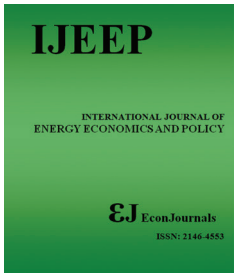

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Hydropower Megaprojects in Colombia and the Influence of Local Communities: A View from Prospect Theory to Decision Making Process based on Expert Judgment used in Large Organizations

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ABSTRACT

Today conflicts between large organizations that promote hydroelectric megaprojects (Sovacool et al., 2015) and local communities are predictable (Ansar et al., 2014). In literature, the causes of these levels of conflict are explored from the point of view of power relationship (Goodwin and Jasper, 1999) and stakeholder framework theory (Rosso et al., 2014). This paper presents an original way to address this research field through an endogenous view (Mieg, 2014) of the organizations focused on decision making process based on expert judgment. The study scopes are environmental decisions under uncertainty that are carried out to develop environmental impact assessment. All organizations that are developing large hydroelectric projects in Colombia during period 2010-2020 were examined. The results indicate the difficulty of organizations (Moritz and Gieri, 2015) to adequately respond to external requests associated with environmental and technological dimensions. Cumulative prospect theory and heuristic and biases framework (Brighton and Gigerenzer, 2015) are the theoretical background. Energy policy recommendations are generated based on adjustment type "external view" that comes from behavioral organizational framework (DellaVigna, 2009). This study identifies a novel approach to design lesser levels of conflict through creating better organizational decision making processes.

Keywords: Decision Making Theory, Large Organizations, Cumulative Prospect Theory, Megaproject
JEL Classifications: D22, Q51, L90

1. INTRODUCTION

In 2014, the hydraulic power generation accounted for 64.2% in Colombia (Unidad de Planeación Minero Energética - UPME, 2014), and during the next decade between buildings, feasibility and pre-feasibility studies, five more hydroelectric are projected, with an installed capacity above to 400 MW (Unidad de Planeación Minero Energética - UPME, 2014). The national picture is a sample of Latin American tendency to implement mega projects to supply electricity demand, it corresponding to the economic growth from countries (Ansar et al., 2014).

Despite the wide coverage of hydroelectric projects planned in the current decade, and the benefits in terms of population served, conflicting opinions and expressions of environmental groups who call the plundering of natural resources, configured in parallel (Unidad de Planeación Minero Energética - UPME, 2014). At the same time questioning the inclusion of communities adjacent to the territories of involvement (McCormick, 2006) for the joint construction of the various stages of consolidation of the project is proposed (Rosso et al., 2014).

The construction of hydroelectric power has gone from being a state policy of democratization of public services to integrate private initiatives to promote the development of sustainable energy from large projects, of course, resulting in economic profits and strengthening social concern about environmental (Ansar et al., 2014). The decision of the private sector responds to indicative plans of governments (Unidad de Planeación Minero Energética - UPME, 2014), large organizations promotes hydropower projects supported on recommendations by highly specialized teams (Barnard, 1968; Hofer and Schendel, 1978) in

increasingly uncertain and ambiguous contexts (Earle and Siegrist, 2008) as environmental impact assessment (Stone, 2011) and social alternatives studies (Conesa, 1997).

The research presented here provides a novel explanation to high levels of conflicts currently predictable between local communities and the construction of hydroelectric projects in Colombia through an endogenous gaze at the large organizations (Busenitz and Barney, 1997) focused on the environmental decision-making process based on expert's judgment. The study covers construction of hydroelectric projects (>350 MW) in Colombia; the participant companies represent all hydropower projects under construction during the study period 2010-2020.

The research employs cumulative prospect theory (CPT) (Tversky and Kahneman, 1992) by considering its relevance as a descriptive theory of choice where expert judgment plays a salient role on organizational decision making process facing conditions of uncertainty. To use this theory is necessary to establish the preferences of experts (Mieg, 2009) and those dimensions or categories where they experience gains or losses relative to a reference point when choosing.

The field information is obtained from direct interviews (Hoffman, 1992) to experts in the workplace[1], taking into account the design of interviews aiming to determine (Ericsson, 2006) the use of the availability heuristic (Tversky and Kahneman, 1974) and its quantification based on the criteria of ease of recall and deliberation time responses (Rubenstein, 2013). The data are classified in areas of gain or loss, taking into account the cumulative frequency of the categorized responses for each expert. On behavioral economic studies corresponds to "observational" studies category (Angner and Loewenstein, 2007).

Various plausible scenarios of the probability function in the multi-dimensional scale are determined and each risky prospect for each organization in the defined scenarios is measured (Moritz and Gieri, 2015). Based on the results, regulatory recommendations for hydropower policy have been identified and organizational adjustments inside decision making process of companies studied. These changes in current situation aim overcome bias involving actual model of decision making based on expert judgment within organizations (Flyvbjerg et al., 2005). Brought back from behavioral economics school, one way to overcome to these kinds of biases (Lovallo and Kahneman, 2003) its finding "external view" style solutions (Gilovich et al., 2002) and within that context, the authors propose the adoption of reference classes forecasting (Lovallo and Kahneman, 2003). To incorporate this adjustment in the mathematical model, environmental and institutional dimensions are set to zero and simulated to obtain the new value function in terms of CPT (Tversky and Kahneman, 1992), thereby, they are obtained the impacts of applying the policy recommendations on the levels of conflict with local communities generated by the bias in the organizational decision-making process based on expert judgment (Flyvbjerg, 2007). In short findings indicate a clear improves on overall performance of large organizations in mitigating conflict with local communities when mega projects are carried out as large hydropower construction. The settings can improve performance through the external view environmental decisions (Kirkebøen, 2009) bearing in mind the results on the losses zone experienced by decision makers to external requests currently in the technological and environmental dimensions.

According to the authors these findings and the research method constitutes an original and effective way to identify opportunities to adjust energy policies of emerging countries like Colombia that are fostering new megaprojects and seeking early involvement of local communities. The authors make use of the interpretations derived from school of heuristics and biases (Tversky and Kahneman, 1974) to generate energy policies aimed on improving (Holmes et al., 2011) decision-making organizational processes to overcome expert's overconfidence bias (Kirkebøen, 2009) and regulatory environment to overcome availability bias (Plous, 1993) produced by considers reliable organization's data (field gathering as primary source) instead of institutional data available (public knowledge as secondary source). The endogenous approach selected by the authors is a line of research which deviates from traditional approaches such as stakeholder theory (Jawahar and McLaughlin, 2001) (Rosso et al., 2014) and power analysis that enjoy broad spread in this field of study (Goodwin and Jasper, 1999). According to authors, research within organizations in order to identify new policies to reduce conflict levels[2] between local communities and large organizations involved in these megaprojects constitutes an unexplored field.

Field information comes from all companies in Colombia that promote large hydroelectric projects, in total corresponding to 4 companies: EMGESA, CELSIA, EPM and ISAGEN. These companies account for over 90% of the energy market currently Colombia and are located within the largest organizations in the country (Unidad de Planeación Minero Energética - UPME, 2014). Selected environmental experts meet the criteria (Mieg, 2009) of excellence (high specific knowledge) and professionalism (recognition within his organization as expert). The information is presented in aggregate form. Two plausible and general assumptions are set: Homogeneity of expertise and homogeneity of organization (Mieg, 2014. p. 88).

2. BACKGROUND AND LITERATURE REVIEW

Breakthroughs in decision making, especially those under conditions of uncertainty and high dependence on experts, has rewritten much of the known theoretical frameworks on the subject, it requires rapid adoption at the community scientific (Moritz and Gieri, 2015), by finding a new taxonomy of theories

1 "…In sum, to obtain the most valid and complete trace of thought processes, scientists should strive to elicit … conditions where verbalizations directly reflect the participants' spontaneous thoughts generated while completing the task..." (Ericsson, 2006. p. 231).

2 We refer to regulatory adjustment that changes expert's point of references towards gain zone. Analogous to "integrating" on Rahim's model (Rahim, 2002. p. 218).

available in this area, especially for application in the field of energy policy.

The authors develop a proposed taxonomy for theories of decision making aimed on highlighting the criteria associated with the different approaches to implementing energy policy.

This taxonomy emerges within the current PhD work, where exploration required a guideline to sort theoretical approaches across field study, focusing on decision-making on mega projects in a consistent manner with the academic tradition (Angner and Loewenstein, 2007). The proposal allows an understanding and delineation of key decision making theories extensively studied. From traditional approaches such as rational choice theory (Tversky and Kahneman, 1986) to the approaches outlined in this century associated with behavioral economics, some of which still been at a stage of ripeness (Censi et al., 2015). It is to highlight the contribution of knowledge of cognitive and psychological studies of human judgment and its implications for the theory of decision making under uncertainty, which establish the state of art for future researches.

Theories of decision available can be separated according to their orientation into two groups: Normative and descriptive. For normative theories, the rational choice theory (Tversky and Kahneman, 1986) is the dominant paradigm (Kuhn, 1962), the main feature is the rational behavior imposed of how a decision should be chosen. For descriptive theories, whose main feature it is observe how decision makers actually choose.

Decision-making involves taking preferences, and preferred types can be classified by two parameters associated with their temporal stability (static or dynamic) and its degree of certainty (deterministic or probabilistic). The theory of rational choice is a clear example of a process of static and deterministic choice (Glöckner and Betsch, 2012), bearing in mind that preferences cannot be changed without violating the property of transitivity (Kahneman and Tversky, 1979). There are theories in which elements such as time of deliberation involving continuous and random changes in the type of preferences (Busemeyer and Townsend, 1993); in these cases we have a process of dynamic stochastic choice (Atkinson and Birch, 1970).

One of the most interesting characteristics of the theories of decision making is the type of rationality implemented. Overflow this article explore numerous rationales currently studied, however, in brief the academic tradition recognize the following main types of rationality: Perfect (Neumann and Morgenstern, 1944), bounded, aesthetics (Shackle, 1972), and retrospective (Klaes and Sent, 2005). The perfect rationality has its greatest application in the theory of rational choice (Simon, 1976): Here man is able to deal with the world as it is and without restrictions on their decision-making process (Klaes and Sent, 2005). The procedural rationality (Simon, 1976) constitutes acceptance of the inability of humans to (Simon, 1976) process the large amount of information and incentives when choosing, leading to be limited by your ability to process information at that time. Aesthetic rationality (Hausman, 2012) proposes a limitation on the ability to imagine the future as a condition of a choice in this (Hansson, 1994). The retrospective rationality (March, 1994) includes the above limitations and information processing capacity of imagination, leading to a world of supremely different from the dominant paradigm of perfect rationality elections. Bounded rationality (Simon, 1976) is therefore the generalization of procedural rationality, aesthetics and retrospectively.

The cognitive sciences have advanced the understanding of the process of expert judgment and there have emerged many theories of decision making; all of which can be categorized as sequential and non-sequential (Mintzberg et al., 1976). Sequential theories accept the existence of an organized and hierarchical process of the formation of the expert judgments; again, the rational choice theory is clearly representative process (Hansson, 1994).

A non-sequential theory incorporate most of psychology findings on this matter (Brighton and Gigerenzer, 2015), and allows to discover several variations of what happens in depth at the time of a human choice (Tversky and Kahneman, 1986). In psychological terms human judgment (Alos-Ferrer and Strack, 2014) depends on the Type 1 and 2 systems: Type 1 is called the fast thinking (intuition) and Type 2 to slow thinking (reasoning). This implies the possibility that human judgments by heuristic routines may evolve, remain or disappear (Gigerenzer, 2015).

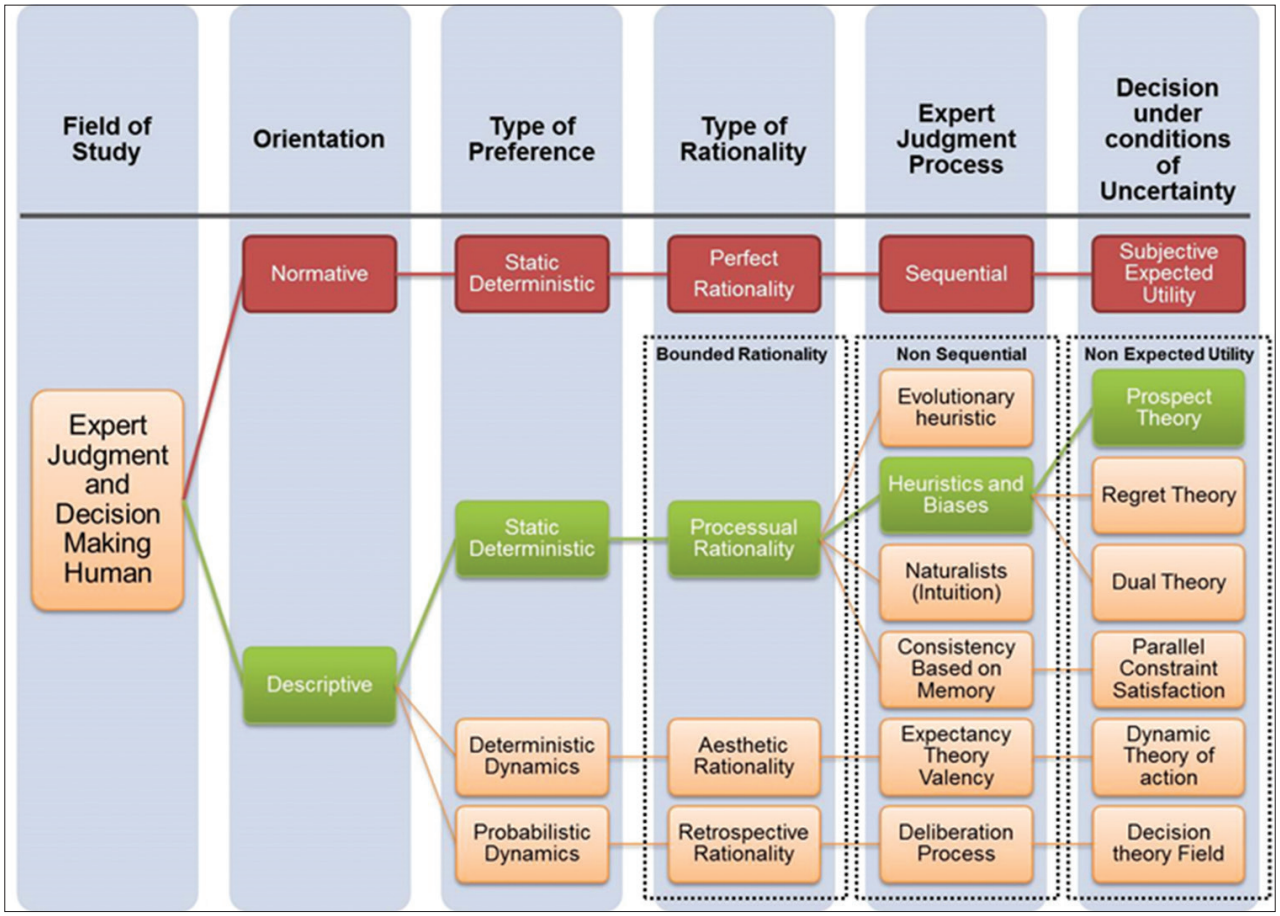
The theories herein may emphasize the use of the system 1 such as flash memory and intuition in the case of naturalists (Kahneman and Klein, 2009) or as debugging of evolutionary heuristics (fast and frugal) (Gigerenzer et al., 2011). Indeed if the judging process is not sequential and dynamic preferences are assumed, theories like the theory of the "valence expectation" (Vroom and Jago, 1988) where the motivation for a constant and parallel association is used (Vroom and Yetton, 1973), or concepts like time of responses are used to explaining the choices(Burghart et al., 2013) as on the functioning of human deliberation processes[3].

Mega projects engineering succeeds only when organizational decision making considers uncertainty coming mostly from technological, institutional, environmental, social and economic aspects (Atkinson and Crawford, 2006). Therefore only those theories of decision where these issues are addressed may actually have applicability in this context. Theories of decision making under uncertainty are in the end, all those that consider the diversity of features to deal to a context full of ambiguity and uncertainty during the project life cycle of large hydropower(Ansar et al., 2014).

The theories of decision making under uncertainty can be segmented into two categories also: Those of subjective expected utility, where the rational choice theory is a clear dominant paradigm (Kreps and Porteus, 1979), and not expected subjective utility (Simon, 1976). All classifications of theories preceding are linked. For instance, CPT (Tversky and Kahneman, 1992) is classified as a descriptive theory, eliciting static and deterministic preferences, assuming bounded rationality and a non-sequential

3 Neuroscience studies mostly (Burghart et al., 2013).

Figure 1: Framework of decision making theories applicable to mega projects on engineering field



Source: Developed by the authors

human judgment process and been part of non-expected utility approach.

As shown is noticeable the potential of the proposed categorization aiming understand the theories of decision making inspired on recent advances of cognitive sciences in the field of energy policy. The solution to this problem of classification accelerates the identification of the theories of decision that can address this problem (Bakka and Lindkvist, 1999). Without such methodological guide the search can be a highly inefficient process in practice (Sovacool and Cooper, 2013), since an erroneous theoretical adoption can lead to assume basic assumptions clearly wrong, and thus lead to invalidate the results of further research (Sovacool, et al, 2015).

The characteristics of a theory of decision making are presented in the theoretical framework proposed by the authors in Figure 1.

The theories of decision making under conditions of uncertainty (Knight, 1921) used in decision-making processes in large organizations can be summarized in 7: Expected Utility Theory (Neumann and Morgenstern, 1944) (Becker, 1976), prospect theory (Tversky and Kahneman, 1992)[4], regret theory (Loomes and Sugden, 1982), dual theory (Yaari, 1987), parallel constraint satisfaction, dynamic theory of action (Kreps and Porteus, 1979), and decision theory field (Busemeyer and Townsend, 1993). Obviously, there are theoretical extensions or changes in building with no particular features within the taxonomy proposed by the authors as corresponding to derivations of the theories presented[5].

After a tour of the various dedicated schools to study decision concludes that prospect theory (Tversky and Kahneman, 1992) identifies the characteristics that match the conditions in which it is decided in the context of a mega project such as the construction of large hydroelectric plants in Colombia (Unidad de Planeación Minero Energética - UPME, 2014). This research is conducted from the perspective of CPT (Tversky and Kahneman, 1992) bearing in mind that the school uses heuristics and biases (Moritz and Gieri, 2015) as a starting point for modeling the internal process of decision making under conditions of uncertainty (Atkinson and Crawford, 2006) from experts (Busenitz and Barney, 1997) and applies to the environmental dimension large hydro (Sovacool and Cooper, 2013).

2.1. Prospect Theory

Before 1979, as mentioned by Wakker (2010), irrational behavior was seen as chaotic and inadequate for modeling. Kahneman and Tversky (1979) prospect theory provides a major break.

4 This term is used in a modern way to refer to the cumulative prospect theory as suggested in his work Köbberling and Wakker (2003).

5 Among them we can mention half-full/half-empty (HeFH) model (Censi, et al., 2015).

In this theory of choice, unlike the theory of expected utility, values are assigned to the gains or losses relative to a reference point, instead of the final values and probabilities are replaced with weights decision. The value function unlike the expected utility is usually concave for gains, convex for losses, as a general rule steeper for losses than for gains. The weights of decisions are almost always lower than the corresponding probabilities, except in a very small range of probabilities.

The theory of Kahneman and Tversky prospects shows that individuals tend to be concerned about short-term results and its subjective value function expresses that there is an emotional value associated with wealth changes (gain or loss) (Kahneman and Tversky, 1979). The utility cannot be apart from emotion and emotions are triggered by changes in the states or contexts of choice (Angner and Loewenstein, 2007).

Prospective risk theory established three starting parameters (Wakker, 2010):

1. About weighting of low probabilities
2. Underweight middle and high probabilities
3. Equal weights for gains and losses.

During the second half of the eighties more complex behaviors to risk were observed. They could not be explained within the theory of risky prospects and, therefore, equal weights were assumed for both gains and losses (Wakker, 2010). Seeking to overcome these drawbacks Tversky and Kahneman (1992) formulated a "CPT."

The authors argued that the third characteristic it instilled equal reaction to the loss or gain by the study subjects did not correspond to the findings (Wakker, 2010); consequently raised the modification third factor by one that reflect the subjectivity of decision makers (Tversky and Kahneman, 1992). Additionally they included a fourth pattern that would explain the fourfold pattern of risk attitudes (Wakker, 2010).

3. METHODOLOGY AND DATA

In order to develop an appropriate descriptive model of decision making (Holmes et al., 2011), it is necessary intensive fieldwork observation and capture information directly in the workplace (Angner and Loewenstein, 2007) (Charness et al., 2013). Therefore, to identify the current environmental decision-making process execute on mega hydroelectric projects[6], the methodological tool adopted were surveys (Ericsson, 2006) with questions of type (Kumar, 2005): Structured (quantitative data) and unstructured (qualitative data). The study contemplates projects that exceed 350 MW of generation power and develop in Colombia (Unidad de Planeación Minero Energética - UPME, 2014) in the period between years 2010 and 2020. To design the methodology tool chosen, were necessary defining precise points of inquiry aiming to corroborate or negate the assumptions made as a hypothesis (Ericsson, 2006). Furthermore, the tool design must allow the replication of data (Charness et al., 2013) from the respondents and generate qualitative inputs useful to validate quantitative results found (Hoffman, 1992).

At early stage the organizations entrusted with implementation of projects relevant to the research are identified. It was concluded that organizations are (Unidad de Planeación Minero Energética - UPME, 2014): EPM[7], ISAGEN, EMGESA, CELSIA are in charge for all mega hydroelectric projects in Colombia between years 2010 and 2020. These organizations have delegated to its environmental experts (Mieg, 2009) to answer the survey designed by authors.

The questions were exactly equal for the 4 experts (Hoffman, 1992), were queried in the same order and with the same procedure, which consisted to give a maximum response time of 5 min to the respondent to reply (Ericsson, 2006). The register of answers was conducted through audio recordings[8] and making notes about the first sentence or explanation enunciated by the expert to each question formulated. Such emphases on the first expert answer ensure that surveys reflect the most immediate concerns of experts of organizations in specific work contexts (Mieg, 2014).Moreover, decision making theory indicates that an expert often use heuristic of availability[9] in its mind (Plous, 1993).

Each survey lasted approximately 30 min, of which 91% of time was used by experts to answer. The responses had a unique option in most items, nevertheless, to explore how organizations prioritize (Mieg, 2014), there two questions that aims to rank given answers from highest to lowest (Plous, 1993). This attributes come from previously selected environmental impact assessment studies (McCormick, 2006) (Conesa, 1997) (ESI, 2005) and previous work done by other research in areas close study field of mega hydroelectric projects (Stone, 2011) (Sovacool and Cooper, 2013) (Ansar et al., 2014).

The first supposition validated by survey design was the coincidence between the person profile of selected in each organization to answer the survey and expert profile (Ericsson, 2006). To verify this point, the survey contains closed questions about the description of the academic excellence of each and the recognition of the expert within the organization, as a confirmation for recognition characteristic (Hoffman, 1992), there is used the references from other organization employees who indicated the persons selected for the survey as environmental experts in hydroelectric projects.

Academic excellence is verified through questions on studies carried out and experience. As trend is evident that the predominant profession is environmental engineering and that all the experts had participated in at least 2 previous hydroelectric projects. Environmental experts was validated from the type of activities carried out within the organization (Mieg, 2009), these information stated that the experts are responsible for making

6 Based on the indicative generation plan issued by the UPME 2015-2020 (2014).

7 Empresas Públicas de Medellín.

8 In those cases where were granted permission by the organization.

9 Availability heuristic is a mental shortcut (Plous, 1993).

environmental decisions, advise and report on the subject (Angner and Loewenstein, 2007).

In a second group of questions be seek confirmation of the postulate "no difference between what is proposed and what the expert runs on each organization" are made, which set one of the root assumptions of fieldwork (Mieg, 2014), as evidence that the organization is fully articulated with delegates to the decision (Moritz and Gieri, 2015) and therefore, the expert answers (Brighton and Gigerenzer, 2015) reflects the organizational position (Holmes et al., 2011) and environmental initiative in mega hydroelectric projects.

For this stage it is explored about the approval of the method of selection and designation of roles in the organization (Holmes et al., 2011), all the experts agreed with current allocation processes, just as in the expanded response commented: "Required leaders have specific knowledge of institutional and environmental procedures that must be filled to start a hydroelectric project of great impact." Also, experts said that they know and agree to the factors taken into account in the team selection, for this purpose they ranked (Kumar, 2005).

The assumption of homogeneity is observed in both quantitative and qualitative information, and is reflected in the statistical mode (DellaVigna, 2009). It is fully supported by the independent positions of each organization (Angner and Loewenstein, 2007). Non-incentivized questionnaires were used[10] (Camerer and Hogarth, 1999; Dohmen et al., 2011; Charness et al., 2013).

The four organizations defend unanimously that environmental impact studies must be performed by experts in order to meet all the technical, legal and social requirements that arise in the course of implementation of large hydropower. Respondents said that the organization reflects its technical recommendations in a high degree, that is, once the reports of the experts are complete merely continues an authorization process before implement it. All experts placed the accuracy of environmental decisions at the highest range of 50-100%, they consider that in hydroelectric projects, organizations have no room for error margins (Becker, 1976), an expert commented: Better to withdraw the initiative if there is a high degree of inaccuracy.

In a third group of question, the survey design is based from the use of immediate availability heuristic (Brighton and Gigerenzer, 2015) (Gilovich et al., 2002). Dimensional factors observed during environmental impact assessment are taken into account by organizations for decision-making. The four experts placed in first position the local communities, which is consistent with qualitative data (Yüksel, 2012). Qualitative findings derived from the analysis of the addendums to the response required by the experts, are evidenced that organizations prioritizes the community as a sine qua non for project viability (Charness et al., 2013). Thus the conflicts that may arise with the communities surrounding the project are highly valued even as a factor of withdrawal of the project.

10 "...The question about risk taking in general generates the best all-round predictor of risky behavior…" (Dohmen et al., 2011. p. 1).

Availability heuristic (Plous, 1993) was presented when experts were requested to enumerate the sources of information recommended. They placed first the primary information, i.e., one that knows first-hand and lastly nearby institutions. This ranking process evidences how experts valued individual knowledge higher than ones provided by third parties.

The last assumption, upon which the questionnaires inquire, was to confirm the presence of uncertainty in decision-making (Atkinson and Crawford, 2006). It is worth remembering that prospect theory is applicable to decision-making under uncertainty conditions (Tversky and Kahneman, 1992). In order to validate this postulate asked the representatives of the organizations whether they considered taking decisions under uncertainty (Kahneman and Klein, 2009), unanimously the answer was yes, the qualitative explanation refer to social and cultural sources as indicators unpredictable variables that generate uncertainty.

The rising diversity of opinions is related to sources of uncertainty and ambiguity identified by experts (Atkinson and Crawford, 2006) (Wakker, 2010).

To validate the identity of the organization and the expert, each expert commented that time allocated is adequate to advance the process of environmental decision-making (DellaVigna, 2009). The questionnaire asks them if the uncertainty is due to the abrupt interruption of the work processes, however, there is none of the experts agree (Rubenstein, 2013). Additional comments to the answer: "We have enough time, even sometimes; the time exceeds the normal activity needs."

3.1. Model Simulation

Based on data collected with questionnaires(Charness et al., 2013), value function (attitudes to risk) for each expert has been elicited, according to the sense of loss or profit they have towards external requests categorized by dimensions that generate situations uncertainty (Wakker, 2010).

The analysis of information begins with the filter of results through Pestel analysis, which allows disaggregate the macro environmental conditions and the situation of an organization (Yüksel, 2012) around the axes: Political, economic, socio-cultural, technological, environmental and legal-institutional dimensions.

The dimensions identified based on expert answers are show in Table 1, i.e., considering: The repetition of categories in the speech and the degree of importance assigned, deliberations time to resolve the questions of the survey.

Table 1 shows that experts consider the social and institutional dimensions as the main factors in the environmental decision-making (Conesa, 1997), in spite of that, the technological and environmental dimensions are not considered by experts decision making, therefore, when experts receive on environmental or technological dimensions uncertain requests, are evaluated on loss zone of the value function (Tversky and Kahneman, 1992). The gain region is framed in social and institutional

Table 1: Characterizations of value function to each organization

Identified zone	Expert zone	Organization expert A	Organization expert B	Organization expert C	Organization expert D	Grouping all organizations
Gain zone	High gain	Social dimension	Social dimension	Institutional dimension	Institutional dimension	Social dimension
	Low gain	Environmental dimension	Economic dimension	Economic dimension	Technological dimension	Institutional dimension
Reference point	Neutral	Economic dimension	Institutional dimension	Social dimension	Environmental dimension	Economic dimension
Lost zone	Lost low	Institutional dimension	Environmental dimension	Environmental dimension	Social dimension	Environmental dimension
	High loss	Technological dimension	Technological dimension	Technological dimension	Economic dimension	Technological dimension

Source: Developed by the authors

dimension requests. The point of reference is found on economic dimension.

Assessing the value function with the dimensions above using the parameters determined by Bui (2009) to Colombian decision makers, it is evident that although the social and institutional dimensions are more present in the experts environmental analysis, these two scenarios conducted to negative value function using CPT because the responsiveness is not enough for potential uncertain challenges.

To quantify the model and verify the prospect theory based model[11], it is assigned a payout of 100 to high gain, a payout of 50 to low gain, a payout of 0 to reference point (neutral), a payout of −50 to low loss zone, and a payout of −100 to high loss(Charness et al., 2013).

The formulation used following the CPT model it is show in Equations 1-5.

$$w^{+}(p)=\frac{p^{\gamma}}{\left(p^{\gamma}+(1-p)^{\gamma}\right)^{\frac{1}{\gamma}}} \quad (1)$$

$$w^{-}(p)=\frac{p^{\delta}}{\left(p^{\delta}+(1-p)^{\delta}\right)^{\frac{1}{\delta}}} \quad (2)$$

$$f(x)=\begin{cases} x^{\alpha}, \text{ if } \alpha>0 \\ \ln x, \text{ if } \alpha=0 \\ 1-(1+x)^{\alpha}, \text{ if } \alpha<0 \end{cases} \quad (3)$$

$$g(x)=\begin{cases} -(-x)^{\beta}, \text{ if } \beta>0 \\ -\ln(-x), \text{ if } \beta=0 \\ (1-x)^{\beta}-1, \text{ if } \beta<0 \end{cases} \quad (4)$$

11 These values correspond to typical payout used in the experiments of behavioral economics (Angner and Loewenstein, 2007). In addition, sensitivity analyzes were carried out for extremely small and extremely high values (Holmes et al., 2011).

Table 2: Coefficients used in the CPT model

Parameter symbol	Value setting	Original value from CPT
α	0.46	0.88 (Tversky and Kahneman, 1992)
β	0.88	0.88 (Tversky and Kahneman, 1992)
λ	1.74	2.25 (Tversky and Kahneman, 1992)
γ	0.69	0.61 (Tversky and Kahneman, 1992)
δ	0.36	0.69 (Tversky and Kahneman, 1992)

Source: Developed by the authors. CPT: Cumulative prospect theory

$$v(x)=\begin{cases} f(x), \text{ if } x>0 \\ 0, \text{ if } x=0 \\ \lambda\times g(x), \text{ if } x<0 \end{cases} \quad (5)$$

Source: Power form of CPT (Tversky and Kahneman, 1992).

The quantitative model uses the power function that meets the most important features such as stochastic dominance[12].

Since the study is conducted with experts from Colombia, it is necessary adjust model to the cultural conditions of the country, for this reason three choices of CPT parameters (1992) found to be significant for Colombian decision makers by Bui (2009) were analyzed.

The parameters were selected by calculating the closest absolute distance from the original model parameters indicated by Tversky and Kahneman (T&K).

The model called "Model 111" in this study (Bui, 2009) presents the coefficients under the selected criteria, which are suitable for incorporation into the model characterization of the studied Colombian organizations. The coefficients obtained are shown in Table 2 and are used for mathematical modeling.

The next step is to identify the probability vector for Colombia, this involves use of a suitable model to assess the condition of the country in these five dimensions, and quantitatively represent the probability function, which reflects the presence of requests in that dimension.

12 A critique to the used model can be found in the Birnbaum's paradoxes (2008).

Table 3: Value function outcomes using CPT model

CPT model using Colombian coefficients	Value function assessed by case						
	Scenario analysis - CPT model outcomes						
Results by organization	Colombian more probable case	Social salience case	Environmental salience case	Economic salience case	Institutional salience case	Technological salience case	Equal dimensional case
A organization	−16.95	−15.34	−15.74	−16.70	−18.68	−20.15	−17.23
B organization	−17.35	−15.34	−18.68	−15.74	−16.70	−20.15	−17.23
C organization	−17.25	−16.70	−18.68	−15.74	−15.34	−20.15	−17.23
D organization	−16.99	−18.68	−16.70	−20.15	−15.34	−15.74	−17.23
Consolidated all organizations	−17.26	−15.34	−18.68	−16.70	−15.74	−20.15	−17.23

Source: Developed by the authors. CPT: Cumulative prospect theory

For this, three studies CEPAL (NU. CEPAL, 2015), YCELP (Hsu et al., 2014), and YALE (ESI, 2005) were reviewed to validating which one had complete information for all dimensions of analysis. Hence, was not required conversion of information, ensuring that authors criteria are not involved in the transformation of the basic information. From Yale model (ESI, 2005) after review was the probability vector selected for Colombia.

The probability vector for Colombia (ESI, 2005) is located at 19% for the social dimension, 24% environmental dimension, 18% economic dimension, 21% institutional dimension, and 18% technological dimension. These probabilities are in the middle range[13], indicating that the value function does not operate in extreme odds (Wakker, 2010).

With these values: Payout matrix, CPT coefficients and probability vector; they create a typical configuration in decision-making theory. In the simulations are included a sensitivity analysis that is carried out using a probability vector of 40% to selected dimension and 15% to the rest, and equal vector of 20% to each dimension.

4. RESULTS AND DISCUSSION

The results obtained by applying the CPT model (Charness et al., 2013) for cases of the organizations studied in Colombia are shown in Table 3.

This indicates that decision makers in large organizations associated with hydroelectric projects have one common characteristic that refers to loss risk aptitude in the technological dimension requirements (Wakker, 2010).

It also indicates the willingness of organizations to most probable local communities' requirements in Colombia (ESI, 2005). In any of the analyzed scenarios the value function outcomes were negative values, which implies a risk-seeking behavior to requests that emerge from outside to organizational perimeter (Bromiley and Rau, 2014). Experts and organizations that advance large hydroelectric projects in Colombia for the period 2010-2020, are operating in the area of loss under all proposed scenarios (Moritz and Gieri, 2015)[14].

Figure 2 summarizes the process of environmental decision-making used by the organizations that are in charge of the implementation of mega hydroelectric projects in Colombia[15], the model indicates stages from deliberation, presentation of recommendation and acceptance the organization through the adoption of the proposed recommendation. The model was build based on the findings (DellaVigna, 2009) from the survey (Charness et al., 2013) and observation of the work context (Ericsson, 2006) in which experts develop activities reflecting dynamics of organizations (Bromiley and Rau, 2014).

The decision-making process begins with a community requirement regard to mega project. With this initial request, the organizations evaluates the feasibility of covering this claim taking into account the degree of impact on environmental assessment already built (Conesa, 1997), the organizational structure rule to deal those issues on each organization, and economic interest in participating in solving unmet demand (Bromiley and Rau, 2014). To determine priority to the project, the organization assigned to the internal evaluation unit where experts are assigned (Holmes et al., 2011).

Once the functional area in charge is allocated, the person in charge to lead group start an internal judgment, in which all previous expert perceptions are consider, previous approaches to similar situations and the questioning of the actual human biases are avoided (Brighton and Gigerenzer, 2015), experts do not realize their risk-taking behavior (Glockner and Betsch, 2008).

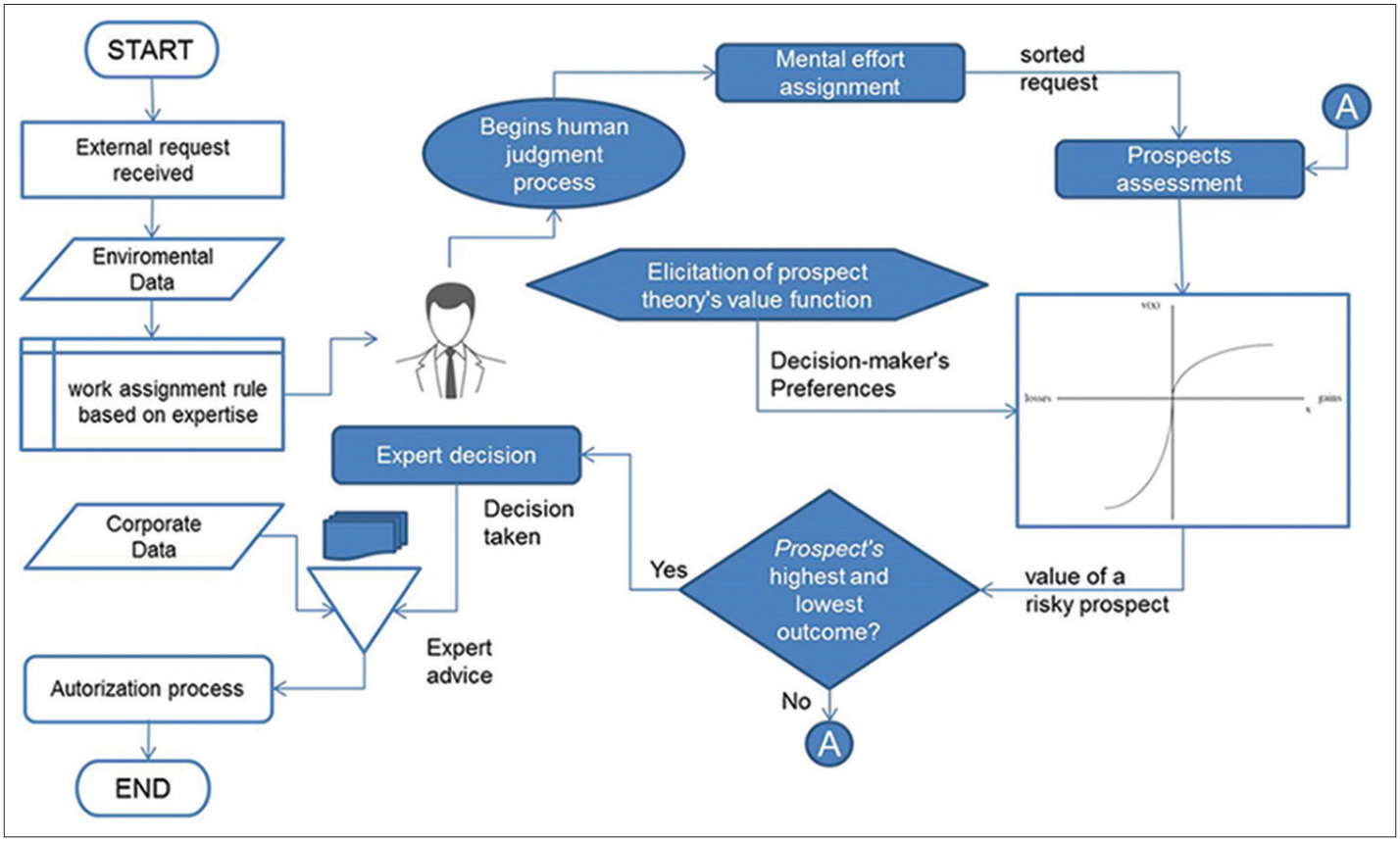
Likewise, the expert seek to mental shortcuts implying lowest cognitive effort at decision making (Plous, 1993), a well-known process established to decision making in advance, taking advantage of their curriculum, professional and personal knowledge. At this point, is where availability heuristics emerges (Brighton and Gigerenzer, 2015), that is, the expert arrives at your previous knowledge to organize the priorities to be addressed during the process (Moritz and Gieri, 2015). The greater the mental effort to recall a dimension, expert consider it must be less important than alternative dimensions which are readily recalled, so they fixed reference point, and experiences any deviation as a sure loss located in the value function (Tversky and Kahneman, 1992; Bromiley and Rau, 2014).

13 Between 15% and 40%.

14 Probability vectors with emphasis on Social, Institutional, Economic, Environmental and Technological dimensions.

15 In Scheme 1, the individual activities carried out by the expert are marked in blue color and organizational activities are marked in white color.

Figure 2: Environmental decision-making under uncertainty identified in field in large organizations



Source: Developed by the authors

The process of multi-dimensional analysis carried out by the expert occurs like this (Charness et al., 2013): (a) Take each of the social, economic, institutional, technological and environmental scenarios (Shmelev, 2012), (b) evaluate them from value function in advance, (c) From this analysis establishes the most probable outcome of alternative solutions, (d) Defined the risks function presented by each scenario, (e) Once the total scenario is seen in a panorama of gain for the expert (who may or may not be consistent with external data on the subject), it issues a final recommendation to the organization to be validated and approved (Mieg, 2014), (f) to complete the process of organizational decision making, the expert recommendation is contrasted with organizational data to ensure compliance with the quality minimum requirements and so internally. The recommended decision goes to be adopted or rejected by the organization; at this stage there is no place to change without notice (Holmes et al., 2011).

4.1. Adaptations to the Current Model

From the payoff matrix results in the decision-making process based on prospect theory model applied in a novel way, it's possible to draw energy political recommendations.

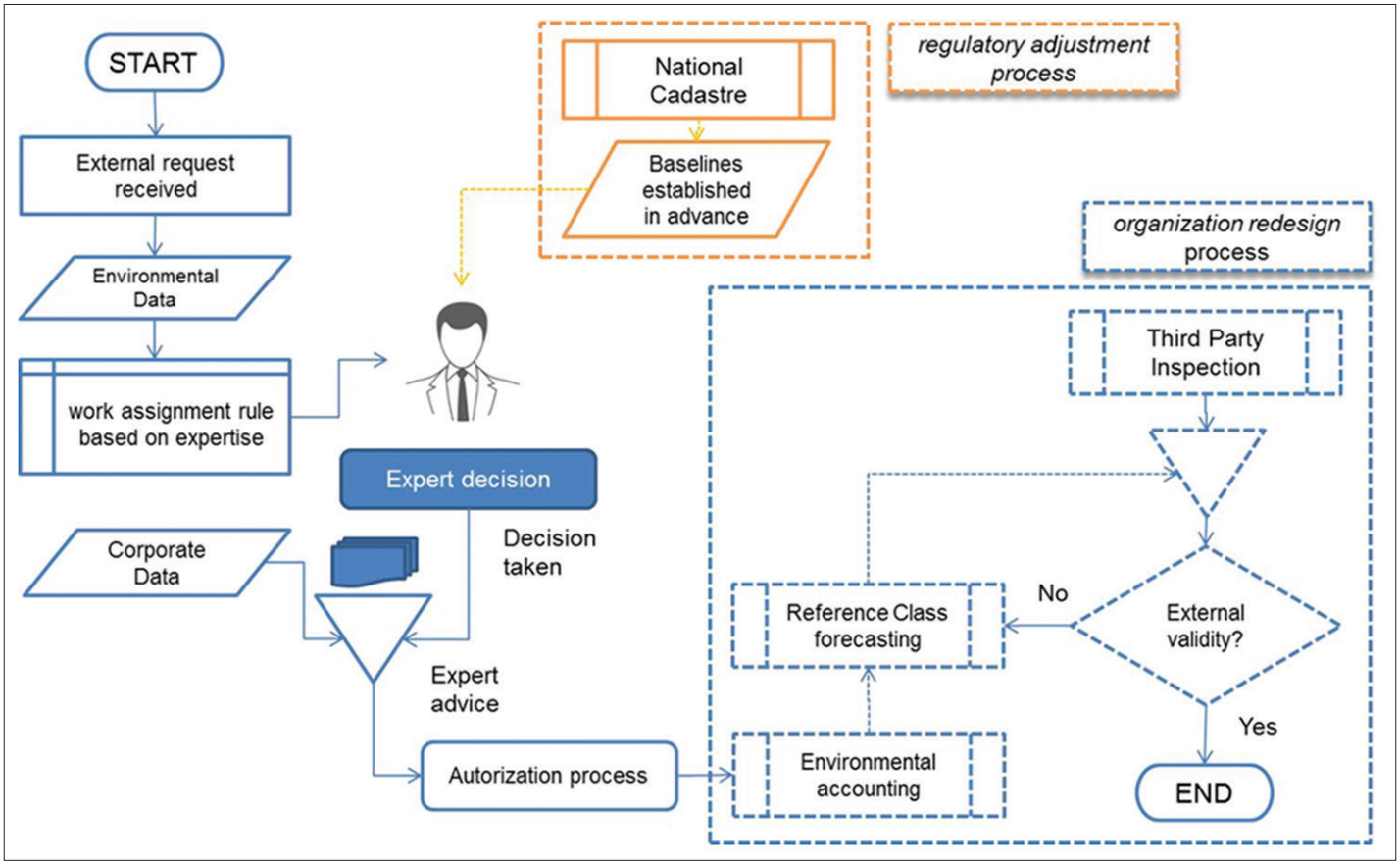
The built model describing the decision-making process constitutes clear evidence that the immediate availability bias occurs in the delegated expert when it is generating the environmental recommendation of each organization studied. As a result of this finding, it is identified that any changes proposed should challenge directly assigning mental effort and evaluation performed by the expert.

The model also allows observing the Kahneman assumption (Gilovich et al., 2002) on human inability to counter the biases from self-confidence or the maximum mental effort therefore must go to an outside agent who exercises the review of the rigor and appropriateness of the value[16] calculations. In order to counteract the effects of the presence of bias immediate availability in organizations that implement mega hydroelectric projects in Colombia, after a deep scouting, we propose two energy policy adjustment (Bromiley and Rau, 2014): (1) State intervention through public policy to generate an external entity to organizations of mandatory consultation to build the environmental baselines structuring the mega projects (Boyd and Banzhaf, 2007), (2) an inner organization body to validate the results incorporated in the recommendation adopted by the organizations (Flyvbjerg, 2007), which ultimately serve as pilot control to implementation of the proposed mega hydroelectric project (UN et al., 2014).

These adjustments involve assume a model of the process of environmental decision-making, in which: (a) The intervention of the authorities in data availability in advance using "triggering changes" (Bromiley and Rau, 2014. p. 21), and (b) new step in which through environmental accounting are assure its respective validation inspired on "behavioral institutional design" (Thaler and Benartz, 2004) (DellaVigna, 2009) and "creating opportunities for change" (Bromiley and Rau, 2014. p. 22-23). The model is presented in Figure 3.

16 Known as "Utility" in rational choice theory (Becker, 1976).

Figure 3: Environmental decision-making under uncertainty propose to be adopt in large organizations



Source: Developed by the authors

The new model presents changes in the internal process of deliberation by the expert[17], and once the activity to generate recommendation under their charge begins, the team led by its expert leader must resort to external data to the organization which established environmental baselines in advance through a process regulated by the State, the local community can contribute at the crossroads of different axes of control and oversight over the final information used on environmental baselines[18].

After the deliberation of the expert based on data obtained from external entities consolidated, the final recommendation incorporated these two steps (Bromiley and Rau, 2014): (1) A new internal data verification through environmental accounting (Odum, 1996) and (2) reference class forecasting (Flyvbjerg, 2007) where organizations may ensures "external view" compliance.

Applying these adjustments in the organizations in the CPT model can observe a significant change in the value function. In Table 4, are presented value function outcome obtained if we incorporate the recommendations.

The results are striking, as presented in Table 5, for half of the organizations surveyed implies change their area of operation, from high losses to a low gains (Dohmen et al., 2011). One organization remains in the loss zone although with a lower value. Only one organization deteriorates and increases the loss zone. The results indicates that these recommendations may be view as one general approach (Heath et al., 1998) to decline typical conflict level between local community and large organizations that arises when a large hydroelectric is proposed in Colombia.

5. CONCLUSIONS AND POLICY IMPLICATIONS

Organizations in Colombia who run the construction of hydroelectric, are characterized by organizations such as "large organizations," in fact, hydroelectric projects are considered by these organizations, as an element of organic growth within the stage "processing" since it corresponds to the main traditional business, the generation of electric energy based on a mature technology. As has been studied these organizations, characterized as "large organizations" to run activities take decision making models based on experts (Garcia and Zerda, 2016).

Large organizations to develop various activities and projects move parallel responsibilities under the specialty area experts, and seek to minimize risk and increase the ability to generate profits.

17 "…Prospect theory would suggest that framing the status quo as a situation that could lead to a loss could trigger more risk taking than presenting the current situation as leading to a gain…"(Bromiley and Rau, 2014. p. 21).

18 Ours results match we World Bank's recommendations who stated: "… It is clear that further advancement in terms of concepts and theory is required;…, the development and testing of measurement methods is needed…"(UN, et al., 2014, p. 2-4).

Table 4: Value function outcomes using CPT model under organizational change proposal

CPT model using Colombian coefficients	Value function assessed by case						
	Scenario analysis - CPT model outcomes - recommendations incorporated						
Results by organization	Colombian more probable case	Social salience case	Environmental salience case	Economic salience case	Institutional salience case	Technological salience case	Equal dimensional case
A organization	−8.20	−6.59	−8.04	−8.04	−9.79	−8.04	−8.09
B organization	2.84	3.83	2.47	3.43	2.47	2.47	2.95
C organization	2.94	2.47	2.47	3.43	3.83	2.47	2.95
D organization	−17.72	−19.35	−17.37	−20.82	−15.91	−17.37	−18.05
Consolidated all organizations	2.93	3.83	2.47	2.47	3.43	2.47	2.95

Source: Developed by the authors. CPT: Cumulative prospect theory

Table 5: Variation percentage of value function using CPT model outcomes under organizational change proposal

CPT model using Colombian coefficients	Value function assessed by case						
	Scenario analysis - CPT model outcomes - % improvement						
Results by organization	Colombian more probable case	Social salience case	Environmental salience case	Economic salience case	Institutional salience case	Technological salience case	Equal dimensional case
A organization	52	57	49	52	48	60	53
B organization	116	125	113	122	115	112	117
C organization	117	115	113	122	125	112	117
D organization	−4	−4	−4	−3	−4	−10	−5
Consolidated all organizations	117	125	113	115	122	112	117

Source: Developed by the authors. CPT: Cumulative prospect theory

For prospect theory the mechanism by which the burden of decision making to a highly qualified staff moves which provides the consequences and costs generated by each alternative, is not a surmountable factor at the individual level, however, should be taken into account as a non-permanent constant that can vary according to context and feel of each individual who intervenes.

Determine the environmental damage of the implementation of a project in one place, is often one of the aspects that experts give incidentally, even those data are exposed to communities in one or another way to get social approval or meet the requirement of prior consultation. The picture to the community directly affected by the construction of a mega-project type hydropower cannot be deciphered at the time of decision making, among other reasons because the effects will face only be known many years, decades, or centuries after its development.

But despite the uncertainty surrounding this kind of mega-projects, experts (representing the major advocacy organizations) do not perceive the volatility of the data on which they base their decisions. Human nature aimed at controlling all variables in an uncertain future, generates organizations, the state and the community remain controversial and hostile relations during project implementation.

The conflicts faced by the agents arising from the proliferation of such mega projects and data hidden in the socialization with communities. Today in the world there are estimated 45,000 dams, and about half of large rivers are blocked by dams, similarly estimated hydropower have displaced 40 million people. The emergence of anti-dam movement is a large scale and universal. Since its emergence in the 70s of last century, activists argue that their costs outweigh their benefits, because they have long-term impact and there is uncertainty about its environmental impacts. Local communities continue to be seen by the decision makers in the organizations responsible for building these large engineering projects as adverse to such initiatives and their relationship typically occurs conflicting ways. All this occurs in an environment of ambiguity and deep complexity where the structuring of large engineering projects beyond the capacity of environmental assessment of agents as happens today with mining.

From the payoff matrix results in the decision-making process based on prospect theory model applied in a novel way, it's possible to draw energy political recommendations.

The results show that experts are risk seeker. Organizations who rely the environmental decision making process based on expert judgment on early phases of hydropower projects, have a predictable behavior as risk seeker because expert evaluate as losses external request by local communities. This behavior becomes remarkable when technological or environmental dimensions are relevant to cover external requests by local communities. All these expert biases must be corrected through organizational adjustments as those proposed by authors.

As has been demonstrated the reason for present levels of conflict may be explain with the acceptance of endogenous organizational causes (Bromiley and Rau, 2014), being decision making models based experts a paramount reason (Ansar et al., 2014). For this reason public policy requires induce organizational changes that limit conflict scale where resources for resolving disputes be minimal.

To organizations exist dimensions underestimated when making environmental decisions (Holmes et al., 2011); this implies

conciliation processes with a higher cost for both organizations and communities in posterior stages of hydropower projects (Moritz and Gieri, 2015). The generations of public policies that ensure proper maturing process of projects considering these new findings in the Colombian electricity market are necessary. In a preliminary way the authors explored a different kind of project in Chile and found the same results so a possible new research field emerges on mega projects area to validate the scope of the findings.

Sustainable environmental assessment (Ansar et al., 2014) involves equal treatment within the dimensions in order to avoid its contextualization with the reality of each project. If these elements are not addressed within organizations, the real possibility of influence of the communities understood as equal treatment within the various categories of requests is reduced and thus its early involvement. Finally, the found situation requires the exploration of energy policy (Sovacool and Cooper, 2013) settings to route it to the purposes of sustainable development from the field of study of organizations (Bromiley and Rau, 2014) and their operation within the institutional framework of Colombia.

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