability of the project.

As the 2014 Directive amendment comes into force, points (2) and (3) need to be addressed in
symbiosis. On asking practitioners how they included climate change when producing an ES, P6
stated they “used a variety of information and informal guides available as not one source was solely
appropriate”. This statement, along with the low grades allocated to the last few questions in the
review demonstrates the disjointed nature of including climate change and the need for guidelines.
IEMA and engineering consultancy Mott MacDonald are later this year launching guidance on climate change adaptation and resilience in EIA (IEMA 2015) and the EC have an extensive guide on integrating climate change and biodiversity into EIA. This shows there will no longer be an absence of guidance for including climate change, however their application by professionals is uncertain. This suggests that the issue may not be the inclusion of climate change but how it is embraced by individual professionals. Other elements of EIA have gone through similar transitions, with, for example the UK’s Chartered Institute for Ecological and Environmental Management Guidelines pushing forward better practice in ecological assessment (Briggs & Hudson 2013).

5 Conclusion

Including climate change in EIA will be a new but necessary challenge for professionals. Through a novel review process, this paper has identified that within the sample of UK ESs studied, climate change mitigation and adaptation is widely inexplicitly included in various chapters of an ES and there is a lack of post-auditing and commitment towards the proposed measures. Reasons for this include the lack of mandatory requirements, guidance and experience of including climate change, along with the linear process of EIA.

With some caveats based on our examination of a sample of projects from one sector, this study has suggested that EIA is not currently a good platform to consider climate change; however for its successful integration, it is recommended that stronger links between the EIA process and continual environmental management are needed through a more holistic consideration of climate change and more explicit use of sustainability terms. Guidelines for integrating climate change mitigation and adaptation are required in the UK (and see above, are now forthcoming) along with the enhancement of the competence of practitioners through a change in their behaviour and attitudes from viewing EIA less as a systematic process but rather as an integrative process. Finally, an additional challenge will be adapting the EIA framework to consider climate change successfully and sustainably given the conventional nature of EIA practice.
Including climate change in EIA should not be seen in isolation as a solution to mitigating or adapting to climate change as only small proportions of new developments require an EIA and the climate impacts from ongoing activities are excluded. Future research should investigate how to consider climate change impacts from existing developments and activities and should evaluate the lessons learnt from integrating climate change into EIA.

Acknowledgements

Thanks to the consultants who took the time to answer our questions and review the criteria. Particular thanks to R. Mulley, B. Miller and E. Beagely for their assistance and feedback in the early stages of this project. Thanks also to IEMA for circulating the review criteria to their members and to the members who responded and provided feedback.

References


Department for Transport. 2015. Design Manual for Roads and Bridges. Available online at:

Williamslea: http://www.standardsforhighways.co.uk/ha/standards/dmrb/index.htm


European Commission. 2013. Guidance on Integrating climate change and biodiversity into environmental impact assessment. [online] Available at:


IEMA. 2015. EIA and Climate change. [online] Available at: http://www.iema.net/eia-climate-change [Accessed 22/03/2016].


22/03/2015.
Table 1. The categories that the climate related terms were grouped into.

<table>
<thead>
<tr>
<th>Category</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change impact</td>
<td>Description or explanation of generic impacts of climate change</td>
</tr>
<tr>
<td>Climate change impact on the development</td>
<td>Description of how climate change will affect the development</td>
</tr>
<tr>
<td>Impact of the development on climate change</td>
<td>Description of how the development will contribute to climate change</td>
</tr>
<tr>
<td>Need for the development</td>
<td>An explanation of the need for the development with reference to climate change</td>
</tr>
<tr>
<td>Benefits of the development</td>
<td>An explanation of the benefits of the development with reference to climate change</td>
</tr>
<tr>
<td>Policy</td>
<td>Any mention of climate-related policy</td>
</tr>
<tr>
<td>Data/modelling</td>
<td>Any reference to climate-related data or modelling methods</td>
</tr>
<tr>
<td>Mitigation measures</td>
<td>Any mention of climate-related mitigation measures</td>
</tr>
</tbody>
</table>
Table 2. Summary of the three main review criterion that influenced the content of the review criteria developed in this study.

<table>
<thead>
<tr>
<th>Source</th>
<th>Summary of review criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee and Colley review criteria (1992)</td>
<td>Grades ESs A-F under four main topics:</td>
</tr>
<tr>
<td></td>
<td>1. Description of the development, local environment and the baseline conditions</td>
</tr>
<tr>
<td></td>
<td>2. Identification of impacts, prediction of impact magnitude and assessment of impact significance</td>
</tr>
<tr>
<td></td>
<td>3. Alternatives, mitigation and commitment to mitigation</td>
</tr>
<tr>
<td></td>
<td>4. Communication of results – presentation, balance and non-technical summary</td>
</tr>
<tr>
<td>Oxford Brookes review package (Glasson et al., 2011)</td>
<td>Grades ESs A-F under eight different criterion:</td>
</tr>
<tr>
<td></td>
<td>1. Description of the development</td>
</tr>
<tr>
<td></td>
<td>2. Description of the environment</td>
</tr>
<tr>
<td></td>
<td>3. Scoping, consultation and impact identification</td>
</tr>
<tr>
<td></td>
<td>4. Prediction and evaluation of impacts</td>
</tr>
<tr>
<td></td>
<td>5. Alternatives</td>
</tr>
<tr>
<td></td>
<td>6. Mitigation and monitoring</td>
</tr>
<tr>
<td></td>
<td>7. Non-technical summary</td>
</tr>
<tr>
<td></td>
<td>8. Organisation and presentation of information</td>
</tr>
<tr>
<td>Department of the Environment Transport and the Regions (DETR) review pro-forma of mitigation measures in environmental statements (1997)</td>
<td>Made up of two sections:</td>
</tr>
<tr>
<td></td>
<td>1. Overview of project: Project location, type, date of ES, project description, timing, nature of area and importance of environmental resources.</td>
</tr>
<tr>
<td></td>
<td>2. Treatment of mitigation: Questions such as:</td>
</tr>
<tr>
<td></td>
<td>‘to what extent does the mitigation cover the appropriate scope of negative impacts’</td>
</tr>
<tr>
<td></td>
<td>‘to what degree; does the ES provide a clear description of the mitigation measures; is there a commitment to the evaluation of measures; is there a commitment to the adoption of mitigation; are reasons given for no or insufficient mitigation’</td>
</tr>
</tbody>
</table>
Table 3. An outline of purpose of the three sections in the review criteria and the source they were adapted from.

<table>
<thead>
<tr>
<th>Section</th>
<th>Purpose</th>
<th>Graded?</th>
<th>Source adapted from</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section one 'general project features'</td>
<td>This provides a useful overview of the project for quick-reference, especially useful for external sources unfamiliar with the project.</td>
<td>No</td>
<td>DETR review pro-forma</td>
</tr>
<tr>
<td>Section two 'project and mitigation descriptions'</td>
<td>Used as an informative tool outlining the climate change impacts and subsequent mitigations suggested in the ES along with other relevant information. This information will supplement the scoring in section three and is useful to gain an understanding of; the climate change issues, how they have been identified and detail into the mitigation suggested.</td>
<td>No</td>
<td>DETR review pro-forma; Oxford Brookes review package</td>
</tr>
<tr>
<td>Section three 'mitigation evaluation'</td>
<td>An assessment of the climate change mitigation through individually graded questions. Questions inquire into the detail of the mitigation and if there is evidence of; a justification for the need for mitigation, evidence of is effectiveness and commitment to implementing and monitoring the mitigation.</td>
<td>Yes</td>
<td>Adapted from the Oxford Brookes review package part 6 'mitigation and monitoring' and from the DETR review pro-forma. The scoring system was broadly adapted from the Lee and Colley review package.</td>
</tr>
</tbody>
</table>
Table 4. The grading criteria for allocation of grades A-E for each question.

<table>
<thead>
<tr>
<th>Grade/Question</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1. Is a justification given for the need for mitigation in the policy (3.1.1), development (3.1.2) and climate change (3.1.3) contexts?</td>
<td>Clearly justified with full evidence where necessary Note: for 3.1.1 Grade A given for at least three levels of policy explained.</td>
<td>Good justification given (with some evidence where necessary) Note: for 3.1.1 Grade A given for only two levels of policy explained.</td>
<td>Partial or generic justification with limited evidence Note: for 3.1.1 Grade A given for only one level of policy explained.</td>
<td>Incomplete justification</td>
<td>No justification given. Measure is stated with no rationale.</td>
</tr>
<tr>
<td>3.2. Is a justification given for the chosen mitigation?</td>
<td>Each measure is clearly justified with full evidence where necessary</td>
<td>Good justification given (with some evidence)</td>
<td>Partial or generic justification</td>
<td>Incomplete justification</td>
<td>No justification given. Measure is stated with no rationale.</td>
</tr>
<tr>
<td>3.3. How detailed is the description of the mitigation measure?</td>
<td>Fully detailed, all the listed information is provided.</td>
<td>Detailed, with small or minor omissions; most of the information is given.</td>
<td>Some detail, some of the information is given to a level that is sufficient.</td>
<td>Little detail</td>
<td>No detail or additional information given.</td>
</tr>
<tr>
<td>3.4. Is the effectiveness or benefits of the chosen mitigation stated?</td>
<td>The effectiveness/benefits are clearly stated with evidence where necessary. Or the benefits are unknown and this is stated.</td>
<td>The effectiveness/benefits are explained.</td>
<td>The effectiveness/benefits are stated but not explained.</td>
<td>Little or inconsistent mention of the effectiveness/benefits.</td>
<td>The effectiveness/benefits are not mentioned.</td>
</tr>
<tr>
<td>3.5. Is there evidence of commitment to implementing the mitigation?</td>
<td>There is comprehensive evidence of commitment to mitigation.</td>
<td>There is good evidence of commitment.</td>
<td>There is some evidence of commitment.</td>
<td>There is little information given with key omissions.</td>
<td>There is no evidence of commitment.</td>
</tr>
<tr>
<td>3.6. Is there evidence of measuring or monitoring the success of the mitigation measures?</td>
<td>There is detailed and comprehensive evidence of monitoring of the measures</td>
<td>There is significant evidence of monitoring</td>
<td>There is some evidence of monitoring initiatives</td>
<td>There is very little or inconsistent mention of monitoring</td>
<td>There is no mention of monitoring</td>
</tr>
</tbody>
</table>
Table 5. An outline of the ten transport projects and their relevant chapter containing climate change that was evaluated in this study.

<table>
<thead>
<tr>
<th>Project</th>
<th>Year of ES</th>
<th>Chapter containing climate change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Northern Line Extension (NLE)</td>
<td>2013</td>
<td>ES Chapter 16 ‘Climate change adaptation and mitigation’</td>
</tr>
<tr>
<td>2. High Speed 2 (HS2)</td>
<td>2013</td>
<td>Volume 5 ‘preliminary consideration of potential climate change impacts’</td>
</tr>
<tr>
<td>4. North Doncaster Chord</td>
<td>2011</td>
<td>ES Chapter 7.3 ‘climate change’</td>
</tr>
<tr>
<td>5. Mersey Gateway</td>
<td>2008</td>
<td>ES Chapter 19 ‘air quality and climate’</td>
</tr>
<tr>
<td>6. M1 Junction 19 improvement</td>
<td>2010</td>
<td>Volume 1 chapter 6 ‘air quality and climate change’ and Volume 2 chapter 1 air quality and climate change’</td>
</tr>
<tr>
<td>7. London Luton Airport</td>
<td>2014</td>
<td>Volume 1 Chapter 5 ‘carbon’ and Volume 2 Chapter 16 ‘climate change risk assessment’</td>
</tr>
<tr>
<td>8. Northern Distributor Road, Norwich</td>
<td>2012</td>
<td>ES Chapter 6 ‘air quality’</td>
</tr>
<tr>
<td>9. Birmingham International Airport</td>
<td>2008</td>
<td>ES Chapter 5 ‘climate change’</td>
</tr>
<tr>
<td>10. London Ashford Airport</td>
<td>2006</td>
<td>ES Chapter 15 ‘air quality’</td>
</tr>
</tbody>
</table>
Table 6. An overview of the grades allocated for each individual project and question. Colour-coded for visual impact: green represents a good quality answer, yellow an average answer and red an unsatisfactory answer.

<table>
<thead>
<tr>
<th>Project/Question</th>
<th>3.1.1</th>
<th>3.1.2</th>
<th>3.1.3</th>
<th>3.2</th>
<th>3.3</th>
<th>3.4</th>
<th>3.5</th>
<th>3.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>NLE</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>n/a</td>
<td>C</td>
</tr>
<tr>
<td>HS2</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>Leeds NGT</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>North Doncaster Chord</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>Mersey Gateway</td>
<td>A</td>
<td>C</td>
<td>D</td>
<td>C</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>B</td>
</tr>
<tr>
<td>M1 Junction Improvement</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>Northern Distributor Road, Norwich</td>
<td>B</td>
<td>A</td>
<td>E</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>Birmingham International Airport</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>A</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>London Ashford Airport</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td>D</td>
<td>E</td>
</tr>
</tbody>
</table>
Table 7. The chapters in each project where inexplict climate mitigation and adaptation were present.

<table>
<thead>
<tr>
<th>Chapter/Project</th>
<th>Ecology</th>
<th>Air quality</th>
<th>Landscape and visual</th>
<th>Traffic and transport</th>
<th>Waste</th>
<th>Water</th>
<th>Resources</th>
<th>Socio-economics</th>
<th>Materials</th>
<th>Cultural Heritage</th>
<th>Geology and soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>NLE</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HS2</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leeds NGT</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Doncaster Chord</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mersey Gateway</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M1 Junction Improvement</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>London Luton Airport</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern Distributor Road, Norwich</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birmingham International Airport</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>London Ashford Airport</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 8. Examples of the projects and chapters which contained inexplicit climate mitigation and adaptation.

<table>
<thead>
<tr>
<th>Chapter/project</th>
<th>Ecology</th>
<th>Landscape and visual</th>
<th>Water resources</th>
<th>Waste</th>
<th>Traffic and transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>NLE</td>
<td>Landscape planting and specimen tree planting.</td>
<td>Restoration with new trees, shrubs and climbing plants.</td>
<td>Avoidance or reduction of impacts on floodplains and flood storage areas.</td>
<td>Reuse of excavated material as fill material.</td>
<td>Construction traffic to be minimised. The number of private car trips to and from each site (both workforce and visitors) minimised.</td>
</tr>
<tr>
<td>HS2</td>
<td>Tree and wildflower planting.</td>
<td>Planting of two million trees. Avoid or reduce landscape effects by protecting existing trees and vegetation.</td>
<td>Buildings to use water efficient technology e.g. grey water recycling.</td>
<td>Deal with waste at the top of the hierarchy. Re-use waste materials on site as fill. Encourage recycling on site.</td>
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<tr>
<td>Leeds New generation</td>
<td>Landscape planting.</td>
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<tr>
<td>North Doncaster Chord</td>
<td>Minimum vegetation clearance. Tree and hedgerow re-planting into a tree belt.</td>
<td></td>
<td></td>
<td>Staff training through ‘toolbox talks’ to reduce waste, water and increase the use of sustainable materials. Re-use waste where possible.</td>
<td>Minimise and appropriate scheduling movement of construction traffic.</td>
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<tr>
<td>Mersey Gateway</td>
<td>Landscape planting.</td>
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<td></td>
<td>Regular maintenance of construction vehicles. Schedule construction works outside peak traffic flow hours.</td>
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<tr>
<td>M1 Junction improvement</td>
<td>Increased vegetation cover with standard trees.</td>
<td>Woodland, hedgerow and shrub planting.</td>
<td>Five attenuation/drainage ponds to deal with flooding and run-off.</td>
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<tr>
<td>Luton Airport</td>
<td>New tree planting with two trees for every one lost.</td>
<td>Reduce the predicted effect on the wildlife site through an action plan.</td>
<td>Attenuation storage to be provided.</td>
<td></td>
<td>Designated HGV routes to avoid residential areas. Junction improvements to prevent congestion.</td>
</tr>
<tr>
<td>Northern Distributor Road</td>
<td>Landscaping and habitat creation.</td>
<td>Green wooded corridor, mounding and planting.</td>
<td>Completion of a flood risk assessment.</td>
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<tr>
<td>Birmingham International Airport</td>
<td>Creation of grassland areas. Management plan to enhance floristic diversity and biodiversity value.</td>
<td>Tree screening and landscaping to provide screening.</td>
<td>Control of runoff by a site drainage system.</td>
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<tr>
<td>Ashford Airport</td>
<td>Planting of trees and hedges for screening.</td>
<td>Storm water management measures.</td>
<td>Minimise waste at the source.</td>
<td>Travel plan to encourage alternative transport to private car. Car sharing, taxi service promotion.</td>
<td></td>
</tr>
</tbody>
</table>
Figure 1. Flow chart outlining the steps involved in the three phases of research for this paper.