A Literature Review:
Colombia's Hidroituango Hydroelectric Project

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Abstract

This paper presents a scoping review of research on the Hidroituango hydroelectric project in Colombia. On the basis of an inclusive review of research, community and media sources, we theorize from the assembled documentation key characteristics of "cascading risks" which contributed to the catastrophic failures being under-analysed in risk assessments. We profile the technical elements and the shareholders' experience as aspects of the project, its temporal and spatial development, and socioeconomic, environmental and political implications. A combined diversity of cascading risk, obstacles and pitfalls are shown to be present. These have further resulted in cascading failures: deaths, civil emergencies, conflict, and a tense relation to communities and to the nation due to the delays and crises of the development.

Keywords

Energy infrastructure, hydroelectricity, environmental conflicts, rural development, risk, disaster

A Literature Review and Analysis:
Colombia's Hidroituango Hydroelectric Project

Introduction

This paper presents a synthesis of the a scoping literature review on a hydroelectric case study that illustrates an unusual variety of risk types and relations between them. It forms the technical basis of a further analysis of risk and failure in terms of their intangible and tangible qualities and the confusion of these two, with definitions and lessons on the reach of cascading risks published in Fast Capitalism (accepted and forthcoming at time of writing).

The documentation and profiling of Hidroituango, the biggest hydroelectric project in Colombia's history is or the most part only available in Spanish, and focuses on specific factors, not the way risks and impacts have combined resulting in delays to the commissioning of the project. Hidroituango is notorious for its project management and engineering failures, it is also distinguished by many impacts on the communities around the project. Globally hydropower dams and generating stations have records of spectacular cascading failures where inadequate materials, construction technique, maintenance, operator error and disregard for safety lead to industrial disasters (Gordon, 2012). Although the standards, technology and contractors are shared, there is a relative scarcity of international comparisons between hydroelectric projects, possibly due to the apparent specificity of each site, national interest, and the tendency to differentiate the projects from each other by identifying them with national developmental pride.

Hidroituango is located in a remote, central area of Colombia characterized by Indigenous and longstanding river communities with artisan economies, significant coca production and a history of armed struggles between guerillas, local and regional paramilitaries and the national army (see Map, Figure 1). The 1980 to 2022 project process was marked by assassinations, emergency evacuations, mass murder of local residents and continuing conflicts including mining the road to the site to prevent access. After heavy rain in the spring of 2018,

landslides and the collapse of the mountain above it blocked the river diversion tunnel around the dam site. Water had to be released through the incomplete turbines, damaging the machine room to avoid a breach of the dam. Then, a sudden bursting of the blockage flooded the river downstream with three times its normal flow, causing a civilian disaster affecting up to 120,000 with about 25,000 people evacuated.[1] Delayed four years, the power station only started partially functioning in December 2022 (See Timeline, Table 1).

In particular, we synthesize diverse voices to permit an inclusive approach to understanding the project but also to support the communitarian and activist processes for defending the territory where the dam has been developed. This last element is relevant for the broader social concerns of this paper since the communities of the region have been historically marginalized and victimized by all of the armed actors that operate in this region of Colombia.

The first section of the paper presents the method used for reviewing the academic and community organization literature and the creation of a critical path of the project as developed. The second section profiles the project actors and the history of the project. We evaluated the research literature on three axes in the third section: social, environmental and political. We conclude with a clinical discussion of the types of risk and cascading risks (Heidarzadeh and Feizi 2022) illustrated in this case, dangers or impacts, and finally develop the understanding of cascading risks and failures with the topological concept of "reach."

Review Method and Sources

The current paper builds on a range of expert and community sources that have shaped understandings of a coexistence variety of risks in the construction of a hydroelectric project. A literature review allows the identification and analysis of recent and current literature (Grant and Booth, 2009). Our review process included an array of literature such as institutional reports, academic journals, industry and local journalism, online media presenting community voices

[1] Social media sites have attempted to document the sequence of events and failures. See for example, Petley, 2018; SANDRP, 2018.

and interviews, Master and Doctoral theses, and armed conflict databases.[2] These are in icluded in the attached Bibliography.

However, our review does not simply aim to exhaust the academic and scientific literature which continues to develop, particularly in Spanish. This review seeks to give form to the intermingled social, environmental, technical and design process of a hydroelectric project while interacting with a great array of historical, social, geological and emergent risks. One characteristic of our review method is the inclusion of voices that have been marginalized in the technical literature. Through media and social media sources, we were able to incorporate documents (such as interviews, reports and audiovisual pieces) that recover the social and cultural impacts of its construction process and the pitfalls and relations to the communities near the project.

At the same time, we systematize and provide an analysis of the dispersed literature related to the construction process of the hydroelectric project and the emergence and intensification of risks that led to a major social, economic and environmental disaster. These are summarized in tables and an original Chronology of the project (see Table 4). We reviewed open access databases in English as well as in Spanish since most of the reaction and analysis of the project has been and is produced in this language. GoogleScholar, Scielo and Redalyc as well as the CINEP database and other Colombian sources above were used.

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[2] These include the Centro de Investigación y Educación Popular's Banco de Datos de Derechos Humanos, DIH y Violencia Política (CINEP 2022); the Human Rights, International Humanitarian Law and Political Violence of Popular Education and Research Centre-CINEP; two documents from the Conflict Routes (Rutas del Conflicto); two documents from the Environmental Conflict Observatory from National University of Colombia (Observatorio de Conflictos Ambientales); one document from the National Centre of Historical Memory (Centro Nacional de Memoria Histórica); and one document from the Land of Resistants | Editorial Board (Tierra de Resistentes | Consejo de Redacción) and the publications of Movimento Rios Vivos.

The Hidroituango Hydroelectric Project

The Hidroituango Dam is located on the Cauca River 176km north of Medellin (see Profile, Table 1), the capital of the department of Antioquia. Due to the length of the reservoir (79 km), Hidroituango influences the territorial dynamics of fourteen municipalities in Antioquia Department (Hidroituango, 2016b).[3] The Cauca River is the second largest river that runs through Colombia from south to north. The relevance of the Cauca River can be seen in its influence over 150 Colombian municipalities by either crossing them, or determining their territorial frontiers, economic resources, and the cultural and socio-spatial lives of their more than 10 million inhabitants. The dam has been built in the Cauca Canyon, 8km down from the Pescadero bridge on the road between the municipality of Ituango and Puerto Valdivia (a small village of the municipality of Valdivia and closest population) (Hidroituango, 2016b; El Espectador, 2021). Hidroituango has flooded 4.538ha of tropical dry broadleaf forests and the dam holds back a 79km reservoir of 20 million cubic metres of water (Soler and Roa, 2015; see Map, Figure 1).

This region has great seismic activity which requires special considerations when building any kind of infrastructure (Hidroeléctrica Ituango S.A. E.S.P, 2022). Challenges are amplified due to its geographical characteristics, geopolitical position and socioeconomic marginality. Its topographical characteristics of steep mountains and a series of canyons produce an area with very significant access difficulties that require the investment of resources to connect the municipalities to other parts of the country. The main route to Hidroituango is via the road to Ituango municipality from the Medellin-Cartagena highway that runs to the Caribbean coast. As part of the project, a new road was built by the former construction consortium to connect Valdivia to the dam (Hidroituango, 2016b).

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[3] Liborina, Ituango, Toledo, Briceño, Peque, Sabanalarga, Buriticá, Orobajo, Barbacoas, Valdivia, San Andrés de Cuerquia, Santafé de Antioquia, Olaya and Yarumal municipalities.

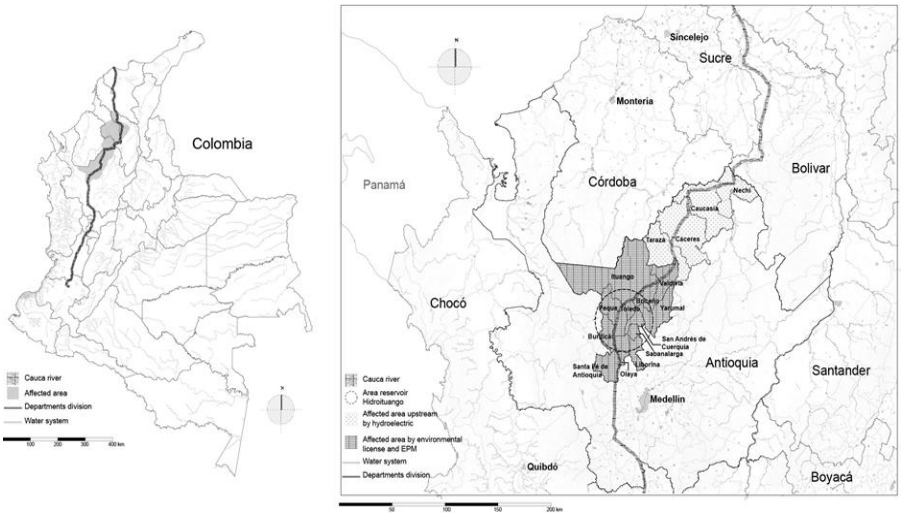

Figure 1: Map: Hidroituango, Antioquia State, Colombia (Artwork: J. Guevara, 2021)

Table 1. Hidroituango Timeline

Date	Hidroituango Construction and Development
1820s...	Nutabes settler culture displaced from region & pushed into Cauca River Canyon. Agrarian, gold panning and prospecting
1969	First hydroelectric projects
1974	Ituango Canyon 800m elevation drop identified for hydro development by Integral SA
1979-82	Feasibility study leads to postponement of the project by Interconexión Eléctrica-ISA
1996	Murder of 5 people and displacement of 700 people by ACCU paramilitary group
1997	17 Murders, houses razed & cattle taken by ACCU.
	Governor authorized to promote hydroelectric project
1998	Massacre of 11 people by ACCU, displacement of Nutabes
	Hidroituango SA consortium formed including Integral SA, Antioquia Dept (IDEA) & EADE Antioquia Energy Co.
2000	Empresas Públicas de Medellín (EPM) buys controlling stake in EADE
2004	Environmental Management Plan
2006	EPM acquires EADE, becomes main shareholder & only producer & distributor of electricity in Antioquia
2007	Environmental License granted by the Ministry of Environment
2008	IDEA wrests control over the project from EPM. Contract to provide 1085GWh/year from 2018. Expropriation of land for the project.
	Ministry of Internal Affairs declares no aboriginal interest or impact but Nutabe demand recognition.
2009	Ministry of Environment mandates resettlement of displaced communities.

2010	Consortium signs public private partnership with EPM to build-operate-own-maintain-transfer
2011	Nutabes claim to aboriginal status rejected by the Ministry of Internal Affairs
	Construction tendered
2012	Living Rivers Movement (MRV) report on human rights violations & problems of the project. Denunciation of paramilitaries. AUC Autodefensas Unidas de Colombia paramilitary checkpoint & confrontation with supposed guerrilla collaborators in the communities. Detentions & confiscation of property by government officials. FARC guerrillas mine & close road to Ituango
	Construction contract awarded to CCCItuango (Conconcreto, Coninsa & Camargo Corrêa Infra consortium).
2013	Local protests against impacts on fishing & local gold prospectors. Illegal arrests. Torture & murder of local human rights defender
	EPM takes on risks from CCCItuango
2014	2 Cauca River diversion tunnels open to permit dam construction
2015	FARC attacks on public transport buses. Death threats against local gold prospectors & residents refusing evictions. Threats against community leaders by Army. Denunciation of contracts between EPM, Army & National Police in National Congress.
2016	National Agrarian Strike
2017	3rd tunnel constructed to help problems closing tunnels 1 & 2 to start filling the dam. MRV demand a stop to construction of transmission lines due to lack of public consultation.
2018	Mar-May: Tunnel 1 & 2 closed. Apr 28 Collapse of tunnel 3. Landslides & earth subsidence block diversion tunnels. Emergency evacuations of over 26000. Power station machine hall flooded to relieve water pressure through turbines. Apr 30 Tunnel 2 unblocks & re-blocks, flash flooding downstream causing 544+ deaths , affecting water levels & requiring more evacuations. May 10 Machine hall used to reduce rate of rising reservoir water level, May 16 State of Emergency declared.
	National Authority of Environmental Licenses (ANLA) orders EPM to suspend operations until an expert review of the stability of the dam's infrastructure, effectively suspending Hidroituango's environmental license.
	MRV denounce possible flooding over mass graves. According to the Historical Memory National Centre (CNMH) since 1958, there have been 110 massacres and 2435 people disappeared in the 17 municipalities influenced by Hidroituango's project. International human rights attention by the EU . Eviction of 400 prospectors & families without compensation. Murder of 2 MRV leaders. Attorney General begins investigation of contracts, construction, impacts & violence surrounding the project. Construction suspended. Attacks on police, Murders related to control of local coca crops. Murders & attacks on community activists & campaigners by paramilitaries & project interests. Attacks on EPM facilities & vehicles.
2019	Environmental crisis due to decrease of Cauca River flow downstream. Financial dispute between project partners due to delays.
	Environmental mitigation required by Attorney General. Further threats against & disappearances of local leaders.
2020	Restart of construction. EPM sues CCCItuango
	Political & financial struggle between urban Medellin versus regional interests in consortium i.e., GEA Grupo Empresarial Antioqueño.
2021	Arbitration between EPM and Hidroituango SA.
	Mapfre insurance agrees payment of USD$984M for damages to EPM
2022	November Deadline to start electricity production missed.
	Environmental Licensing authority ANLA fines project proponents including CCC Ituango USD$1M for not implementing environmental mitigation. Attorney General charges ex-politicians & managers.
	CCCITuango withdraws from construction of Units 3 and 4. To avoid regulatory fines for delays, 600MW commercial operation of turbines 1 and 2 starts Dec 16 2022 after preventative evacuation of 4200 downstream residents from the municipalities of Ituango, Briceño, Tarazá and Valdivia
2023-24	Oct. Contract for phase 2 after 2022 request for bids annulled due to alleged irregularities and lack of experience. Awarded to the sole bidder: Colombian-Chinese consortium Yellow River Engineering and Schrader Camargo CyS USD$254M despite claims of favouritism in the process

Sources: Compiled from sources in References

Hidroituango's hydroelectric power station has eight submerged intakes through which water enters each turbine generator unit independently. Each unit is composed of the turbines and the generators located in an underground machine house or generating hall. The transformers are also located in the generating hall in a transformer chamber (EPM estamos ahi, 2013). After the water has passed through the turbines, four discharge pipes return the water back to the river. The underground power station also possesses an exit shaft for high-tension electrical transmission cables, construction access galleries, a ventilation tunnel and a shaft to evacuate smoke in case of fire (EPM estamos ahi, 2013).

Construction consortium and project management

The building consortium CCC Ituango was created by companies selected by the City of Medellin development corporation, Empresas Públicas de Medellín (EPM), to build the dam across the Cauca River (see Tables 3 Shareholders and 1 Timeline). This consortium succeeded EPM Ituango, an earlier consortium composed by EPM itself (99.41%), CHEC (0.14%) and minority shareholders (0.45%), that had been created after the suspension of an auction to build the dam in 2010. This earlier consortium reflected urban-rural struggles to shift control from the powerful Antioquia Department, represented by the Instituto para el Desarrollo de Antioquia (IDEA) to urban interests based in the City of Medellin. However, EPM Ituango in its turn was not able to proceed with a Build, Operate, Own, Maintain and Transfer (BOOMT) contract due to an unfavourable ruling by the National Government regarding the Master Plan for the project (Torres, 2019).

Table 3. Hidroituango Shareholders

Company or Institution	Number of shares	Percentage of shares	Public, Private or Mixed	International, National, Departmental (provincial) or Local
Instituto para el Desarrollo de Antioquia (IDEA) (Institute of Development of Antioquia)	30.539.584.791	50,741261%	Public	Departmental
Empresas Públicas de Medellín E.S.P. (EPM) (Public Companies of Medellín)	27.885.783.007	46,331992%	Public	Local
Departamento de Antioquia	1.291.495.015	2,145808%	Public	Departmental
Minority Shareholders	315.978.185	0,524995%	Private	(No information)
Central Hidroeléctrica de Caldas (CHEC) (Owned by EPM)	85.934.593	0,142780%	Mixed	National
La Nación	46.490.817	0,142780%	Public	National
Financiera Energética Nacional S.A. (FEN)	21.619.223	0,035920%	Mixed	National

Source: Hidroituango, 2016

The building consortium thus had to be retendered. The resulting CCC Ituango is composed by Conconcreto, Coninsa and Camargo Corrêa Infra (see Table 2).[4] Two of the companies are Colombian while the other is Brazilian. Also,

[4] Besides the international financial backers (See Table 4) the consortium partners include:

Conconcreto: A Colombian private company founded in 1961. This construction company develops, structures, designs and manages different infrastructural and housing projects. Since 1993, the company started to internationalize its portfolio; currently, the company has projects in Colombia, Central America and Florida. The company is a member of the Pactia private equity fund, the most influential real estate fund of Colombia in which the GEA or Grupo Empresarial Antioqueño is also partner (Conconcreto, 2022).

Coninsa: A Colombian private company founded in 1999 after the fusion of Coninsa S.A. and Ramón H. Londoño. This company designs and builds for different economic sectors, such as commerce, housing, infrastructure, tourism, health services, among others. The company also has a real estate service (Coninsa, 2020).

Camargo Corrêa Infra: A Brazilian company founded in 2017 as a subsidiary of Construções e Comércio Camargo Corrêa with more than eighty years of experience. Con-

the manner in which this consortium won the contract is under judicial investigation at the time of writing since there were unclear and undocumented elements of the process. This consortium was in charge of constructing Phase 1 of the project: the dam, spillway, underground machine room, tunnels and installation of four generator units. Phase 2 was tendered in October 2023, after an unclear and debatable process including the decision of CCC Ituango to decline the construction of Units 3 and 4. Phase 2 attracted a single valid bid presented by Schrader Camargo-Yellow River, a Colombian-Chinese consortium (CyS). CyS will be responsible for civil construction work on units 5 to 8 of the project (Bnamericas, 2023; Vargas, 2023). As of August 2024, Hidroituango has 4 generator units functioning and the other four are in the process of construction/installation. It is reported that Hidroituango is producing the 10% of the electricity consumed in Colombia (Álvarez, 2024).

Documenting Hidroituango in the Literature

Social

Under the category of social, we consider both documentation of local culture and values, and impacts on institutions and ways of life. These are not only a matter of intangibles or ideas. They are economic and material. For example, the relocations of cemeteries and graveyards (Vargas, 2022; Zuleta and Escobar, 2020), social impacts, risk mitigation and emotional distress (Idrovo, 2018; Castillo de Herrera, 2019). We found studies that seek to understand the virtuality of the river as a cultural value and intangible good based on the voices of inhabitants (Arroyo and Robayo, 2020).

For example, the cultural practice of *barequeo,* gold panning, spans all three registers (Cardona, Pinilla and Gálvez, 2016). Critical articles relate the processes of 'reterritorialization' of the area to the economic demands of a global economy, for example the reorganization of property relations and the social

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struções e Comércio Camargo Corrêa had built hydroelectric power plants, metro systems, railways and other urban mobility solutions locally and internationally. Camargo Corrêa Infra specializes in heavy construction of infrastructure projects (Camargo Corrêa Infra., n.d.; see also La Pulla 2018 on past controversies).

geography of the area through mechanisms that perpetuate the social and spatial marginalization of the cultural identities of the communities near Hidroituango (Noreña, 2013; Cardona, Pinilla and Gálvez, 2016; Suárez, 2017; Núñez and Ocampo, 2020; Pardo, 2022).

Table 4. International Actors in the Hidroituango Project

Ind. Electronic. GH S.A. (Spain)	Atlas Copco (Sweden)	ATB RIVA CALZONI (Italy)
MAPFRE (Spain)	Scania (Sweden)	Klohn Crippen Berger Ltda (Canada)
BBVA bank (Spain)	Aqualogus (Portugal)	Hatch S.A.S (Canada)
Santander bank (Spain)	Artelia (France)	Caisse de dépôt et placement du Québec (CDPQ)
KFW bank (German state-owned investment and development bank)	E&A Portugues (Portugal)	GE Renewable Energy
SUEDKABEL GmbH (Germany)	Siemens Transformers Co. (Germany)	IMPSA (Argentine)
Helmut Friedrich Miller (Electromechanics consultant)	Industrial and Commercial Bank of China	BNDES bank (Brasil)
ALIMAK HEK (Sweden)	Fondo Chino para el Cofinanciamiento para América Latina (CHC) (China)	BNP Paribas (Belgium and France)
EDC Canada		

Source: Zuleta, 2021

Castillo de Herrera (2019) presents the main discussions of a diagnostic seminar 'La situación de la Central Hidroeléctrica Pescadero Ituango S.A. E.S.P, Hidroituango, un diálogo para construir soluciones.' This depicted the technical causes of the project's problems, the social consequences, a set of recommendations for compensation and affirmative actions, and possible solutions to remedy the socioeconomic effects produced by Hidroituango. Scholars and a community leader of the region participated in the seminar.

Vargas (2002) documents the process to relocate the cemeteries of Orobajo, Barbacoas and La Fortuna as part of the Integral Restitution of Living Conditions for communities. This program is part of the mitigation and relocation processes of the project. In total, 349 human remains were exhumed and transferred. Remains from La Fortuna and Barbacoas were reburied in the cemeteries of the nearby municipalities of Peque, Buriticá and Sabanalarga, while the remains from Orobajo are being held by the Laboratory of Anthropological Osteology and Forensics of the Universidad de Antioquia as part of a process of

previous consultation with the Indigenous community of the Nutabe (Vargas, 2022). However, the region and river banks may actually have functioned as a massive graveyard during the recent armed conflict (1993-2016) due to the work of '*Enterradores*' (grave diggers). These inhabitants of the region used to bury the bodies they found floating down the Cauca River. Many of the buried bodies will never be found due to the decision of EPM to flood the 79-kilometre length of the reservoir in early 2018 (Zuleta and Escobar, 2020; Montoya-Dominguez and Santander-Durán, 2021: 123; CNMH 2020). The river rose to a width of 900m in just over a month by April due to heavy rains which also contributed to the landslides and collapse of the diversion tunnel (see Petley, 2018).

The hydrogeology of the river has supported long-standing cultural and economic activities. Artisanal prospecting and panning for gold along the river depended on the water flow. Miners sieved and washed sand and gravel from the riverbed and banks. This traditional practice of *barequeo* relied on traditional knowledge and ecological practices. However, this practice was restricted by the building consortium and EPM. *Barequeo* will be banned entirely once the project starts functioning (Cardona, Pinilla and Gálvez, 2016).

In the worldview of the Barequeros and the Nutabe (the Indigenous community settled in the canyon of the Cauca River) the river has a special character. It is called the 'Patrón Mono' ('blond boss'). The 'Mono' provides the subsistence of those who inhabit its territory and is considered a common good that requires traditional practices and the observance of traditional norms to engage with it (Cardona, Pinilla and Gálvez, 2016). However, this aspect of the river is in danger since relocations and displacements locate these communities kilometres away from the river, restricting their socioeconomic and cultural relation to it. Arroyo and Robayo (2020) studied the feelings of children and adolescents regarding Hidroituango and the changes it has caused in the river. In their study, the authors found that children and adolescents nostalgically remember 'becoming river' and 'being like water' in their encounters and connections to the river, encounters and connections lost due to new restrictions and the new use and shape of the river. Both these authors and Idrovo (2018) identify trauma resulting from the environmental emergencies produced by

the water level surges from the collapsing, sudden unblocking and eventual re-blocking of the bypass tunnel at the Hidroituango project in 2018 (see Table 1 Timeline). Geologists such as Petley have continued to monitor the complexity of the slopes and rock around the dam (Global Reinsurance, 2022; Petley, 2018, 2019). The experience and high probability of flooding, Idrovo (2018) argues, generated emotional distress that was not therapeutically treated.

Other social impacts have been identified by the communities in the area while the project was being built. Torres (2013) found six interrelated impacts: 1) changes of property due to the enactment of declarations of 'public utility' of those lands (eminent domain); 2); mobility restrictions imposed by the building consortium and EPM; 3) the transformation of labour relations due to employment needs of the construction which resulted in the abandonment of crops, fishing and livestock activities; 4) voluntary and involuntary displacement due to the presence of armed actors and to the lack of a proper identification of all the families and inhabitants in the area of the project, for instance, the case of the Nutabe community that was not identified as such; 5) the interacting in-migration of newcomers (i.e., employees of Hidroituango) that bring new demands and transform the spatio-cultural elements of communities; and 6) the co-constitutive process of becoming with the transformation of the mobilities around the territory and relations to place and the land.

For the project's backers, one of the national justifications of the project is that Hidroituango connects and integrates a geographical space that has been historically marginalized with a high presence of local armed actors disputing control of the region. Cardona, Pinilla and Gálvez (2016) argue that the project produces a process of erasure and re-signification of the territory, where there is no reference to the historical and traditional practices of the region's inhabitants. Others portray this as a convergence of biopolitics and global capital (neoliberal processes and corporations) (Soler & Roa, 2015). Writing in English, they identify different technologies that impose on communities new identities directed by global capitalism. In a similar argument, Suarez (2017) argues that 'extractivism' appears as a predominant discourse that brings together the ideas of development and progress as part of the reterritorialization of marginalized spaces (cf. Willow 2018).

Suarez argues that EPM has sought to resignify the sense of community among the populations near Hidroituango. These techniques focus on the production of a scripted historical narrative that reshapes understandings in favour of the project while imposing a different time horizon on the communities. A second technology is 'epistemic colonization,' understood as an 'expropriation of local knowledge and expertise' (Suárez, 2017, p. 5), while inserting techno-scientific knowledge to manage the environment and the populations. A final technique is corporate social responsibility that has a participatory focus to socially engineer a consensus about minor elements of the project in order to build the social legitimacy required to avoid social, legal and other obstacles with the larger aspects of the project (Suárez, 2017). These shape the goodwill of the population toward EMP and the project.

An example of this process of resignification of the sense of local history has been an anthropological project based on the archaeological patrimony of the area impacted by Hidroituango. A travelling exhibition and other forms of diffusion were sponsored by Hidroituango S.A. The research project was conducted by the in-house archaeological team of Integral S.A. (Noreña, 2013). It is critiqued by, for example, casting and framing local tacit knowledge as a distant past. This is not accessed locally or through family remembrance but as museum exhibits explained by archaeologists and curators.

The social impact of Hidroituango may be observed in the different cases of violence and displacements of people all along the history and construction of the project (Pardo 2022). This impact is well documented by the Living Rivers Movement (Movimiento Rios Vivos), the CINEP and others as can be found in the Chronology of the project (see also Table 1). Núñez and Ocampo (2020) suggest that constant confrontations between the local communities and Hidroituango can be characterized as a reaction to the violence, displacement and dispossession that has been generated by and alongside the project. The authors coined the term 'r-existence': a resistance produced by an existing entity as reaction against an extrinsic action or force that puts the entity's existence at risk.

Environment

Closely correlated with the socioeconomic and cultural impacts of the project are the environmental implications of major changes in the river flow, the creation of a large reservoir and the impact of spin-off development and forestry operations facilitated by the new access roads. Some studies argue that the construction of the project lacks a complete diagnosis of its impacts, but also maintain that this situation can be corrected by an inter-institutional and multi-actor approach (Montoya and Santander, 2021). Other researchers, such as Torres (2013), consider that the problem was not the lack of an accurate diagnosis but the lack of concrete plans for action (i.e., mitigation). As a baseline, the pre-existing balance was highlighted by Arango-Arroyave (2014) who shows the sustainability and intricate relation of *barequeo* to local plants. In a unique 'settlement' with nature, the traditional prospecting and panning of river gravel and silt alluvia uses particular local species of plants to separate the gold and other species of plants to fabricate accessories and the tools needed in this traditional and artisanal activities. The author concludes that these practices have less impact on the environment compared to other forms of prospecting and panning; the *barequeo* used local elements and tools engaging in a co-responsible dynamic of preserving their environment. These traditional and ecological practices expose how the *barequeres* identity involved their co-constitutive relationship with the land and the river (Arango-Arroyave, 2014).

Among studies that identify the environmental effects of the construction of Hidroituango, the works of Torres (2013), Pardo (2022), and Zuleta and Hurtado (2014) describe how the Hidroituango project has led to the deterioration of flora and fauna. These studies discuss the changing land use, its transformations and consequences, and the lack of tools to manage these changes (Sánchez, 2013; Torres, 2013). Montoya and Santander (2021) argue that studies for the project omitted several environmental characteristics of the area where it was built and the specificities of the Cauca River. Due to the lack of a complete baseline and analysis, the authors propose to implement strategies to discuss the technical and political drivers of the project in an inter-institutional and multi-actor investigation to improve the evaluation and monitoring of the development.

By contrast, Torres (2013) studied the diverse environmental impact studies produced by Integral S.A., Hidroituango S.A., E.P.S. and EPM. The findings suggest that these companies identify the main risk elements that might be affected by the project, but lack a concrete action plan to mitigate those risks. This finding is supported by the Living Rivers Movement that reported how the Hidroituango project altered a 26000 hectare, virgin forest along the 79 kilometres of the reservoir (Zuleta and Hurtado, 2014; Movimento Rios Vivos 2022). Sánchez (2013) and Torres (2013) argue that Hidroituango has produced a radical change in the land use within the areas it influences and impacts. This change has generated such a diverse array of socio-environmental conflicts that the communities and the local authorities neither expected nor did they have the proper tools to respond.

Political

Several studies interconnect relevant processes and dynamics such as traditional and capitalistic conceptions of development, global capitalism and the State (Soler and Roa, 2015). Other articles incorporate local elements and actors such as the armed actors and their political consequences seen in the concept of 'hydrocracy' (Soler and Roa, 2015) and the triad of 'criminals-businesses-State' (Román, Insuasty, Valencia and Zuluaga, 2020; Zuluaga and Insuasty, 2020). Other works analyze the armed actors' interactions (Voyvodic, 2021). Some studies map the socioeconomic impacts and benefits for the communities (Torres, Caballero, and Awad, 2014; Pardo, 2022).

Marín and Montenegro (2021) reflect on ownership practices or modes that have allowed the accumulation of capital and connection to global capitalism. Hidroituango has benefited from three different ownership practices that destroy the territory (lives of humans and non-human) to increase capitalist accumulation. These three ownership strategies are population displacements, environmental damage, and inequality. For the authors, these three modalities are present in the Hidroituango project and make the neoliberal agenda of accumulation and dispossession explicit as well as providing an example of the presence of global capitalism.

Román, Insuasty, Valencia and Zuluaga (2020) studied Hidroituango as an example of the development model imposed by global capitalism. In their book, the authors analyzed the role of the State in the development of the project and the different alliances with local and global capitalism, and criminal groups that facilitated the construction of the project. This alliance is exemplified by Zuluaga and Insuasty (2020) as the triad of 'criminality-business-State.' In a similar line, Soler and Roa (2015) argue that hydroelectric projects serve to justify the displacement and dispossession of communities. The authors consider that this dynamic is hidden in discourses of 'development,' 'progress' and 'public utility.' This is possible due to the links between economic and political powers at national and global levels as privileged actors with access to global funding streams. Zuleta (2021) also argues that Hidroituango's project deserves a deeper discussion in terms of its construction funding. She presents the manner in which the project was funded by international capital and the roles of multiple actors in this process (see Table 4, Zuleta, 2021). These alliances give form to what the authors called 'hydrocracies': politico-economical processes of controlling the water and the accumulation of capital (Soler and Roa, 2015, p. 245).

The work of Voyvodic (2021) argues that understanding of development, infrastructure and security is traversed by four political interactions between armed actors: confrontation, coexistence, co-option, and subcontraction. Confrontation occurs when territorial competition is high and requires a State response of militarization; coexistence happens when there is a chance from the State to appeal to communities to avoid armed confrontations; co-option is established when armed actors institutionalize their presence, establishing rules; and subcontracting requires that the actors are no longer in direct dispute which allows them to specialize and maintain their presence in their area of influence (2021:13). For the case of Hidroituango, the interactions of confrontation, co-option and subcontracting were identified by the author.

The Living Rivers Movement and other organizations signed an open letter addressed to the Parliament of Canada in which they denounced the sociopolitical conflict and violence involved in the construction of the dam, alongside the

participation of Canadian investments (Caisse de dépôt et placement du Québec (CDPQ)) in Hidroituango. This open letter argues that several strategies were used to hasten 'clearing the territory and thus lowering production costs associated with compensation of displacing people, a campaign of terror was fomented upon the population of territories established in that area of the Cauca River where the dam was to be built.' (Movimiento Ríos Vivos and various Organizations, 2019)

Rincón-Henao (2020) highlights the international relevance of the Living Rivers Movement by presenting a community dissenting voice that questions the Hidroituango project (See also Power, 2021). This movement aims to defend the territory and the permanence of the communities on it and is 'composed by fourteen associations and more than 1200 families of peasants, fishermen and barequeros' (p. 248). The movement has been actively opposed to Hidroituango through the constitution of international networks and support. It has demanded political accountability in the face of cultural de-recognition and the insecurity produced by the project and questionable acts by State forces and armed actors (p. 256). A variety of strategies have been used by the Living Rivers Movement to protect the human rights of the communities affected by Hidroituango (Widén 2018). The first strategy is systematically reporting and denouncing any acts against human rights; the second strategy is to demand an effective response from the government to protect the collectives and communities that face different kinds of risks; the third strategy is to demand an inclusive process to identify victims, sites and bodies that have suffered forced disappearance; and finally, the Living Rivers Movement has focused on 'reporting and communicating environmental impacts.' (Rincón-Henao 2020, p. 253).

Montenegro (2019) discusses how the framework to define public policies in the energy sector favoured integration with a global market instead of responding to the local and national needs and demands. For Montenegro (2019), this perspective makes the ecological relations of the communities in these territories invisible. The result was major socio-politico-environmental impacts.

The work of Quinche-Martín and Cabrera-Narváez (2020) describes an interconnection of political ecology and the Social and Environmental Accounting in

Hidroituango. These elements also relate to the existence of public policies that favoured global capitalism while making invisible the socio-ecological impacts of infrastructural projects. Officials do not recognize the different conflicts generated by the project. For instance, the authors argue that EPM 'In its sustainability reports do not reflect nor recognise the existence of a latent conflict, except for what is related to the obstructions in the dam that have caused floods–considered as natural contingencies–and the effects on the soil caused by landslides and the loss of biodiversity' (2020:68), while hiding other socio-politico-economic conflicts present in the area. An example is urban-rural struggles for regional economic and political control between Antioquia and Medellin, represented by EPM itself.

Against this, Torres, Caballero, and Awad (2014) studied the economic benefits for the communities where Hidroituango operates. In their study, they concluded that there are no direct benefits to these communities. They only received socioeconomic impacts that rupture their practices and unravelled less tangible but nonetheless real relations and ways of living. Most of these socio-economic risks transform and reduce the well-being of the inhabitants next to and near Hidroituango (Pardo 2022). This is echoed by the Living Rivers Movement (Movimiento Ríos Vivos), which has pursued an international campaign to position their communitarian struggle against Hidroituango (Rincón-Henao 2020).

Politically and economically, Hidroituango is a project that pits the middle class-based municipal leadership and power of the Medellin city government allied with the national state against the wealthy regional elites of Antioquia. It also influences multiple municipalities. For this reason, Úsuga and Sánchez (2022) propose a novel administrative body that comprises the different municipalities affected by Hidroituango. In their study, the authors proposed three different administrative forms and inquired with regional and local actors about the feasibility of a Planning and Management Region, an Association of Municipalities, or an Administrative and Planning Province.

In terms of consequences of the armed conflict, from the municipality of Ituango alone, more than 17,000 people have been displaced. The municipalities that are influenced by Hidroituango have suffered the displacement of more than 50% of their population. The community information from these municipalities reports a total of 111 massacres in the recent history of the region (Zuleta and Hurtado, 2014).

Conclusion and Next Steps

The literature on Hidroituango documents a series of failures that impacted the local population directly in both a tangible manner such as ecosystem impacts on the river and watershed, loss of dwellings and forced movement as well as socially and intangibly in terms of impacts on communities and land-based values. The proponents and insurers of the project were also impacted financially, politically and in reputational terms.

Despite the tableau of risks and failures presented, the experience of the contractors and the various international backers (see Table 4), the proponents would have been well versed in procedures to mitigate impacts and failures. For example, Caisse de dépôt CDPQ, a Québec, Canada, pension fund, was involved in financing the development of the James Bay Hydroelectric Development complex by HydroQuébec (from 1972 onwards), which included the huge Robert Bourassa dam, power station and reservoir. Similar to Hidroituango, the project was in a remote location requiring a new highway for access, it impacted Indigenous communities, entailed land claims and rights negotiations, the creation of a regional development body, conflict and also sabotage (by labourers), an ambitious river diversion through an even larger tunnel, similar turbines also located in an underground generating hall, more massive flooding of an expansive reservoir and long-distance electrical transmission lines to urban users. However, despite this involvement there is no assessment of whether Hidroituango benefited from Québec experience in managing hydroelectric projects.

This case study illustrates a complex infrastructure initiative developed by professional and experienced engineers and construction firms. In the survey of the literature on Hidroituango, there is a lack of deep information about

risks. The detailed chronology developed from the literature survey also reveals a pattern of non-implementation of precautionary and mitigation measures. This amounted to an acceptance of the risks. In the project, risks that were known were poorly circulated, risks to communities and the local economy were accepted by the proponents as part and parcel of regional development but the fallout from failures that materialized from taking such risks was not fully understood. Lack of information and disagreement over the acceptability of major risks and of the impact of the dam in turn limited not only local community adaptation, but the lack of thorough assessment limited the ability of experts to rigorously evaluate the conduct of the project. This is true from the specific engineering technicalities to the legal instruments used to organize and manage the work. Negative aspects of the infrastructure initiative were externalized to river communities and the environment.

The next step is to analyse the notable features of the Hidroituango project:

-the disregard of risks despite extensive experience of the project team

-the diversity of risks (armed conflict, Indigenous claims, environmental challenges and hazards, social impacts)

-the unexpected and spectacular nature of the failures and the manner in which risks compounded and cascaded, moving up in scale and entailing yet further risks, such that secondary failures were more devastating than initial failures.

-the 'reach' of impacts, shifting beyond the immediate project to the region, national and international scales

-lessons for understanding the nature and materiality of risk and failure.

A further article will present an analysis of the cascading risks and failures that may be observed in the project and the documentation gathered in this review.

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