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# Consideration of climate change on environmental impact assessment in Spain

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ABSTRACT

Most of the projects subject to environmental impact assessment (EIA) are closely related to climate change, as they contribute to or are affected by it. The growing certainty about climate change and its impacts makes its consideration an essential part of the EIA process, as well as in strategic environmental assessment (SEA).
This paper examines how climate change (CC) has been taken into account in EIA in Spain through the analysis of 1713 environmental records of decision (RODs) of projects submitted for EIA. In 2013 Spain approved one of the most advanced laws in terms of CC consideration in environmental assessment, although it had not yet accumulated extensive practice on the issue. This contrasts with the situation of countries like Canada or the USA, which have a significant body of experience without specific legal requirements.
Only 14% of the RODs analysed included references to CC, and in more than half of the cases it was a mere citation. Thermal power plants, which are subject to specific GHG regulations, show the highest consideration, while transport infrastructures, which are important contributors to CC, show a very low consideration. Almost all the references are related to their contribution to CC, while consideration of the effects of CC is minimal.
The increasingly common incorporation of CC into SEA, should not imply its exclusion from EIA, because both processes have different aims and uses. Including the obligation to consider CC in the EIA regulations is highly desirable, but probably not enough without other measures, such as practical guidance, training and motivational programmes for practitioners and evaluators. But even these actions cannot ensure effective and adequate assessments of CC. Probably more resources should be spent on creating greater awareness in all the agents involved in EIA.

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## 1. Introduction

Climate change (CC) is a global problem which presents increasing scientific certainty and a detailed understanding of its causes, impacts and consequences. Policies, plans and actions aimed to reduce the anthropogenic contribution to CC and remedy the vulnerability of ecosystems and societies are necessary.

Many plans and programmes subject to strategic environmental assessment (SEA) as well as projects subject to environmental impact assessment (EIA) are closely related with CC, contributing to or being affected by it. SEA and EIA, tools for integrating environmental considerations into decision making, have great potential to incorporate CC considerations, contributing to both its mitigation and adaptation. Nowadays, CC aspects in environmental assessment are receiving growing international attention, but few countries have gathered a significant amount of experience. Some developed countries have improved significantly in recent years, and according to Agrawala et al. (2010) Canada is probably the benchmark.

The Canadian Environmental Assessment Agency (CEAA) has provided guidance about the integration of CC in EIA (CEAA (Canadian Environmental Assessment Agency), 2003), based on a previous report (Lee, 2001). After the analysis of the effectiveness of EIA made by the CEAA, Hazell (2010) concludes that it failed in effectively addressing GHG emissions. Stinson (2010) recommends improving and promoting the use of guidance, the proposal of significance thresholds and legislative changes, and thinks that the EIA of projects may be more appropriate to address adaptation to the impacts of CC than to reduce GHG emissions. Ohsawa and Duinker (2014) also analyse CEAA guidance, which was cited in more than half of the examined environmental impact statements (EISs), and conclude that assessing GHG emissions and proposing mitigation measures in EIAs are currently well established practices.

In the USA the Council on Environmental Quality (CEQ) issued a first guidance draft in 1997 updated in 2010 (CEQ (Council on Environmental Quality), 1997, 2010) about consideration of the CC effects in accordance with the National Environmental Policy Act (NEPA). The guidance proposes to analyse direct and indirect GHG

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emissions when they are expected to surpass 25,000 t of $CO_2$ equivalent per year, or even less in long-term projects. This does not mean that significant effects are going to appear above that value, but it serves as an indicator to justify a detailed analysis. Although the guidance is non-binding, federal agencies have begun to incorporate the consideration of CC and GHG emissions in their EISs (Woolsey, 2012).

The Green and White Papers on adaptation to CC in Europe (EC (European Commission), 2007, 2009) propose its incorporation into EIA and SEA Directives, which has been done for the EIA Directive 2014/52/EU but not for the SEA's, not yet reviewed. The European Commission has published two guidelines about the integration of CC and biodiversity in EIA and SEA (EC (European Commission), 2013a,b).

The UK Environment Agency has guidelines on CC, planning and SEA (EA (Environment Agency), 2008, 2011) and the Institute of Environmental Management and Assessment has published two documents about CC and environmental assessment (IEMA (Institute of Environmental Management and Assessment), 2010a,b). Hamada (2008) studied how CC is treated in EISs in the UK, noticing that although the issue is taken into account, it does not really influence decision making, because it mainly consists of general remarks. Yi and Hacking (2012) analysed the consideration of CC in urban development projects, concluding that it is still in its infancy, not being adequately addressed in the EISs, lacking scientific rigour and failing to predict and evaluate GHG emissions and CC impacts. They propose to establish adequate protocols and guidelines.

In Germany the consideration of CC is usual in SEA, but less so in EIA. Helbron et al. (2011) suggested a set of indicators to include the adaptation to CC in land planning and Wende et al. (2012) analysed the consideration of CC impacts in the SEA of land use plans in Saxony and East England.

The Netherlands Commission for Environmental Assessment established that attention should be paid to mitigation for actions that contribute significantly to GHG emissions such as industrial projects, power plants, infrastructure, crops in greenhouses, construction, waste processing, mining, water or airfields (Draaijers and van der Velden, 2009).

Several guides are available in Western Australia to assist the preparation of EISs, including GHG emissions as an environmental factor to assess, with the objectives of minimization and compensation (EPA, 2010). Sok (2014) discussed the consideration of CC in EIA in this territory, noting that the main aspect analysed is GHG emissions, but it is a discretionary matter and with very different judgments in the different cases. He proposes establishing appropriate guidelines and training along with the use of SEA to attain better considerations of CC. According to national guidance (ACT (Australian Capital Territory), 2012), in the Australian Capital Territory impacts of CC on policy proposals must be assessed. The Northern Territory Government has a brief but comprehensive guide devoted to the consideration of GHG emissions and CC in EIA (NT (Northern Territory), 2009).

The integration of CC considerations in China is mainly implemented at the SEA level and it is currently facing problems due to lack of regulations, standards, criteria and experience (Chang and Wu, 2013). The topic that receives most consideration is energy consumption and GHG emissions. Li et al. (2013) propose mechanisms to consider CC in SEA and Deng and Wang (2014) demand indicators for the same purpose.

In South Korea the assessment of GHG emissions in EISs is not a legal requirement, but the scoping committee can decide on its inclusion (Yi and Hacking, 2011). In Cambodia CC has been considered in some EISs, but it is generally only mentioned, without further analysis (Sok, 2014).

Kamau and Mwaura (2013) studied the considerations of adaptation to CC in EISs in Kenya and found them weak in predictive scenarios and their possible impacts on projects.

Gilder et al. (2011) indicate that the mitigation and adaptation to CC in South Africa has already been taken into account in some EIA processes, but that incorporation into the legislation is still advisable; although an amendment for this inclusion was raised in 2008, it finally did not figure in the 2010 EIA Act.

The guidelines of the International Union for Conservation of Nature for the application of SEA in Central America (UICN (Unión Internacional para la Conservación de la Naturaleza), 2007) include recommendations for the consideration of CC. The Caribbean Community and the Secretariat of the Pacific Regional Environment Programme have prepared a guide on the integration of adaptation to CC in EIA in the Caribbean and South Pacific (CARICOM-SPREP (Caribbean Community-Secretariat of the Pacific Regional Environment Programme), 2004). It proposes the inclusion of CC in the definition of the EIA, providing criteria to ensure the identification of significant impacts and guidelines for the preparation of EISs as well as standards on qualifications and experience of practitioners.

Sok et al. (2011) studied the incorporation of CC into the EIA through 160 responses to a survey sent to professionals from different countries. They analyse how CC should be incorporated into EIA in its different phases, screening, scoping, EIS, public participation, evaluation and approval and implementation and monitoring. In all cases, regulations and guidelines are considered a priority.

Watkins and Durning (2012) analyse 25 EISs from UK, USA, Canada, Australia, New Zealand, Egypt, Hong Kong, India, Russia, Georgia and Mauritius, from a range of different developments, concluding that the terminology used to describe GHG emissions varies widely, creating confusion and making cross-study comparisons and cumulative considerations very difficult.

## 2. EIA and climate change in Spain

In the European Union (EU) the EIA process was incorporated by Directive 85/337/EEC (EU (European Union), 1985), amended several times, most recently by Directive 2014/52/EU (EU (European Union), 2014). With the incorporation of Spain into the EU in 1986, Community legislation, including EIA regulations, became mandatory. Until then, Spain lacked a proper EIA process. The first EIA Act was the transposition of Directive 85/337/EEC to Spanish law, the Royal Legislative Decree (RDL) 1302/1986 on EIA (BOE (BOLETÍN OFICIAL DEL ESTADO), 1986), which is currently abrogated. Two years later the associated Regulations were promulgated by Royal Decree 1131/1988 (BOE (BOLETÍN OFICIAL DEL ESTADO), 1988).

After nearly a decade of EIA implementation in Europe, Directive 85/337/EEC was amended by Directive 97/11/EC (EU (European Union), 1997), with the main objective of introducing provisions to clarify, supplement and improve the EIA process. This amendment resulted in a modification of Spanish EIA regulations, Law 6/2001 (BOE (BOLETÍN OFICIAL DEL ESTADO), 2001). Subsequently, different national and EU regulations were enacted, such as those related to public participation, rights of access to information and justice in environment, and in 2006 a Judgement of the European Court of Justice stated that Spain had incompletely adopted the EIA Directive (EU (European Union), 2006). The SEA Law 9/2006 (BOE (BOLETÍN OFICIAL DEL ESTADO), 2006), derived from the implementation of Directive 2001/42/EC on SEA (BOE (Boletín Oficial del Estado), 2001), also amended the EIA Act. All these changes led to a revised EIA Act, in RDL 1/2008 (BOE (BOLETÍN OFICIAL DEL ESTADO), 2008). Finally, a new Environmental Assessment Act, Law 21/2013, was approved in December 2013 (BOE (BOLETÍN OFICIAL DEL ESTADO), 2013), unifying the EIA and the SEA processes into the same legal text. Shortly after the EIA Directive 2014/52/EU was approved, which did not demand significant changes to the current law.

The ordinary EIA process in Spain includes an initial scoping phase (mandatory until 2013 and voluntary after Law 21/2013), the preparation of an EIS, a phase of public information and consultation, and the issue of a resolution, the Record of Decision (ROD), by the environmental agency. With regard to allocation of jurisdiction, the Central Government is responsible on the EIA of projects whose authorization

corresponds to the State, while in the remaining cases the jurisdiction falls to the Autonomous Communities (Regional Governments).

The Directive 85/337/EEC and the RDL 1302/1986 indicated that the direct and indirect effects of the projects on different factors, including climate, should be identified, described and assessed appropriately, and these requirements have been maintained in successive EIA regulations. CC is implicitly included among the environmental factors, although there is no explicit reference to it until Law 21/2013, which anticipates Directive 2014/52/EU specifying the obligation to consider CC. A key difference between EU and Spanish regulations is that while in the EU the consideration of CC is only compulsory in EIA, in Spain it must be considered both in EIA and in SEA. Accordingly, nowadays Spain has one of the most advanced laws in the world in terms of the obligation to incorporate CC in the environmental assessment, although it does not derive from the accumulation of actual experience, as we discuss later.

The history of the EIA process in Spain is reviewed in many books and papers, although most of them have become outdated with successive amendments to the legislation. Some useful references are Nogueira (2009); Carrasco and Enríquez-de-Salamanca (2010); Lozano et al. (2012); Enríquez-de-Salamanca (2014) or Burzaco (2014). Several papers analyse the quality of EISs in Spain, specifically or together with other EU countries (Alonso et al., 1996; Barker and Wood, 1999; Canelas et al., 2005), and all of them conclude that some of the reviewed EISs were unsatisfactory, although significant improvements are found in the final years of each survey.

In the present study we analyse the consideration of CC in EIA in Spain in the past and in the present, a study that has not been previously undertaken, as far as we know, in any published paper. The aim of our research is to estimate the degree of integration of CC in EIA, with respect to a set of significant factors, namely: the type of projects and developers, the impacts considered, the level of detail and the mitigation measures, and to relate the Spanish situation with the international context, particularly with the most advanced countries in the field.

## 3. Methodology

This research is based on the analysis of all RODs issued by the Central Government since the start of the EIA process in Spain (although it was incorporated in 1986 the first ROD was published in 1989) until the end of 2014. This methodology has been frequently used in Spain in research about EIA: consideration of ecological compensation (Villarroya and Puig, 2010, 2013; Carrasco et al., 2013), social impact (Pardo, 1994), dams (Pizarro and Soca, 2001) seawater desalination plants (Fuentes-Bargues, 2014) or mitigation measures in roads (Gómez, 2007; Aizpurúa, 2010).

As Villarroya and Puig (2013) indicate a ROD is the public document where the approving agency presents the factors assessed in reaching a final environmental authorization decision on a project, and apart from the EIS it is the main and only publicly available documentary source on EIA decision making. It is also the most concrete legally binding document on EIA.

Although the structure of the RODs has varied over the years, some essential aspects are invariant: the description of the process, of the environmental impacts considered, of mitigation measures, of opinions or allegations made in the phases of scoping and public information and of some conditions for the project, whether design or mitigation measures (Carrasco and Enríquez-de-Salamanca, 2010; Villarroya and Puig, 2013; Fuentes-Bargues, 2014).

The analysis of the RODs is less exhaustive than the EISs themselves, but summarizes all the significant impacts of the projects and how they have been analysed. There is a possibility that a significant impact analysed in the EIS may not be included in the ROD. We assume, as the previously cited authors, that the degree of imprecision is very low and unavoidable, and that it does not invalidate the conclusions of the study, although the possibility that some significant impacts could be misrepresented remains.

Being public resolutions, it is possible to access all RODs, unlike the EISs, whose consultation after the public information phase is difficult, if not impossible. This methodology allowed us to analyse a large number of cases, 1713 in this research. Furthermore, RODs include information about the whole EIA process that is not present in the EIS, such as the main opinions or allegations submitted in the scoping or public information phases, as well as developer responses.

Among all the addressed RODs we have selected those that include any reference to CC, at any stage of the EIA process, and made by any of the participants, even if they are not included in the EIS. We used the following keywords to detect references to the analysed issue: “climate”, “climate change”, “greenhouse effect”, “greenhouse gases”, “gases”, “$CO_2$”, “carbon”, “emissions” or “heating”. Although all RODs are digitized, the older ones are in raster format, not allowing a digital search for terms. In such cases (18 RODs, 1% of the total), we have read the whole text, manually detecting references to CC. For those RODs containing any reference to CC we have recorded the following information:

- Approval resolution (title, date and Official Gazette).
- Developer name, indicating whether it is public or private.
- Project type, according to the classification of Table 1.
- Type of consideration of CC: a mere citation or an assessment.
- Type of impacts: contribution to CC or effects of CC on the project.
- Agents who cited CC: developer, environmental agency, NGOs, …
- Measures or conditions established in relation to CC.

Unfortunately, the studies about consideration of CC in EIA that we are aware of are not useful for the Spanish situation. For instance, the database prepared by the Columbia Law School (Woolsey, 2012) based on 227 EIS between 2009 and 2011 for CC impacts, used the detailed categories given in Gerrard (2008), while barely two categories are appropriate for the Spanish case. As noted below, we found that CC is mainly just cited, in more than half of the cases, or it is a simple quantification of $CO_2$ emissions which is not used at all in the rest of the EIA.

With regard to SEA, although Law 21/2013 establishes a strategic environmental decision at the end of the process, it is a recent legal requirement and there is not enough experience yet to make a relevant analysis. However, the case of the SEA in the Spanish Transport Infrastructure Plan 2005–2012 (PEIT) is noteworthy because its contribution to global warming was used as an impact indicator (García-Montero et al., 2010).

## 4. Results

We performed a complete analysis of the information recorded (level of consideration of CC, impacts related to CC, project group, developer and specific measures), their time evolution and their mutual relationships, and the main results are presented below.

### 4.1. Type of consideration of climate change

In a first period between 1989 and 1998 RODs did not contain any reference to CC (except one power plant in 1994). More references to CC appeared after 1999, but there is no clear trend over time (Fig. 1). The highest consideration rates occurred in 2005, 2000 and 2010 in relative value, or in 2009, 2005 and 2010 in absolute value. The temporal changes in the consideration of CC are mainly related to the type of projects dominant each year, especially the amount of thermal power plant projects evaluated. We have not detected an independent trend that could be associated with a temporal improvement in the quality of studies.

On average, CC is considered in 14% of the cases. There are different ways to consider CC in the EIA process but, mainly it is just used as an

**Table 1**
Classification of projects submitted to EIA, degree and type of consideration of climate change.

| Project type (group/subgroup) | Projects submitted to EIA | | RODs with references to CC | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total | | | CC assessed | | | | CC cited | | | |
| | No. | % | No. | % | | No. | % | | | No. | % | | |
| | | | | Abs[1] | Rel[2] | | Abs[1] | Rel[2] | Rel[3] | | Abs[1] | Rel[2] | Rel[3] |
| 1. Production and transport of energy | 349 | 20.4 | 88 | 7.5 | 25.2 | 38 | 3.2 | 10.9 | 43.2 | 50 | 4.3 | 14.3 | 56.8 |
| a. Thermal power | 66 | 3.9 | 56 | 4.8 | 84.8 | 23 | 2.0 | 34.8 | 41.1 | 33 | 2.8 | 50.0 | 58.9 |
| b. Hydroelectric | 159 | 9.3 | 10 | 0.9 | 6.3 | 0 | 0.0 | 0.0 | 0.0 | 10 | 0.9 | 6.3 | 100.0 |
| c. Renewable energy | 3 | 0.2 | 2 | 0.2 | 66.7 | 0 | 0.0 | 0.0 | 0.0 | 2 | 0.2 | 66.7 | 100.0 |
| d. Power lines and substations | 115 | 6.7 | 20 | 1.7 | 17.4 | 15 | 1.3 | 13.0 | 75.0 | 5 | 0.4 | 4.3 | 25.0 |
| e. Nuclear energy | 6 | 0.3 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 |
| 2. Oil and gas | 110 | 6.4 | 21 | 1.8 | 19.1 | 13 | 1.1 | 11.8 | 61.9 | 8 | 0.7 | 7.3 | 38.1 |
| a. Natural gas (extraction storage, transport) | 86 | 5.0 | 15 | 1.3 | 17.4 | 7 | 0.6 | 8.1 | 46.7 | 8 | 0.7 | 9.3 | 53.3 |
| b. Oil and derivatives (refineries, storage) | 24 | 1.4 | 6 | 0.5 | 25.0 | 6 | 0.5 | 25.0 | 100.0 | 0 | 0.0 | 0.0 | 0.0 |
| 3. Transport infrastructures | 719 | 41.9 | 36 | 3.0 | 5.0 | 15 | 1.3 | 2.1 | 41.7 | 21 | 1.8 | 2.9 | 58.3 |
| a. Roads | 434 | 25.3 | 12 | 1.0 | 2.8 | 1 | 0.1 | 0.2 | 8.3 | 11 | 0.9 | 2.5 | 91.7 |
| b. Railways | 137 | 8.0 | 2 | 0.2 | 1.5 | 1 | 0.1 | 0.7 | 50.0 | 1 | 0.1 | 0.7 | 50.0 |
| c. Airports, aerodromes and heliports | 74 | 4.3 | 18 | 1.5 | 24.3 | 11 | 0.9 | 14.9 | 61.1 | 7 | 0.6 | 9.5 | 38.9 |
| d. Ports | 74 | 4.3 | 4 | 0.3 | 5.4 | 2 | 0.2 | 2.7 | 50.0 | 2 | 0.2 | 2.7 | 50.0 |
| 4. Water management | 402 | 23.5 | 17 | 1.5 | 4.2 | 6 | 0.5 | 1.5 | 35.3 | 11 | 0.9 | 2.7 | 64.7 |
| a. Water transfers, channels, irrigation | 159 | 9.3 | 7 | 0.6 | 4.4 | 2 | 0.2 | 1,3 | 28.6 | 5 | 0.4 | 3.1 | 71.4 |
| b. Desalination and sewage treatment plants | 75 | 4.4 | 7 | 0.6 | 9.3 | 3 | 0.2 | 4,0 | 42.9 | 4 | 0.3 | 5.3 | 57.1 |
| c. Dams and reservoirs | 94 | 5.5 | 3 | 0.3 | 3.2 | 1 | 0.1 | 1,1 | 33.3 | 2 | 0.2 | 2.1 | 66.7 |
| d. Rivers | 74 | 4.3 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0,0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 |
| 5. Mining | 70 | 4.1 | 0 | 0.0 | 0.0 | 0 | 0.0 | 0,0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 |
| 6. Other projects | 63 | 3.7 | 2 | 0.2 | 3.2 | 1 | 0.1 | 1.6 | 50.0 | 1 | 0.1 | 1.6 | 50.0 |
| Total | 1173 | 100.0 | 164 | 14.0 | 14.0 | 73 | 6.2 | 27.9 | 44.5 | 91 | 7.8 | 28.8 | 55.5 |

Abs[1]: no. ROD/total ROD. Rel[2]: no. ROD/no. projects submitted to EIA. Rel[3]: no. ROD/no. ROD with references to CC.

argument to defend or attack a project, and only in rare cases has it been taken into account in the EIA. We established two main types of CC consideration, assessed or only cited:

- Effects associated with CC are assessed. In these cases, the RODs record that the effects of CC (contribution or effects in the project) were quantified or somehow assessed during the EIA. We have established three subcategories (Fig. 2):

a) *The effects are measured and used in the assessment*. The effects are quantified, almost always via GHG emissions (particularly $CO_2$), and are used frequently to compare alternatives.
b) *The effects are measured, but not used in the assessment*. Projects in this category usually include calculations of $CO_2$ emissions, which are not used at all.
c) *Some general consideration of the effects is carried out*. These RODs include brief references to CC, although not as vague as in the cases where it is only cited.

- Effects associated with CC are only cited. This category gathers studies where an agent made reference to CC during the EIA process, but there is no true assessment. This is not a real consideration of CC in EIA, but only a concern or a use (often biased) by an agent. We propose three subcategories according to which agent cites CC (Fig. 3):

a) *Citation by the developer*. The developer usually cites CC as a justification for the project, in the EIS or in the responses to scoping or public information phases.
b) *Citation by other agents*. Third parties refer to CC in the scoping or public information phases. Frequently these parties are environmental NGOs opposing the project, or public agencies indicating that the contribution to CC should be considered in the EIS.
c) *Citation by both parties*. Frequently the developer and other agents develop a dialectical "battle" throughout the EIA process, the former to justify the positive effect of the project in reference to CC and the latter (usually environmental NGOs) to disagree.

### 4.2. Type of impacts related to climate change

We have defined two main categories according to the type of CC impacts assessed:

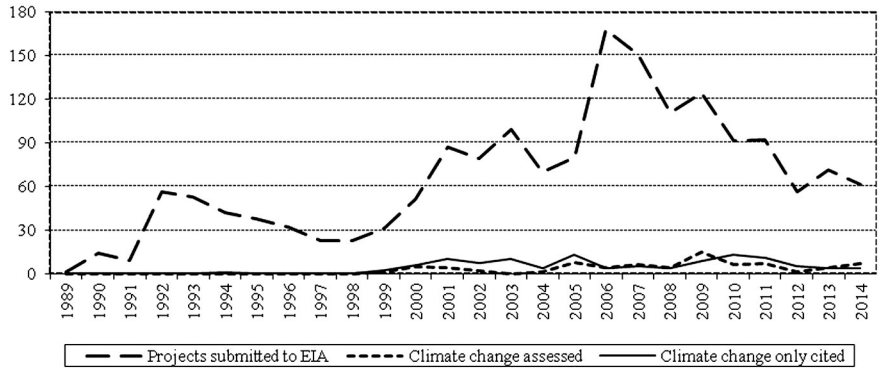


**Fig. 1.** Type of consideration of CC (number of RODs per year).

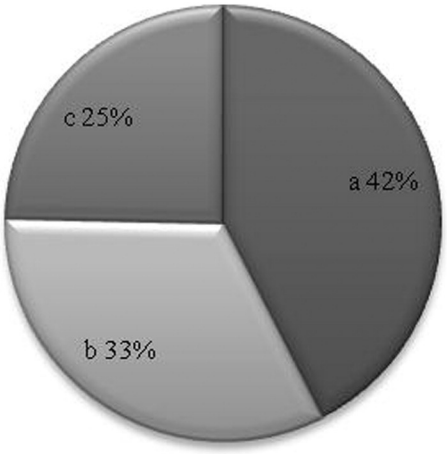


**Fig. 2.** Categories of CC assessment in the EIA.

- Contribution to CC. They represent 95% of the total. The main effect assessed or cited is the contribution to CC due to GHG (usually $CO_2$) emissions.
- Effects of CC on the project. Only 5% of the projects have references to these effects. One single project, a dam, made a true assessment, analysing the changes in the contributions of water from the basin due to CC. In the remaining cases the influence of CC is only cited.

### *4.3. Consideration of CC according to project type*

We classified the projects into groups and subgroups, calculating the degree of consideration of CC in each category as the ratio of the number of RODs where it has been taken into account with respect to the total of projects submitted for EIA (Table 1).

Considering the project groups, the maximum level of consideration corresponds to energy production and transportation projects, followed by oil and gas. Transport infrastructure projects have a very low value considering that the sector is closely related to CC. There is no consideration of CC in mining RODs, and it is low in the rest of the projects. At the subgroup level the maximum consideration occurs in thermal power plants and it is also high in renewable energies, although it is usually only used to justify the project's suitability. Lower rates are found in oil, airport, power lines and gas projects and even lower in desalination and sewage treatment plants, hydroelectricity, ports, water transfers, channels and irrigation, dams and reservoirs, other projects, roads and railways. There is no consideration at all in nuclear projects, mining and river activities.

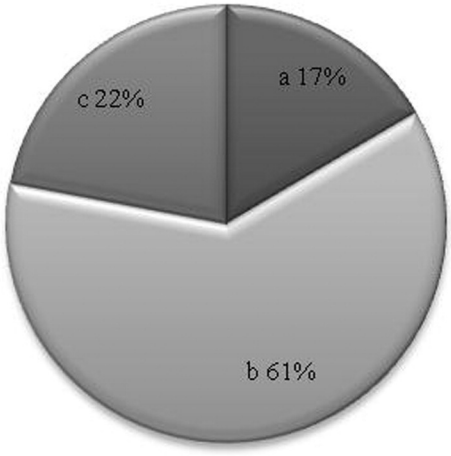


**Fig. 3.** Categories of CC citation in EIA.

For each category, we have differentiated the type of consideration of CC: whether assessed in some way or only cited (Table 1). The results obtained are:

- Production and transport of energy. A quarter of the analysed RODs includes references to CC.
  - *Thermal power plants.* Virtually all of them are combined cycle plants. This category accounts for a third of the cases considering CC, although it does not reach 4% of the projects submitted for EIA. Usually, they provoke strong social rejection because of their emissions of gaseous pollutants and GHGs, particularly when compared to renewable energies. Developers frequently calculate pollutant $CO_2$ and gas emissions and compare them with other power plant types (coal or diesel), in order to justify the project. There are few true assessments of GHG emissions and comparison of alternatives, and they are often partial or biased. The comparisons are usually made against more polluting technologies, overlooking renewable energies (wind or solar), which are obviously cleaner. Often the affected NGOs and municipalities invoked the contribution to CC, and the developer reply highlighting the advantages of these plants when compared to those of coal or diesel.
  - *Hydroelectricity.* CC is only cited in a minority of cases, mostly by the developer to justify the project. Frequently these projects have had negative RODs due to their environmental impacts on rivers, so CC becomes a favourable argument for developers, always private, to defend them. Environmental NGOs usually consider this justification insufficient.
  - *Renewable energy projects.* Only three projects have been assessed, and in two of them the developer cites CC as a justification. Although wind and solar farms proliferated in Spain in the last few decades, in almost all cases they fall under Regional Government's jurisdiction.
  - *Power lines and substations.* Less than a fifth of cases consider CC, typically addressing potential emission of $SF_6$, a GHG, during maintenance of switches. In some cases, environmental NGOs argued that power lines indirectly contribute to CC because they serve power plants.
  - *Nuclear energy.* All the projects are improvements of existing plants without any new construction and none of the RODs have references to CC.
- Oil and gas. One fifth of these RODs have references to CC.
  - *Natural gas.* This category includes projects of extraction, deep storage, transport (pipelines), compression stations and regasification terminals, less than a fifth of them with references to CC. The contribution to CC is often cited by environmental NGOs to criticise the projects and it is assessed only in half of these cases.
  - *Oil and derivatives.* This item includes projects of refineries and storage of oil or derivatives (diesel). A quarter of them had references to CC and in all cases they consist of a quantification of project's contribution.
- Transport infrastructures. These are the projects most commonly submitted for EIA along the analysed period, because the Central Government is responsible for the General State Road Network (the largest in the country), the vast majority of the railways, the ports and all major airports. CC has only been considered in a minority of these projects, a mere 5%.
  - *Roads.* Less than 3% of the RODs include references to CC, which almost always consist of arguments against the road; only the most recent project analysed incorporates the assessment of the contribution to CC, through the calculation of $CO_2$ emissions associated with construction.
  - *Railways.* Also in this subgroup the consideration of CC is minimal, although most of the Spanish High-Speed Rail Network was developed and assessed during the period evaluated. Only one project includes a true assessment, quantifying the reduction in $CO_2$ emissions in each alternative as a result of the uptake by the train of private vehicle users.

- *Airports, aerodromes and heliports*. A quarter of the cases includes references to CC, mostly calculations of emissions, including $CO_2$, but the results are not assessed.
- *Ports*. There is a low consideration of CC in this subgroup; in half of the cases there is an assessment and the other half only cited it.

• Water management. Only 4% of RODs contain reference to CC. Two thirds of the cases citing possible impacts of CC on the projects were in this group.
- *Water transfers, channels, irrigation and catchments*. There is a wide variety of water management projects, usually for irrigation or inter-basin transfer. Only 4.4% of the RODs include references to CC, in a quarter some assessment is registered and the rest only include a citation.
- *Desalination and sewage treatment plants*. Nearly a tenth of the RODs have references to CC, usually desalination plants, divided roughly equally between assessing and citing. In two cases CC is used to justify the purchase of electricity instead of constructing a power plant, but there is no calculation or comparison of alternatives.
- *Dams and reservoirs*. Only three of nearly a hundred RODs have references to CC, in one case an assessment and in two a mere citation.

• Mining. Mining is usually a jurisdiction of Regional Governments, except in special cases where the Central Government is responsible for granting authorization. So, there are not many projects evaluated, and none of them include references to CC.

• Other projects. The projects in this group do not belong to any of the previous categories. Two RODs have references to CC, an environmental reclamation where it is merely cited, and a conveyor belt for excavation materials where the contributions of the alternatives are analysed.

### 4.4. Consideration of climate change according to the developer

Out of all the RODs where CC has been considered, around one third of the projects have public developers (32%) while the rest (68%) are private. This result does not imply a higher concern on the part of private developers but it is explained by the link between project nature and the developer type. Public developers are responsible for most of the transport infrastructure (except some private aerodromes and heliports) and water management projects, whereas private developers are nearly always responsible for projects for production and transportation of energy, oil and gas. As a result, it is not possible to compare the consideration of CC between public or private developers among the same types of project.

### 4.5. Requirement of specific measures in the EIA

The RODs that include specific conditions or measures related to CC are less than a fifth of the cases (19%) of those where it is considered (Fig. 4). In most cases the required measure is an authorization for emission of GHG, issued by the Regional Government in accordance with the legislation on GHG trading. Actually, it is a legal obligation for thermal power plants and gas facilities and, although it is included as a requirement in the ROD, it is not really a mitigation measure. In two cases the quantification of $CO_2$ emissions in the environmental monitoring programme is required, and in another two the carbon footprint of the project after the EIA should be calculated. In one case the ROD proposes technical conditions. The most interesting case is a 2013 ROD of an extraction and transportation of natural gas, which proposed an equivalent compensation of the predicted $CO_2$ emissions using reforestation as a carbon sink. In two other projects compensatory measures for $CO_2$ emissions (carbon sink plantations) were requested during their EIA, but finally the RODs did not include them as an obligation.

## 5. Discussion and conclusions

After the analysis of all the RODs of projects submitted for EIA by the Spanish Central Government until the end of 2014, we found that only

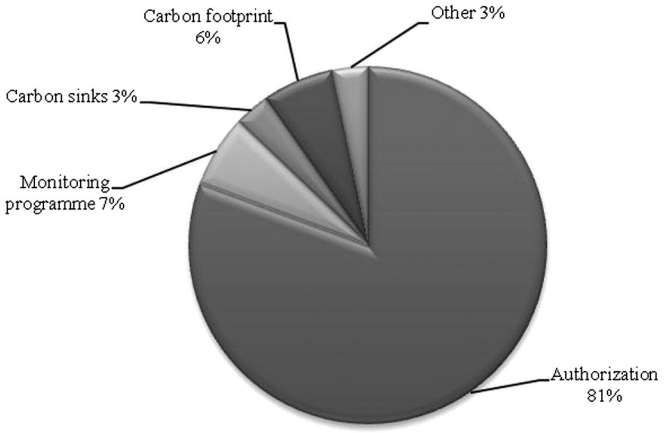


**Fig. 4.** Measures required in the RODs in relation to CC.

14% include references to CC, and in more than half of the cases the topic is merely cited, by the developer to support the project, by other agents to criticize it or to request the incorporation into the EIS or by both parties with opposing purposes. When an assessment is made, it is most frequently a quantification of $CO_2$ emissions, which is not used at all in more than half of the cases. The consideration of the effects of CC on the projects is even more insignificant, present in only 5% of the cases.

The analysis per type of project shows that there is only a high consideration of CC in thermal power plants, because they are subjected to GHG emission permits. However, less than half of these cases are real assessments. RODs of other projects with significant GHG emissions, like transport infrastructures, have strikingly low consideration levels. Among road projects, which amount to a quarter of all the projects submitted to EIA, there is only one case of true CC assessment. The situation is similar in railways, although the entire Spanish High-Speed Rail Network was developed in this period and the Commuter Rail Network has also grown significantly. Only airports have higher consideration rates, although almost all the cases include only a quantification of $CO_2$ emissions, which is not used to assess impacts, compare alternatives or propose mitigation measures. These results are opposite to those of Hamada (2008) for the UK, who detected greater consideration of CC among EISs of roads and transport infrastructures than in other projects.

The low consideration of CC cannot be attributed to technical difficulties. There are specific methodologies and tools to calculate the contribution to CC for many types of projects, especially for transport infrastructures. Some of them have been developed in Spain (García-Montero et al., 2010, OCCC(Oficina Catalana del Canvi Climatic), 2012; CEDEX (Centro de Estudios y Experimentación de Obras Públicas), 2013; IDAE (Instituto para la Diversificación y Ahorro de Energía), 2013; EEA (European Environment Agency), 2015) and are particularly simple to apply in roads. Also, some technical tasks carried out for road planning, e.g. traffic estimations, are the basis for calculating GHG emissions.

The requirement to consider the effects on climate has been present since the first EU and Spanish EIA regulations, although without explicit reference to CC. In Spain, such legal obligations to incorporate CC in EIA appeared in Law 21/2013, although it is not indispensable, once it is implicitly included among all the significant impacts that any EIA must take into account, as several studies confirm. In the USA Smith (2010) argued that the impact of GHG emissions is precisely the kind of cumulative impact analysis required by the NEPA. Pyke & Batten (2008) suggested that the analysis of the effects of projects on global warming should be a mandatory part of any EIA according to this Act, which provides the authority and mechanisms to directly address them. In Canada the EIA regulations (CEAA (Canadian Environmental Assessment Agency), 2012) do not include specific requirements for considering

CC, and the issue is treated in guidelines. In our analysis, CC appeared in 14% of the RODs of projects submitted for EIA, in most cases before the 2013 EIA Act.

Barker and Wood (1999) concluded that EIA legislation seems to have had a beneficial influence on the quality of EIA reports in Denmark, Greece, and Portugal, but not in Spain. According to Pölönen et al. (2010), the EU legislation and guidance on EIA (especially in Finland) provide a good framework for impact assessment, and they do not hinder, but rather they catalyse, the effective utilization of this instrument. Sandham et al. (2013) indicated that the emphasis on legal reform in South Africa, and elsewhere in the world, as the basis to improve the quality of EIA practice is overstated, and does not result in better quality EIS.

Including the consideration of CC in EIA legislation is not strictly necessary, but desirable. It is evident that an explicit requirement in the EIA regulations may help to prevent surprising situations like the scarce consideration of CC in the EIA of transport infrastructure in Spain. In fact, the higher degree of consideration found in thermal power plants can be attributed to other regulations where these facilities are classified as important GHG contributors. Even after explicit references in the EIA regulations, it is possible to find that the influence of CC on a project has no bearing on decision making, as Hamada (2008) noted for the UK, or that this factor is considered negligible, poorly assessed or just solved with a mere citation of CC, as the present study shows in the case of Spain. Also, as Sandham et al. (2013) indicates, the emphasis on legal reforms as a means to improve EIA quality is overstated.

One recurrent solution is the development of guidelines, indicated by Lee, and Colley, (1992) and Yi and Hacking (2012) for UK, Alonso et al. (1996) for Spain, Tekelemichael (1997) for Ethiopia, Kibbassa (1997) for Tanzania, Morrison-Saunders et al. (2001) for Western Australia, Kabir and Momtaz (2012) for Bangladesh or Mounir (2015) for Niger, or in general by Sok et al. (2011) and Sok (2014) through a survey of professionals from different countries or Zhang et al. (2013) after reviewing 33 refereed journal papers. Currently, there are specific guidelines about CC and environmental assessment in some countries or regions, such as Canada, the United States and the EU (CEAA (Canadian Environmental Assessment Agency), 2003; CEQ (Council on Environmental Quality), 2010; EU (European Union), 2013, respectively). Canadian guidance is the most well known, with a satisfactory level of efficacy (Ohsawa and Duinker, 2014), followed by the USA, while the European guidance is more recent and, at least in Spain, is not having much impact.

A common discussion is whether the CC should be considered in EIA or SEA. There is a clear tendency to incorporate CC in SEA, because many reduction actions are strategic, such as the modal split of transport. But that desirable trend should not lead to exclude CC from EIA, where it can also play a significant role. While in SEA decisions are strategic, in EIA considerations about CC are useful to compare alternatives (constructive, design or functional), adapt the projects or design specific compensation measures. Enriquez-de-Salamanca (2015) discusses two cases, a motorway and a railway, where the contribution to the CC has been used in the comparison and selection of alternatives.

An important limitation is the absence of significance thresholds, leading to underestimating the CC contribution of individual projects. This is a mistake because, as Smith (2010) highlights, GHG emissions are clearly cumulative impacts. The USA guidance (CEQ (Council on Environmental Quality), 2010) sets a limit value of 25,000 t $CO_2$e per year, and lower values for long-term projects, and although the exact value may be questionable it is certainly a useful reference. For example, this level is achieved in a 50-km road with 10,000 vehicles per day or 100 km and 5000 vehicles, without taking into account that they are long-term projects that should be considered with even lower traffic rates. Most of the motorways submitted for EIA in Spain, which almost never considered CC, would fit this scenario. Threshold values for the inclusion of CC in EIA would not be strictly necessary; the contribution and the impacts of this factor on the projects should be considered in all cases, to determine whether or not they are significant, as is the case with other impacts such as biodiversity. However, thresholds could mark the obligation to compensate GHG emissions, or to undergo emission allowance regulations.

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