

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

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10 **Abstract**

11 Climate change mitigation and adaptation can be perceived as neglected in Environmental
12 Impact Assessment (EIA). In the light of amendments to the European Union EIA Directive
13 (2014), we developed a novel criteria-based review package to assess climate change
14 mitigation and adaptation as documented in Environmental Statements, and applied this to
15 a sample of ten transport developments from England. Justifications relating to climate
16 policy, climate science, the effect of climate change on the development, and its
17 vulnerability to climate risks were well explained in most projects. Many projects lacked
18 detail of climate change mitigation and adaptation measures and their benefits, whilst
19 evidence of commitment to mitigation and adaptation or to post-decision monitoring was
20 poor or non-existent; reportedly due to costs, time constraints and absence of mandatory
21 requirements. It is recommended that to improve the effectiveness of the consideration of
22 climate change mitigation and adaptation in EIA, the production of guidelines, change of
23 behaviour of EIA practitioners, more holistic consideration of climate change issues, rigorous
24 post-decision monitoring and use of climate change terminology are more widely adopted.

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

26 **1. Introduction**

27 1.1 Background

28 Climate change has become a key environmental issue in the past decade, with a growing attention
29 towards mitigating and adapting to the potential effects of extreme weather events, increased
30 global temperatures and rising sea levels (IPCC 2014). Stand-alone methodologies and tools have
31 been developed to help major activities consider the risks posed by climate change such as the
32 World Bank 'climate risk screening' and 'greenhouse gas accounting' tools. However, it has been
33 suggested that a more effective approach is to incorporate the consideration of climate change

34 within existing modalities such as Environmental Impact Assessment (EIA) (Agrawala et al 2012).
35 Recently there have been steps to formalise its inclusion in the decision making process for major
36 developments, for example in Spain (Enriquez-de-Salamanca et al 2016) and China (Chang & Wu
37 2013).

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

48 1.2 The European Union EIA Directive and revisions

49 Climate change is not explicitly included in the formal requirements of the EIA Directive
50 (2011/92/EU) in that 'climatic factors' is listed along with soil, water, air and landscape as a factor
51 that should be assessed. For this reason, along with issues of availability of historical climate
52 information and uncertainty in climate predictions, it is not current practice to explore climate
53 change in the EIA for the majority of project types (Chang & Wu 2013). Additionally, in Europe there
54 is still little practical experience integrating climate change mitigation and adaptation into EIA, and a
55 general uncertainty surrounding how to tackle the problem amongst the actors involved (Jiricka et al
56 2016). Currently, the consideration of climate-related impacts is typically limited to assessments of
57 flood risk, carbon dioxide and greenhouse gas emissions.

58 Despite this, the demand for the inclusion of climate change in EIA is growing (Ncube 2011; Yi &
59 Hacking 2012). Reasons include its growing environmental and economic importance; the long
60 timescales of certain projects, meaning they are likely to be affected by the changing climate; the
61 emergence of Government strategies such as the *HM Government (2011): Climate Resilient*
62 *Infrastructure: Preparing for a Changing Climate* and upcoming revisions to European Union
63 legislation. Revisions to the EU Directive (2014/52/EU), effective by 2017, focus on improving the
64 consistency and quality of EIA content. The Directive amendment states the need to explore '*the*
65 *impact of the project on climate and the vulnerability of the project to climate change*' (annex IV 5.
66 (f)), confirming the need to consider climate change at greater detail and specificity than current
67 practice.

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

84 including climate change mitigation and adaptation in EIA to develop recommendations for its
85 impending future inclusion.

86 1.3 Consenting process for transport projects in England

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

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

95 For projects to be considered as a NSIP, they must fall within the various thresholds as outlined in
96 the Planning Act 2008. For example, a motorway exceeding 15 hectares would be considered a NSIP.

97 For railway or tramway Schemes that do not fall under the Planning Act's NSIP consenting
98 infrastructure, an order is made under the Transport and Works Act 1992 (Transport and Works Act
99 Order).

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

103 1.4 Climate Change Policy

104 Within the last few decades, there have been various climate change related policies and
105 programmes in the UK such as the Climate Change Levy introduced in 2001, the Renewables
106 Obligation (2002) and the EU Emissions Trading System (2005). Most notable is the 2008 Climate
107 Change Act which sets a legally binding target of an 80% reduction in 1990 emissions by 2050.

108 In regards to mitigation and adaptation, as of yet there are no climate change mitigation and
109 adaptation policies however in 2013, the National Adaptation Programme was published as the
110 Government's long term strategy to address the risks identified in the first UK Climate Change Risk
111 Assessment (2012). In addition, the National Planning Policy Framework outlines the need to 'adopt
112 proactive strategies to mitigate and adapt to climate change'.

113 1.5 Review methods for EIA evaluation and quality assurance

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

123 Furthermore, there has been increasing attention towards the evaluation of EIA effectiveness using
124 more substantive review process specifically developed for assessing a particular aim (e.g. Jay et al
125 2007, Briggs & Hudson 2013) or project type (e.g. wind farms in Germany and the UK: Phylip-Jones
126 et al 2013)

127 There are a small number of existing studies reviewing climate change mitigation and adaptation in
128 EIA which have taken a case study approach, evaluating a specific project type. Yi and Hacking (2011)
129 considered urban development projects in South Korea, exploring specific assessment methods; and
130 Ncube (2011) reviewed a sample UK urban regeneration projects studying resilience and adaptation,
131 with a detailed survey of consultants involved in the projects. This approach is best suited to

132 considering 'how' and 'why' type questions as opposed to experiments and surveys which provide
133 data for analysis (Schell 1992).

134 1.6 Aims of this study

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

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150 **2. Method**

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

155 2.1 Phase one: initial research

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

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

173 2.2 Phase two: development of a new climate change assessment method for evaluation of
174 Environmental Statements

175 To assess climate mitigation and adaptation in more detail than phase one, the development of a
176 criteria-based method was required (Appendix B). The review approach was adapted from three
177 established methods- the Lee and Colley (1992) review package, the Oxford Brookes review package
178 (Glasson et al 2012) and the UK Department of the Environment Transport and the Regions (DETR)
179 (1997) review pro-forma of mitigation measures in environmental statements (Table 2).

180 The review process was split into three sections of which the first and second gathered information
181 on the project and its climate-related mitigation and adaptation without allocating grades. This was
182 in order to gain a background understanding of the project and mitigations. The third section
183 evaluated and graded the mitigation and adaptation (Table 3). Outputs from section 1 and 2 are
184 essential for the criteria-based review and grading process in section 3 but only give context rather
185 than establish the quality of delivery, so the results section focuses on section 3. Section 3 (included
186 in full in Appendix E) focuses on evaluation of the proposed climate mitigation and adaptation, with
187 six criteria: justification of need (3.1, including sub-criteria for policy context, development context
188 and climate change context); justification of chosen approach(es) (3.2); level of detail of proposed
189 measures (3.3); effectiveness, benefits and uncertainties surrounding the approaches (3.4); evidence
190 of commitment (3.5) and evidence of plans for monitoring (3.6). Although 3.2-3.6 did not include a
191 further tier of sub-criteria, each assessed more than one related topic and the overall commitment
192 grading was judged on those topics combined. For example 3.5 (commitment) includes
193 consideration of timelines, budgets, involvement of other organisations, and focus on specific tasks.
194 Where all of those topics (if relevant to the particular project) were dealt with in comprehensive
195 detail- an A grade would be given; at the other end of the scale, if they were not considered at all an
196 E grade was given, or a D grade was given for minimal consideration only.

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198 The Lee and Colley review package scoring system was broadly used for the grading of questions but
199 with scores of A-E used to marginally simplify the grading. The grading criteria for each question
200 were individually established as they each assessed a different aspect of the climate mitigation and
201 adaptation (Table 4). Additionally, this provides more informed guidance when repeating the
202 criteria.

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

210 2.3 Phase three: application of review package

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

215 Ten projects were chosen as case studies for this research. These were obtained via an extensive
216 online search. The criteria for project selection were those in the transport sector that contained a
217 chapter specifically considering climate change (Table 5). The reasons for project selection within the
218 transport sector are as outlined in 1.4. In addition, whilst energy projects were additionally studied
219 in the initial stages of this research, as transport emissions are rising faster than from other energy-
220 using sectors (Woodcock et al 2009) and to focus the assessment, the assessment of energy projects
221 was omitted from further assessment. In addition, whilst the location for the initial project selection
222 were those within the UK, the ten case study projects were chosen within England in order to focus

223 the assessment. The time window for project selection were those produced within the past ten
224 years as these projects would fall into the EIA Directive (85/337/EEC) requirements for which all of
225 the projects would have adhered to the same EIA regulations, as no changes were made to 'climate'
226 inclusion in the Directive amendment 2009/31/EC or Directive 2011/92/EU.

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

238 Following recommendations from the professionals, each case study was also evaluated for inexplicit
239 climate related mitigation and adaptation. This is an area that has not been subject to much scrutiny
240 in the context of EIA to date, but, for example international aid projects can comprise a major factor
241 in addressing climate related issues (Donner et al 2016); where there are overlaps between direct
242 climate-related activities and those which may have other primary objectives (Pickering et al 2015).
243 In the absence of an established framework, we considered that these inexplicit components consist
244 of mitigation or adaptation that contains benefits contributing to mitigating or adapting to climate
245 change, but their climate benefits are not directly referred to in the ES. Mitigation or adaptation
246 which has inexplicit climate change benefits can include: the recycling or reusing materials, traffic
247 management through using low emission vehicles, site and office based energy saving measures or

248 the planting of trees. For this assessment, all mitigation and adaptation within each chapter was
249 thoroughly reviewed and any climate-related mitigation or adaptation not referenced to climate
250 change was documented into a table containing the mitigation or adaptation measure and the
251 chapter in which it was included.

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

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257 **3 Results**

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

262 3.1. Justification for the need for mitigation and adaptation

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

266 3.1.1 *Justification: policy context*

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

274 3.1.2 *Justification: development context*

275 The second part of the question focused on the justification for the climate change effect(s) on the
276 development or the project's contribution toward climate change. Eight projects were awarded an A
277 and the remaining two either a B or C. Those that achieved an A detailed the specific risks to the
278 project along with data, predictions and evidence where available. There was also reference to the
279 specific areas of the project that would contribute to climate change. For example, High Speed 2
280 (HS2) outlined where increased greenhouse gas emissions would originate (from the construction
281 phase in embedded materials and activities and from the operational phase through the use of

282 electricity and freight). This was supported by emissions data and an extensive greenhouse gas
283 assessment. Ashford Airport gained a B as the impacts on the development were discussed, but
284 there was a lack of data, despite specific discussion of increases in greenhouse gas emissions.
285 Mersey Gateway gained a C as detail of the project's contribution to climate change was limited to
286 the statement: 'traffic during the operational and construction phase will result in emissions'.
287 Furthermore, the Mersey Gateway chapter 'air quality and climate' mainly focused on the impacts to
288 air quality with little reference to climate change throughout, despite the importance of carbon
289 dioxide emissions to climate change being stated in the chapter introduction.

290 3.1.3 *Justification: climate change context*

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

300 3.2 Justification for mitigation and adaptation

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

307 element of the mitigation or adaptation or instead provided a general statement as the justification.
308 For example, Luton Airport's justification was limited to: 'these measures are to mitigate emissions
309 during construction and demolition phases'.

310 3.3 Detail given in mitigation and adaptation description

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

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

325 3.4 Inclusion of the effectiveness or benefits of the mitigation

326 Question 3.4 assessed the level of justification given of the effectiveness or benefits of the measure
327 (Table 4). Grades ranged from A-D with eight of the projects receiving either a C or D. The Northern
328 Distributor Road was the only project to achieve an A. This was due to the project containing a full
329 assessment of the benefits of the tree and shrub planting mitigation. The benefits of the remaining
330 mitigation measures were explained and where this was not possible, this was stated. In addition to

331 the Northern Distributor Road, the Leeds New Generation Transport was the only project to gain a B.
332 This project presented a table measuring the overall performance of each mitigation and adaptation
333 measure, grading them from moderate to high. Furthermore, the table described 'management of
334 impacts to the scheme' and 'management of impacts to the wider environment'. The mitigations
335 were additionally appraised in the project's appendices however not all measures were included
336 therefore the project was limited to a B.

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

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

350 3.5 Evidence of commitment

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

354 Grades ranged from B-D with two projects achieving a B, two a C and the remaining five a D. The
355 Northern Line Extension was not given a grade as the document that contained information of

356 commitment to the mitigation and adaptation could not be located. North Doncaster Chord and
357 Luton Airport gained B grades as these projects stated their commitment to the mitigation along
358 with actions to achieve their commitment. For example, Luton Airport outlined a three year carbon
359 management plan, managed by British Gas, and a target to save 3000 tonnes of carbon by December
360 2013 compared to 2010. North Doncaster Chord outlined Network Rail's sustainability policy and
361 steps to achieve this which included a detailed consideration of embodied carbon, engaging with
362 suppliers, a sustainable construction strategy and maximising opportunities for sustainable materials
363 transport. These projects were not awarded an A because the evidence of commitment was not
364 comprehensive with both lacking budgets, North Doncaster lacking targets and organisations
365 involved, and Luton Airport lacking detail in specific tasks.

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

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

380 3.6 Evidence of measuring or monitoring

381 This question assessed the existence of monitoring or measuring of the climate mitigation and
382 adaptation measures (Table 4). Grades ranged from B to E with only Mersey Gateway achieving a B,
383 the NLE achieving a C, six projects receiving a D and two an E.
384 Mersey Gateway outlined a monitoring regime with the council along with proposed continuous and
385 non-continuous monitoring methods. The NLE exhibited evidence of monitoring within external
386 documents such as the 'energy management plan' which outlined audits for all energy using
387 processes to identify high energy demand areas that could be targeted for reduction measures.
388 Projects that achieved a D had vague mentions of monitoring, such as the Northern Distributor Road
389 which, in the section 'how the measures will be implemented, measured and monitored', mentioned
390 the CEMP but gave no further information. Leeds New Generation contained a section on
391 monitoring and evaluation however there was an absence of specific monitoring measures.
392 Finally, HS2 and Ashford Airport achieved E grades as there was no indication of monitoring
393 measures.

394 3.7 Inexplicit climate mitigation

395 All projects contained forms of inexplicit climate mitigation and adaptation in various chapters other
396 than those concerning climate change (Tables 6 and 7).
397 The Northern Distributor Road and North Doncaster Chord contained the highest number of
398 chapters with inexplicit climate related measures of seven and six chapters respectively. In
399 comparison, the airport projects and Mersey Gateway contained the lowest number with only three
400 or four chapters including inexplicit climate measures. Inexplicit climate mitigation and adaptation
401 appeared in eight of the ecology chapters and seven landscape and visual and water resources
402 chapters. Waste and traffic and transport were also included in six and five chapters respectively
403 (Table 7 and 8).
404 Other various climate mitigation and adaptation measures present in the socio-economics,
405 materials, cultural heritage and geology chapters included: increasing the proportion of open space,

406 using waste products where applicable, planting trees, shrubs and woodland to screen views and

407 works not to be carried out in extreme weather respectively.

408

409 4 Discussion

410 The discussion addresses the key findings from the application of the review package. It focuses on
411 the reasons for a lack of commitment to climate mitigation and adaptation and post-decision
412 monitoring and the many forms of inexplicit climate mitigation and adaptation measures that are
413 not referenced directly to climate change. The review method and its limitations are assessed and
414 the discussion concludes by evaluating if EIA is a good platform to consider climate change.

415 4.1 Lack of evidence of commitment, monitoring or measuring

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

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

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

431 Following consultation with professionals, P6 explained that *“when producing the ES, if aspects, such*
432 *as post-auditing and evidence of commitment, are not required, they are not further explored despite*

433 *being best practice*". Reasons for this neglect include the cost and time of monitoring, vague impact
434 predictions and the absence of mandatory or auditable requirements (Wood et al 2000; Wang et al
435 2003), and a more recent review identified implementation costs, lack of enforcement and a lack of
436 appropriate legislation as the three main barriers to EIA follow-up (Jones & Fischer 2016). In
437 reference to the latter, fundamental to EIA is explicitly incorporating requirements into legislative
438 frameworks (Wood et al 2000; Jay et al 2007) however the requirement for post-decision auditing is
439 not explicit in the current EIA regulations. Revisions to the Directive (2014/52/EU) move towards a
440 clearer requirement for monitoring and commitment, by stipulating that Member States shall
441 implement mitigation measures and subsequent monitoring procedures for the significant adverse
442 effects (Article 8a (4)).

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

458 4.2 Commitment to climate change

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

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

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

482 4.3 Inexplicit climate mitigation

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

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

506 4.4 Assessment of the review process

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

519 Climate change in itself, is an aspect EIA should be 'reasonably expected to contain' (IEMA 2010; EC
520 2013) however as current practice has identified that climate change issues are not yet coherently
521 explored, asking expectant questions is an important step to advance knowledge in climate change
522 and EIA and expose the areas that are not adequately being addressed. The development of a novel
523 review method exploring new aspects of EIA is also important. Whilst there is variable literature
524 surrounding climate change in EIA, very few studies have reviewed climate mitigation and
525 adaptation, let alone developed a unique assessment method.

526 4.5 Limitations in method

527 Developing a review package requiring judgement on specific grade allocations can be subjective
528 and is dependent on the experience of the reviewers and their ability to judge the ES against the
529 assessment criteria (Glasson et al 2012). Furthermore, the criteria need to be as transparent as
530 possible for which it may be possible to refine our review package to include a further level of sub-
531 criteria in order to achieve this (see Methods Section 2.2 and Appendix E).

532 As this study exclusively evaluated climate change mitigation and adaptation within a small number
533 of transport projects that contained a chapter focussing on climate change, this could give an
534 incorrect impression of climate mitigation and adaptation within all ESs. For example, in the
535 inexplicit climate mitigation and adaptation assessment, the ecology and landscape chapters
536 contained inexplicit climate measures in the highest number of projects. This is expected within
537 transport projects as they are likely to adversely impact ecology and landscape features whereas
538 impacts to air quality and traffic are likely to be reduced following mitigation. This is a characteristic
539 inherent to transport projects but unlikely for some other project types. Despite this, the evaluation
540 of climate mitigation and adaptation within transport projects remains important as transport is
541 increasingly vulnerable to climate change and its emissions are major contributors to climate change
542 (Nagurney et al 2010). In addition, the wider impacts of the transport sector go beyond assessment
543 of projects and lie in changing transport modes, fuels and demands (Pathak and Shukla 2016).
544 Furthermore, as phase one of the method revealed that a more focused approach was required for a
545 higher level of analysis, evaluating specific ESs considering climate change was necessary for the aim
546 of this study.

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

554 4.6 Is EIA a good platform to evaluate climate change?

555 Given the regulation amendments and increasing concern over how to consider climate change in
556 EIA, it is important to address whether EIA is a good platform to evaluate climate change. Including

557 climate concerns in EIA only accounts for climate change impacts from new developments required
558 to undertake EIA. This excludes climate impacts from ongoing activities and from new developments
559 not requiring an EIA. As very small proportions of developments require an EIA (Department for
560 Communities and Local Government 1999), the impacts mitigated or adapted to within new
561 developments compared to those from existing developments will be very small. Additionally, as EIA
562 primarily identifies the impact of a project on the environment rather than the impact of
563 environmental change, EIA may not fully evaluate climate change (Agrawala et al 2011).

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

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

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

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

576 As the 2014 Directive amendment comes into force, points (2) and (3) need to be addressed in
577 symbiosis. On asking practitioners how they included climate change when producing an ES, P6
578 stated they *“used a variety of information and informal guides available as not one source was solely
579 appropriate”*. This statement, along with the low grades allocated to the last few questions in the
580 review demonstrates the disjointed nature of including climate change and the need for guidelines.

581 IEMA and engineering consultancy Mott MacDonald are later this year launching guidance on
582 climate change adaptation and resilience in EIA (IEMA 2015) and the EC have an extensive guide on
583 integrating climate change and biodiversity into EIA. This shows there will no longer be an absence
584 of guidance for including climate change, however their application by professionals is uncertain.
585 This suggests that the issue may not be the inclusion of climate change but how it is embraced by
586 individual professionals. Other elements of EIA have gone through similar transitions, with, for
587 example the UK's Chartered Institute for Ecological and Environmental Management Guidelines
588 pushing forward better practice in ecological assessment (Briggs & Hudson 2013).

589 **5 Conclusion**

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

596 With some caveats based on our examination of a sample of projects from one sector, this study has
597 suggested that EIA is not currently a good platform to consider climate change; however for its
598 successful integration, it is recommended that stronger links between the EIA process and continual
599 environmental management are needed through a more holistic consideration of climate change
600 and more explicit use of sustainability terms. Guidelines for integrating climate change mitigation
601 and adaptation are required in the UK (and see above, are now forthcoming) along with the
602 enhancement of the competence of practitioners through a change in their behaviour and attitudes
603 from viewing EIA less as a systematic process but rather as an integrative process. Finally, an
604 additional challenge will be adapting the EIA framework to consider climate change successfully and
605 sustainably given the conventional nature of EIA practice.

606 Including climate change in EIA should not be seen in isolation as a solution to mitigating or adapting
607 to climate change as only small proportions of new developments require an EIA and the climate
608 impacts from ongoing activities are excluded. Future research should investigate how to consider
609 climate change impacts from existing developments and activities and should evaluate the lessons
610 learnt from integrating climate change into EIA.

611

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613

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618

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759

760 *Table 1. The categories that the climate related terms were grouped into.*

Category	Explanation
Climate change impact	Description or explanation of generic impacts of climate change
Climate change impact on the development	Description of how climate change will affect the development
Impact of the development on climate change	Description of how the development will contribute to climate change
Need for the development	An explanation of the need for the development with reference to climate change
Benefits of the development	An explanation of the benefits of the development with reference to climate change
Policy	Any mention of climate-related policy
Data/modelling	Any reference to climate-related data or modelling methods
Mitigation measures	Any mention of climate-related mitigation measures

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762

763 *Table 2. Summary of the three main review criterion that influenced the content of the review criteria*
 764 *developed in this study.*

Source	Summary of review criteria
Lee and Colley review criteria (1992)	Grades ESs A-F under four main topics: <ol style="list-style-type: none"> 1. Description of the development, local environment and the baseline conditions 2. Identification of impacts, prediction of impact magnitude and assessment of impact significance 3. Alternatives, mitigation and commitment to mitigation 4. Communication of results – presentation, balance and non-technical summary
Oxford Brookes review package (Glasson et al., 2011)	Grades ESs A-F under eight different criterion: <ol style="list-style-type: none"> 1. Description of the development 2. Description of the environment 3. Scoping, consultation and impact identification 4. Prediction and evaluation of impacts 5. Alternatives 6. Mitigation and monitoring 7. Non-technical summary 8. Organisation and presentation of information
Department of the Environment Transport and the Regions (DETR) review pro-forma of mitigation measures in environmental statements (1997)	Made up of two sections: <ol style="list-style-type: none"> 1. Overview of project: <p>Project location, type, date of ES, project description, timing, nature of area and importance of environmental resources.</p> 2. Treatment of mitigation: <p>Questions such as: ‘to what extent does the mitigation cover the appropriate scope of negative impacts’ ‘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’</p>

765

766

767 *Table 3. An outline of purpose of the three sections in the review criteria and the source they were*
 768 *adapted from.*

Section	Purpose	Graded?	Source adapted from
Section one 'general project features'	This provides a useful overview of the project for quick-reference, especially useful for external sources unfamiliar with the project.	No	DETR review pro-forma
Section two 'project and mitigation descriptions'	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.	No	DETR review pro-forma; Oxford Brookes review package
Section three 'mitigation evaluation'	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.	Yes	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.

769

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771 Table 4. The grading criteria for allocation of grades A-E for each question.

Grade/ Question	A	B	C	D	E
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?	Clearly justified with full evidence where necessary Note: for 3.1.1 Grade A given for at least three levels of policy explained.	Good justification given (with some evidence where necessary) Note: for 3.1.1 Grade A given for only two levels of policy explained.	Partial or generic justification with limited evidence Note: for 3.1.1 Grade A given for only one level of policy explained.	Incomplete justification	No justification given. Measure is stated with no rationale.
3.2. Is a justification given for the chosen mitigation?	Each measure is clearly justified with full evidence where necessary	Good justification given (with some evidence)	Partial or generic justification	Incomplete justification	No justification given. Measure is stated with no rationale.
3.3. How detailed is the description of the mitigation measure?	Fully detailed, all the listed information is provided.	Detailed, with small or minor omissions; most of the information is given.	Some detail, some of the information is given to a level that is sufficient.	Little detail	No detail or additional information given.
3.4. Is the effectiveness or benefits of the chosen mitigation stated?	The effectiveness/benefits are clearly stated with evidence where necessary. Or the benefits are unknown and this is stated.	The effectiveness/benefits are explained.	The effectiveness/benefits are stated but not explained.	Little or inconsistent mention of the effectiveness /benefits.	The effectiveness/benefits are not mentioned.
3.5. Is there evidence of commitment to implementing the mitigation?	There is comprehensive evidence of commitment to mitigation.	There is good evidence of commitment.	There is some evidence of commitment.	There is little information given with key omissions.	There is no evidence of commitment.
3.6. Is there evidence of measuring or monitoring the success of the mitigation measures?	There is detailed and comprehensive evidence of monitoring of the measures	There is significant evidence of monitoring	There is some evidence of monitoring initiatives	There is very little or inconsistent mention of monitoring	There is no mention of monitoring

773 *Table 5. An outline of the ten transport projects and their relevant chapter containing climate change*
 774 *that was evaluated in this study.*

Project	Year of ES	Chapter containing climate change
1. Northern Line Extension (NLE)	2013	ES Chapter 16 'Climate change adaptation and mitigation'
2. High Speed 2 (HS2)	2013	Volume 5 'preliminary consideration of potential climate change impacts'
3. Leeds New Generation Transport	2013	ES Chapter 7 'carbon effects' and Volume 4 'climate change management assessment'
4. North Doncaster Chord	2011	ES Chapter 7.3 'climate change'
5. Mersey Gateway	2008	ES Chapter 19 'air quality and climate'
6. M1 Junction 19 improvement	2010	Volume 1 chapter 6 'air quality and climate change' and Volume 2 chapter 1 air quality and climate change'
7. London Luton Airport	2014	Volume 1 Chapter 5 'carbon' and Volume 2 Chapter 16 'climate change risk assessment'
8. Northern Distributor Road, Norwich	2012	ES Chapter 6 'air quality'
9. Birmingham International Airport	2008	ES Chapter 5 'climate change'
10. London Ashford Airport	2006	ES Chapter 15 'air quality'

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777 Table 6. An overview of the grades allocated for each individual project and question. Colour-coded
 778 for visual impact: green represents a good quality answer, yellow an average answer and red an
 779 unsatisfactory answer.

Project/Question	3.1.1	3.1.2	3.1.3	3.2	3.3	3.4	3.5	3.6
	Justification: policy context	Justification: development context	Justification: climate change context	Justification for mitigation	Detail of mitigation	Effectiveness or benefits stated	Evidence of commitment	Measuring/ monitoring
NLE	A	A	A	B	C	D	n/a	C
HS2	A	A	B	A	C	C	D	E
Leeds NGT	A	A	A	B	C	B	C	D
North Doncaster Chord	A	A	B	B	C	D	B	D
Mersey Gateway	A	C	D	C	B	C	D	B
M1 Junction Improvement	A	A	A	B	B	C	C	D
London Luton Airport	B	A	E	C	C	C	B	D
Northern Distributor Road, Norwich	A	A	A	B	C	A	D	D
Birmingham International Airport	B	A	B	B	B	D	D	D
London Ashford Airport	B	B	B	C	C	D	D	E

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781 Table 7. The chapters in each project where inexplicit climate mitigation and adaptation were
 782 present.

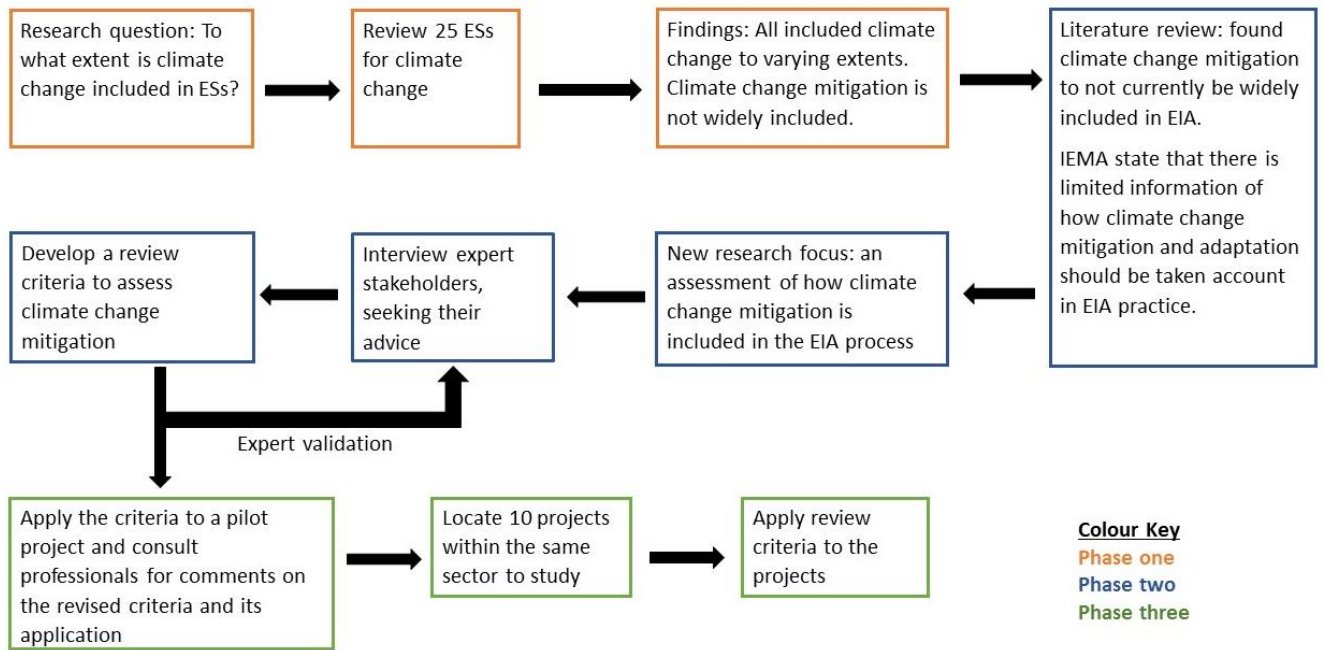
Chapter/Project	Ecology	Air quality	Landscape and visual	Traffic and transport	Waste	Water resources	Socio-economics	Materials	Cultural Heritage	Geology and soils
NLE	X	X	X				X			
HS2			X	X	X	X				
Leeds NGT	X	X			X	X				
North Doncaster Chord	X	X		X	X		X	X		
Mersey Gateway	X			X	X					
M1 Junction Improvement	X		X			X		X		
London Luton Airport	X		X	X		X				
Northern Distributor Road, Norwich	X	X	X		X	X			X	X
Birmingham International Airport	X		X			X				
London Ashford Airport			X	X	X	X				

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Table 8. Examples of the projects and chapters which contained inexplicit climate mitigation and adaptation.

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



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Figure 1. Flow chart outlining the steps involved in the three phases of research for this paper.

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