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Digital Innovation in Environmental Impact Assessment and Licensing

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Introduction

Environmental Impact Assessment (EIA) is a strategic tool designed to evaluate environmental impacts by identifying, monitoring, and mitigating the causes of adverse effects on natural heritage. It supports decision-making by managers and organizations, promotes transparency throughout the assessment process, and enables the adoption of the most appropriate methods and practices for environmental planning and management.

With the rapid advancement of digital technologies, numerous tools are now available to support more dynamic and comprehensive environmental impact analyses. According to Howard (2020), several challenges associated with the EIA process remain widely recognized, particularly those related to scoping, follow-up, and environmental monitoring.

These limitations have long been recognized in environmental governance. As highlighted by Ortolano and Shepherd (1995), the lack of continuous post-project monitoring and the late implementation of EIA - often conducted merely to satisfy formal regulatory requirements - have historically reduced the preventive potential of the instrument. Given these persistent gaps and the inherent complexity of the process, digital innovation offers significant opportunities to improve current EIA practices (Costanzo & Sánchez, 2019).

One initiative illustrating this approach is the implementation of an Environmental Impact Assessment Protocol to support environmental licensing procedures involving Brazilian federal protected areas. Developed by the General Coordination for Impact Assessment (CGIMP) (2018) of the Chico Mendes Institute for Biodiversity Conservation (ICMBio), the initiative led to the

development of information systems for the assessment and monitoring of environmental impacts in protected areas throughout Brazil.

Background

The Chico Mendes Institute for Biodiversity Conservation (ICMBio), established under Law No. 11,516 of August 28, 2007, is the federal agency responsible for managing Brazil's federal protected areas. Among its institutional responsibilities is the implementation of national environmental policies, including those related to environmental licensing. Through the General Coordination for Impact Assessment (CGIMP), ICMBio is responsible for the technical assessment of environmental impacts that activities or development projects may cause to federal protected areas and their buffer zones, without prejudice to the responsibilities of the competent environmental licensing authority.

Before the enactment of Law No. 15,190 of July 31, 2025, which modified ICMBio's binding role in environmental licensing procedures, the Institute participated in environmental licensing processes conducted by federal and state licensing authorities through administrative opinions and the issuance of Environmental Licensing Authorizations (Autorização para o Licenciamento Ambiental - ALA), in accordance with CONAMA Resolution No. 428 of December 17, 2010.

This process required Environmental Impact Assessments for federal protected areas affected by the impacts of proposed projects and activities. Technical opinions and reports were prepared based on a thorough evaluation of environmental studies to support management decisions. The issuance of an ALA by ICMBio was mandatory whenever impacts on protected areas (Unidades de Conservação – UCs) were identified, considering applicable regulations and the Management Plan of each protected area.

Based on this framework, the Environmental Licensing Process Management Improvement Program (PMG - Licenciamento) was established through Ordinance No. 57 of January 17, 2018. The program aimed to improve the management of environmental licensing authorization procedures by increasing efficiency, standardization, automation, and the quality of technical analyses.

Additionally, an Environmental Impact Assessment Protocol was developed to establish standardized methodologies for evaluating potential impacts on federal protected areas resulting from the installation and operation of projects and activities. The protocol also provided procedures for assessing environmental compatibility, defining applicable mitigation or compensation measures, and reviewing and updating ICMBio's institutional regulations governing environmental impact assessment.

In parallel, several information systems were developed to organize institutional databases and improve the management of information related to ICMBio's participation in environmental licensing procedures. These systems enhanced transparency and efficiency in

technical analyses, strengthened decision-making reliability, improved knowledge management, and supported biodiversity conservation strategies.

This approach aligns with contemporary Environmental Management Systems (EMS), which, according to Zaverlik and Naumovska (2024), function as essential components of technological governance by integrating regulatory compliance management, risk assessment, and the efficient transmission of environmental data to regulatory authorities.

Methodology

The legal framework supporting the modernization of ICMBio's technical assessment procedures was consolidated through the PMG - Licenciamento. The adopted methodology consisted of four implementation stages, culminating in the application of information management technologies and Environmental Impact Assessment tools aimed at automating technical analyses.

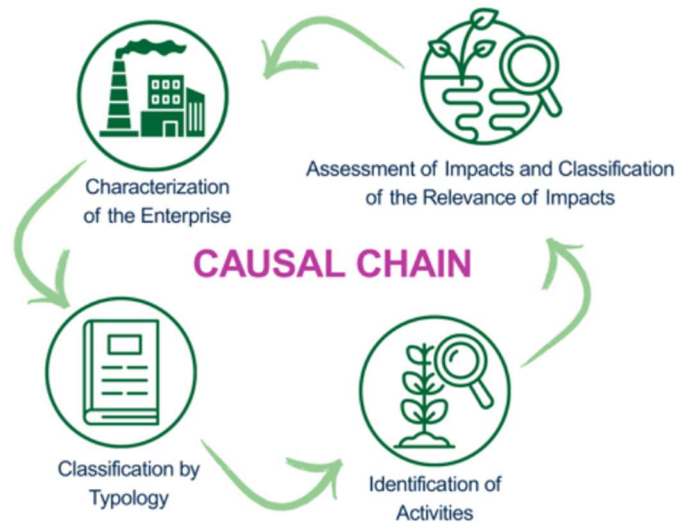
The first stage, carried out in 2017, involved the systematization of data using spreadsheets and the organization of environmental licensing cases that had received technical opinions and Environmental Licensing Authorizations (ALAs) issued by the Presidency of ICMBio. The primary objective of this stage was to implement rigorous process and deadline management through the adoption of the corporate platform Citsmart.

The second stage focused on the design and standardization of procedural workflows for environmental licensing processes at the national level. This phase integrated procedures conducted by ICMBio headquarters, Regional Offices (GRs), and other institutional units involved in environmental licensing or in impact assessments coordinated by the CGIMP technical team.

The subsequent stage consisted of developing the Environmental Impact Assessment Protocol. The conceptual framework was established through three technical workshops held between June and October 2018, based on case studies involving terrestrial, coastal-marine, and linear infrastructure projects. The initial methodology, proposed by the CGIMP technical team, was tested and refined during these workshops with the participation of civil servants and technical collaborators experienced in environmental impact assessment from Protected Areas, Regional Offices (GRs), Directorates, and Research Centers.



Impact Assessment Protocol



The final implementation stage consisted of gathering the technical requirements for developing the information systems used to support Environmental Impact Assessment and the monitoring of project-specific environmental conditions, namely ALA, Soala, and Coala.

ICMBio's modernization process reflects both the instrumental and conceptual categories of innovation described by Costanzo and Sánchez (2019). The instrumental dimension is represented by the development and implementation of the Soala and Coala systems as technological tools for automating administrative procedures and managing geospatial and administrative data.

The conceptual dimension refers to the paradigm shift in technical assessment promoted through the standardization established by the Environmental Impact Assessment Protocol. The protocol reorganized technical analyses around three fundamental pillars - Normative, Environmental, and Supporting Components - transforming isolated technical opinions into structured and standardized assessments. In this context, the collaborative workshops were essential for validating these innovations by ensuring that the technological solutions effectively incorporated the technical expertise of practitioners working in the field.

The first step in implementing the automation phase of the PMG - Licenciamento was the development of the Environmental Licensing Authorization System (ALA), in which the basic information regarding each proposed project is entered. This initial stage highlights the importance of requirements engineering in the development of environmental information systems. As emphasized by Ruiz-Martínez and González-Gómez (2021), the systematic identification of technical, functional, and operational requirements among stakeholders is fundamental to ensuring that the resulting system can process complex data accurately and unambiguously.

Once the project is deemed eligible for technical assessment and any preliminary regulatory constraints have been ruled out, the information is integrated into the Environmental Licensing Authorization System (Soala). Within this platform, the remaining stages of the licensing workflow are conducted, including the assessment of positive and negative environmental impacts, the evaluation of mitigation measures, the establishment of environmental conditions to be incorporated into the authorization, and the compliance review performed by the CGIMP technical team.

To monitor compliance with the specific environmental conditions established in issued authorizations and ensure the effective mitigation of project impacts, the Environmental Conditions Monitoring System (Coala) was developed. This system maintains a centralized database of environmental conditions, allowing users to register authorization requirements, generate monitoring reports, request compliance documentation from project proponents, and systematically monitor compliance with established environmental conditions.



Results

The Soala system streamlined the issuance of Environmental Licensing Authorizations (ALAs) by integrating technical assessments prepared by specialists from federal protected areas with the compliance review conducted by the CGIMP team, incorporating key Environmental Impact Assessment procedures into a unified workflow. The system cross-references project information with the legal instruments establishing each protected area and their respective Management Plans, thereby ensuring regulatory compliance.

The standardization of impact assessments and mitigation measures has substantially improved administrative efficiency by significantly reducing response times and accelerating

licensing procedures. The centralized repository of environmental licensing records facilitates rapid information retrieval while preserving institutional memory. Furthermore, the system ensures a consistent technical approach across federally protected areas, reducing subjectivity in environmental assessments.

The system has also strengthened decision-making by ensuring that technical opinions are based on reproducible assessment criteria and accurate geospatial information, thereby reducing the likelihood of inconsistent evaluations for comparable projects. In addition, transparency has been enhanced through full traceability of information and broader access to licensing data. The integration of standardized digital workflows has further improved the technical consistency of the documents produced by ICMBio.

To address the long-standing challenge of follow-up and environmental monitoring identified in the EIA literature (Howard, 2020), ICMBio implemented the Coala system for monitoring environmental conditions attached to licensing authorizations. The system functions as a dynamic database that enables systematic monitoring of environmental obligations.

Unlike traditional monitoring approaches, Coala supports the automated collection of compliance reports and facilitates the verification of project-specific environmental conditions through field monitoring. This innovation bridges the gap between administrative decision-making, license issuance, and effective biodiversity conservation by ensuring that mitigation and compensation measures are properly implemented and monitored throughout the project's life cycle.

Furthermore, these systems position ICMBio to comply with Law No. 15,190/2025, which redefined the environmental licensing framework previously governed by CONAMA Resolution No. 428/2010. Under the new legal framework, ICMBio acts as an "involved authority," while the automation and standardization of procedures support the legal principles of administrative efficiency and environmental damage prevention established in Articles 1 and 2.

Technological integration specifically fulfills Article 2(IV) by strengthening interinstitutional coordination through robust, traceable, and evidence-based technical opinions, substantially reducing legal uncertainty and minimizing the judicialization of environmental licensing disputes.

Final Considerations

The modernization of ICMBio's technical assessment process goes beyond the mere digitization of documents by adopting the "digital by default" strategy advocated by Howard (2020). This approach recognizes that digital technologies should support the entire assessment process rather than simply the production of its final report. The Soala and Coala systems demonstrate the potential of digital technologies to strengthen Environmental Impact Assessment and environmental licensing in Brazil by supporting evidence-based decision-making and contributing to the management and conservation of federal protected areas, while also fulfilling the strategic objectives established by the PMG - Licenciamento.

Furthermore, the standardization of analytical workflows through the Environmental Impact Assessment Protocol has improved the technical consistency and transparency of

environmental licensing procedures while strengthening project monitoring within protected areas and facilitating compliance monitoring. These initiatives represent significant advances in the modernization of environmental governance within ICMBio. The environmental conditions database also provides an important analytical tool for cross-referencing and comparing information across projects located within the same protected area, making it possible to identify recurring environmental impacts that require enhanced monitoring and the implementation of more effective mitigation measures.

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