The state of current practice of Environmental Impact Studies: the case of small hydropower projects

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Abstract

Environmental authorities can abort an EIA process of an Annex I or Annex II project, by refusing the respective EIA Report, on the grounds of technical or methodological insufficiencies, previously identified. However, it cannot be taken for granted that, once an EIA Report is formally accepted, as part of an EIA process, its quality standard is, consistently, of a satisfactory level.

This paper summarises the results of a one-year research project aimed at assessing the quality of EIA studies carried out for a specific type of Annex II projects. A number of reasons made us select small scale hydropower dams for this research. An extensive survey was carried out to analyse all EIA Reports that were the basis of successful EIA processes involving this kind of small scale projects, under the old and the new legislation, that is, over the last two decades. Often times unnoticeable to the general public and the media, located in isolated areas upstream secondary rivers, these projects are likely to generate some significant environmental impacts, in particular on the aesthetic value and character of local landscapes and on pristine ecological habitats. And yet, they are usually regarded as environmental friendly projects designed to produce emission free energy.

The design of the evaluation criteria benefited from the literature review on similar research projects carried out in other EU countries. The evaluation exercise revealed a number of technical and methodological weaknesses in a significant percentage of cases. A set of simple and clear cut recommendations is proposed twofold: to improve the current standard of EIA practice and to strengthen the role of the EIA Commissions, at the crucial review stage of the EIA process.

1. Introduction

It is generally recognised that one of the major objectives of an EIA system is to provide project licensing, or planning permission, with sound, relevant and social responsive technical and scientific knowledge on the likely environmental effects of a particular development proposal. This technical and scientific knowledge can be incorporated into EIA processes at different stages and through different means, namely: the scoping procedure; the proponent's EIA report; the technical review of the EIA report; the institutional consultation and public participation; and, towards the end of the EIA procedure, the final decision making process. In this paper we are going to concentrate only on the role of the EIA report which is, nonetheless, one of the main doors through which scientific knowledge is brought into the EIA process.

Looking at the massive literature currently available on EIA, a large and diversified number of contributions have been geared towards the assessment of the performance of national EIA systems. Well known comparative and transnational studies have also been published in the US, Canada and in the EU (Lee and Dancey, 1993; Wood, 1995; Sadler, 1996; EC, 1996; Tzoumis and Finegold, 2000; Wende, 2002 . Some have concentrated on the quality of EIA reports and, in particular, on their technical and scientific contents. An early and still rather interesting example worth a revisit is the paper published by Ross, back in 1987, on the Canadian experience of preparing and reviewing Environmental Impact Statements. However, a few of these contributions have chosen a particular type of project for evaluation, to enable a deeper understanding of the key factors that influence the overall quality of EIA reports. An obvious limitation, if not drawback, of this option, is that all research findings that may emerge are rather project specific in nature, and have to be carefully looked at, particularly if an attempt is made to generalize conclusions to other types of projects. In principle, this attempt will seldom be possible,and should not be encouraged.

In our research we have chosen a specific kind of Annex II project to focus the analysis, the case of small hydropower plants. The reasons for this choice are threefold. Firstly, it is a relatively common and straightforward kind of project, well studied from an engineering point of view but, nonetheless, generating a wide range of environmental and socio-economic impacts, albeit not necessarily too serious or damaging in most cases. Secondly, it is regarded as a clean technology to produce electricity, on a decentralised basis, and so likely to attract much attention and investment in the coming years of increasing concerns on the overall attainment of Kyoto emission goals. Thirdly, we found 13 project EIAs of small hydropower plants, completed to date and located in the Northern and Central Region of Portugal. Bearing in mind the nature of and the modest resources available for this research, it is a good and manageable number of cases. All of them include comparable EIA reports. Furthermore, all the additional documentation and information on the corresponding EIA processes has been properly filed and archived by regional environmental agencies and, according to our legislation, has to be readily available for inspection. These agencies - the main sources of data and information that made possible our research project - act as the EIA authorities for Annex II projects in Portugal. Annex I projects are dealt with at central level by the Environment Institute, a government agency that operates under the umbrella of the Ministry for Cities, Planning and the Environment.

Generally speaking, EIA decision making places a number of constraints on and requirements to the contents of an EIA report and, in particular, to the development and application of EIA methods and techniques. These, in turn, have to be increasingly responsive to the *decision making environment* in which an EIA report is scrutinised, used and, often times, manipulated by the different stakeholders involved in the EIA process (Pinho, 1994).

As Leknes (2001) emphasises, looking at a large number of EIAs in the oil industry in Norway, the character of an environmental issue determines the role EIA may play in the decision-making process. Stakeholders use the information provided by an EIA in rather different ways, whether they face a typically professional and technical issue or a political issue. This same differentiated approach applies to issues easily framed by current regulations or rather more complex, diffuse or conflicting in nature.

The roles of EIA in the decision making process may also be affected by the presence of conflicting national, regional and local interests. Often times an EIA is placed in a contradictory position between local development targets and national conservation objectives, or *vice-versa*. In these cases, the search for scientific evidence to support the decision making process is impaired by conflicting environmental values and arguments (see, for instance, Pinho, 1997).

In other words, given the complex and diversified nature of decision making, the same technical and scientific information included in the EIA report is able to generate different readings and understandings, particularly if the contents of the report are not precise and robust, the language is not clear and accessible, the scope of the environmental issues dealt with is not relevant and appropriate, and the methods and techniques soundly justified and accurately applied.

These are indeed some of the most important characteristics to look for in any EIA study. As stressed by Wende (2002), there is a clear relationship between the quality of EIA reports and the extent of modifications and mitigation measures proposed to incorporate the respective projects. That is certainly one of the most important added values of EIA processes.

Previous research has identified a wide range of factors or conditions able to influence the quality of EIAs. These factors are either internal or external to the EIA system. They relate to:

- the specific regulations of and technical guidance available to the preparation of an EIA report;
- the overall design of the EIA process in which the EIA report is just a part, though important;
- the institutional arrangements, the financial resources and the technical skills available in the agencies in charge of the EIA system;
- the pressure and environmental awareness of external agencies, interest groups and the public involved in consultation and participation;

- the practitioners' skills and resources;
- the proponents' environmental awareness, nature and size of the proponents' institution or enterprise;
- type of project and size of the investment.

In the discussion of our research results (section 5) we will come back to some of these factors or quality conditions of an EIA report. We will then confront our findings with other contributions from researchers engaged in similar studies elsewhere. Meanwhile, in line with our option to evaluate EIA reports of a specific type of Annex II project, the following sections provide background information on small hydropower plants, their environmental and social impacts and main mitigation measures available.

2. Main structures and components of small hydropower plants

Small hydropower plants (shp for short) can be of two types: run-of-river and storage type. The first and more common type uses the river flow, basically, as it occurs throughout the day and throughout the year, whereas the second type creates a reservoir to store flowing water to be used later whenever more convenient. The storage type may be also referred to as: i) pondage[1], when it enables water transfer from non peak to peak hours, producing energy at times of low flow or increased demand, or ii) reservoir, if it allows the regulation of larger volumes of inflow, e.g. transferring water volumes from wet to dry season. This last option is most common and convenient when small-hydro plants integrate a multipurpose hydraulic plant.

Water retention, storage and diversion works vary in accordance with shp types. Most run-of-river schemes operate with low diversion structures, often a small dam or a weir. Larger dams are usually associated with multipurpose hydraulic plants. These structures are bound to interrupt river continuity, affecting a significant area upstream, the so-called backwater area.

[1] In practical terms, when flow regulation and retention periods are not relevant, shp are often classified as of run-of-river type.

In addition to the shp structures referred to above (plus associated discharge structures, i.e. spillways and low level outlets), a traditional single purpose small-hydro plant integrates the following structures: the water diversion circuit, i.e. the connection between water intake and powerhouse – including, in general, the headrace channel (an open channel or tunnel), a forebay and the penstock; the powerhouse, where the potential energy of the water is converted into electricity, by means of turbines and generators; and a tailrace channel (or tunnel), returning the diverted water to the river.

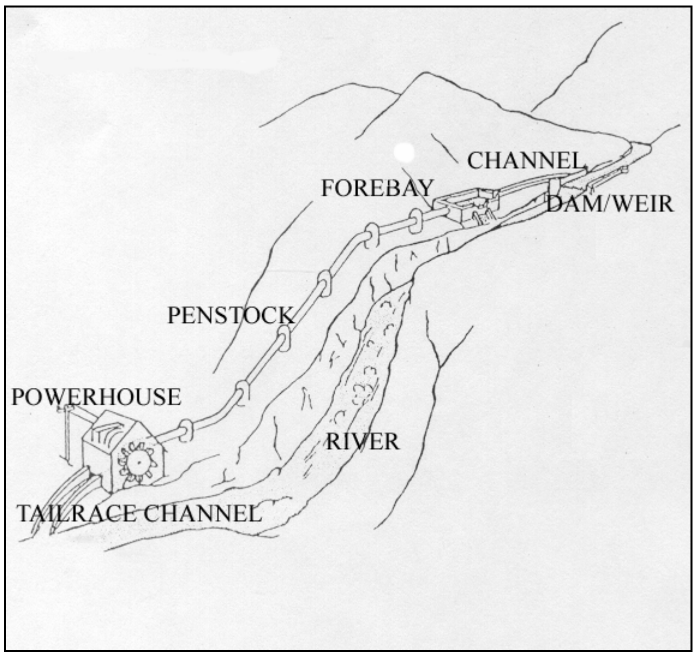

Fig. 1 . Schematic representation of a small hydropower plant

The total area affected by a shp may spread well beyond the sum of the areas occupied by all structures referred to above. It is also important to consider the river stretch between the dam/weir and the end of the tailrace channel, the so-called diversion section, and the affected area downstream of it, the tailwater area. Some adjoining lands have to be also occupied with the substation, transmission lines and the access roads to the power plant site.

Our study is focused on traditional single purpose small-hydro schemes. However, during the last couple of years, particular attention has been paid to the integration of small hydropower plants into larger multipurpose schemes (EC, 2000). These can be divided in two main categories, whether the small-hydro plant is an ancillary part of the main project or not. Examples of the first category are new small-hydro plants added to existing irrigation projects or drinking water systems. In the second category we may have small hydropower plants with complementary functions such as flood protection or recreation purposes. The following analysis may also be applied to this latter case. In what concerns the former one, some specific impacts and mitigation measures may be found in EC (2000). Whenever small-hydros integrate existing hydraulic schemes, one expects that most of the necessary mitigation measures have already been incorporated into the original hydraulic project.

3. Environmental and socio-economic impacts

Impacts of hydropower schemes are highly dependant on the hydropower plant purpose and location on the river section. To start with, we have to consider the following phases along the project life: construction (C), operation (O) and decommissioning (D). During the construction phase, small hydro plants are likely to generate direct impacts on local ecosystems, due to noise and vegetation loss, landscape disruption and occasional water contamination. During the operation phase environmental impacts are usually associated with newly inundated areas, and may result in losses of water quality and oxygen concentration, or in changes in the rates of bedload transport, as well as in noise and in the visual impact of the different hydro scheme components. During the decommissioning phase, significant environmental impacts resulting from abandon structures and the degradation of the surrounding area may also occur. One of the most positive impacts of small hydropower plants, like indeed other renewable energy sources, is their potential contribution to the reduction of greenhouse gases emissions. From a socio-economic point of view there are also positive impacts, such as the provision of some local employment, the creation of new recreational areas and, in most cases, of new irrigation facilities.

The inclusion of a dam or weir on a shp implies that another range of environmental impacts has to be considered. Their presence is bound to influence the areas upstream and downstream the hydroelectric power plant. The main impacts on local terrestrial and aquatic flora and fauna derive from changes introduced into the river flow regime, accompanied by the necessary interruption of the continuum river and of the sediment transport as well as terrestrial habitat losses. The flow regime in the backwater area, in the diversion section and in the tailwater area is deeply altered. The backwater area is converted into a slow velocity / shallow water area and the variation in the water level may cause riverbank erosion. The visual intrusion caused by the dam may also constitute an importa nt impact.

The headrace channel, the penstock, the tailrace channel, the spillway and the transmission lines may cause visual intrusion by introducing contrasting forms, lines, colours and textures into the local landscape. In some cases, mostly when the implantation area involves steep slopes they may cause geological instability. Outdoor penstocks and channels may result in habitat losses for local terrestrial fauna. Noise emissions from the powerhouse are particularly important at high rotation speeds and when turbines are equipped with speed increasers. The powerhouse may also create a significant visual intrusion.

Tables 1 and 2 present a checklist of the environmental and socio-economic impacts of the main project components of small hydro schemes, considering the different phases of the project life.

4. Mitigation Measures

The environmental impacts of shp may be minimised or even eliminated, in some cases, introducing an adequate set of mitigation measures. The impacts resulting from the alteration of the flow regime and the interruption of the free transport of sediments can be mitigated through: i) fish passes, such as ladders, lifts, barrier screens or fish guidance systems; ii) the regulation of a minimum flow; iii) the introduction of flushing gates to remove upstream deposited sediments and iv) the use of landscape and engineering techniques to consolidate river banks (EC, 2000; Penche, 1998).

The visual intrusion created by the headrace channel, the penstocks, the tailrace channel, the spillway, the powerhouse and the transmission lines may be totally or partially mitigated by screening these structures with landform modelling and vegetation, and/or using non-contrasting colours and textures. Penstocks and transmission lines may also be buried (EC, 2000; Penche, 1998) and powerhouses built underground, or coated with local stone, making it similar to local buildings.

Geologically instable steep slopes for underground penstocks and transmission lines can be mitigated using engineering techniques of slope consolidation like grass seeding, wood species plantation, meshes for erosion control or concrete grids with soil and vegetation.

Noise from the turbines in the powerhouse can be reduced placing sound insulating blankets over the turbine casing. A change in the cooling system of the generator from air to water may also reduce noise levels. In addition, a careful design of ancillary components, the proper insulation of the powerhouse walls and roof and, if possible, the underground construction of the powerhouse are all mitigation measures with effective results (Penche, 1998).

The choice of the dry season for the ground movement on water related or adjacent works construction phase is likely to reduce the levels of water turbidity. The immediate restoration of disturbed grounds and recreation of wetlands can reduce biodiversity losses. After decommissioning, if civil works are not subsequently demolished they should be kept in order to reduce the chances of environmental degradation.

The social and economic benefits of small hydro plants are able to increase the public acceptance of these projects balancing, to some extent, the different negative impacts we referred to above. Among the most relevant socio-economic benefits of shp projects are the possible aesthetic and recreational value of the reservoir, which may well be used to attract tourist facilities, the production of low cost energy for irrigation purposes and the temporary and permanent creation of new local jobs in the construction and operation phases of these projects.

Table 1 – Environmental impacts

	Targets	Impacts	Phases
Weir or Dam	Local People	Water transfer from non peak to peak hours	O
		Visual intrusion	O
		Risk of an artificial flood (depending on the height of the dam or weir)	O
		Noise	C/O
	Aquatic and Terrestrial Fauna and Flora	Noise	C
		Break of river continuity	C/O
		Ground movements and displacements	C
		Interruption of bedload transport	O
		Vegetation cutting	O
		Embankment morphology changes	O
		Abandoned areas environmental degradation	D
Powerhouse	Terrestrial Fauna and Flora	Vegetation cutting	C
		Noise	C/O
	Local People	Visual intrusion	C/O
		Noise	C/O
		Ground movements / landscape morphology	C/O
		Reuse for other purposes (e.g. exhibition centre)	D
Backwater Area	Terrestrial Fauna and Flora	Loss of vegetation	O
		River water regime (lower velocities)	O
		Eutrophication, variation of water temperature	O
		Embankment morphology changes	O
		Minor and local climatic change	O
Diversion Section	Aquatic Fauna and Flora	Water course diversion - modification of natural river regime	O
Headrace Channel/penstock	Aquatic and Terrestrial Fauna and Flora Local People	Landscape morphology changes	C/O
		Noise	C
		Increase in water turbidity	C
		Geological Instability	C/O
		River banks erosion	O
		Visual intrusion (surface penstock)	O
		Water leakage difficult to detect (underground penstock)	O
Tailrace Channel	Aquatic and Terrestrial Fauna and Flora Local People	Ground movements / landscape morphology	C/O
Tailwater Area	Aquatic Fauna and Flora	River bank erosion	O
		Noise	C
		Increased water turbidity	C
		Modification of the natural river regime	O

Table 1 – Environmental impacts (cont).

	Targets	Impacts	Phases
Enlargement of existing roads	Local People	Visual intrusion	C
	Terrestrial Fauna and Flora	Tree cutting	C
Roads and sheds for the yard	Terrestrial Fauna and Flora Local People	Animal disturbance caused by traffic	C/O
		Visual intrusion (temporary)	C
Transmission Lines	Local People	Visual intrusion (aerial lines)	O
General	Terrestrial Fauna	Geological instability	C
		Bird collisions	O
	Local People	Water pollution	C
		Greenhouse gases reduction	O
		Abandoned structures and powerhouse components	D
		Restoration of the original river flow	D

Table 2 – Socioeconomic impacts

	Targets	Impacts	Phases
Weir or Dam	Farmers	Loss of grazing area	O
	Forestry	Loss of production	O
Backwater Area	Local People	Recreation purposes (angling)	O
		Irrigation purposes	O
Enlargement of existing roads	Local People	New local economy opportunities	O
General	Work-force	Employment opportunities	C/O
	Local People	Minor contribution to reduce social and security costs (related to green house emissions)	O
		Cost cuts with alternative sources of energy (such as gas, coal and oil imports)	O
		Satisfaction of local energy demand	O
		Settlement opportunity	O
		Potential archaeological and cultural heritage loss	O

Key: C - Construction
O – Operation
D – Decommissioning

4. Evaluation of environmental impact reports of small hydropower plants

As we referred to in the introduction, we were able to analyse the contents of 13 EIA reports of small scale hydropower projects, 8 located in the Northern Region and 5 in the Central Region of Portugal. From the total, 7 are run-of-river schemes, 5 hydro schemes with water storage and 1 is a multi objective scheme. To our knowledge, these numbers correspond to all projects of this kind submitted to the environmental administration, since the passage of the first law on EIA, back in 1990, until the end of 2003.

The evaluation of these EIA reports was structured around 12 criteria as follows:

- includes scoping
- characterizes the project
- presents alternatives
- characterizes the local environment
- identifies impacts
- describes impact prediction
- proposes mitigation measures
- includes monitoring proposals
- includes technical difficulties or lack of knowledge
- describes public concerns and suggestions
- presents the results in a clear, complete manner
- includes an adequate non-technical summary (NTS)

Each of these criteria was subdivided in several sub-criteria (see Table 3) and based on the previous work of various authors, namely: Hyman (1982), Ross, (1987), Henriques (1991), Lee and Cooley (1992), EC (1994), Wood (1995), Sadler (1996), Barker and Wood (1999), Partidário and Pinho (2000), Morrison-Saunders, Annandale, Capellutti (2001), Wende (2002), Gray and Edward-Jones (2003).

For each EIA report we tried to assess to what extent each and every evaluation criterion had been fulfilled. If the criterion was not considered at all, the grade was zero. In case it had been considered, three performance standards were added: 1 - Low, for an incomplete and/or technically poor consideration of the evaluation criterion; 2 – Medium, for a reasonable consideration and/or technically fair approach, and 3 – High, for a well developed and technically solid consideration of the evaluation criteria. Table 4 shows the overall picture of our research results. The EIA reports are presented in columns by chronological order to make evident any eventual progress, at a glance. The different evaluation criteria are presented in rows. The final row presents an overall score for each EIA report on the assumption that each criterion is evenly weighted.

In order to understand the different conditions able to influence the overall quality of an EIA report, we looked at the final results according to different perspectives (Table 5):

- the changes in legislation in the study period: from 1990 to 1999 with the Decree-Law 186/90 from the 6th of June; and from 2000 to 2003 with the Decree-Law 69/2000 from the 3rd May;
- the variety of specialists in the EIA team, measured by the number of different technical and scientific backgrounds relevant to the EIA under analysis;
- the size of the project measured in megawatts of power;
- the type of small hydropower project: run-of-river or storage type.

Table 3. Evaluation Criteria and sub-criteria

Criteria	Sub-criteria
1. Includes scoping	1.1. Identifies the main and appropriate subjects to analyse in the EIA report. 1.2. Identifies the most significant impacts adequately. 1.3. Involves the main actors in scoping.
2. Characterizes the project	2.1. Identifies and characterizes the different components of the project. 2.2. Characterizes the construction, operation and decommissioning phases; describes for each phase, the materials, the energy used and produced; the effluents, residuals and emissions produced. 2.3 Describes the relationship between the project and local, regional and national plans that affect the surrounding environment. 2.4. Describes the location of the project, its different accesses and identifies sensitive areas that can be affected. 2.5. Includes the reasons why the proposed project was chosen.
3. Presents alternatives	3.1 Identifies the different alternatives that should be considered to satisfy the same objectives in the construction, operation and decommissioning phases of the project. 3.2 Presents a rigorous exploration and an objective evaluation of all reasonable alternatives; describes all alternatives in relation to the location of the project, its components and the different technological processes available. 3.3. Describes the zero alternative, that is, the no project option. 3.4. Explains the reasons why certain alternatives have been eliminated from the study.
4. Characterizes the local environment	4.1. Characterizes the baseline environmental situation that should involve the description and characterization of all the environmental factors likely to be affected. 4.2. Describes the methodology to characterize each environmental factor and the methods used to carry out all analytical tasks. 4.3. Includes quantitative information whenever necessary and cartographic material for the best understanding of the baseline data; presents scientific justifications, whenever necessary. 4.4. Includes the characterization of the archaeological and historical heritage and all relevant socio-economics aspects.
5. Identifies impacts	5.1. Identifies the actions able to generate impacts in all phases of the project, and the actions that may change natural processes. 5.2. Identifies the impacts of the project for each and every environmental factor selected, in the different project phases, using the database supplied by the research and analysis of the conditions of the area and of the conditions of the project.
6. Describes impact prediction	6.1. Presents the methodology for impact prediction and evaluation and indicates the scientific uncertainty associated to each prediction; methods should be explained and the reasons to choose the level of detail of the analysis should be supplied. 6.2. Identifies other impacts that may occur after the implementation of minimization measures, and evaluates impacts that can happen due to abnormal conditions. 6.3. Avoids the introduction of subjective value judgments and the imposition of practitioners' opinions about the importance of social or environmental impacts. 6.4. Evaluates impacts according to their relative significance, regarding objective characteristics of the impact such as area of influence, type, nature, magnitude, duration, reversibility and probability. 6.5. Characterizes the underlying cause-effect relationships of each environmental impact; evaluates retroactive, synergistic and cumulative impacts.

Table 3. Evaluation Criteria and sub-criteria (Cont.)

Criteria	Sub-criteria
7. Proposes mitigation measures	7.1. Describes the minimization measures or compensation proposals with details concerning its implementation and efficiency. 7.2. Provides evidence of the proponent's commitment and capacity to implement mitigation measures. 7.3. Justifies, whenever applicable, the absence of mitigation proposals for significant impacts previously identified. 7.4. Proposes a monitoring program whenever uncertainty exists about the practical results of a minimization measure to allow future adjustments if needed.
8. Includes monitoring proposals	8.1. Describes the objectives of monitoring programmes and their scientific justification. 8.2. Describes precisely what type of indicators should be monitored; how and when should be monitored and which organization should be responsible for monitoring. 8.3. Provides evidence of the proponents' commitment to the monitoring programme.
9. Refers technical difficulties or lack of knowledge	9.1. Identifies the limitations or difficulties felt by the practitioners' team during the preparation of the EIA report.
10. Describes public concerns and suggestions	10.1 Identifies interest groups and the general public involved in consultation. 10.2. Incorporates the multiplicity of values supplied by the public, experts and interest groups; describes the steps that were taken to determine the opinions of local populations concerning the social consequences of likely impacts. 10.3 Provides evidence of the consideration of community's feelings and opinions. 10.4. Provides explicit reasons why certain suggestions were not adopted. 10.5. Identifies the degree of concern or conflict with the public.
11. Presents clear and complete results	11.1. Presents a clear study, coherently organized, well written and easily understood by non-specialists and the public; sources of information are mentioned in a clear way; any information, data or approach coming from external sources is appropriately supported by a reference; it includes a complete list of references. 11.2 Indicates which group of technical and scientific subjects have guided the preparation of the study and what was the appropriate legislation and regulations. 11.3. Technical terms are explained in full detail in a glossary or text; the opinions and reports of the experts are complemented with an appropriate interpretation and are not merely enclosed in the study. 11.4. Indicates the names and qualifications of the technical team. 11.5. Presents the final conclusions about the positive and negative impacts of the proposal, considering the different phases of the project.
12. Includes an adequate non-technical summary (NTS)	12.1. Contains the identification of the main environmental factors potentially affected by the proposal and alternatives, the most significant impacts and the corresponding mitigation measures. 12.2. It should be clear, concise and well written, without excessive technical language or complex statistics. 12.3. Indicates the monitoring plans that had been proposed in the EIA report.

Table 4. Matrix of research results.

EIA Report **Criterion**	**1** Dec. 1990	**2** Jul. 1991	**3** Apri.1992	**4** Nov.1995	**5** Ago. 1997	**6** Nov. 1999	**7** Feb. 2000	**8** Mar. 2000	**9** Jun. 2000	**10** Jan. 2001	**11** Oct. 2001	**12** May. 2003	**13** May 2003	Overall Score by evaluation factor
1.characterizes the project	1.0	0.4	1.4	1.8	1.4	2.0	1.8	2.0	2.0	2.6	2.6	2.8	2.2	**1.8**
2.presents alternatives	0.0	0.0	0.0	1.0	0.8	1.4	0.2	0.0	0.0	0.6	2.4	0.6	0.6	**0.6**
3.characterizes the local environmental	3.0	0.8	2.0	3.0	1.8	3.0	2.3	2.8	2.3	2.8	3.0	2.8	2.8	**2.5**
4.identifies impacts	1.2	0.8	0.6	1.4	1.2	2.6	2.8	2.6	2.8	3.0	2.0	1.0	2.4	**1.9**
5.describes impact prediction	0.5	0.8	0.8	1.5	1.0	2.8	1.8	2.8	1.3	1.5	1.0	1.3	2.0	**1.4**
6.proposes mitigation measures	0.8	0.5	0.8	1.3	1.8	2.0	1.5	2.0	1.8	2.3	2.0	1.5	2.0	**1.5**
7.includes monitoring proposals	0.0	0.0	0.0	1.4	0.6	1.6	1.2	1.0	0.6	1.6	2.6	1.4	1.2	**1.0**
8.recognises lack of knowledge	0.0	0.0	0.0	1.0	1.0	2.0	0.0	2.0	2.0	1.0	3.0	1.0	2.0	**1.2**
9.refers public concerns, suggestions	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.5	0.0	0.0	0.0	0.0	1.0	**0.2**
10.presents full and clear results	1.4	0.8	1.0	2.4	1.6	2.8	2.4	2.8	2.2	2.6	3.0	2.2	2.6	**2.1**
11.includes an adequate NTS	0.0	0.0	0.8	1.6	1.4	2.2	2.4	2.2	2.4	2.2	2.2	2.8	2.0	**1.7**
12. includes scoping	0.0	0.0	0.0	0.0	0.0	2.8	1.5	2.8	0.0	0.0	0.0	0.0	1.5	**0.7**
Overall Score of each EIS	**0.7**	**0.3**	**0.6**	**1.4**	**1.0**	**2.1**	**1.5**	**1.9**	**1.4**	**1.7**	**2.0**	**1.4**	**1.9**	**1.4**

Considered (0,1-3)

0.0 Not considered

Overall Score

- Very poor (0,0 - 0,4)
- Poor (0,5 - 0,9)
- Fair (1,0 - 1,4)
- Fair/Good (1,5 - 1,9)
- Good (2,0 - 2,4)
- Very Good (2,5 - 3,0)

Table 5. Results presented according to different analytical perspectives

Characteristics	Legislation		Type of team		Power Produced		Type of Project	
	DL 186/90, 6th June	DL 69/00, 3rd May	Team with few specialists	Team with many specialists	Hydro Projects P<2 MW	Hydro Projects 2<P<10MW	Run-of-the-river scheme	Hydro Scheme with Storage
Criteria	Overall Score by evaluation factor		Overall Score by evaluation factor		Overall Score by evaluation factor		Overall Score by evaluation factor	
1.characterizes the project	1.5	2.4	1.4	2.2	1.8	1.9	1.9	1.9
2.presents alternatives	0.4	0.8	0.7	0.5	0.6	0.5	0.7	0.5
3.characterizes the local environmental	2.3	2.7	2.3	2.6	2.1	2.8	2.3	2.7
4.identifies impacts	1.7	2.2	1.2	2.5	1.4	2.3	1.6	2.4
5.describes impact prediction	1.5	1.4	0.9	1.9	1.0	1.8	1.2	2.0
6.proposes minimization measures	1.3	1.9	1.2	1.9	1.4	1.7	1.5	1.7
7.includes monitoring proposals	0.7	1.5	0.8	1.2	0.9	1.1	1.1	1.2
8.includes tech. difficulties or lack of knowledge	0.8	1.8	0.8	1.4	1.2	1.1	1.1	1.4
9.describes public concerns and suggestions	0.1	0.2	0.0	0.3	0.0	0.3	0.1	0.2
10.presents the results in a clear, complete manner	1.9	2.5	1.7	2.5	1.8	2.4	2.0	2.5
11.includes a good non-tecnhnical summary (NTS)	1.3	2.3	1.0	2.3	1.6	1.8	1.6	2.2
12. includes scoping	0.9	0.3	0.0	1.2	0.0	1.2	0.2	1.4
Average score of the EIA	1.2	1.7	1.0	1.7	1.1	1.6	1.3	1.7

Overall Score

- Very poor (0,0 - 0,4)
- Poor (0,5 - 0,9)
- Fair (1,0 - 1,4)
- Fair/Good (1,5 - 1,9)
- Good (2,0 - 2,4)
- Very Good (2,5 - 3,0)

5. Discussion of research results

In the overall (see Table 4), considering all EIA reports and all 12 criteria, the average score obtained was 1.4, corresponding in our scale to Fair (indeed close to Fair/Good). This is, nevertheless, a relatively modest score that may provide, at a first glance, an unfair picture of EIA studies in Portugal. According to some performance evaluations of national EIA systems in EU countries (see, for instance, Barker and Wood, 1999), Portugal has been performing reasonably well. The reasons for this modest score, overall, may be found in the nature and size of the project under analysis – small hydropower plants.

According to Morrison-Saunders, Annandale and Capellutti (2001), the main driving forces for good EIAs are the pressures from the environmental administration, time and resources to prepare the EIA reports, pressures from the public, political expectations, and financial resources available. In addition, the quality of an EIA report seems to depend upon the size of the project and of the attached financial investment, the size of the proponents' company, and the potential public controversy it may attract (Barker and Wood, 1999). The bigger the project, the better has to be the EIA report. Small hydro plants (shp) are not big projects by definition, are not usually proposed by large companies of the energy sector and are not located in popular or easily accessible areas. They prefer locations in isolated areas upstream secondary rivers, passing almost unnoticeable to the general public and the media.

Nevertheless, Table 5 reveals that the size of the project measured in megawatts of power and type of shp (run of river or storage type) had a marginal effect on the quality of the EIA reports produced. In line with what we have just said, the size of the investment seems to matter. Larger schemes with storage facilities offered better quality EIA reports.

The level of detail and adequacy of national regulations, as well as the availability of technical guidance on the format, structure and contents of EIA reports, whether of a general nature or project specific, is usually considered an important contribution to improve the standard of EIA practice (Wood and Jones, 1997; Blackmore, Wood and Jones, 1997). In our case the preparation of the 13 EIA reports under analysis, could not benefit from project specific guidance, although general guidance has been available for some years (see Partidário and Pinho, 2000). Another missing aspect in Portuguese EIA practice is the definition of national and regional explicit goals and objectives for the most relevant environmental factors, as looks to be the way ahead if transparency is sought in EIA (see Morrison-Saunders and Bailey, 2000).

The characteristics of the practitioners' team, in terms of a thorough representation of the different scientific disciplines covered by an EIA, are surely important factors affecting the overall quality of the study. Our results are clear in this respect (see Table 5). Multidisciplinary matters to produce satisfactory EIA reports.

But more important than finding good reasons for the modest aggregate score we arrive at is to look at the detailed results, row by row, of Table 4. Clearly, criteria 9 (incorporation of public suggestions), 2 (alternatives) and 12 (scoping) score worst, followed by criteria 7 (monitoring) and 8 (recognition of lack of knowledge). From the top, criteria 3 (baseline information) and 10 (clear results) score best, followed by criteria 4 (impact identification), 1 (project description) and 11 (Non Technical Summary). These results are not surprising. We have to say that in most cases they correspond to our expectations. Nevertheless they deserve some further comments.

The incorporation of public suggestions in the EIA report is not common in Portugal, unless a social survey or a series of interviews is conducted prior to the public participation phase, by the EIA team and as part of their work to prepare the EIA report. This practice is current in Annex I projects, particularly in the more controversial ones, but is seldom found in Annex II projects. However, this is not to say that, public views and suggestions are not incorporated into the EIA process. Indeed, the environmental administration has to prepare, in all cases, a separate report of the public participation and institutional consultation that, together with the EIA report, will form the basis of the final decision.

Most worrying are the poor results found in criteria 2 and 12, consideration of alternatives and scoping, in particular if we have in mind the nature of the project under analysis. Decisions over the type, power and location of a small hydropower plant along a river are complex, interrelated and able to determine, to a large extent, the viability of other schemes, i.e. of other *alternatives*. Scoping was lacking, in most cases (9 out of 13), and yet is one of the quality factors most appraised by researchers and practitioners (see, for instance, Barker and Wood, 1999), although not without difficulties in practice (Pinho and Margalha, 2003).

Looking now at the criteria with better scores, the survey of environmental baseline conditions comes first, closely followed by the criterion of clear and concise results. Both of these criteria deserve some attention. We will start with the latter, expressing our initial surprise with the high score obtained. It represents an encouraging result that surely reflects not just the work of EIA practitioners in Portugal but also the work of the EIA Commissions. These Commissions, appointed specifically for each and every EIA process, carry out the technical review of EIA reports before the public consultation takes place. In case an EIA report is not satisfactory the proponent has the right to introduce the suggested changes, otherwise the process is aborted. In our research, all 13 cases we were able to analyse had already passed the review process. And we know for experience, that one of the aspects of an EIA report that EIA Commissions are most demanding is exactly, the way the final results are worded and presented.

The highest score for the quality of baseline surveys is not surprising. It is perhaps the chapter of an EIA report that is most bulky and comprehensive. Unfortunately, that does not mean necessarily that all the information it contains will be relevant for other parts of the EIA report and for the main conclusions, even when a scoping exercise is carried out before. This high score (very good in our scale) contrasts with the lower score (fair/good) obtained for the description of the project. Unfortunately, the description of the project and the baseline conditions are often within the same review area of similar evaluation exercises (e.g. Barker and Wood, 1999) and so no significant information has been produced to understand how each of these topics, separately, would perform.

The strength and technical robustness of the contents of an EIA report depends upon a balanced blend of two scientific inputs: environment and social sciences to understand, in the first instance, the milieu in which a project is expected to land and, on the other hand, design and engineering sciences to understand the very nature of the project under analysis. At a later stage these two inputs have to come together to identify the likely sources and precise mechanisms of project - milieu interaction that, in the end of the day, will be responsible for the generation of environmental and social impacts. These two types of know-how are essential quality requirements of an EIA report if a solid and comprehensive basis for decision is sought. However there are reasons to believe that in the past, and at least in Portugal, most EIA practice was characterised by the prevalence of the first scientific input in detriment of the second (Pinho, 1994). This research project seems to confirm this fear nowadays.

Tables 4 and 5 also reveal the evolution of EIA performance over time. At a first glance it looks like a steady improvement of the quality of EIA reports has occurred from 1990 to 2003. A closer look permits to identify two periods corresponding roughly to the 1990s, coinciding with the old legislation and the first EU Directive, and the early 2000s, with the new legislation and the second EU Directive (Table 5). Throughout the 90s there was a real improvement with a tendency to stabilise around 2000 and thereafter. In the Portuguese context this conclusion may surprise, given that the new legislation is far more detailed and demanding then the previous one. However, as we emphasised before, the quality of an EIA report is dependent upon a rather wide range of factors and circumstances, and not just on the current legislation and regulations. Furthermore, the trend we have just identified seems in line with recent research carried out in other country contexts.

Early evaluations of the quality of EIA reports in the EU pointed out that a systematic improvement over time was clearly observed (Barker and Wood, 1999). Our results for the 90s confirm this idea. However, more recently, EIA has moved beyond the experimental phase and routines have now emerged for certain parts of the procedure. This conclusion, presented by Wende (2002) looking at the German situation, may be valid in other countries.

Moving from the EU to the US, the methodology used by EPA to review draft EISs (our EIA reports) comprises two scales of evaluation, both qualitative, one referring to the overall impact of the preferred alternative, a four point rating, and the other to the adequacy of the environmental information included in the draft EIS, a three point rating (see Tzoumis, Finegold, 2000). Our study has some analogies to the latter approach that indeed evaluates the quality of the EIS document from a technical and scientific point of view. As the authors suggest, one would expect these rates to get better overtime, as experience and better techniques and methodologies area available to practitioners. However, the results of their research point clearly in the opposite direction. There was a decline of adequate ratings, the stability of inadequate ratings and the rise of insufficient documents, the middle category. The authors are not clear about the reasons for such results, since there is no evidence that the level of expectations from the reviewers had rise overtime.

Our results seem to provide some support to these general conclusions. In Portugal, review practices are becoming standardised and crippled with financial difficulties and shortages of staff in the environmental administration. In addition, these present times of recession and uncertainty do not seem to provide much help to the environment.

6. Conclusions and recommendations

Generally speaking, our results seem to corroborate the main findings and conclusions already published by other researchers on the factors affecting the quality of EIA reports. Surely, the nature of most strengths and weaknesses of EIA practice in Portugal is similar to the ones observed in other national systems of EIA within the EU. After all, two EIA Directives, in two decades, are expected to produce converging results.

However, the meaning and extent of the specific problems found and the merits of the adopted solutions are certainly different.

The main contribution of this research project derives from the detailed analysis we were able to carry out of a series of EIA reports prepared for a particular type of project – small hydropower plants (shp). We had already warned the reader that such option has some advantages but does not allow easy generalizations. Having said that, we gather enough evidence to conclude that the quality of EIA reports of shp in Portugal was not significantly affected by the approval, back in 2000, of a rather more comprehensive and demanding EIA legislation, the Decree-Law 69/2000. The quality of EIA reports has stabilised while the legal requirements became more demanding. An enforcement deficit, or implementation gap, is bound to steadily emerge. A call to strengthen present EIA review mechanisms is needed. Our research provided some clues and ideas that may help in this respect. Multidisciplinary teams in EIA studies, better understanding of the technical complexities of the projects under analysis with engineers, architects and project designers in EIA teams, effective scoping with early public participation, due consideration of all real alternatives including the zero option, availability of project specific EIA guidance, are all aspects that may prove decisive if an effective improvement of the quality of EIA reports is envisaged.

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