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The environmental impact assessment in Chile: Overview, improvements, and comparisons

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ABSTRACT

In this study, we carried out a comparative analysis of the Chilean Environmental Impact Assessment (EIA) system using evaluation criteria compared against three countries to allow for an objective evaluation within the growing demand of society for a more creditable and trustable EIA system.

A total of 18 evaluation criteria were selected from the literature, and four new criteria for comparing EIA systems were proposed. The Chilean EIA system was compared to that of Brazil, Spain, and Canada using the following four evaluation criteria categories: EIA Legislation (four criteria), EIA Administration (four criteria), EIA Process (eleven criteria), and After EIA (three criteria). A Hierarchical Agglomerative Cluster Analysis for assessing similarity among the EIA systems of Chile, Canada, and Spain was performed: the similarity being 88%. A Principal Component Analysis shows that only 13 of the selected 22 criteria contribute to the variability of the selected EIA systems. The main strengths of the Chilean EIA system are the existence of Specialized Environmental Courts for the resolution of disputes and Appeal options before execution. The identified weaknesses are an EIA system with high centralization at the national level, the absence of consideration of project alternatives, no requirement for scoping, and that the process of Strategic Environmental Assessment is not binding.

Modifications to the Environmental Impact Assessment System Regulation are proposed by authors as feasible improvements particularly in relation to, Decentralization of the EIA system, Alternatives for design, Scoping incorporation, Register of reviewers of baseline information, and the public information process and post-evaluation.

The method used seeks out to serve as guidance for countries with similar environmental and social contexts, as well as environmental legislation improvement needs.

1. Introduction

1.1. The EIA in the world

The Environmental Impact Assessment (EIA) is a legal and administrative tool for identifying, predicting, and interpreting the environmental impact of a project or activity and proposing preventive measures (Ferrer, 2016). The EIA was incorporated as an environmental management tool in the USA in 1970 by the National Environmental Policy Act (NEPA). Subsequently, other countries such as Australia, Canada, Sweden, and New Zealand developed similar mechanisms for environmental monitoring.

In 1992, the United Nations Conference on the Environment held in Rio de Janeiro (UN, 1992a) defined a pathway for the use of the EIA as a tool for encouraging impact assessment during the installation, operation, and abandonment of projects. The EIA was recognized as an instrument for reducing the adverse effects of particular projects and activities (Sánchez and Croal, 2012). By 2012, EIA procedures for decision-making had been adopted by 191 countries (Morgan, 2012). The establishment of roadmaps, within the preventive tool framework of the EIA, was crucial for verifying and improving contents such as 'Principle 17 of the Rio Declaration on Environment', 'Article 14 of the Convention on Biological Diversity' and 'Agenda 21' (UN, 1992b).

The EIA system is a preventive environmental management

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instrument through which the EIA is developed (MINSEGPRES, 1994). To evaluate models performance applied across countries, several authors have identified 26 evaluation criteria, which are compiled in Table 1. Wood (1995) sets out 14 evaluation criteria, ranging from legal bases to a Strategic Environmental Assessment (SEA) (A, G, M–X). Annandale (2001) takes into account some of the criteria defined by Wood (1995) (A, G, M–T, V) and includes one additional criterion, the *Administrative support* (H). Ahmad and Wood (2002) reviewed these yet again and remove irrelevant criteria (H) from both Annandale (2001) and (M) Wood (1995) while adding seven more (B–C, I, K–L, U, W–Z). Khosravi et al. (2019) selected specific criteria (A, G, N–Q, U–V) from Wood (1995) and criterion (I) from Ahmad and Wood (2002), and added criteria D–F relating to EIA adjustments to national legislation.

Several authors have either replicated, completed, or adapted to local conditions some of the criteria from Wood (1995) described in Table 1, such as El-Fadl and El-Fadel (2004) in the Middle East and North Africa, Nadeem and Hameed (2008) in Pakistan, Badr (2009) in Egypt, Moradi (2009) in Iran, Wayakone and Makoto (2012) in Laos, Al-Azria et al. (2013) in Gulf Cooperation Council States, Heaton and Burns (2014) in Abu Dhabi and the United Arab Emirates, Ahmad and Ferdausi (2016) in Bangladesh, and Aung (2017) in Myanmar.

1.2. The EIA in Chile

In Chile, Law 19,300 of *Bases Generales del Medio Ambiente* (General Environmental Bases, GEB), published in 1994, created the *Comisión Nacional del Medio Ambiente* (National Commission of the Environment, NCE) and recognized the EIA as a tool for environmental management (MINSEGPRES, 1994; De la Maza, 2001). After three years, in 1997 the first *Reglamento del Sistema de Evaluación de Impacto Ambiental* (Environmental Impact Assessment System Regulation, EIASR) was published, establishing the typology of projects that require EIA; in general, the rules governing EIA and community participation in the country (MINSEGPRES, 1997).

The EIASR had two significant changes. In 2001, the decree was replaced by a new regulation (MINSEGPRES, 2001), and in 2012 the version currently in force was published. The last modification introduces changes to the content of the *Estudio de Impacto Ambiental* (Environmental Impact Study, EIS) and the *Declaración de Impacto Ambiental* (Environmental Impact Declaration, EID), in which citizen participation is only possible if the projects have environmental charges (MMA, 2012). During the 1994–2018 period, a total of 25,096 projects (EID and EIS) were submitted. Of this number, 63.5% were approved. Fig. 1 shows the number of projects submitted and approved per region in Chile.

In 2010, the creation of the Ministry of Environment and the repealing of the NCE following the enactment of Law 20,417 marked a milestone in environmental matters in Chile. The *Servicio de Evaluación Ambiental* (Environmental Assessment Service, EAS) was created, with the primary mission of managing the EIA system in Chile (Moraga, 2017; MINSEGPRES, 2010). The amendment to the Law introduced important issues such as citizen participation, self-reporting, and early termination of the environmental assessment procedure in cases where relevant and essential information was lacking (Bergamini, 2015). This legislative innovation involved a new modification of the 2012 EIASR, giving rise to the current regulation (MMA, 2012). Article three of the EIASR defines the types and characteristics of projects entering the EIA. After the *screening* process a sectoral license (non-environmental) must be obtained by projects not entering the EIA, however, projects entering the EIA (either as an EID or an EIS) must obtain an Environmental Permit. Also, the EIASR establishes the minimum content of environmental reports and how the EIA system should be applied; maintaining both project-entry processes: EID and EIS (MMA, 2012; De la Maza, 2001). An EID is a document presented under oath that describes the project, ruling out the generation of effects, characteristics, or circumstances included in articles 5 to 10 of the EIASR (MMA, 2012).

The generation of any of the following conditions give rise to the presentation of an EIS: (i) health risks to the population, (ii) significant adverse effects on renewable natural resources, (iii) resettlement of human communities or significant changes in living systems and

Table 1
Evolution of the main evaluation criteria used across the different EIA systems, adapted from Khosravi et al. (2019).

Category	Criterion	Code	Wood (1995)	Annandale (2001)	Ahmad and Wood (2002)	Khosravi et al. (2019)
EIA Legislation	Legal bases	A	X	X	X	X
	Provisions for appeal by the developer or the public against decisions.	B			X	
	Legal or procedural specification of time limits	C			X	
	Implications of proceeding without EIA approval	D				X
	EIA process steps in regulations	E				X
	Adequacy of the law for conducting an EIA	F				X
EIA Administration	Review of the EIA report	G	X	X	X	X
	Administrative support	H		X		X
	Competent authority for EIA and determination of environmental acceptability	I			X	X
	EIA centralization at the national level	J				X
	Level of coordination with other planning and pollution control bodies	K			X	
	Specification of sectoral authorities' responsibilities in the EIA process	L			X	
EIA Process	Coverage	M	X	X		
	Alternatives for design	N	X	X	X	X
	Screening	O	X	X	X	X
	Scoping	P	X	X	X	X
	Content of the EIA report	Q	X	X	X	X
	Adoption of decisions	R	X	X	X	
	Impact control	S	X	X	X	
	Mitigation	T	X	X	X	
	Consultation and participation	U	X		X	X
	System control	V	X	X	X	X
	Strategic Environmental Assessment	W	X		X	
	Cost and benefit	X	X		X	
	Requirement for environmental management plans	Y			X	
	Experience of Strategic Environmental Assessment	Z			X	

Region	Submitted projects			Approved projects			Approval percentage
	EID	EIS	Total	EID	EIS	Total	
Interregional	560	85	645	266	53	319	49.5%
XV, Arica and Parinacota	294	18	312	180	9	189	60.6%
I, Tarapacá	646	41	687	391	29	420	61.1%
II, Antofagasta	1,422	170	1,592	1,025	127	1,152	72.4%
III, Atacama	1,054	123	1,177	682	78	760	64.6%
IV, Coquimbo	996	87	1,083	493	46	539	49.8%
V, Valparaíso	1,266	114	1,380	694	71	765	55.4%
RM, Metropolitan	4,084	180	4,264	2,377	95	2,472	58.0%
VI, O'Higgins	1,063	42	1,105	629	22	651	58.9%
VII, Maule	1,397	43	1,440	895	29	924	64.2%
XVI, Ñuble	517	31	548	284	17	301	54.9%
VIII, Bio Bio	1,554	104	1,658	964	60	1,024	61.8%
IX, La Araucanía	859	52	911	536	23	559	61.4%
XIV, Los Ríos	603	42	645	340	18	358	55.5%
X, Los Lagos	3,601	57	3,658	2,887	29	2,916	79.7%
XI, Aysén	2,498	36	2,534	1,523	16	1,539	60.7%
XII, Magallanes	1,420	37	1,457	1,032	27	1,059	72.7%
Total	12,548	1,262	25,096	15,198	749	15,947	63.5%

Fig. 1. Number of environmental projects submitted and approved from 1994 to 2018 in Chile, by region, according to information compiled from the Environmental Assessment Service of Chile, accessed on January 12, 2020. https://www.sea.gob.cl/.

customs of human groups, (iv) location and environmental value of the territory, (v) scenic or tourist value, and (vi) alteration of cultural heritage (MMA, 2012; De la Maza, 2001).

De la Maza (2001) evaluated the Chilean EIA system, comparing it to the NEPA process, and detected (i) differences in timing, public participation, and study of alternatives; and (ii) important methodological improvement opportunities, risk perception, and judicial role. It is important to note that De la Maza (2001) studied the Chilean EIA system when the first EIASR was in force. Subsequently, two modifications were made in 2001 and 2012 (MINSEGPRES, 1997; MINSEGPRES, 2001; MMA, 2012).

Lacy (2017) points out that the EAS has created guidelines for specific cases (e.g. hydropower projects, air quality, influence area) aiming at improving the EIA system. The author analysed the EIS and EID from aquaculture projects and detected that only 4.3% of submitted projects were rejected, alongside methodological inconsistencies in sampling and number of sites.

Formal citizen participation begins after the projects have been submitted. For the EIS it is mandatory and explicitly mentioned in paragraph 2°, articles 88 to 92 of the EIASR (MMA, 2012). In the case of an EID, only formal citizen participation is allowed for specific types of projects (e.g. electric lines, energy, sanitary), which are defined in paragraph 3°, article 94 of the EIASR (MMA, 2012). Early participation is voluntary and conducted mainly in cases where other international organizations mandate, e.g. the World Bank (Ocampo-Melgar et al., 2019).

In 2011, the case of citizen participation in the Northern-Central rural area in Chile was studied. Results show frustration from participants, mainly due to the imbalance of resources, knowledge, and interest in approving projects (Lostarnau et al., 2011). Nowadays, society demands a more creditable and trustable EIA system. These aspects were among the topics being concluded in the Councils under the Presidential Advisory Commission for the EIA System evaluation, in which a participatory diagnosis was made, and improvements related to citizen participation, environmental sensitivity, socio-cultural and economic changes, and appearance of new technologies in Chile were proposed (CAPRSEIA, 2017).

It is necessary, for that reason, to evaluate the Chilean EIA using different criteria with scientific aims. In our preliminary comparative analysis of the EIA system criteria compiled from Wood (1995), Annandale (2001), Ahmad and Wood (2002), and Khosravi et al. (2019) (Table 1), we found that none of the authors included baseline-related criteria, which are fundamental for drawing up an EIA (Lacy, 2017). Neither were public information processes included, which are important due to the growing digital transformation of society and the necessary improvements to information access and public participation due to the international standard of international agreements Escazú and Aarhus Conventions (Weaver, 2018; UNECE, 1998; UN, 2018). Other aspects such as project control, sanctions, and resolution of environmental disputes are not considered. While these aspects are not specific items in the EIA, they have an impact on the overall process assessment when analysed from a socio-environmental perspective (Costa, 2012).

This article (1) compiles a set of evaluation criteria from both an international literature review and Chilean official reports; (2) evaluates and ranks those criteria in four countries; (3) reviews the state of the art

of Chile, as compared to others countries; and 4) proposes improvements to the Chilean EIA. For a reliable comparison, three OECD countries with extensive experience in applying EIA were selected: Brazil, Spain, and Canada, which also share similarities with Chile. Brazil is in South America; Spain for historical linkages and cultural similarities with Chile; and Canada because of its large indigenous population that determines the behaviour of people regarding particular uses and customs of the territories. This latter aspect is particularly relevant in Chile, especially in southern regions such as La Araucanía (Fig. 1). For comparative analysis, it is irrelevant whether the country keeps a federal or centralized system since indicators consider national results.

2. Methods

2.1. Selection of conventional evaluation criteria for comparing EIA systems

Based on the review of criteria used by Wood (1995), Annandale (2001), Ahmad and Wood (2002), and Khosravi et al. (2019) in different countries, 18 criteria were selected. Table 2 summarizes the criteria adopted from each author. In summary, 15 criteria were selected from Ahmad and Wood (2002) mainly by requirements of the EIA system (Wood, 1995). Only one criterion was selected from Annandale (2001), taking into account the importance of administrative support. Two criteria were selected from Khosravi et al. (2019) due to the importance of obtaining a license and analysing the centralization model (Costa, 2012).

Of the 18 selected criteria, *legal bases* (A), *alternatives for design* (N), *screening* (O), *scoping* (P), *content of the EIA report* (Q), *review of the EIA report* (G), and *system control* (V) were considered a minimum fundamental basis for EIA system analysis by authors in Table 1. The criteria *adoption of decisions* (R), *impact control* (S), *mitigation* (T), and *consultation and participation* (U) were considered relevant by 75% of the authors; while *Competent Authority for EIA and determination of environmental acceptability* (I), *Strategic Environmental Assessment* (W), *administrative support* (H), and *Cost and benefit* (X) were only considered relevant by 50%. The criteria *provisions for appeal by the developer or the public against decisions* (B), *legal or procedural specification of time limits* (C), *implications of proceeding without EIA approval* (D), *EIA process steps in regulations* (E), *Adequacy of the law for conducting an EIA* (F), *EIA centralization at the national level* (J), *Level of coordination with other planning and pollution control bodies* (K), and *Specification of sectoral authorities' responsibilities in the EIA process* (L) were considered attributable to one particular situation by Khosravi et al. (2019) and Ahmad and Wood (2002). They were a methodological innovation at the time of application.

2.2. Definition of new criteria for evaluating the EIA system

The definition of the new evaluation criteria for the Chilean EIA system was based on a review of the report of the Citizens' Councils under the Presidential Advisory Commission for the evaluation of EIASR in 2017. The workshops held in the administrative regions of Atacama, Biobío, Los Lagos, and Magallanes allowed for a cross-sectional view of the weaknesses of the EIA system to be compiled (CAPRSEIA, 2017).

Four relevant topics for Chile were identified from the systematic report analysis. The first was *baseline information* (AA) referred to as how physical, aesthetic, cultural, and economic information in the project influence area are collected and provided. The second was *public information process and post-evaluation* (AB) referred to the format and type of information available during and after the EIA process; it is important to determine whether the information from the EIA process and post-supervision is accessible for identifying whether environmentally-assessed projects can be monitored. The third was *supervision and punishment for non-compliance* (AC) concerning the existence of a supervisor to sanction regulation violations by projects subject to EIA, and the subsequent definition of sanctions associated with non-compliance of the environmental authorization granted in the EIA process. The fourth was *resolution of environmental disputes* (AD) in attention to the existence of capabilities in a specialized institution to resolute environmental controversies. The *baseline information* criterion was referred to the 'EIA Process' category; the remaining were grouped into a new category named 'After EIA' relative to the evaluation carried out after the projects had obtained an environmental license. The four additional evaluation criteria are presented in Table 2.

2.3. Individual and comparative assessment of the EIA system evaluation criteria

Each of the 22 evaluation criteria (18 from Section 2.1 and four from Section 2.2) was used to evaluate the EIA systems of Chile, Brazil, Spain, and Canada. Data were obtained and reviewed from the official websites of the Governments of Chile,[1] Brazil,[2] Spain,[3] and Canada.[4] The search process consisted in reviewing each country's regulation and indicative information. In parallel, a review of scientific articles, PhD. Thesis, official books, and reports, analysing the EIA system from the four countries studied, was carried out. For the qualitative comparison of evaluation criteria among countries, an ordinal scale ranging from 1 to 5 was assigned to each evaluation criterion according to the ranking (1–5 score) described in Table 3.

After data scoring, a statistical analysis was carried out to assess the level of similarity among the EIA systems of Chile, Spain, Brazil, and Canada. Two complementary statistical tools were used. First, a Hierarchical Agglomerative Cluster Analysis (HACA) was performed using all criteria included in Table 2. The hierarchical agglomerative clustering is a 'bottom-up' approach where each observation starts in its cluster, and pairs of clusters are merged as one moves upwards in the hierarchy (Trevor et al., 2009). The rationale of HACA is to use the nearest neighbour as a method of agglomeration and the Euclidean distance as a measure of similarity (Clarke et al., 2014). For numerical and graphical analyses, the program XLSTATv. 2019.1 by Addinsoft ® (Addinsoft, 2020) was implemented and 20 score criteria were used; only criteria D and AA (Table 2) were excluded.

Second, a Principal Component Analysis (PCA) was carried out to illustrate the patterns and relationships among the EIA systems of Chile, Spain, Brazil, and Canada attending to the dependence (or intercorrelation) of the criteria scores. PCA is a multivariate technique that allows for reducing the dimensionality of the variable space by representing it with fewer orthogonal (uncorrelated) variables that capture most of its variability (Abdi and Williams, 2010). To carry out PCA, criteria B, H, J, N, O, P, R, U, V, W, AB, AC, and AD from Table 2 were selected. Criteria having incomplete information and/or showing the same score in all of the selected countries were removed. Data were standardized and the resemblance matrix calculated using the Pearson correlation coefficient. A quartimax rotation (i.e. an orthogonal rotation to transform vectors associated with the principal component analysis) was applied to represent the results in the first factorial plane of a biplot graph (Addinsoft, 2020).

2.4. Determination of improvement opportunities for EIA

Minimum and maximum values (score 1–5) were identified for the Chilean EIA system through comparison of each criterion in the four countries studied. Gaps (minimum score) and strengths (maximum score) for each criterion compared were analysed. This enabled us to identify and propose opportunities for improving the Chilean EIA

[1] http://www.sea.gob.cl
[2] http://www.mma.gov.br
[3] https://www.miteco.gob.es/
[4] https://www.canada.ca/en/services/environment.html

Table 2
Conventional and additional criteria selected for the evaluation of EIA systems.

Category	Criterion	Code	Reference for original criterion
EIA Legislation	Legal bases	A	Ahmad and Wood (2002)
	Provisions for appeal by the developer or the public against decisions.	B	Ahmad and Wood (2002)
	Legal or procedural specification of time limits	C	Ahmad and Wood (2002)
	Implications of proceeding without EIA approval	**D**	**Khosravi et al. (2019)**
EIA Administration	Review of the EIA report	G	Ahmad and Wood (2002)
	Administrative support	H	Annandale (2001)
	Competent authority for EIA and determination of environmental acceptability	I	Ahmad and Wood (2002)
	EIA centralization at the national level	**J**	**Khosravi et al. (2019)**
EIA Process	Alternatives for design	N	Ahmad and Wood (2002)
	Screening	O	Ahmad and Wood (2002)
	Scoping	P	Ahmad and Wood (2002)
	Content of the EIA report	Q	Ahmad and Wood (2002)
	Adoption of decisions	R	Ahmad and Wood (2002)
	Impact control	S	Ahmad and Wood (2002)
	Mitigation	T	Ahmad and Wood (2002)
	Consultation and participation	U	Ahmad and Wood (2002)
	System control	V	Ahmad and Wood (2002)
	Strategic Environmental Assessment	W	Ahmad and Wood (2002)
	Baseline information	AA	CAPRSEIA (2017)
After EIA	Public information process and post-evaluation	AB	CAPRSEIA (2017)
	Supervision and punishment for non-compliance	AC	CAPRSEIA (2017)
	Resolution of environmental disputes	AD	CAPRSEIA (2017)

Table 3
Ranking used for evaluation criteria.

Ranking	Description
1	Criterion not included in the legal framework; neither indicative guidelines nor implementation are evident.
2	Criterion not included explicitly in legislation and/or model procedures, although there is evidence of use in particular cases.
3	Criterion included in legislation and/or procedures of the model, although there is no evidence of occasional and/or permanent use in the EIA system.
4	Criterion used at a regulation or indicative framework, but not in all cases neither permanently.
5	Criterion included in the regulatory or indicative framework, with evidence of its permanent application in the EIA system.

system.

3. Results and discussion

3.1. Enforcement of the evaluation criteria

HACA of EIA systems of Chile, Brazil, Spain, and Canada was carried out. The 20 evaluation criteria used in the HACA correspond to those described in Table 2. Considering 70% similarity, Fig. 2 shows three groups: the first group included Spain and Canada with 88% similarity. The second group included Chile with 69% similarity with respect to the first group. The third group included Brazil with 63% similarity to the first group. Fig. 2 shows dissimilarity instead of similarity for a better presentation of results.

The second step was PCA implementation to explore the patterns of the EIA systems of Chile, Canada, Spain, and Brazil and their relationship with the 13 criteria (out of the selected 22) that contribute to the variability of the EIA systems. Fig. 3 shows the first factorial plane (F1 and F2), which represents 84.34% of the total variance. The first group (Chile, Canada, and Spain) correlates well with the following criteria: *Administrative support* (H), *Screening* (O), *Adoption of decisions* (R), and *Supervision and punishment for non-compliance* (AC); for the case of Chile high scores have been obtained for following criteria: *Provisions for appeal by the developer or the public against decisions* (B), *Consultation and participation* (U), *System control* (V), *Public information process and post-evaluation* (AB), and *Resolution of environmental disputes* (AD). For the second group (Brazil), a high score is obtained for criterion *Alternatives for design* (N) whereas for the remaining criteria the score is generally

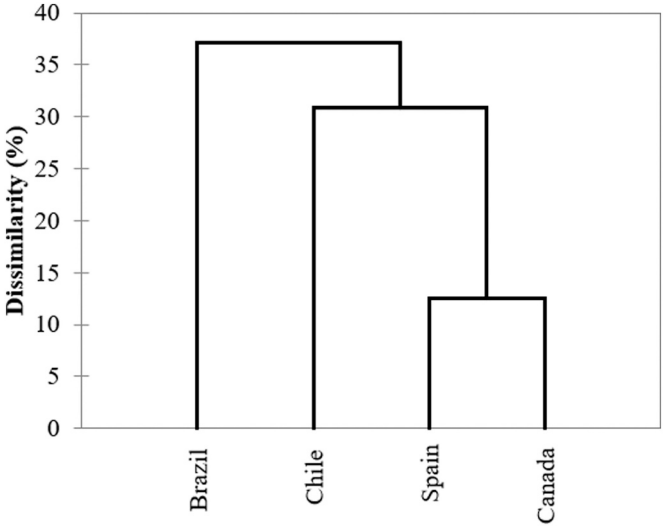

Fig. 2. HACA of the EIA systems of Chile, Spain, Canada, and Brazil using the 20 evaluation criteria from Table 2, and its scores included in Table A.1 in Appendix A. The Euclidean distance among the EIA systems of studied countries is expressed as dissimilarity (inverse of similarity) in the 0–100% range.

lower than that obtained for the entire first group. Table A.2 in Appendix A includes factor loadings of PCA.

The analysis of the 'EIA Legislation' category criteria (Table 2) allowed for us to observe similar evaluation across the following criteria: *Legal bases* (A), *Legal or procedural specification of time limits* (C), and *Implications of proceeding without EIA approval* (D); criteria D for Canada was singled out because information was not found. Criterion *Provisions for appeal by the developer or the public against decisions* (B) showed the main dissimilarities due to differences in countries applications (Fig. 4). In Spain, discrepancies found after project approval are resolved by the Council of Ministers or the competent regional government body. In Canada, no options for a proponent or member of the community to appeal are found (CEAA, 2019). In Chile, appeals by the proponent are solved in two ways: projects evaluated in simplified mode (EID) are resolved by the Executive Director of the Environmental Assessment Service, and projects requiring an EIS are resolved by the Council of Ministers (MMA, 2012). Fig. 4 shows the EIA systems comparison for

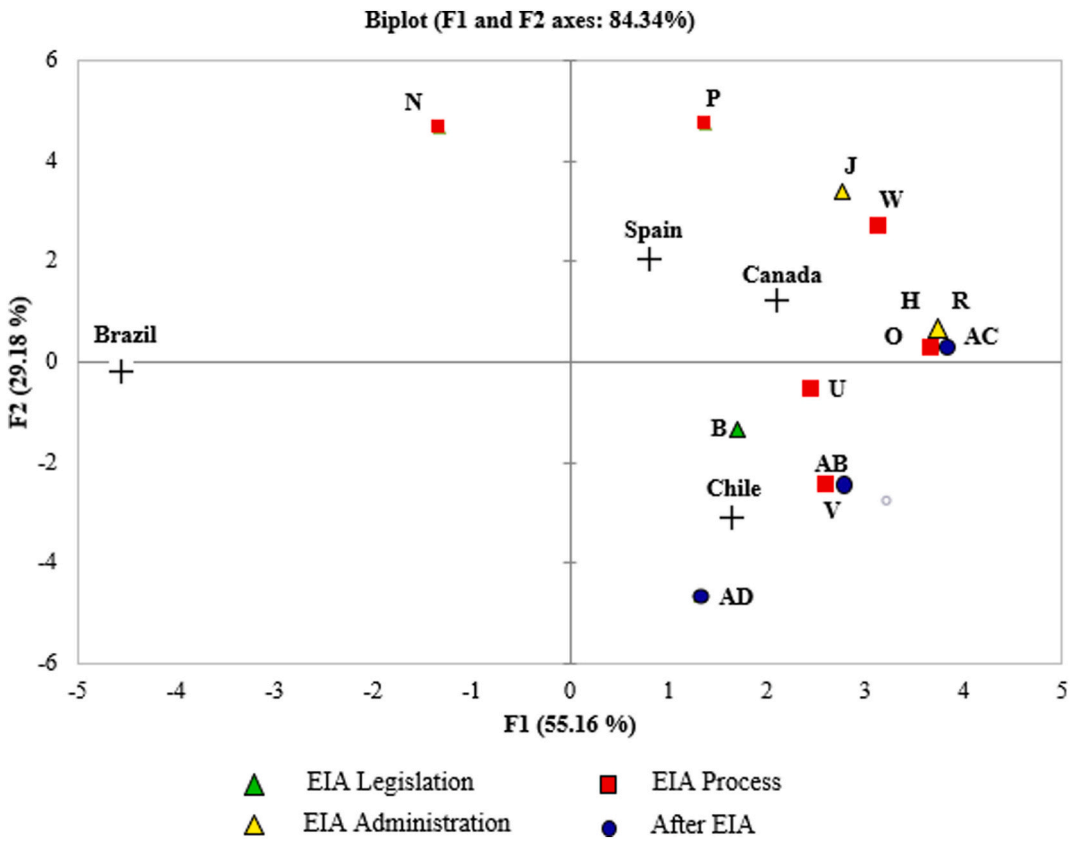

Fig. 3. From PCA, first factorial plane (PC1 and PC2) of the EIA systems of Chile, Spain, Canada, and Brazil and their relationship with the selected criteria *Provisions for appeal by the developer or the public against decisions* (B), *Administrative support* (H), *EIA centralization at the national level* (J), *Alternatives for design* (N), *Screening* (O), *Scoping* (P), *Adoption of decisions* (R), *Consultation and participation* (U), *System control* (V), *Strategic Environmental Assessment* (W), *Public information process and post-evaluation* (AB), *Supervision and punishment for non-compliance* (AC), and *Resolution of environmental disputes* (AD).

Chile, Brazil, Spain, and Canada in relation all evaluation criteria from Table 2.

In the 'EIA Administration' category (Table 2), similarities were found in criteria *Review of the EIA report* (G) and *Competent Authority for EIA and determination of environmental acceptability* (I), and main differences were in the *EIA centralization at the national level* (J) criterion. Spain and Canada are similar in that their legislation at the regional and national levels is obliged to comply with minimum requirements (De Tomás, 2014; Perevochtchikova and André, 2013). Brazil, however, has a centralized regulatory framework without local regulations, which could aid improve the effectiveness of the system (Chalotra, 2016). In Chile, in 2005 the OECD recommended strengthening the environmental institutional framework, and in 2010 the EAS was created to administer the environmental assessment. In 2012, the EIASR was updated and numerous technical guides have been published, serving as an input for new EIA guidelines. The above serves as evidence of the evolution of the administration of the EIA (OCDE, 2005; MINSEGPRES, 2010; MMA, 2012; Moraga, 2017). Projects environmental assessment is carried out at the regional level, except for interregional equivalents, which are evaluated and qualified by the Executive Board. For appeals, the EAS is present in all regions of the country with the main office in Santiago (MINSEGPRES, 2010; MMA, 2012); furthermore, guidelines are frequently issued from the national level, and the EAS determines the acceptability of the projects and reviews the projects.

In relation to the 'EIA Process' category (Table 2), similarities were detected in criteria *Content of the EIA report* (Q), *Impact control* (S), *Mitigation* (T), and *Baseline information (*AA); for criteria AA, the case of Canada could not be evaluated due to the lack of information. The main differences were in criteria *Alternatives for design* (N), *Scoping* (P), *Consultation and participation* (U), and *Strategic Environmental Assessment* (W). The *Alternatives for design* criterion is established in models from Brazil, Spain, and Canada through the existence of an explicit requirement to incorporate design alternatives and justify the selected option (CONAMA, 1986; BOE, 2013; CEAA, 2012). These models consider the main alternatives studied, which are to not carry out the project and the justification of the solution adopted (De Oliviera, 2013; De Tomás, 2014; Perevochtchikova and André, 2013). This criterion (N) is absent in Chile, so only a single scenario during the EIA process is evaluated.

The *Scoping* criterion is not considered in the rules governing the EIA in Chile and Brazil (MMA, 2012; De Oliviera, 2013; Borioni et al., 2017). In Spain and Canada, the EIA considers different types for approaches, e. g. external and internal review (BOE, 2013; Perevochtchikova and André, 2013).

The *Consultation and participation* criterion is found in the four models tested, but differs in form. In Chile, it begins after projects submission, and early participation is voluntary. There are different standards for participation depending on the type of project being processed; for EIS, participation is mandatory. There is the option of a Consultation Process with Indigenous Peoples based on ILO Convention 169 if there are significant environmental impacts associated with indigenous peoples, specifically if projects have affectation to articles 7, 8, and 10 from EIASR (MMA, 2012). In the case of EID, citizen participation is exclusive for some types of projects indicated in article 94 from EIASR (MMA, 2012). When participation takes place, all observations must be considered in the process and the project proponent must respond to each observation.

In Brazil, public hearings have caused discontent among participants (because of limited real effectiveness) and have been identified as one of the main weaknesses of the EIA in the country (Sánchez, 2013; Fonseca et al., 2017). In Spain, although the possibility of consulting agencies

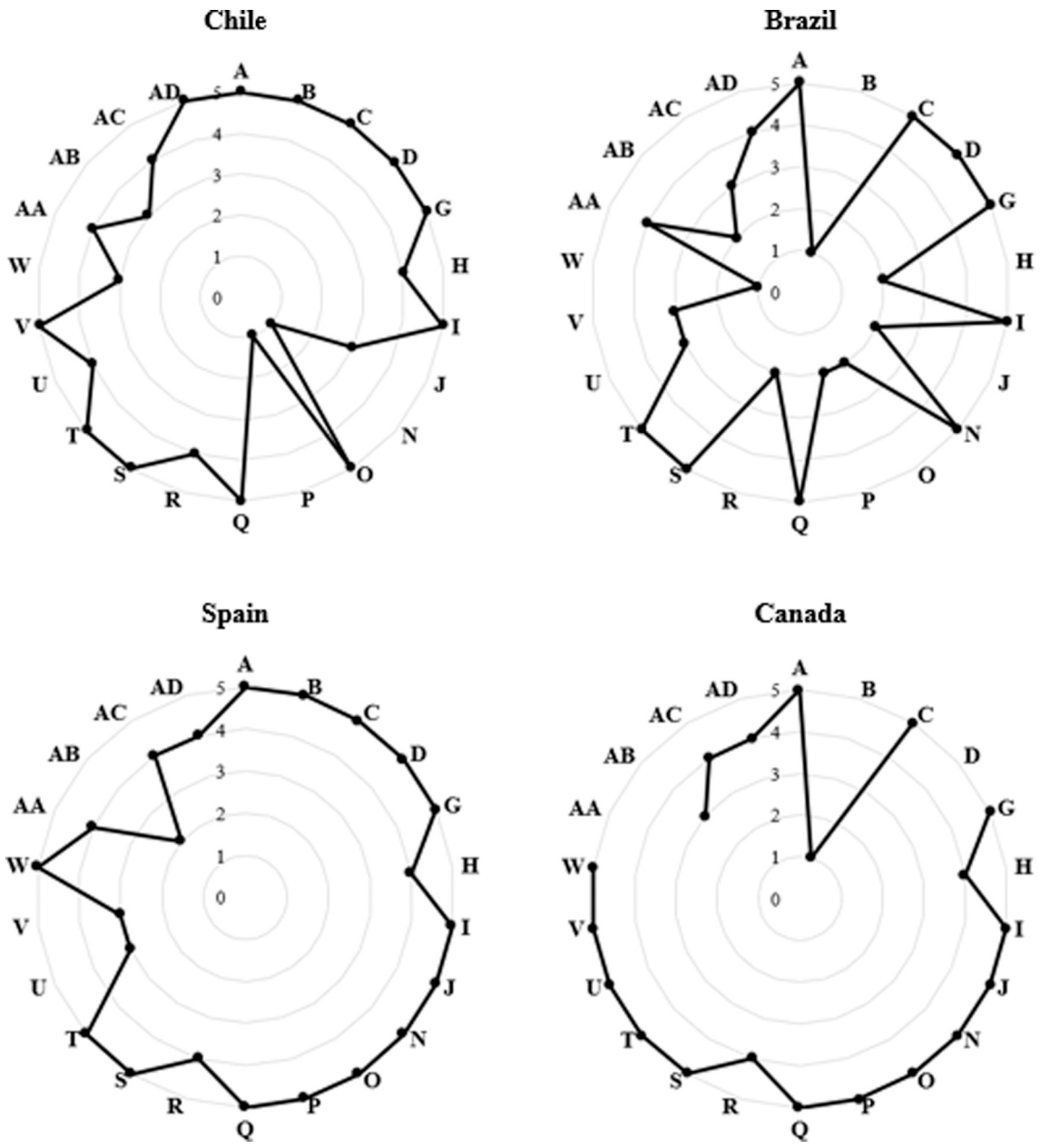

Fig. 4. EIA systems comparison of Chile, Brazil, Spain, and Canada using the evaluation criteria defined in Table 2, and its scores included in Table A.1 in Appendix A. For Canada, information for criteria D and AA could not be accessed.

and people affected directly is considered, a low level of participation and consultation is common. In Canada, early public consultation for identifying public concerns (regarding the proposed scope of the EIA and other related issues) is required for major projects; however, the model differs from the previous two and holds many similarities with the Chilean model. Both, regular and indigenous funding are available to facilitate participation (CEAA, 2015).

The *Strategic Environmental Assessment* criterion differs in its application in all four models studied. In Brazil, there is no obligation to submit to the criterion (Davidivic, 2014). In Canada, it is under the responsibility of the Canadian Environmental Assessment Agency (CEAA) and applies to policies, plans, and programs (CEAA, 2010). In Spain, ordinary and simplified procedures exist for this criterion, which is contained in the Environmental Assessment Act and is homologous to EIA projects (BOE, 2013). In Chile, the policies and plans proposed by the President of the Republic that generate impacts on the environment are subject to this criterion. Territorial planning instruments are also subject to the Secretariat of the Environment (MINSEGPRES, 2010).

With respect to the After EIA category (Table 2), two criteria dissimilarities were detected. The *Public information process and post-evaluation* (AB) criterion differs between systems, none of which fulfil this criterion. In Chile, information on the EIA process is published on the EAS website.[5] For post-evaluation processes, audits information is found on the Superintendency of the Environment website (the agency responsible for supervision). However, the concept through which this information is tracked is named 'Supervision Units', which is not necessarily consistent with the EIA process codes previously carried out. No direct link from each project to its enforcement record is observed, which hinders post-evaluation monitoring.

Brazil has the *Portal Nacional de Licenciamento Ambiental* (National Environmental Licensing Portal, NELP) for complying with the rules on

[5] https://www.sea.gob.cl/

public access to environmental information and data existing in the agencies; however, the information available on project licensing is limited. For post-EIA information, there is a different site for reviewing the sanctioning processes; although no link between both sites can be found. An official website in Spain archives projects from which an EIA document can be obtained, although the whole technical-administrative process of the project (e.g. a list of consultations at the citizen participation stage) cannot be acquired. Also, a submenu containing projects and programs under consultation is published, allowing the public to enter queries online. In Canada, the environmental agency administers a record in which the process history and resources availability of citizen participation are published, along with other information. Table A.1 in Appendix A contains a detailed comparison result of the criteria selected for the four countries.

The *Resolution of environmental disputes* (AD) criterion differs across the countries analysed. In Spain, Brazil, and Canada environmental disputes are resolved through the ordinary courts. In Chile, however, there are three Environmental Courts located in the northern, central, and southern zones of the country. Environmental Courts in Santiago and Valdivia were first operating in 2013, followed by the Environmental Court of Antofagasta, all three for resolving environmental disputes within their jurisdictions; a peculiarity is that each court has a judge with a degree in science. The Environmental Courts are contingent to the political, correctional, and economic superintendence of the Supreme Court (MMA, 2012a).

3.2. Determination of opportunities for improvement of EIA in Chile

We propose to improve three areas of the Chilean EIA system beginning from the analysis of main weaknesses, after the criterion application. The proposed amendments would apply regardless of whether the project is environmentally evaluated as an EID or an EIS.

First improvement is a fusion between the EIA administration and the EIA process, as it considers options to incorporate the *Adoption of decisions* (R) and *EIA centralization at the national level* (J) criteria (Table 2). Nowadays, the petitioner can appeal to the final decisions of the projects to the Council of Ministers for an EIS or at the Executive Director of the EAS for an EID. Full transfer of powers to each region is proposed by eliminating options <appeal>, at the national level because authorities commonly evade regional level problems by transferring them to national-level authorities. This allows for claims to be sent for settlement directly by the Environmental Courts (as were created for resolution of environmental disputes), acting under the law and on the basis of technical decisions reached during the evaluation (CAPRSEIA, 2017).

Second improvement is to incorporate the *Alternatives for design* (N) criterion by proposing an amendment to the EIA regulation, introducing the need to present more than one alternative, and comparing these to the base condition of non-execution of the project. On the one hand, it allows for situations with different impacts on the EIA to be assessed and on the other, it encourages a wider trading range during the project EIA, which is not currently possible due to the single-scenario evaluation (De Oliviera, 2013; CONAMA, 1986; BOE, 2013; De Tomás, 2014; CEAA, 2012; Perevochtchikova and André, 2013).

Third improvement is to integrate the *Scoping* (P) criterion in the EIA system by modifying the EIASR. The proponent should previously deliver an abstract of the project to the EAS for analysis and consult at public institutions, non-profit organizations, and citizens, to prioritize relevant issues (Ocampo-Melgar et al., 2019; CEAA, 2019; Wood, 1995; Perevochtchikova and André, 2013).

Fourth improvement is to include the *Baseline information* (AA) criterion by creating a register of independent reviewers in the EAS. Reviewers must demonstrate knowledge and practical experience in baseline description and impact assessment methodologies (guidelines with requirements for external reviewer must be constructed). The review aims at establishing an additional control of the baselines declared by proponents, eliminating methodological uncertainties and public distrust on this particular matter.

Fifth improvement is to incorporate the *Public information process and post-evaluation* (AB) criterion. The aim is to reduce the monitoring difficulties in the post-evaluation execution of projects by merging the EAS and Superintendency of the Environment platforms, to establish a single criterion under which to search for the environmental license number, once obtained. In addition, we propose each government agency with project supervision authority to incorporate both the results from the processing of Mixed Environmental Permits and audits into the platform. This will facilitate access to information and subsequent monitoring, and reduce public EIA distrust.

In summary, these five improvement opportunities are possible through the EIASR modification, although attention must be paid to incorporating Scoping by increasing the EAS staff. Alternatively, technical capacities in Universities, Research Centres, and Governmental Offices must also be built to enable the incorporation of external baseline information reviewers.

4. Conclusions

HACA shows three groups considering 70% similarity: the first group included Spain and Canada with 88% similarity; the second group included Chile with 69% similarity with respect to the first group; and the third group included Brazil with 63% similarity, also with respect to the first group. PCA shows that only 13 of the selected 22 criteria contribute to the variability of the studied EIA systems, representing 84.34% of the total variance.

The main similarities of the Chilean EIA system to that of Brazil, Spain, and Canada fall within criteria *Legal bases*, *Content of the EIA report*, *Review of the EIA report, Impact control, Mitigation, Legal or procedural specification of time limits, Competent authority for EIA and determination of environmental acceptability, Implications of proceeding without EIA approval*, and *Baseline information.*

The main strengths of the Chilean EIA system in comparisons to Brazil, Spain, and Canada, are the existence of specialized Environmental Courts for resolving disputes and the options for pre-execution appeals. The main gaps are found in criteria *Alternatives for design, Consultation and participation, Strategic Environmental Assessment, EIA decentralization at the national level,* and *Public information processes and post-evaluation monitoring.*

The weaknesses identified in the EIA Chilean system in comparisons to Brazil, Spain, and Canada are: an EIA system with high centralization at the national level, the absence of project alternative considerations, no requirement for scoping, and that the process of Strategic Environmental Assessment is not binding.

In terms of conventional evaluation criteria, the four models show similar criteria to those proposed by Ahmad and Wood (2002), with minor differences in the *Alternatives for design* criterion. However, there are model variations between the criteria used by Annandale (2001) and Khosravi et al. (2019). Of the four new criteria that constitute a methodological innovation, differences are found in the criteria *Public information* and *Resolving environmental disputes*.

The main options for improving the Chilean EIA system are related to criteria *Alternatives for design, Adoption of decisions, EIA decentralization at the national level, Scoping, Baseline information*, and *Public information process and post-evaluation.* The methodological framework introduced seeks out to serve as guidance for Latin American countries with similar environmental and social contexts, as well as environmental legislation improvement needs.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

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