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Programa de Pós-Graduação Stricto Sensu em Recursos Naturais do Cerrado

GABRIEL DE AVILA BATISTA

LICENCIAMENTO E AVALIAÇÃO DE IMPACTO AMBIENTAL:

Percepção, Ciência e Desafios

Anápolis

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Percepção, Ciência e Desafios

Tese apresentada ao Programa de Pós-Graduação Stricto Sensu em Recursos Naturais do Cerrado, da Universidade Estadual de Goiás para obtenção do título de Doutor em Recursos Naturais do Cerrado.

Orientador: Prof. Dr. Paulo De Marco Júnior

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ATA DE DEFESA PÚBLICA DE TESE Nº 136/023

Aos 31 dias do mês de 3 do ano de 2023, às 08h00min, reuniu-se no auditório do bloco IV do Câmpus Central da UEG, a banca Examinadora composta pelos: Dr. Paulo De Marco Júnior (Universidade Federal de Goias), Dra. Priscilla de Carvalho(Universidade Federal de Goias), Dr. Arthur Angelo Bispo(Universidade Federal de Goias),Dra. Fernanda Melo Carneiro (Universidade Estadual de Goias), Dr. Rogério Pereira Bastos (Universidade Federal de Goiás) para sob a presidência do primeiro, procederem à "defesa de doutorado" intitulada: Licenciamento e Avaliação de impacto ambiental: Percepção, ciência e desafios, de Gabriel Avila Batista, discente do PPG Recursos Naturais do Cerrado, nível doutorado. Foi realizada a avaliação oral no sistema de apresentação e defesa de tese de autoria do(a) discente. Terminada a avaliação oral, a Banca Examinadora reuniu-se emitindo os seguintes pareceres mediante as justificativas e sugestões abaixo:

Membro da Banca	Aprovado	Reprovado
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Dra. Priscilla de Carvalho	Sim	
Dr. Arthur Angelo Bispo	Sim	
Dra. Fernanda Melo Carneiro	Sim	
Dr. Rogério Pereira Bastos	Sim	

Justificativas e sugestões:_____

Após avaliação foi APROVADA na defesa. Às 17:30 horas, o (a)Prof. Dr. Paulo De Marco Júnior, presidente da Banca Examinadora deu por encerrada a sessão e, para constar, lavrou a presente Ata:

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Aos meus pais.

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MEMORIAL – DOS DINOSSAUROS AO LICENCIAMENTO AMBIENTAL

GRADUAÇÃO E INÍCIO DA CARREIRA

Concluí minha graduação há 11 anos. Meu trabalho de conclusão de curso foi sobre dinossauros, minha paixão desde a infância. Naquela época, o licenciamento ambiental era apenas um ruído nas histórias dos amigos que estagiavam em empresas de consultoria. Minha experiência prática se resumia à didática – como professor de ciências, informática e xadrez no programa Mais Educação – , e a alguns trabalhos acadêmicos com entomofauna. Meu objetivo de vida era (e ainda é) lecionar. Mas tive que dançar conforme a música, e me dediquei a outras atividades depois da graduação.

Um ano depois, uma amiga me convidou para trabalhar em uma empresa de consultoria ambiental. Havia uma demanda temporária para educadores em um projeto de educação em saúde em Tocantins e no Maranhão. Agarrei a oportunidade, e depois deste trabalho fui efetivado. Comecei desenvolvendo atividades relacionadas a educação, e logo me envolvi em vários projetos paralelos, incluindo entomologia, saúde pública, educação ambiental, análises ambientais e até design gráfico e editoração. Esta experiência me enriqueceu como pessoa e profissional. Convivi com acadêmicos especialistas em diversas áreas. Foram esses traquejos e amizades que aos poucos me levaram de volta a academia.

Minha experiência com o licenciamento ambiental foi, a princípio, confusa. Meu primeiro contato foi com processos e produtos, e as motivações eram complexas e nebulosas. Isso me inspirou a estudar o sistema em si. Com o tempo, percebi diversos problemas na qualidade dos produtos, e me interessei em resolvê-los. Neste contexto, as primeiras soluções que imaginei eram simplistas e se resumiam a ferramentas. Eu acreditava que a qualidade poderia ser aprimorada por meio da automatização. Por isso, três anos depois, minha proposta de projeto para o mestrado foi um aplicativo para coleta e análise de dados ambientais.

MESTRADO

Minha ideia para a pesquisa de mestrado era utilizar os sensores dos smartphones para coleta de dados ambientais e uma rede *ad-hoc* em dispositivos móveis para processamento multi núcleo dos dados coletados. Fui aprovado no CIAMB-UFG com este projeto, mas só compreendi as falhas dele durante as primeiras conversas com meu orientador. Eu confundia tecnologia com ciência. Foi neste momento que minha educação como cientista começou. Meu projeto mudou. Meu objeto de pesquisa deixou de ser uma ferramenta e passou a ser a estrutura ("Framework"). Eu compreendi que as falhas da AIA estavam, em parte, relacionadas as perguntas feitas. Em alguns casos, nem haveria perguntas. As ferramentas eram apenas um meio. A raiz dos problemas deveria estar nos Termos de Referência (TRs) que guiavam os estudos ambientais.

No novo projeto de mestrado mudei o foco para a análise de impacto ambiental do meio biótico. Escolhi trabalhar com hidrelétricas por causa da minha experiência profissional. Nesta pesquisa, verifiquei a concordância dos critérios apresentados nos termos de referência com as diretrizes propostas pela literatura científica. Como eu não era bolsista, mantive meu vínculo celetista. Por isso, apesar de não ter me envolvido em mais atividades acadêmicas, pude observar de forma prática as implicações dos meus estudos. Aos poucos aprimorei minha crítica sobre o tema. No mestrado também me apaixonei pelas ciências ambientais devido a sua natureza multidisciplinar e a todas as possibilidades inerentes a isso. Por isso, decidi continuar a vida acadêmica nessa área e me inscrevi para o processo seletivo do doutorado.

DOUTORADO

Escolhi cursar o doutorado no Programa de Pós-graduação em Recursos Naturais do Cerrado – RENAC-UEG. Eu conheci o RENAC por meio do meu orientador e de colegas do laboratório. O corpo docente era muito elogiado e as disciplinas me chamaram a atenção. Me inscrevi para o processo seletivo no final de 2018. Meu projeto de pesquisa para o processo seletivo tinha uma abordagem muito mais ampla. Eu pretendia avaliar a qualidade dos estudos de impacto ambiental para os componentes, biótico, físico e socioeconômico. Para isso, eu faria uma compilação de boas práticas propostas pela

literatura internacional para o tema, e então discutiria a aplicação dos métodos e ferramentas mais importantes no cenário nacional. Por fim, discutiria o Cerrado em um recorte mais específico.

Uma vez aprovado, encerrei meu vínculo celetista e me dediquei às disciplinas. Em 2019 cursei: “biologia da conservação e seleção de áreas para a conservação”, “princípios da epistemologia da ciência”, “revisão sistemática e informetria aplicada as ciências”, “meta-análise”, “valoração dos recursos ambientais”, “história ambiental e proteção à natureza”, “divulgação científica”, “recursos naturais do Cerrado”, e, “estatística aplicada a dados ambientais”. Publiquei como coorganizador os livros “Guia de campo das PCHs palmeiras e Retiro” e “Guia de Peixes da UHE Estreito”, ambos projetos iniciados durante o mestrado. Publiquei também como coautor os artigos “Predation of Tropidurus oreadicus (Reptilia, Tropiduridae) by Heterophrynus sp. (Arachnida, Phrynidae) in a cave in the Chapada das Mesas National Park, state of Maranhão, Brazil” e “First records of Veery, Catharus fuscescens, for the state of Maranhão, northeast Brazil.”. No final de 2019, a convite do professor Rogério Pereira Bastos, ministrei a palestra “De Grão em grão: O licenciamento ambiental da extração de areia” e concedi uma entrevista à Rádio Rio Vermelho de Silvânia-GO sobre o licenciamento ambiental de extração de areia. Mantive um perfil de divulgação científica e fotografia no instagram (@lehiannel).

Em 2020 cursei as disciplinas “introdução ao R”, “experimentos manipulativos em ciências ambientais” e “redação científica”. Neste ano fui convidado pelo professor Arthur Ângelo Bispo de Oliveira a integrar a equipe do projeto de Monitoramento da Biodiversidade nos municípios de Niquelândia e Barro Alto. Atuei como coordenador de campo e auxiliei na elaboração dos produtos, bem como na gestão de pessoas. Também desenvolvi um aplicativo para coleta de dados de monitoramento da biodiversidade em campo, o SiMBioS (Sistema de Monitoramento da Biodiversidade). O aplicativo não chegou a ser usado nesta época, mas tenho planos de implementá-lo em novos contratos. Este projeto foi encerrado em outubro de 2022. Em paralelo, desenvolvi atividades do estágio docência na UFG e UEG com os professores Paulo De Marco Júnior (bioindicadores -projetos), João Carlos Nabout (monitor da disciplina de estatística) e Juliana Simião (Orientação do trabalho final da disciplina de ecologia – Coleoptera).

Participei do projeto de divulgação científica “Cerrado em Foco”, liderado pela professora Juliana Simião. Integrei o grupo de pesquisa Etnobiologia e Biodiversidade, coordenado pelo professor Arthur Ângelo bispo de Oliveira. Ante o advento da COVID-19, participei de um debate/entrevista sobre este tema realizado pela Casa de Vidro Ponto de Cultura. Ministrei a palestra “A zoologia no processo de licenciamento ambiental: Dinâmica, desafios e contribuições.”. Entre 2020 e 2021 fui coautor dos estudos “*Perceptions about massive environmental impacts: A Brazilian study case* (aceito, em fase final de publicação na *Annals of Brazilian Academy of Science*)”, “Perspectivas sobre a produção científica em unidades de conservação”, “Índice de qualidade técnica: Implementação em unidades de conservação”, e “Unidades de conservação? Avaliação da qualidade dos estudos técnicos de criação de áreas protegidas no Cerrado” (ainda a serem submetidos). Nestes dois primeiros anos também participei presencialmente e virtualmente em diversos eventos.

As maiores mudanças em minha vida acadêmica ocorreram em 2021, durante a pandemia. No dia 12 de maio assisti ao vivo a votação do PL 3729/2004. Percebi que, de forma geral, “para o bem ou para o mal”, os representantes do povo tinham pouco conhecimento a respeito do licenciamento ambiental, seus objetivos e instrumentos. Pior do que isso, havia esforço em desinformar. Acompanhei a discussão sobre o tema nas redes sociais durante as semanas seguintes. Esse cenário me inspirou. Aproveitei o “momentum” do tema e decidi mudar meu projeto de pesquisa e adicionar um novo capítulo. Investigar a percepção do povo a respeito do licenciamento ambiental através das redes sociais, considerando que o tema é importante. Além disso, a desinformação poderia ter algum efeito sobre a forma como as pessoas percebiam isso. Meu primeiro capítulo na época estava pela metade. Deixei-o em “stand-by” e me dediquei a escrever um projeto para o comitê de ética. Pouco tempo depois, em setembro, comecei a divulgar o questionário e coletar os dados. Essa foi a pesquisa que mais me divertiu. Foi a porta de entrada para a psicometria, modelos de equação estrutural, análises de caminho, teoria de resposta ao item, entre outros. Pretendo me especializar neste tipo de pesquisa.

Meu exame de qualificação foi em Maio de 2022. Depois disso, redesenhei minha tese de acordo com a experiência acadêmica, as orientações da banca e o contexto. A

partir daquele momento incorporei a informação como uma diretriz comum a todos os meus capítulos. Mudei o foco para o componente biótico e deixei a compilação de métodos, comparação com o cenário nacional e Cerrado para trabalhos futuros. Escolhi como primeiro capítulo a percepção pública, e escrevi dois novos capítulos a partir de alguns objetivos dos cinco outros capítulos do projeto original. Além disso, removi do primeiro artigo os resultados relativos ao perfil socioeconômico a análise lexicográfica – pretendo discutir estes resultados no futuro, em outro artigo. O cronograma estava apertado, e tive que lidar com seis episódios de COVID, entre outros desafios pessoais. No final de Janeiro de 2023 eu pedi prorrogação da defesa de Fevereiro para Março.

Foi uma jornada formação. Estou feliz com o que aprendi, principalmente na fase final. O contrafactual do projeto inicial me incomodou muitas vezes. Em vários momentos me perdia no que "poderia ter sido". No entanto, agora, estou feliz com "o que é" e com "quem sou". Mas ainda não estou satisfeito. Vou continuar a jornada acadêmica com a certeza de ainda tenho muito a aprender e contribuir como cientista. Quanto ao futuro, pretendo continuar com as pesquisas relativas a análise de impacto ambiental e licenciamento ambiental, mas quero expandir os horizontes e explorar novas áreas. Principalmente no que remete a psicometria, percepção ambiental e modelos de equação estrutural. Vou me dedicar a aprimorar estes conhecimentos e a melhorar meu currículo, para que em um ou dois anos possa aplicar para o estágio de pós-doutorado, e então para a docência.

SUMÁRIO

RESUMO GERAL

Com 53 anos de história e adotada por mais de 180 países, a Avaliação de Impacto Ambiental (AIA) é o processo de apoio a decisões sustentáveis mais bem sucedido atualmente. Sua dinâmica multidisciplinar abrange os componentes biótico, físico e socioeconômico. Apesar de sua história e abrangência, a AIA ainda está em processo de adequação, principalmente nos países em desenvolvimento, como o Brasil. A nível nacional, a AIA ampara o processo de licenciamento ambiental (LA), subsidiando informações para decisões sustentáveis. Neste sentido, a nível nacional e internacional, a AIA é um assunto comum na produção científica, com pesquisas relacionadas a conservação da biodiversidade, métodos e inclusão do público no processo, por exemplo. Ademais, a literatura sobre este tema é focada em "qualidade" em detrimento de efetividade e teoria. Neste contexto, exploro ao longo de três artigos as relações entre os processos de licenciamento ambiental, avaliação de impacto ambiental e informação, nas esferas pública (percepção e opinião) e acadêmica (revisada por pares). No primeiro artigo apresento um modelo de equação estrutural que destaca as relações entre diferentes tipos de mídia, opinião pública sobre o projeto de lei 3729/2004 e o perfil socioeconômico dos brasileiros. No segundo, exploro as conexões entre a produção científica sobre os métodos do componente biótico da AIA, os frameworks (qualidade, teoria e efetividade) e as demais disciplinas. No último capítulo analiso as condicionantes ambientais e econômicas da literatura científica explorada no segundo capítulo. Em uma síntese geral, os resultados indicam que o licenciamento ambiental não é um tema de interesse para a maioria dos brasileiros. Em paralelo, a nível internacional, os focos da literatura são qualidade, biodiversidade e impactos ambientais. Além disso, a maior parte destas pesquisas, incluindo as mais relevantes, é feita em países desenvolvidos em detrimento dos países com maior biodiversidade. Neste sentido, discuto a importância dos comunicadores de ciência como mediadores de informação; a importância da inclusão da gestão e políticas na discussão da literatura; e a necessidade de uma maior colaboração da comunidade científica com pesquisas em países em desenvolvimento.

Palavras-chave: Avaliação de impacto ambiental, Licenciamento ambiental, Modelo de equação estrutural, Cienciometria, Projeto de Lei 3729/2004

GENERAL ABSTRACT

Within 53 years of history and used by more than 180 countries, the Environmental Impact Assessment (EIA) is the most successful sustainable decision support process today. Its multidisciplinary dynamics covers the biotic, physical and socioeconomic components. Despite its history and scope, the EIA is still in the process of adaptation, especially in developing countries, such as Brazil. At the national level, the EIA supports the environmental licensing process (EL), providing information for sustainable decisions. In this sense, at national and international level, EIA is a common subject in scientific production, with research related to biodiversity conservation, methods and inclusion of the public in the process, for example. Furthermore, the literature on this topic is focused on "quality" to the detriment of effectiveness and theory. In this context, I explore over three articles the relationships between environmental licensing processes, environmental impact assessment and information, in the public (perception and opinion) and academic (peer-reviewed) spheres. In the first article I present a structural equation model that highlights the relationships between different types of media, public opinion on bill 3729/2004 and the socioeconomic profile of Brazilians. In the second, I explore the connections between the scientific production on the methods of the biotic component of EIA, the frameworks (quality, theory and effectiveness) and the other disciplines. In the last chapter I analyze the environmental and economic constraints of the scientific literature explored in the second chapter. In a general summary, the results indicate that environmental licensing is not a topic of interest to most Brazilians. In parallel, at an international level, the focuses of the literature are quality, biodiversity and environmental impacts. Furthermore, most of this research, including the most relevant ones, is carried out in developed countries to the detriment of countries with greater biodiversity. In this sense, I discuss the importance of science communicators as information mediators; the importance of including management and policies in the literature discussion; and the need for greater collaboration between the scientific community and research in developing countries.

Keywords: Environmental Impact Assessment, Environmental Licensing, Structural Equation model, Scientometrics, Bill 3729/2004

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INTRODUÇÃO GERAL

A avaliação de impacto ambiental (AIA) [1]surgiu nos EUA, 1969, como um instrumento da *National Environmental Policy Act* (NEPA) (Sánchez, 2013). Entre as décadas de 70 e 80 as bases metodológicas, políticas e sociais foram implementadas a AIA; e no final deste período a maioria dos países desenvolvidos já a havia adotado (Biswas and Modak, 1999). Na década de 90 a AIA foi reconhecida pela ONU, aprimorada e adotada por mais de 100 países (Wood, 2003). Em 2012 AIA já havia sido implementada em pelo menos 181 países. (Morgan, 2012). Durante toda sua história, a AIA foi tema para pesquisas científicas. Sua efetividade era amplamente discutida no meio acadêmico (Wood, 2003). Em 2010, a estrutura da literatura científica sobre a AIA foi dividida em três "frameworks" [2]centrais interrelacionados: "qualidade", "teoria" e "efetividade", com a maior parte das publicações discutindo a "qualidade" (Retief, 2010). Tópicos como biodiversidade (Gontier et al., 2006; Mandai and Souza, 2021), participação pública (Glucker et al., 2013) e aspectos políticos (McCullough, 2017) são abordados nestes frameworks.

Nesse contexto, entre os principais problemas da biodiversidade destacam-se amostragem inadequada (Ferraz, 2012), lacunas na análise e modelagem (Gontier et al., 2006) e ineficácia da AIA como política proteção (Bond et al., 2021). No espectro político, a sociedade, importante elemento do meio ambiente, é excluída ou ignorada nos processos de decisão (Glucker et al., 2013). Em paralelo, a efetividade das políticas ambientais relacionadas a AIA é prejudicada pela corrupção (Williams and Dupuy, 2017). Esses e outros problemas são mais comuns em países em desenvolvimento devido a situação econômica (McCullough, 2017), leis ambientais ineficazes (Wood, 2003) e a carência de recursos para desenvolvimento e pesquisa (Cashmore, 2004; Lee and George, 2000).

Os países em desenvolvimento são, geralmente, megadiversos (Fisher and Christopher, 2007; Veech, 2003) e tem políticas ambientais emergentes (Adenle et al.,

[1] Desambiguação: Em inglês o termo é "Environmental Impact Assessment". O acrônimo "EIA" é o mesmo utilizado para Estudos de Impacto Ambiental, em português. No Brasil, os estudos de impacto ambiental são uma ferramenta da AIA.

[2] "Frameworks" referem-se a estrutura da literatura científica. Um artigo científico pode estar relacionado a qualquer combinação dos frameworks.

2014; Barber et al., 2014). Além disso, muitos deles passam por um período de aumento na industrialização e demanda de energia. Consequentemente, a AIA tem um papel central como referência para as decisões e ações mitigatórias nestes lugares (Mandelik et al., 2005). Todavia, há desafios a serem superados, dentre eles a inclusão efetiva da população (Glucker et al., 2013) e da ciência (Cashmore, 2004) na AIA. Neste sentido, a pressão legislativa exercida pela população e a produção científica poderiam ser motivadas pelas condições ambientais do país, como a perda de cobertura vegetal original, por exemplo. Porém, este quadro é mais complexo do que parece, pois a produção científica está diretamente relacionada com o Produto Interno Bruto per capita (PIB) e com os recursos aplicados em Pesquisa e Desenvolvimento (P&D) (Meo et al., 2013). Em paralelo, a inclusão popular no processo no processo legislativo pode ser afetada pelas mídias sociais (Battaglini and Patacchini, 2019; Grossman, 2022) e prejudicada com a desinformação (Forti et al., 2022; Hafiidz et al., 2021).

Os efeitos da redução de recursos em P&D na produção científica, e da desinformação na opinião pública, podem ser observados no Brasil entre 2019 e 2022. Durante este período, o setor de pesquisa e desenvolvimento foi ameaçado com cortes no orçamento em diferentes ocasiões (Grossman, 2022; Hafiidz et al., 2021). Enquanto isso controvérsias negacionistas (Rajão et al., 2022) e cortinas-de-fumaça (Ferrante and Fearnside, 2020; Vale et al., 2021) disseminadas nas redes sociais prejudicaram a percepção ambiental do público. Em 2019, vimos os efeitos da desinformação nas discussões sobre o derramamento de óleo na costa brasileira (Lemos et al., 2020). Em 2020, testemunhamos os incêndios na Amazônia serem negados pelo público geral, alguns políticos e o governo vigente (Silva, 2021). Assim, cabe questionar o quanto a percepção da população é afetada em relação as políticas ambientais. Informação de baixa qualidade pode reduzir a pressão que o povo exerce em seus representantes legislativos. Neste cenário, o Projeto de Lei (PL) 3729/2004 (Brasil, 2004), discutido no plenário 2021, é um ótimo objeto de estudo. O principal objetivo deste PL é a “simplificação” do processo de licenciamento ambiental (Geller, 2021). Todavia, conforme observado em casos semelhantes na Austrália, Canadá, África do Sul e Reino Unido, este tipo de reforma pode reduzir a eficiência da AIA (Bond et al., 2014). Ademais, da maneira como está, este projeto pode reduzir a eficácia desta política. Entre os

diversos pontos de interesse no conteúdo desta norma estão a isenção de atividades potencialmente impactantes, renovação automática de algumas licenças e o aumento de ameaças a biodiversidade (Minc et al., 2021). Dadas estas circunstâncias, disserto sobre estes temas nos capítulos desta tese.

OBJETIVOS

Em suma, o propósito da minha tese é investigar as interações entre os procedimentos de licenciamento ambiental, a metodologia da avaliação de impacto ambiental – enfocando nos componentes bióticos – e as dinâmicas de informação, tanto na esfera pública (opinião) quanto científica (avaliada por pares).

Para isso, no primeiro artigo, elaborei um modelo que traça conexões entre a percepção pública a respeito do licenciamento ambiental, especificamente o Projeto de Lei 3729/2004, distintas fontes de mídia (digital não revisada por pares, tradicional, técnica e acadêmica revisada por pares) e o perfil socioeconômico brasileiro.

No segundo artigo, examinei as relações entre a produção científica internacional sobre métodos aplicados ao componente biótico e os frameworks, temas e outros componentes (físico e socioeconômico) da avaliação de impacto ambiental.

Por fim, no terceiro artigo, analisei as motivações subjacentes entre a literatura científica discutida no segundo capítulo e as motivações socioambientais – como a perda de cobertura vegetal original e investimentos em pesquisa e desenvolvimento – nos países onde essas pesquisas foram realizadas.

REFERÊNCIAS DA INTRODUÇÃO

Adenle, A.A., Stevens, C., Bridgewater, P., 2014. ScienceDirect Global conservation and management of biodiversity in developing countries : An opportunity for a new approach. Environ. Sci. Policy 45, 104–108. https://doi.org/10.1016/j.envsci.2014.10.002

Barber, P.H., Ablan-lagman, M.C.A., Cahyani, D., Crandall, E.D., Ravago-gotanco, R., Juinio-meñez, M.A., 2014. Advancing biodiversity research in developing countries : the need for changing paradigms 90, 187–210.

Battaglini, M., Patacchini, E., 2019. Social Networks in Policy Making. Annu. Rev. Econom. 11, 473–494. https://doi.org/10.1146/annurev-economics-080218-030419

Biswas, A.K., Modak, P., 1999. Conducting environmental impact assessment in developing countries. UN University Press, Tokyo.

Bond, A., Pope, J., Morrison-Saunders, A., Retief, F., 2021. Taking an environmental ethics perspective to understand what we should expect from EIA in terms of biodiversity protection. Environ. Impact Assess. Rev. 86, 106508. https://doi.org/10.1016/j.eiar.2020.106508

Bond, A., Pope, J., Morrison-Saunders, A., Retief, F., Gunn, J.A.E., 2014. Impact assessment: Eroding benefits through streamlining? Environ. Impact Assess. Rev. 45, 46–53. https://doi.org/10.1016/j.eiar.2013.12.002

Brasil, 2004. Projeto de Lei Nº 3729/2004. https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=257161, Brazil.

Cashmore, M., 2004. The role of science in environmental impact assessment: Process and procedure versus purpose in the development of theory. Environ. Impact Assess. Rev. 24, 403–426. https://doi.org/10.1016/j.eiar.2003.12.002

Ferrante, L., Fearnside, P.M., 2020. Military forces and COVID-19 as smokescreens for Amazon destruction and violation of indigenous rights. Die Erde 151, 195–200. https://doi.org/10.12854/erde-2020-542

Ferraz, G., 2012. Twelve guidelines for biological sampling in environmental licensing studies. Nat. a Conserv. 10, 20–26. https://doi.org/10.4322/natcon.2012.004

Fisher, B., Christopher, T., 2007. Poverty and biodiversity: Measuring the overlap of human poverty and the biodiversity hotspots. Ecol. Econ. 62, 93–101. https://doi.org/10.1016/j.ecolecon.2006.05.020

Forti, L.R., Travassos, M.L. de O., Coronel-Bejarano, D., Miranda, D.F., Souza, D., Sabino, J., Szabo, J.K., 2022. Posts Supporting Anti-Environmental Policy in Brazil are Shared More on Social Media. Environ. Manage. https://doi.org/10.1007/s00267-022-01757-x

Geller, N., 2021. PARECER ÀS EMENDAS DE PLENÁRIO AO PL N.º 3729, DE 2004 E APENSADOS. Brasil.

Glucker, A.N., Driessen, P.P.J., Kolhoff, A., Runhaar, H.A.C., 2013. Public participation in environmental impact assessment : why , who and how ? Environ. Impact Assess. Rev. 43, 104–111. https://doi.org/10.1016/j.eiar.2013.06.003

Gontier, M., Balfors, B., Mörtberg, U., 2006. Biodiversity in environmental assessment—current practice and tools for prediction. Environ. Impact Assess. Rev. 26, 268–286. https://doi.org/10.1016/j.eiar.2005.09.001

Grossman, E., 2022. Media and Policy Making in the Digital Age. Annu. Rev. Polit. Sci. 25, 443–461. https://doi.org/10.1146/annurev-polisci-051120-103422

Hafiidz, M., Ismail, F., Nurfarahin, D., Junaidi, J., M, A., 2021. Roles of media in policymaking: A literature review. Int. J. Public Heal. Clin. Sci. 8, 1–14.

Lee, N., George, C., 2000. Environmental Assessment in Developing and Transitional Countries: Principles, Methods and Practice, First ed. ed. John Wiley & Sons, Ltd., Manchester, United Kingdom.

Lemos, A.L.M., Bitencourt, E.C., dos Santos, J.G.B., 2020. Fake news as fake politics: the digital materialities of YouTube misinformation videos about Brazilian oil spill catastrophe. Media, Cult. Soc. https://doi.org/10.1177/0163443720977301

Mandai, S.S., Souza, M.M.P. de, 2021. Guidelines for the analysis of the inclusion of

biodiversity in Environmental Impact Statements. Environ. Impact Assess. Rev. 87, 106523. https://doi.org/10.1016/j.eiar.2020.106523

Mandelik, Y., Dayan, T., Feitelson, E., 2005. Planning for biodiversity: The role of ecological impact assessment. Conserv. Biol. 19, 1254–1261. https://doi.org/10.1111/j.1523-1739.2005.00079.x

McCullough, A., 2017. Environmental Impact Assessments in developing countries: We need to talk about politics. Extr. Ind. Soc. 4, 448–452. https://doi.org/10.1016/j.exis.2017.07.002

Meo, S.A., Al Masri, A.A., Usmani, A.M., Memon, A.N., Zaidi, S.Z., 2013. Impact of GDP, Spending on R&D, Number of Universities and Scientific Journals on Research Publications among Asian Countries. PLoS One 8, e66449. https://doi.org/10.1371/journal.pone.0066449

Minc, C., Duarte, E., Krause, G., Teixeira, I., Carvalho, J.C., Goldemberg, J., Filho, J.S., Silva, M., Ricupero, R., 2021. Projeto de Lei Geral do NÃO-Licenciamento Ambiental promove insegurança jurídica e ameaça agravar a crise econômica Brasileira.

Morgan, R.K.R.K.R.K., 2012. Environmental impact assessment: The state of the art. Impact Assess. Proj. Apprais. 30, 5–14. https://doi.org/10.1080/14615517.2012.661557

Rajão, R., Nobre, A.D., Cunha, E.L.T.P., Duarte, T.R., Marcolino, C., Soares-Filho, B., Sparovek, G., Rodrigues, R.R., Valera, C., Bustamante, M., Nobre, C., Santos de Lima, L., 2022. The risk of fake controversies for Brazilian environmental policies. Biol. Conserv. 266. https://doi.org/10.1016/j.biocon.2021.109447

Retief, F., 2010. The evolution of environmental assessment debates: Critical perspectives from South Africa. J. Environ. Assess. Policy Manag. 12, 375–397. https://doi.org/10.1142/S146433321000370X

Sánchez, L.E.L.H., 2013. Avaliação de Impacto Ambiental: Conceitos e métodos, 2ª. ed. Oficina de Textos, São Paulo, SP.

Silva, H.M., 2021. Wildfires and Brazilian irrationality on social networks. Ethics Sci.

Environ. Polit. 21, 11–15. https://doi.org/10.3354/esep00194

Vale, M.M., Berenguer, E., Argollo de Menezes, M., Viveiros de Castro, E.B., Pugliese de Siqueira, L., Portela, R. de C.Q., 2021. The COVID-19 pandemic as an opportunity to weaken environmental protection in Brazil. Biol. Conserv. 255. https://doi.org/10.1016/j.biocon.2021.108994

Veech, J.A., 2003. Incorporating socioeconomic factors into the analysis of biodiversity hotspots. Appl. Geogr. 23, 73–88. https://doi.org/10.1016/S0143-6228(02)00071-1

Williams, A., Dupuy, K., 2017. Deciding over nature: Corruption and environmental impact assessments. Environ. Impact Assess. Rev. 65, 118–124. https://doi.org/10.1016/j.eiar.2017.05.002

Wood, C., 2003. Environmental impact assessment in developing countries. Int. Dev. Plan. Rev. 25, 301–321. https://doi.org/10.3828/idpr.25.3.5

1 PERCEPTION OF ENVIRONMENTAL LAWS THROUGH SOCIAL MEDIA: CHALLENGES TO POLICY EFFECTIVENESS

Journal: Journal of Environmental Impact Assessment Review

1.1 HIGHLIGHTS

- Most people are not interested on the theme; hence it is a small thread on social media.
- Only wealthy and academic respondents have significative interest in environmental policy.
- Among the media, only the academic (peer-reviewed) affect knowledge, importance, and opinion given to the theme.
- The misrepresentation of public voice for this subject on social media may hinder citizens' participation in policy-making process.
- We propose “burst the bubble” with science communication on social media as a solution.

1.2 ABSTRACT

Information plays a central role in how organized societies deal with complex issues such as environmental policies. However, poor-quality sources globally impact societal perception. Within this scenario, Brazil may represent a useful model case with recent policy changes aiming to reduce government control on environmental impacts. In 2022, the discussion about the 3729/2004 bill was an example of the pressure to reduce the efficiency of the environmental licensing process. Here we assessed how socioeconomic aspects affect the public interest in the theme and its preferences for information sources. Moreover, we evaluated the effect of these sources on the perception of environmental law regarding the licensing process and this particular Bill. We interviewed 2052 people by an opt-in online survey all over Brazil, generating 415 records suitable for analysis. We build a structural equation model to understand the relationship between the latent variables (Knowledge, Interest, Preferred Media Sources, and Importance) and the Bill. Our results show that the respondent's interest in the Bill is concentrated in this society's academic and high-income portion. However, the subject is not a significant thread on any media. Academic media(peer-reviewed) has a positive effect on knowledge and the importance given to the theme. We also show a

higher probability of non-reliable answers when the respondents declare a preference for academic media. Moreover, the public prefers social media platforms, information exchange with coworkers, and websites rather than academic media to inform themselves about Bill 3729/2004 and environmental licensing. We further discuss the importance of scientific communication to avoid the concentration of knowledge about this theme in a bubble of wealthy or highly educated respondents. We conclude that the active participation of academics in the general community may give the general public the basic information needed to make them an active voice in the policymaking process.

Keywords: environmental licensing; environmental policy; PL 3729/2004; environmental impact assessment; science communication

1.3 INTRODUCTION

Digital media is an outstanding information source nowadays, with 60% of the world population accessing the internet and social media platforms (SMPs) (Statista, 2022; The World Bank, 2020). Moreover, easiness and immediate access to data make it the preferable information source among many (Kim and Sin, 2011). The SMPs have broad social impacts (Li and Sakamoto, 2014), influencing knowledge construction and sharing (Ahmed et al., 2019; Gelfert, 2018) and further decision-making (Power and Phillips-Wren, 2011). Hence, the absence of efficient controls for information causes extensive effects (Peterson, 2020; Power and Phillips-Wren, 2011; Scheufele and Krause, 2019), with impacts on health (Das and Ahmed, 2022), climatic science (Lewandowsky, 2020), and environmental policies (Capelari et al., 2020). Low-quality information surpasses peer-reviewed and quality screening in sharing speed and reach, as it is easier and faster to propagate fake news than to present facts, evidence, and logical arguments (Vosoughi et al., 2018).

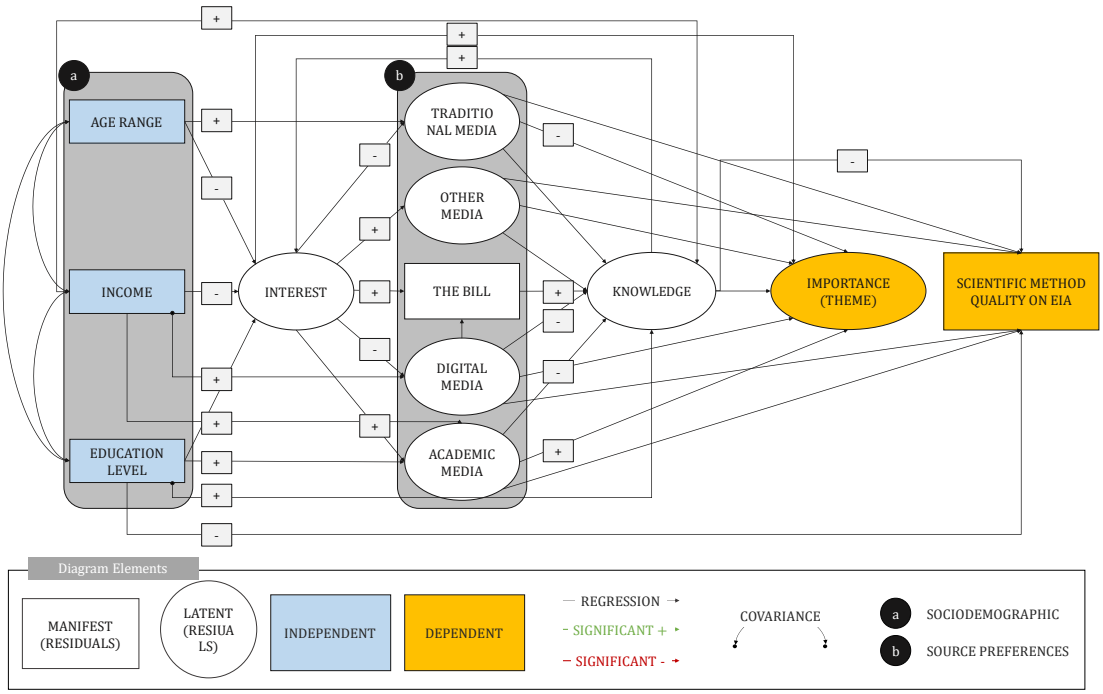
Within the discussion framework of the impact of misinformation on policy decisions, Brazil is a critical case since we watched the Amazon fires in 2020 denied by the general public, some politicians, and the government, even in front of empirical evidence (Silva, 2021). A similar social-media episode happened in 2019 with oil spills on the Brazilian coast (Lemos et al., 2020). These digital era issues may create a negative perception in citizens and directly affect the implementation of environmental policies, primarily due to fake denialist controversies (Rajão et al., 2022) and smokescreens (Ferrante and Fearnside, 2020; Vale et al., 2021). Not surprisingly, policymakers are dismantling the environmental licensing process (BARBOSA; ALVES, IALVES, GRELLE, 2021). One example of this process is Bill nº 3729/2004 (Brasil, 2004), which aims to “simplify” the environmental licensing process (Brasil, 2004; Geller, 2021). This Bill's approval is the primary goal of some politicians, and lobbyists use the known flaws of the process as arguments to justify emergently changes in the law (Bragagnolo et al., 2017). However, if the Bill is approved, it will be a throwback for environmental policies and environmental impact assessment since it may represent a waiver for potentially impactful activities, automatic license renewal, and increase threat to biodiversity (Minc et al., 2021).

The discussion of environmental policies generated commotion on different media sources, especially on social media platforms (SMPs). The public expressed their favorable and unfavorable opinions based on the information gathered from different media sources such as the SMPs, television, specialized literature, and others. This digital behavior may affect the decision-making process (Power and Phillips-Wren, 2011), with positive and negative effects (Mitchelstein et al., 2020), as citizens' demands on social media are essential to the reciprocal engagement of the politicians with the public (Tromble, 2018). In this context, it is essential to understand media preferences as information sources about environmental policies to strengthen public support for scientific evidence-based bills, increasing their chances of being approved. However, understanding this behavior and how it affects opinion is complex. Individual preferences may vary according to personality, age, education, income, and social circle (Roberts and Foehr, 2008). It is also necessary to consider that some of these variables, especially the personality components, cannot be measured directly (Borsboom et al., 2003), deserving the use of a psychometric approach to provide a meaningful understanding of these relationships (Cooper et al., 2012; Furr, 2018).

Hence, we assess the citizen's media preferences – Digital Media (DIM), Traditional Media (TRM), Academic Media (ACM), and Other Media (OTH) – as information sources about the Brazilian environmental licensing (EL) system, emphasizing the Bill nº 3729/2004. We chose this Bill because it is an example of national environmental policy from which we could illustrate the public relation with environmental policies still to be discussed. Furthermore, we assess the influence of other socioeconomic characteristics – Income, Education level, and age range on the media sources and latent variables such as Self-attributed knowledge, importance, and opinion about the Scientific Quality of Environmental Impact Assessment (EIA). In our hypothetical model, the inner model latent and manifest variables play both a dependent and an independent role. |The sociodemographic variables are independent, while the Importance and Scientific Quality of EIA are independent.

The conceptual model in **A1. Figure 1** synthesizes our broad hypothesis and determines our methodological approach. Within the sociodemographic aspects, we expected causal effects from age range to traditional media and from education to

Academic Media. Income would affect digital media and interest, as respondents with higher salaries would have more time and resources. We hypothesized Age range as an explanatory factor for Traditional Media and Education Level as a causal effect on academic media preferences. Age range and income would decrease the interest, and education level would increase. All media sources would be explanatory factors to the knowledge, importance, and scientific and technical quality of (EIA). However, Traditional Media and Digital Media would have a negative effect on these three variables, while Academic media would have a negative effect only on the scientific quality of EIA. We considered the reading of the Bill as one manifest media variable. Digital media would positively affect the reading of the Bill, as this media is easily accessible online. The four information sources would affect the person's level of knowledge according to personal socioeconomic variables since this may affect the individual information quality filter. Citizens with more knowledge about the impacts on the environment and how it works may have a more critical view of the Bill and give it more importance. Therefore, knowledge should negatively affect the opinion about the quality of the environmental impact assessment method quality – as there are many scientific critics.



A1. Figure 1. Hypothesized explanatory Structural Equation Model for information sources preferences regarding Bill 3729/2004. **THE BILL:** Bill 3729/2004

1.4 MATERIAL AND METHODS

1.4.1 Data Collection

We collected the empirical data in online opt-in surveys shared passively via social media platforms, advertisements, and actively in the same media. We chose to do a digital opt-in survey for two reasons: **a)** because of the COVID-19 pandemic, as it assured the health security of researchers and respondents by avoiding social contact, and **b)** this method provides access to a bigger pool of potential respondents via the internet (Thielo et al., 2021); and so our sample would represent a significative portion of the Brazilian people, as today, 78.3% of the Brazilian adult population have access to the internet (IBGE, 2019). Furthermore, web surveys also reduce social desirability bias (Persson and Solevid, 2014; Poder et al., 2015). Our target audience was Brazilians – or foreign residents in Brazil – above 18 years old, with a population equivalent to 164.6 million people (IBGE, 2021). From this number, we calculated (Kauermann and Kunchenhoff, 2010; Manitz et al., 2021) a minimum sample size of 385 respondents (p = 0.05; n = 164.600.000; ci = 0.95).

We used Google Forms (Google LLC, 2021) to create a double-opt-in survey (**A1. SM. Table 1**) (without rewards for respondents) (Callegaro et al., 2014). We used a dynamic structure, in which the question's order, context, and set change according to the respondent's answers. Hence, we accurately collected target audience groups, hypotheses, and exploratory questions (SM Raw Data), reducing the burden bias as the survey adapts to the respondent. We also tried to reduce the habituation and question-order biases by placing similar questions in different sections of the survey, except for some specific cases, which we analyzed with IRT to verify the data confidence. Only three questions in the survey were open-ended probes (Luebker, 2021). We used these questions to gather reliable information about the source preferences and the opinions of those interested in the subject (Holland and Christian, 2009). Further details on probe questions and advertisement sharing on supplementary material **(*A1. SM. Text 1* and A1. SM. Text 2).** The ethics committee from the "Universidade Estadual de Goiás" approved this project (CAAE nº 48526921.6.0000.8113).

We collected data from 34 manifest variables linked to eight latent constructs (***A1. Table 1***): Interest (INT), Traditional Media (TRM), Other Media (OTH), Digital Media (DIM), Academic Media (ACM), Knowledge (KNO), Preferences (PRE), and Importance (IMP). It is important to emphasize that we considered scientific papers academic media rather than digital media, although they are common in digital format. We built our latent variables of KNO and IMP from three fundamental dimensions: Bill, environmental licensing, and technical/scientific method. The construct KNO reflects the self-attributed knowledge about the bill dimensions. The INT latent variable outlines the context motivation to seek information about the Bill, while IMP illustrates the judging value given to de subject as a basis for the opinion. We also added economy, environment, and physical, socioeconomic, and biotic environments as extra dimensions of importance. This grouping was necessary to build more precise latent variables as these aspects are multidisciplinary – science, law, and environment. All media manifests are dichotomous and suit a continuous underlying correlation distribution. We assume the four media latent constructs are normally distributed, with values varying accordingly to the information sources people use to inform themselves about the Bill. The follow-up manifest was obtained from the calculation and ordination (in years range) from data input.

A1. Table 1. Manifest variables and latent constructs related to Knowledge (KNO), Interest (INT), Importance (IMP), Traditional media (TRM), Academic media (ACM), Digital Media (DIM), Other Media (OTM)

Manifest variable	Latent constructs	Description
Knowledge about the Bill	Knowledge	Respondent's self-declared Knowledge degree about bill 3729/2004
Knowledge about science	Knowledge	Respondent's self-declared Knowledge degree about science in the environmental licensing
Knowledge about environmental licensing	Knowledge	Respondent's self-declared Knowledge degree in environmental licensing
Interest in environmental licensing	Interest	Respondent's interest degree in environmental licensing
Interest in the Bill	Interest	Respondent's interest degree on the Bill 3729/2004
Reading the Bill	Interest	The respondent used the Bill as the source.

Manifest variable	Latent constructs	Description
Follow-up the Bill	Interest	Time (in years) since the respondent is following up on this subject.
Importance in the Bill	Importance	The importance respondents gave to bill 3729/2004
The importance respondents give to environmental licensing for the economy	Importance	*ipsis litteris*
The importance respondents give to science for the environmental licensing	Importance	*ipsis litteris*
The importance respondents give the environmental licensing to the environment	Importance	*ipsis litteris*
The importance respondents give to the biotic environment	Importance	*ipsis litteris*
The importance respondents give to the socioeconomic environment	Importance	*ipsis litteris*
The importance respondents give to the physical environment	Importance	*ipsis litteris*
Message applicative	Digital media	WhatsApp, Telegram, and others.
Independent media	Digital media	Blogs, specialized websites, podcasts, and others.
Social media platforms	Digital media	Facebook, Twitter, Instagram, and others.
YouTube	Digital media	Video platform.
Scientific papers	Academic Media	Peer-reviewed content.
Classes	Academic Media	University classes.
Technical books	Academic Media	Specialized content.
Technical courses	Academic Media	Specialized content.
Newspapers	Traditional media	Printed newspapers.
Television	Traditional media	Open or paid TV Channels.
Radio	Traditional media	Radio broadcast from radio stations.
Governmental reports	Traditional media	Law, Statute, Bill, Report.
Conversation with friends	Other media	*ipsis litteris*
Conversation with coworkers	Other media	*ipsis litteris*
Other sources	Other media	Open-ended.
Bill 3729/2004	The Bill	Reading the Bill

Our manifest variables (**A1. Table 2**) are Age group, Income, education degree, Quality of the scientific method in environmental impact studies, and opinion on the Bill.

A1. Table 2. Socioeconomic profile independent variables.

Independent variable	Description
Income	Income in five categories.
Age range	The age range is in five categories (Ordered from seven categories sampled on the survey).
Method quality	Opinion about the scientific and technical quality of environmental licensing.
Education level	Educational degree.

We used a five-point Likert scale for each variable, except sources preferences, which we surveyed as dichotomous. We present the questions and other details in the supplementary material (**A1. SM. Table 1**). We checked the factorial analysis assumptions verifying our data with Bartlett's sphericity test (Bartlett, 1951; Revelle, 2022). We checked the dataset with the Keiser-Meyer-Olkin factor to measure sampling adequacy (Kaiser, 1970; Revelle, 2022).

1.4.2 Analytical procedures

We did all analyses in the R environment (R Core Team, 2021). We used Polychoric (PC; for dichotomous variables) and Tetrachoric (TC; for discretized ordinal variables) correlation coefficients (Revelle, 2022) to assess the correlations of the variables and build a base model for further analyses. The PC and TC are better suited for our data which fit its assumptions (Ekström, 2011; Verma and G. Abdel-Salam, 2019).

We tested our survey instrument and its dimension's reliability (Revelle, 2022; Revelle and Condon, 2019), assessing the root mean square residual (RMSR) when applicable. We also performed internal consistency reliability coefficient testing for each of our latent variables with McDonald's omega (ωt) (Revelle and Zinbarg, 2009; Zwick and McDonald, 2000) coefficient because our data do not fit the Cronbach's Alpha (α) coefficient assumptions. We chose GFI, AGFI, and SRMR as reliability indexes of the model because these indices are based on variance and covariance, and the first two are

analogous to R^2. Despite some concerns about using χ^2, we also presented them for comparison with other studies (Kline, 2015).

For a general description of overall relations among our model's component variables, we performed a principal component analysis (PCA) based on TC and PC correlation matrixes (Kassambara and Mundt, 2020; Lê et al., 2008; Wei and Simko, 2021). All Latent constructs (**A1. Table 1** and **A1. Table 2**) were built based on the scores of a factorial analysis (FA) (Haig, 2014; Revelle, 2022; Spearman, 1904). We retain only one factor for each FA using standard procedures and varimax rotation. From all the latent constructs and manifest variables present in **A1. Figure 1**, we built the SEM (Cheung and Lai, 2021; Duncan, 1975; Epskamp, 2022; Jorgensen et al., 2021; Rosseel, 2012) using the Lavaan package in R (Rosseel, 2012).

We used Item Response Theory (IRT) (Chalmers, 2012; Revelle, 2022; Rizopoulos, 2006) as a post hoc latent trait analysis to verify the manifest variables' information contribution to the latent constructs. The IRT was initially designed to verify students' ability with test item difficulty levels, but have many different applications, such as assessing misinformation propagation on social networks platforms (Kumar et al., 2016). We used IRT to check the probabilities for each item agreement level and thus verify the reliability of the answer categories. We used the three logistic parameters (3PL), which include the guessing parameter of non-zero probability to endorse that item within the low levels from the latent construct. As there are no "correct and incorrect answers" in the study design, "use or no use," we considered "guessing" for information sources as the probability of the answer not being reliable for reasons like biases. Furthermore, we used the discrimination parameter "a" to classify information accordingly to its quality, as this criterion indicates the capacity to group people with similar abilities (Baker and Kim, 2004).

1.4.3 Sampling limitations

Almost 22% of the Brazilian population still does not have access to the internet – for many reasons – so for SMPs to reach this population is difficult. We noticed a strong bias toward a negative view of environmental research expressed by respondent’s comments on advertisements, including asking other people not to answer the survey.

These results may reflect the intense politicization of environmental issues in this society in recent years and may affect the respondent answers rate.

1.5 RESULTS

A total of 2052 individuals accessed the survey between September 2021 and March 2022. From those, 2042 suited our target audience, and 2038 accepted to participate in our research, whose 656 declared to know about both environmental licensing and the Bill, and 415 confirmed to inform themselves about this subject. All data have 100% validity, with no missing cases. The cumulative relative frequency of respondents by survey groups and subgroups were proportionally equivalent during the sampling period. The dataset Keiser-Meyer-Olkin factor for sampling adequacy had a good fit (MSA: 0.75).

Among the media (**A1. Table 3**), the most common sources were governmental reports and scientific papers (both with 48,92%), conversations with coworkers (47,95%), social media (45,06%), and independent media (44,82%). The least frequent media sources are radio (8,19%) and open-ended question answer “other sources” (6,75%).

A1. Table 3. Summary of responses – Frequency (%) by Information Media Sources (total n = 415)

Variable	Frequency (%)	N
Message applicative	21,69	325
Independent media	44,82	229
social media	45,06	228
YouTube	23,13	319
Scientific papers	48,92	212
University classes	37,11	261
Technical books	24,58	313
Technical courses	21,69	325
Newspapers	20	332
Television	29,40	293
Radio	8,19	381
Governmental reports	48,92	212
Conversation with friends	12,77	362
Conversation with coworkers	47,95	216
Other sources	6,75	387
Reading the Bill 3729/2004	43,13	251

Most of the respondents are post-graduated (**A1. Table 4**) (Likert 5 - 46.02%) in an age range of 25-34 years old (Likert 2 - 29.39%) and with an income of 3-4 minimum wages (Likert 2 - 29.63%; R$ 3636,00 – R$ 4848,00; U$D 774,41 – 1032,54, quote April 14, 2022). Most of them have been following the topic for less than three years (Likert 1 – 51,6%) and declare that their knowledge about the Bill is average (Likert 3 – 45,8%). Most respondents also declare extreme interest in the Bill (Likert 5 – 73%), and the topic is of maximum importance (Likert 5 – 83,1%). Regarding the quality of the scientific and technical methods from the environmental licensing, the predominant declaration is average (Likert 3 - 33%).

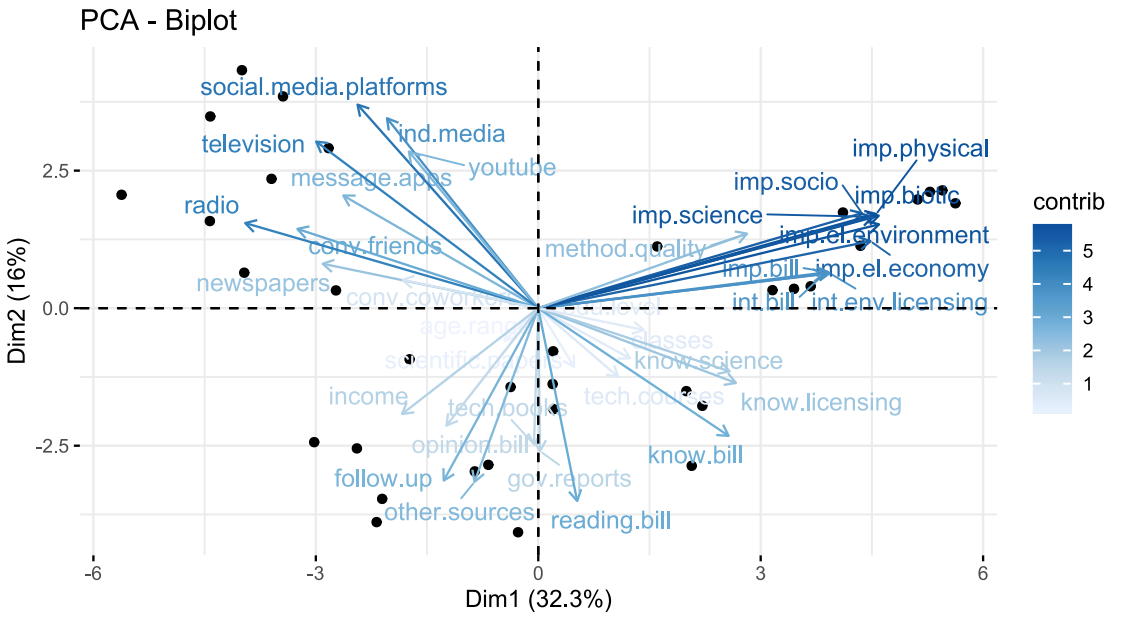
A1. Table 4. Frequency distribution (%) of responses at the level of the Likert scale for each observed variable. The total number of respondents was 415.

variable	1	2	3	4	5
Interest in the Bill	0,48	0,96	6,99	18,55	73,01
Interest in environmental licensing	0,24	0,48	6,27	23,37	69,64
Knowledge about the Bill	0,24	6,02	45,78	34,70	13,25
Knowledge about environmental licensing	0,24	2,41	26,99	42,65	27,71
Knowledge about science	0,48	3,61	26,27	44,10	25,54
The importance respondents give to the Bill	3,13	1,45	3,61	8,67	83,13
Importance of the environmental licensing to the economy	1,20	0,72	3,86	10,36	83,86
Importance of the environmental licensing to the environment	0,24	0,72	3,13	3,13	92,77
Importance of the biotic aspects on environmental licensing	0,48	0,48	0,96	5,30	92,77
Importance of the socioeconomic aspects on environmental licensing	0,24	1,20	2,89	13,01	82,65
Importance of the physical aspects on environmental licensing	0,24	0,24	1,20	7,47	90,84
Importance of science on environmental licensing	0,24	0,24	1,93	5,06	92,53
Importance of age range on environmental licensing	5,06	29,40	25,78	15,18	24,58
Education level of the respondent	4,58	4,82	27,71	16,87	46,02
Income of the respondent	28,92	29,64	26,75	12,05	2,65
Time the respondent is following up on the subject	51,57	19,04	11,33	9,16	8,92

variable	1	2	3	4	5
Respondents Opinion about the environmental impact assessment method quality	3,13	6,75	33,01	29,16	27,95

Only 32% of respondents (n = 2052) who know about environmental licensing are familiar with the Bill (n = 656), although it has been in the process for 18 years. Among these, 415 seek information about the topic. Among the respondents who informed themselves about the Bill, 27% read the whole text, from whom only 0.2% declared not to know the Bill, and 6% stated having poor knowledge. The contrast is even more significant when checking the follow-up time against the reading of the Bill. A total of 113 respondents who still need to read the Bill and its amendments declared a follow-up time longer than four years.

The principal component analysis (PCA) uses these correlation matrixes to draw a clear framework of these relationships (**A1. Figure 2**) to simplify the dimensions. We removed the "Other sources" variable from the PCA because of its low correlation coefficients and to better understand the components. There is a noticeable correlation between "importance" and "interest", as well within method quality. The lesser contributions are from "age range" and "follow-up", indicating a lesser contribution from time variation. The manifest "Conversation with coworkers" is the variable with the lowest contribution to its dimension, while "television", "social media platforms", and "technical courses" have the higher contributions. Reading the Bill seems related to using "governmental reports" and "other sources".



A1. Figure 2. The instrument (survey) PCA was created from a mixed correlation (polychoric and tetrachoric) matrix.

Academic media is grouped in the opposite dimension of digital and traditional media, and the KNO and academic variables group slightly. However, the academic Bartlett's sphericity test media contribution is meager, with the spotlight on "scientific papers", which has the second lower contribution, "age range", followed by "Education level". The understanding of PCA configuration suggested what variables were more suitable for grouping or exclusion in the next steps of our research.

The IRT "guessing" index (**A1. Table 5**, column "g") points to no chance of "guessing" about using digital media as an information source concerning the Bill. Moreover, it indicates a higher "guessing" coefficient regarding all the academic media. Usually, the IRT guessing measures the chances of someone answering a question guessing. In this context, we hypothesize there is a higher chance of the data from these variables being unreliable because the answer does not correspond to the actual behavior of the respondent.

A1. Table 5. Item Response Theory statistics from the sources' preferences. M2: 129.6147; df: 63; p<0.001; RMSEA 0.05; SRMSR: 0.08; TLI 0.85; CFI: 0.90; u = 1

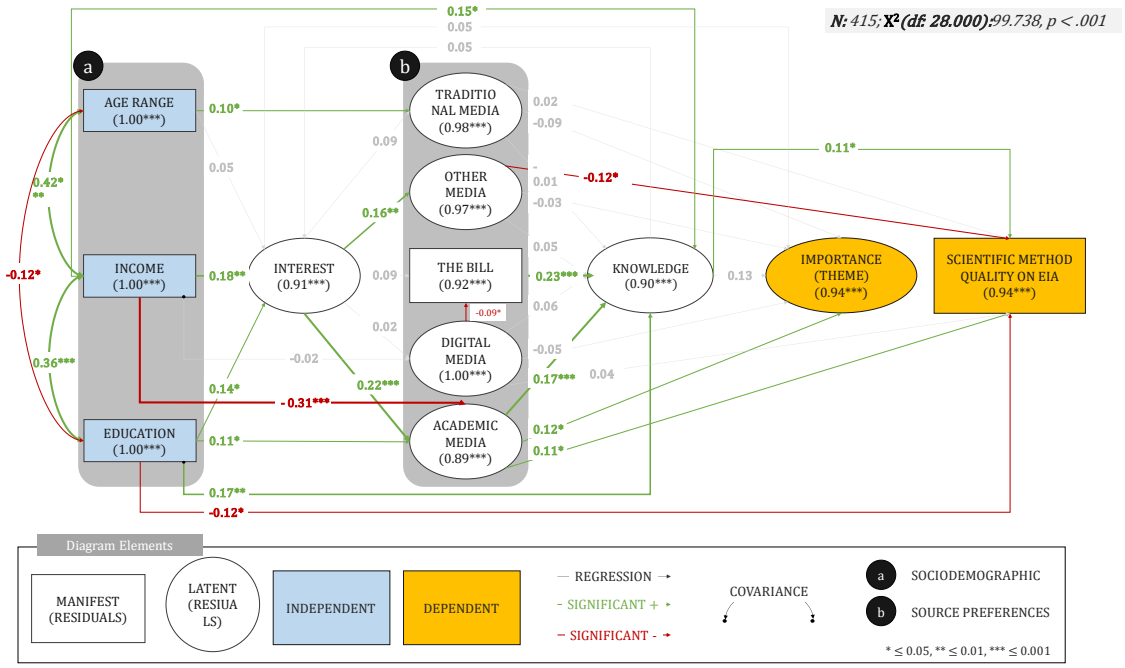
manifest variables	-3	-2	-1	0	1	2	3	a	B	g
Messaging applications	.02	.05	.11	.18	.22	.17	.09	1.06	1.47	.000
Independent media	.03	.09	.24	.39	.30	.13	.04	1.20	0.23	.000
Social media platforms	.03	.09	.23	.37	.29	.13	.04	1.29	0.21	.000
YouTube	.02	.05	.12	.25	.32	.22	.10	1.17	1.29	.000
Newspapers	.03	.05	.09	.13	.14	.12	.08	0.71	2.14	.001
Television	.00	.02	.12	.51	.80	.30	.06	1.65	0.88	.030
Radio	.00	.01	.04	.13	.37	.50	.27	1.34	2.29	.000
Conversation with friends	.02	.04	.08	.12	.15	.14	.10	1.38	2.25	.051
Conversation with coworkers	.04	.07	.09	.10	.09	.07	.05	5.09	1.20	.401
Peer-reviewed scientific papers	-	-	-	-	-	-	-	32.2	1.50	**.453**
Classes	-	-	-	-	-	-	-	15.3	1.75	**.346**
Technical books	-	-	-	-	-	-	-	11.3	1.70	**.212**
Technical courses	-	-	-	-	-	-	-	10.9	1.76	**.186**
Governmental reports	-	-	-	-	-	-	-	35.3	1.49	**.453**
Test info	0.19	0.47	1.11	2.19	2.68	1.78	0.83			
SEM	2.27	1.46	0.95	0.68	0.61	0.75	1.10		-	
Reliability	-4.17	-1.12	0.10	0.54	0.63	0.44	-0.20			

1.5.1 Explaining the information sources' preferences

The SEM (**A1. Figure 3**) has an average reliability (GFI: 0.982; AGFI: 0.951; SRMR: .067; χ^2(df: 28.000): 99.738, $p < 0.001$; RMSEA: 0.081; $p < 0.001$; CFI: 0.734; TLI: 0.441) and contribution to the theory. All three sociodemographic variables are significant predictors (Figure 9). Older respondents prefer traditional media (Z: 0.10; $p < 0.05$). Therefore, the consumption of this source does not affect other variables. People with higher salaries consult fewer academic media (Z:-0.31; $p < 0.001$) and claim to have more interest (Z: 0.18; $p < 0.01$) and knowledge (Z: 0.15; $p < 0.05$) in the subject. There is no relationship between income and digital media, contradicting the hypothesis for this relationship. People with higher education have more interest (Z: 0.14; $p < 0.05$) in the subject, prefer academic media, and know more (Z: 0.17; $p < 0.01$) about the subject. The higher the education level, the worse the evaluation of scientific methods in environmental impact studies (Z: -0.12; $p < 0.05$).

People with more interest in the theme prefer academic media (Z: 0.22; $p < 0.001$) and other types of media (Z: 0.16; $p < 0.01$) rather than traditional and digital media. Greater interest does not mean that these people read the Bill since the relationship was not significant, and self-declared knowledge also does not explain respondents' interest. People who prefer other media declare a negative opinion about environmental impact assessment's technical and scientific quality (Z: - 0.12; $p < 0.05$).

Academic media stood out with a positive effect on self-declared knowledge, the importance of the Bill, and the technical quality of environmental impact studies. Reading the Bill has a positive effect on self-declared knowledge. However, the consumption of digital media significantly adversely affects the reading of the Bill, contrary to the original hypothesis. People who claim to know more about the subject declare to have read the Bill and have a favorable opinion about the quality of technical and scientific methods of environmental impact analyses.



A1. Figure 3. Structural equation model for the relationships between socioeconomic profile, media preferences, and latent interest, knowledge, and importance related to the knowledge of the licensing Bill in Brazil.

1.6 DISCUSSION

The licensing process is crucial for avoiding and controlling environmental impacts in industrialized societies (Sánchez, 2013). Despite this, our results indicate that the Brazilian public is unaware of the licensing process and the Bill that can change its functioning. Environmental policy is a complex theme, an intersection between laws, science, and all other aspects of the environment, including the public itself. Citizens access the topic in different media but do not go deeper into it. Only a group of people with higher income and level of education are interested in the subject. This scenario poses an essential question about how environmental issues are communicated into this society and the consequences of environmental protection.

Digital media is not significant in people's knowledge and opinions and is not affected by their interest in the subject. This result was unexpected, considering how digital media is pervasive in present-day life. Nevertheless, this suggests that respondents may give lower importance to this subject to the point that it is not relevant in this media. For most respondents, the topic is not significant enough and is just a "headline" as more than 488.311 people visualized the advertisement, 2052 responded, and only 415 knew about the Bill. People will not engage in policy information about what they do not see as an issue. This reduced engagement has been a known problem since 1999 (Blake, 1999a, 1999b; Thompson and Rayner, 1998), and there were no changes in people's behavior even in the face of new communicational technologies. This scenario is contrary to what we expected since digital media is accessible for almost 80% of Brazilian (IBGE, 2019) and has a great potential for sharing information. Henceforth, within our results, the only media to fulfill its role as a channel of information is the academic one. The academic media educational potential is observed in its positive effect on Knowledge, Importance, and Opinion about method quality on EIA. However, a small group of people within the universities has this benefit.

It is worrying that this subject turned into an excluding matter, as the most popular and accessible sources are digital and traditional media. This scenario's consequences can be disastrous. Environmental protection is on the headlines for issues such as forest fires and amazon biodiversity conservation. However, this matter does not reach the fundamental aspects of law discussion that define how this society treats the

problem. Otherwise, there is strong evidence that some organized groups – such as agribusiness – represent a force against environmental licensing (Ruaro et al., 2022) and other environmental protection laws, such as the forest code (Soares-Filho et al., 2014). Public engagement on subjects in social media is significant to politicians' engagement (Lin and Kant, 2021; Tromble, 2018), policymaking (Alperin et al., 2018; Battaglini and Patacchini, 2019), and decision-making (Power and Phillips-Wren, 2011; Sadovykh et al., 2015). Hence, they are excluded from the decision-making process, as there is no public voice to pressure their representatives. The negative relation between income and the preference for academic media aggravates this. Under this scenario of conflicts among different political forces, better communication of scientific evidence and environmental issues is crucial.

In front of our findings, we suggest the academy appropriate this channel and use it as it was created for: sharing information (Ahmed et al., 2019). This solution aggregates the best of the two media as digital media inform, but only academic media educates. Some scientists are already doing this. Many respondents identified the names of personalities who are pioneers of scientific divulgation on digital media and talked about this theme. However, more is needed, as it only reaches the academic community and higher educated citizens. It is crucial pierce this bubble. The public needs resources and sources for critical thinking, and the academy can provide good quality information. Although scientific education through digital media is a plausible solution, reaching the public depends on understanding the causes of their preferences.

We did not observe any logical mechanism that indicates the respondents' motivations of interest, knowledge, and importance. We hypothesize that these people are affected by social desirability (Grimm, 2010) in which the respondent feels proper to answer socially desirable responses, although this declaration does not match reality, as observed in other studies (Atkeson et al., 2014; Birks et al., 2018; Erten, 2015; Persson and Solevid, 2014; Wlömert et al., 2019). This bias may also explain why some people claim to be informed through scientific articles when they do not. Furthermore, an overestimation of the social character may be another possible cause. Social character overestimation is common in digital media, as this environment has peer pressure and normative and informational conformity (Power and Phillips-Wren, 2011).

To our knowledge, this study is the only one available to deal with these issues and focus and the perception of this broad audience concerning environmental issues in Brazil. Thus, it is helpful to make a methodological appraisal of this, seeking future improvements as a best practice for SEM modeling (Xia and Yang, 2019). Therefore, the final model is acceptable but can still be improved. The addition of a robust socioeconomic profile latent variable and the improvement of the interest variable considering its internal consistency are essential possibilities for future studies. Otherwise, replication is always an important issue for such studies, primarily aiming to represent a large society. The four latent media preferences (TRM, OTH, DIM, and ACM) variables can also be redesigned. The Likert scale may offer more degrees of understanding about its internal correlations and bring to light science a broad comprehension of the causes and effects of social media. Finally, our research is multidisciplinary, and an improved model could also be tested and applied to a broader thematic context of decision-making.

Science needs faces, voices, and personalities. The scenario of knowledge about environmental issues suggests that academics must find a bridge with easily accessible content and act as digital influencers to reach the public. We propose a collaborative work of scientific communication to solve this issue. However, science communication faces challenges such as complexity and variety, diversified audiences, and undefined boundaries of public and private interest goals (Bubela et al., 2009). Hence, it is necessary to recruit and train more scientists to communicate with the public (Brownell et al., 2013). There is still hope against dismantling the environmental licensing, as bill 3729/2004 still needs to be approved in the Senate. Until then, we must share good quality information and trust about environmental licensing or any other theme. It could be one of the ways of giving people quality information they could use as a basis for the voice of democracy towards the decision-makers.

1.7 CONCLUSION

Despite its importance, Bill 3729/2004 is not a subject of matter to Brazilian people. Within this scenario, the licensing process concerns the wealthy and academics. Accordingly, it is a non-significative thread on digital media, which could eventually lead to more widespread concern on this theme. Hence, the public pressure over the environmental legislative processes is jeopardized even in the face of the informational power of digital media. This issue will result in a misrepresentation of the public interest over the theme since most citizens do not care about it. In this scenario, scientific education is a suitable solution since it adapts academic knowledge to pierce the bubble, reaching the citizens. Considering the relevance of environmental legislation to broad themes such as sustainability and biological conservation, citizenship interest will probably burst only when academic knowledge reaches public knowledge effectively through digital media, which is still a challenge in Brazil.

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1.9 COMPETING INTERESTS

The authors declare no competing interests for or from any stakeholders.

1.10 REFERENCES

Ahmed, Y.A., Ahmad, M.N., Ahmad, N., Zakaria, N.H., 2019. Social media for knowledge-sharing: A systematic literature review. Telemat. Informatics 37, 72–112. https://doi.org/10.1016/j.tele.2018.01.015

Alperin, J.P., Dumas, C., Karami, A., Moscrop, D., Singh, V., Zamir, H., Ilhan, A., Dorsch, I., 2018. Politicians & the public: The analysis of political communication in social media. Proc. Assoc. Inf. Sci. Technol. 55, 646–649. https://doi.org/10.1002/pra2.2018.14505501071

Atkeson, L.R., Adams, A.N., Alvarez, R.M., 2014. Nonresponse and mode effects in self- and interviewer-administered surveys. Polit. Anal. 22, 304–320. https://doi.org/10.1093/pan/mpt049

Baker, F.B., Kim, S.-H., 2004. Item Response Theory: Parameter Estimation Techniques. Second Edition, revised and Expanded. CRC Press, Boca Raton, New York.

Barbosa, L.G., Alves, M.A.S., Grelle, C.E.V., 2021. Actions against sustainability: Dismantling of the environmental policies in Brazil. Land use policy 104, 105384. https://doi.org/10.1016/j.landusepol.2021.105384

Bartlett, M.S., 1951. The Effect of Standardization on a χ 2 Approximation in Factor Analysis. Biometrika 38, 337. https://doi.org/10.2307/2332580

Battaglini, M., Patacchini, E., 2019. Social Networks in Policy Making. Annu. Rev. Econom. 11, 473–494. https://doi.org/10.1146/annurev-economics-080218-030419

Birks, M., Smithson, J., Antney, J., Zhao, L., Burkot, C., 2018. Exploring the paradox: A cross-sectional study of academic dishonesty among Australian nursing students. Nurse Educ. Today 65, 96–101. https://doi.org/10.1016/j.nedt.2018.02.040

Borsboom, D., Mellenbergh, G.J., Van Heerden, J., 2003. The Theoretical Status of Latent Variables. Psychol. Rev. 110, 203–219. https://doi.org/10.1037/0033-295X.110.2.203

Bragagnolo, C., Carvalho Lemos, C., Ladle, R.J., Pellin, A., 2017. Streamlining or

sidestepping? Political pressure to revise environmental licensing and EIA in Brazil. Environ. Impact Assess. Rev. 65, 86–90. https://doi.org/10.1016/j.eiar.2017.04.010

Brasil, 2004. Projeto de Lei Nº 3729/2004. https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=257161, Brazil.

Brownell, S.E., Price, J. V., Steinman, L., 2013. Science communication to the general public: Why we need to teach undergraduate and graduate students this skill as part of their formal scientific training. J. Undergrad. Neurosci. Educ. 12.

Bubela, T., Nisbet, M.C., Borchelt, R., Brunger, F., Critchley, C., Einsiedel, E., Geller, G., Gupta, A., Hampel, J., Hyde-Lay, R., Jandciu, E.W., Jones, S.A., Kolopack, P., Lane, S., Lougheed, T., Nerlich, B., Ogbogu, U., O'Riordan, K., Ouellette, C., Spear, M., Strauss, S., Thavaratnam, T., Willemse, L., Caulfield, T., 2009. Science communication reconsidered. Nat. Biotechnol. 27, 514–518. https://doi.org/10.1038/nbt0609-514

Callegaro, M., Baker, R., Bethlehem, J., Göritz, A.S., Krosnick, J.A., Lavrakas, P.J., 2014. Online panel research: History, concepts, applications and a look at the future. Online Panel Res. A Data Qual. Perspect. 1–22. https://doi.org/10.1002/9781118763520.ch1

Capelari, M.G.M., de Araújo, S.M.V.G., Calmon, P.C.D.P., Borinelli, B., 2020. Large-scale environmental policy change: Analysis of the Brazilian reality. Rev. Adm. Publica 54, 1691–1710. https://doi.org/10.1590/0034-761220190445x

Chalmers, R.P., 2012. {mirt}: A Multidimensional Item Response Theory Package for the {R} Environment. J. Stat. Softw. 48, 1–29. https://doi.org/10.18637/jss.v048.i06

Cheung, S.F., Lai, M.H.C., 2021. semptools: Customizing Structural Equation Modelling Plots.

Cooper, H., Camic, P.M., Long, A.T., Panter, D., Rindskopf, D., Sher, K.J., 2012. APA handbook of research methods in psychology, Vol 1: Foundations, planning, measures, and psychometrics., 1ª. ed. American Psychological Association, Washington. https://doi.org/10.1037/13619-000

Das, R., Ahmed, W., 2022. Rethinking Fake News: Disinformation and Ideology during the time of COVID-19 Global Pandemic. IIM Kozhikode Soc. Manag. Rev. 11, 146–159. https://doi.org/10.1177/22779752211027382

Duncan, O.D., 1975. An introduction to structural equation models, 1ª. ed. Elsevier Inc, Academic Press, London, England.

Ekström, J., 2011. On the relation between the polychoric correlation coeficient and spearman's rank correlation coeficient. UCLA - Dep. Stat. Pap.

Epskamp, S., 2022. semPlot: Path Diagrams and Visual Analysis of Various SEM Packages' Output.

Erten, İ.H., 2015. Social desirability bias in altruistic motivation for choosing teaching as a career. Hacettepe Egit. Derg. 30, 77–89.

Ferrante, L., Fearnside, P.M., 2020. Military forces and COVID-19 as smokescreens for Amazon destruction and violation of indigenous rights. Die Erde 151, 195–200. https://doi.org/10.12854/erde-2020-542

Furr, R.M., 2018. Psychometrics: An Introduction, 3ª. ed. SAGE, Los angeles.

Gelfert, A., 2018. Fake News: A Definition. Informal Log. 38, 84–117.

Geller, N., 2021. PARECER ÀS EMENDAS DE PLENÁRIO AO PL N.º 3729, DE 2004 E APENSADOS. Brasil.

Google LLC, 2021. Google Forms [WWW Document]. Google LLC. URL https://docs.google.com/forms/u/0/ (accessed 6.18.21).

Grimm, P., 2010. Social Desirability Bias, in: Wiley International Encyclopedia of Marketing. John Wiley & Sons, Ltd, Chichester, UK, p. 2010. https://doi.org/10.1002/9781444316568.wiem02057

Haig, B.D., 2014. Investigating the psychological world: Scientific method in the behavioral sciences, Massachusetts Institute of Technology. The MIT Press, London, England.

Holland, J.L., Christian, L.M., 2009. The influence of topic interest and interactive

probing on responses to open-ended questions in Web surveys. Soc. Sci. Comput. Rev. 27, 196–212. https://doi.org/10.1177/0894439308327481

IBGE, 2021. Tabela 5918: População, por grupos de idade - 1º Trimestre de 2021 [WWW Document]. IBGE - Inst. Bras. Geogr. e Estatística. URL https://sidra.ibge.gov.br/tabela/5918 (accessed 6.19.21).

IBGE, 2019. PNAD Contínua - Pesquisa Nacional por Amostra de Domicílios Contínua: Acesso à internet e à televisão e posse de telefone móvel celular para usso pessoal 2019.

Jorgensen, T.D., Pornprasertmanit, S., Schoemann, A.M., Rosseel, Y., 2021. \texttt{semTools}: {U}seful tools for structural equation modeling.

Kaiser, H.F., 1970. A second genertion little jiffy. Psychometrika 35, 401–415.

Kassambara, A., Mundt, F., 2020. factoextra: Extract and Visualize the Results of Multivariate Data Analyses.

Kauermann, G., Kunchenhoff, H., 2010. Stichproben. Methoden und praktische Umsetzung mit R. Springer-Verlag, Berlin.

Kim, K.S., Sin, S.C.J., 2011. Selecting quality sources: Bridging the gap between the perception and use of information sources. J. Inf. Sci. 37, 178–188. https://doi.org/10.1177/0165551511400958

Kline, R.B., 2015. Principles and Practice of Structural Equation Modeling, 4th ed. Guilford Press, New York, NY, USA.

Kumar, K.P.K., Srivastava, A., Geethakumari, G., 2016. A psychometric analysis of information propagation in online social networks using latent trait theory. Computing 98, 583–607. https://doi.org/10.1007/s00607-015-0472-7

Lê, S., Josse, J., Husson, F., 2008. {FactoMineR}: A Package for Multivariate Analysis. J. Stat. Softw. 25, 1–18. https://doi.org/10.18637/jss.v025.i01

Lemos, A.L.M., Bitencourt, E.C., dos Santos, J.G.B., 2020. Fake news as fake politics: the digital materialities of YouTube misinformation videos about Brazilian oil spill catastrophe. Media, Cult. Soc. https://doi.org/10.1177/0163443720977301

Lewandowsky, S., 2020. Climate Change Disinformation and How to Combat It. Annu. Rev. Public Health 42, 1–21. https://doi.org/10.1146/annurev-publhealth-090419-102409

Li, H., Sakamoto, Y., 2014. Social impacts in social media: An examination of perceived truthfulness and sharing of information. Comput. Human Behav. 41, 278–287. https://doi.org/10.1016/j.chb.2014.08.009

Lin, Y., Kant, S., 2021. Using social media for citizen participation: Contexts, empowerment, and inclusion. Sustain. 13. https://doi.org/10.3390/su13126635

Luebker, M., 2021. How Much is a Box? The Hidden Cost of Adding an Open-ended Probe to an Online Survey. Methods, Data, Anal. 15, 7–42. https://doi.org/10.12758/mda.2020.09

Manitz, J., Hempelmann, M., Kauermann, G., Kuechnhoff, H., Shao, S., Obershauser, C., Westerheide, N., Wiesenfarth, M., 2021. samplingbook: Survey Sampling Procedures.

Minc, C., Duarte, E., Krause, G., Teixeira, I., Carvalho, J.C., Goldemberg, J., Filho, J.S., Silva, M., Ricupero, R., 2021. Projeto de Lei Geral do NÃO-Licenciamento Ambiental promove insegurança jurídica e ameaça agravar a crise econômica Brasileira.

Mitchelstein, E., Matassi, M., Boczkowski, P.J., 2020. Minimal Effects, Maximum Panic: Social Media and Democracy in Latin America. Soc. Media Soc. 6. https://doi.org/10.1177/2056305120984452

Persson, M., Solevid, M., 2014. Measuring political participation - Testing social desirability bias in a web-survey experiment. Int. J. Public Opin. Res. 26, 98–112. https://doi.org/10.1093/ijpor/edt002

Peterson, M., 2020. A high-speed world with fake news: brand managers take warning. J. Prod. Brand Manag. 29, 234–245. https://doi.org/10.1108/JPBM-12-2018-2163

Poder, T.G., Bellemare, C.A., Bédard, S.K., Lemieux, R., 2015. Social acceptance and population confidence in telehealth in Quebec. BMC Health Serv. Res. 15, 1–9.

https://doi.org/10.1186/s12913-015-0727-1

Power, D.J., Phillips-Wren, G., 2011. Impact of social media and Web 2.0 on decision-making. J. Decis. Syst. 20, 249–261. https://doi.org/10.3166/jds.20.249-261

R Core Team, 2021. R: A Language and Environment for Statistical Computing.

Rajão, R., Nobre, A.D., Cunha, E.L.T.P., Duarte, T.R., Marcolino, C., Soares-Filho, B., Sparovek, G., Rodrigues, R.R., Valera, C., Bustamante, M., Nobre, C., Santos de Lima, L., 2022. The risk of fake controversies for Brazilian environmental policies. Biol. Conserv. 266. https://doi.org/10.1016/j.biocon.2021.109447

Revelle, W., 2022. psych: Procedures for Psychological, Psychometric, and Personality Research.

Revelle, W., Condon, D.M., 2019. Reliability from α to ω: A tutorial. Psychol. Assess. 31, 1395–1411. https://doi.org/10.1037/pas0000754

Revelle, W., Zinbarg, R.E., 2009. Coefficients alpha, beta, omega, and the glb: Comments on sijtsma. Psychometrika 74, 145–154. https://doi.org/10.1007/s11336-008-9102-z

Rizopoulos, D., 2006. ltm: An R package for Latent Variable Modelling and Item Response Theory Analyses. J. Stat. Softw. 17, 1–25.

Roberts, D.F., Foehr, U.G., 2008. Trends in media use. Futur. Child. 18, 11–37. https://doi.org/10.1353/foc.0.0000

Rosseel, Y., 2012. {lavaan}: An {R} Package for Structural Equation Modeling. J. Stat. Softw. 48, 1–36. https://doi.org/10.18637/jss.v048.i02

Ruaro, R., Zaia Alves, G.H., Tonella, L., Ferrante, L., Fearnside, P.M., 2022. Loosening of environmental licensing threatens Brazilian biodiversity and sustainability. Erde 153, 60–64. https://doi.org/10.12854/erde-2021-614

Sadovykh, V., Sundaram, D., Piramuthu, S., 2015. Do online social networks support decision-making? Decis. Support Syst. 70, 15–30. https://doi.org/10.1016/j.dss.2014.11.011

Sánchez, L.E.L.H., 2013. Avaliação de Impacto Ambiental: Conceitos e métodos, 2ª. ed. Oficina de Textos, São Paulo, SP.

Scheufele, D.A., Krause, N.M., 2019. Science audiences, misinformation, and fake news. Proc. Natl. Acad. Sci. U. S. A. 116, 7662–7669. https://doi.org/10.1073/pnas.1805871115

Silva, H.M., 2021. Wildfires and Brazilian irrationality on social networks. Ethics Sci. Environ. Polit. 21, 11–15. https://doi.org/10.3354/esep00194

Soares-Filho, B., Rajão, R., Macedo, M., Carneiro, A., Costa, W., Coe, M., Rodrigues, H., Alencar, A., 2014. Cracking Brazil's Forest Code. Science (80-.). 344, 363–364. https://doi.org/10.1126/science.1246663

Spearman, C., 1904. " General Intelligence" Objectively Determined and Measured. Am. J. Psychol. 15, 201–292.

Statista, 2022. Number of worldwide social network users [WWW Document]. Statista. URL statista.com/statistics/278414/number-of-worldwide-social-network-users/

The World Bank, 2020. Individuals using the Internet (% of population) | Data [WWW Document]. World Bank. URL https://data.worldbank.org/indicator/IT.NET.USER.ZS (accessed 1.30.23).

Thielo, A.J., Graham, A., Cullen, F.T., 2021. The Opt - In Internet Survey, in: Barnes, J.C., Forde, D.R. (Eds.), The Encyclopedia of Research Methods in Criminology and Criminal Justice. John Wiley & Sons, Inc, New Jersey, USA, p. 960.

Tromble, R., 2018. Thanks for (actually) responding! How citizen demand shapes politicians' interactive practices on Twitter. New Media Soc. 20, 676–697. https://doi.org/10.1177/1461444816669158

Vale, M.M., Berenguer, E., Argollo de Menezes, M., Viveiros de Castro, E.B., Pugliese de Siqueira, L., Portela, R. de C.Q., 2021. The COVID-19 pandemic as an opportunity to weaken environmental protection in Brazil. Biol. Conserv. 255. https://doi.org/10.1016/j.biocon.2021.108994

Verma, J.P., G. Abdel-Salam, A.-S., 2019. Assumptions in Nonparametric Correlations,

in: Testing Statistical Assumptions in Research. John Wiley & Sons, Inc., Hoboken, NJ, USA, pp. 175–191. https://doi.org/10.1002/9781119528388.ch6

Vosoughi, S., Roy, D., Aral, S., 2018. The spread of true and false news online. Science (80-.). 359, 1146–1151. https://doi.org/10.1126/science.aap9559

Wei, T., Simko, V., 2021. R package “corrplot”: Visualization of a Correlation Matrix.

Wlömert, N., Pellenwessel, D., Fox, J.P., Clement, M., 2019. Multidimensional Assessment of Social Desirability Bias: An Application of Multiscale Item Randomized Response Theory to Measure Academic Misconduct. J. Surv. Stat. Methodol. 7, 365–397. https://doi.org/10.1093/jssam/smy013

Xia, Y., Yang, Y., 2019. RMSEA, CFI, and TLI in structural equation modeling with ordered categorical data: The story they tell depends on the estimation methods. Behav. Res. Methods 51, 409–428. https://doi.org/10.3758/s13428-018-1055-2

Zwick, R., McDonald, R.P., 2000. Test Theory: A Unified Treatment. J. Am. Stat. Assoc. 95, 1012. https://doi.org/10.2307/2669496

1.11 SUPPLEMENTARY MATERIAL – PAPER 1

A1. SM. Table 1. Survey's questions

QUESTION (INQUIRY)
Do you fit into ALL audience categories?
Do you agree to take part in this research?
Do you authorize the use of your response data in future research?
Do you know (or have you heard about) environmental licensing and/or 2004 LAW PROJECT No. 3729, which provides for environmental licensing?
Do you keep yourself informed about this Law Project?
Since when did you follow this subject?
How do you inform yourself about this subject?
Please tell us the names of the fonts you consider most reliable among the options you have marked.
How much interest do you have in this Law Project?
What do you think is the importance of this Law Project?
What is your opinion?
What is your level of knowledge about this Law Project?
Have you read the final version of this Law Project, including the amendments?
How much interest do you have in this topic?
How much do you consider Environmental Licensing IMPORTANT FOR THE COUNTRY'S ECONOMIC PROGRESS?
How much do you consider environmental licensing IMPORTANT TO THE ENVIRONMENT?
In your opinion, what is the importance of the BIOTIC ENVIRONMENT (aspects related to living beings in general)?
In your opinion, what is the importance of the SOCIOECONOMIC ENVIRONMENT (aspects related to humans, such as economy, culture, and society) in the environmental licensing process?

QUESTION (INQUIRY)
In your opinion, what is the importance of the PHYSICAL ENVIRONMENT (aspects such as relief, geology, soil, hydrography, climate, and the like) in the environmental licensing process?
In your opinion, what is the importance of SCIENCE in the environmental licensing process?
In your opinion, what is the quality of the technical and scientific methods applied in environmental impact studies?
What is your level of knowledge?
What is your level of knowledge about the SCIENTIFIC FUNDAMENTALS of environmental impact studies in environmental impact assessments?
In what state (Federative unit) do you live?
How old are you?
How did you have contact with this research?
What is your level of instruction?
What is your current professional situation?
What is your monthly income range?
What is your primary area of training?

A1. SM. Text 1. Details about Open-ended questions

The open-ended option among the information sources preferences – "Other sources" – was created to verify if the respondent's used the bill as an information source. We placed another question to assess if the respondents used the bill as a source apart from this open-ended probe to minimize social desirability bias. We also objectively presented the question: "Did you read the last version of the bill, including it emends?". We considered using specific information sources as a preference for that media.

A1. SM. Text 2. Details about shared advertisements

The survey was first shared in paid advertisement campaigns (Total budget: R$ 3310,00, U$ 706,03 dollar quote in Apr/11/2022) on Social Media Platforms (SMPs) like

Facebook and Instagram. Brazil is the 5º greatest country in SMPs users worldwide (STATISTA, 2020), with 130 / 99 million monthly users, respectively (STATISTA, 2021a, 2021b). However, in January 2022, after five months of sampling, the cost-benefit of recruiting potential respondents with SMPs advertisements was not as expected because of a sudden reduction in the number of Facebook users, which is why we left passive recruiting and moved to mediated active sharing. For that, we asked professors and managers of graduate programs – within areas directly or indirectly related to environmental licensing – from either particular or public Brazilian universities to act as trusted sharing mediators to the survey, sending it to the academic public and society in general. In parallel, the researchers systematically shared the survey with Federal and State university groups on these SMPs. This sampling lasted from February to March 2022.

1.11.1 A1. Supplementary material References

STATISTA. **Social media user worldwide 2020, by country**. Disponível em: <https://www.statista.com/forecasts/1145300/social-media-user-by-country>. Acesso em: 18 jun. 2021.

STATISTA. **Facebook users by country 2020**. Disponível em: <https://www.statista.com/statistics/268136/top-15-countries-based-on-number-of-facebook-users/>. Acesso em: 3 mar. 2021a.

STATISTA. **Instagram: users by country**. Disponível em: <https://www.statista.com/statistics/578364/countries-with-most-instagram-users/>. Acesso em: 18 jun. 2021b.

2 ENVIRONMENTAL IMPACT ASSESSMENT METHODS FOR THE BIOTIC COMPONENT: SCIENTOMETRICS AND SYSTEMATIC REVIEW

Journal: Journal of Environmental Impact Assessment Review

2.1 HIGHLIGHTS

- Decision-making, management and policymaking are not often discussed within the scientific literature about EIA's biotic component methodology.
- Theoretical grounding and effectiveness follow-up are under-discussed in the literature.
- Methodology discussion related to conservation and Environmental Impacts is significative for the literature relevance.
- Effectiveness follow-up discussion negatively correlates to the debate of quality.

2.2 ABSTRACT

Environmental Impact Assessment (EIA) is a crucial process facing the growing impacts of industrialization and energy demand. It has been a scientific subject since it first appeared 60 years ago. Hence, the scientific debate about this theme grows around multidisciplinary components – biotic, physical, and socioeconomic – and correlated frameworks – theory, quality, and effectiveness. Therefore, quality is the most discussed framework in Environmental Impact Assessment (EIA) literature. Within this scenario, the debate concerning methodology issues for EIA's biotic component is common. The biotic environment scientific production is diverse due to the biota's sensitivity to impacts and multidimensional interactions. Hence, we explored the scientific production of EIA biotic components methodology over the last 23 years. We performed a systematic review approach to sample Web of Science (WoS) data. The eligibility criteria are publication period (2001 – 2023), language (English), document type (peer-reviewed), and theme (EIA as main, parallel comparative element). Within these criteria, the raw data contained 2578 studies. We used an active learning model to screen and label 231 as potentially relevant and further reading to select 163 as a subset. Therefore,

we categorized the results accordingly to their framework (quality, theoretical, and effectiveness), theme, and disciplinarity. Furthermore, we applied Generalized Linear Modelling (GLM), factorial and grouping analyses to verify themes, framework, and disciplinarity. Moreover, we analyzed the theme's evolution over time. Our findings show that after 18 years, quality is still the main issue within the biotic methodology literature. In 23 years, decision-making, policymaking, and management were essential or declining themes in this discussion. There is not sufficient investigation regarding the effectiveness of the proposed methods nor EIA's theoretical grounding on which to base the quality proposals. Although framework and disciplinarity are not significant to the scientific relevance of literature, articles related to Conservation and Environmental impacts are. Hence, we discuss the possibility of science production not being as effective as a reference for EIA as it should be.

Keywords: Methods, Guidelines, Rules, Protocols, Environmental Impact Assessment

2.3 INTRODUCTION

The world's growing demand for natural resources and its exploration consequences on the environment started concerning researchers and governments in the '70s (Hironaka, 2002; United Nations Environment Programme, 2018). Environmental Impact Assessment or Appraisal (EIA) was created in the USA in 1969 as a multidisciplinary environmental planning tool (Sánchez, 2013). Since then, in its 50 years, EIA has become a popular research object (Zhuang et al., 2011) and was adopted and adapted by numerous developing countries (McCullough, 2017). Furthermore, it is a universal environmental policy tool (Fonseca et al., 2017), as almost all countries base their EIA systems on legislation (United Nations Environment Programme, 2018). Within this scenario, the subject frameworks (Retief, 2010) discussed by different areas in matters of efficacy (Cashmore et al., 2010; Hatami, 2018), methods (Zhuang et al., 2011), and case studies (Bindra and Karim, 2019; Zeleňáková et al., 2018). The multidisciplinary nature of EIA is also a common debate for biotic (Ferraz, 2012; Woznicki et al., 2016), socioeconomic (DAGILIŪTĖ and JUOZAPAITIENĖ, 2015), and physical (Thuy et al., 2020) environments. Although decades of history and worldwide implementation, there are some issues with EIA, starting from its meaning and objectives, which remain subjective and have many interpretations (Sánchez, 2013) – here, we use as a guideline the International Association for Impact Assessment (IAIA) definition, which states EIA as a process to identify the consequences of an action or proposal (International Association for Impact Assessment, 2021).

The debate about EIA quality is a motor theme in EIA literature (Bond et al., 2018; Retief, 2010). Examples of this discussion within the biotic components are inadequate sampling (Dias et al., 2017; Ferraz, 2012), over extensive execution time (Middle and Middle, 2010), poor treatment of biodiversity data on Environmental Impact Statements (EISs)(Gannon, 2021), and a high quantity of irrelevant data (Fonseca and Rivera Fernández, 2020). The issues vary with different combinations according to the subject, local, and jurisdiction. Therefore, global compliance with scientific literature could bring enlightenment to EIA methodology. A better understanding of the challenges, solutions, frameworks, and theme evolution may guide the scientific community in EIA's improvement efforts.

Within this general scenario, we aimed to explore the EIA's methodology for biotic components, compiling the literature about methods, procedures, rules, and guidelines. Moreover, investigate the correlation between EIA's scientific production relevance, framework, themes, and disciplinarity and its evolution through time. Hence, we discuss ten topics related to EIA's methodology for the biotic component over the last 23 years – assessment, biodiversity, challenges, conservation, decision-making, ecology, habitat, impacts, regions, and solutions. Furthermore, we test the hypothesis that framework, multidisciplinary, and themes are decisive to the scientific products' relevance. We assume the frameworks should be interrelated and equally significant to scientific products' relevance. Moreover, researchers from different areas would access multidisciplinary products frequently; hence they would be more relevant. Furthermore, articles which discuss well-established themes would be more relevant.

Here, we performed a Systematic Review (SR) without metanalysis to achieve these objectives. This method is a replicable method for evidence and data sampling and allows a transparent, rigorous, and objective study of a selected background. The SR may be updated according to scientific improvements (Centre for Evidence-Based Conservation - CEE, 2013).

2.4 METHODS

This research was made in two steps: science map and analises. We proceeded the science mapping by literature retrieval (search string creation and database search), selection (semi-automated and human) and data extraction (categorization). Following these steps, we arbitrarily selected the keywords based on empirical analysis. The selected searching terms are: ((“environmental impact” AND (“assessment” OR “stud*” OR “appraisal” OR “licensing process*” OR “project appraisal”)) AND (“guideline$” OR “method*” OR “protocol$”) AND (“biotic*” or “biologic” OR “ecologic” OR “biodiversity”)). This search string includes thematic keyword variations, study object keywords, and biotic component-related keywords.

For the selection process we followed an approach to the PRISMA statement (Page et al., 2021) without topics related to metanalysis. We used five eligibility criteria to select and group studies synthesis, as detailed in **A2. Table 1**. We opted for the WoS

as an information source as it is one of the most comprehensive scientific Data Bases and includes specialty biological collections (Pranckutė, 2021).

A2. Table 1. Eligibility criteria: inclusion, exclusion, and logic.

#	CRITERIA	INCLUSION	EXCLUSION	LOGIC
1	**Publication period**	Published from 2000 to 202e	Published in another period.	We opted to sample that period to reduce and balance the historical bias in the synthesis.
2	**Language**	English	Other languages	Most international scientific literature is published in English.
3	**Source Type**	Journals	Grey literature, thesis, dissertations, books, conference proceedings, websites	Articles published in journals are scientifically attested sources. (José de Oliveira et al., 2019). Ensure replication.
4	**Document Type**	Articles: Peer-reviewed and DOI registered.	Any other than articles.	
5	**Research object or subject**	Studies with EIA as the foremost, parallel, or comparative subject.	Papers with the subject are another assessing system, method, or tool, but without any relation to EIA.	Although many assessment alternatives originated from EIA, some are well-developed subjects, and their discussion is out of this thematic cutoff.

2.4.1 Selection Process

We made the selection process in two steps: semi-automated and manual. The first step had four stages. First, we filtered the WoS results by eligibility criteria 1, 2, 3, and 4. We applied the 5th eligibility criteria on the second stage. We used the open-source machine learning-aided tool ASReview – which uses active learning to classify relevant or irrelevant papers – to accelerate the screening process and reduce errors and biases (van de Schoot et al., 2021). This tool because it has a good benchmark

performance, has a significant number of classifiers, and allows any combination among them. The ASReview allowed us to speed up the SR's usual time effort from 6 to 24 months (Khangura et al., 2012) to three months, maintaining the rigor. Our setup is A) Classifier: naïve Bayes; B) Query strategy for active learning: random selection, ignoring model-assigned probabilities; C) Balance strategy: Full sample all the labeled records.

To train the machine predictive learning model we used empirical relevant titles among the obtained results. Hence, we used ASReview to screen the abstract and titles until we reached the asymptote after 60% of the papers. We believe this unusual learning curve is related to EIA's multidisciplinary and multidimensional nature. Hence, we manually filtered the output and selected the final set.

2.4.2 Data Collection

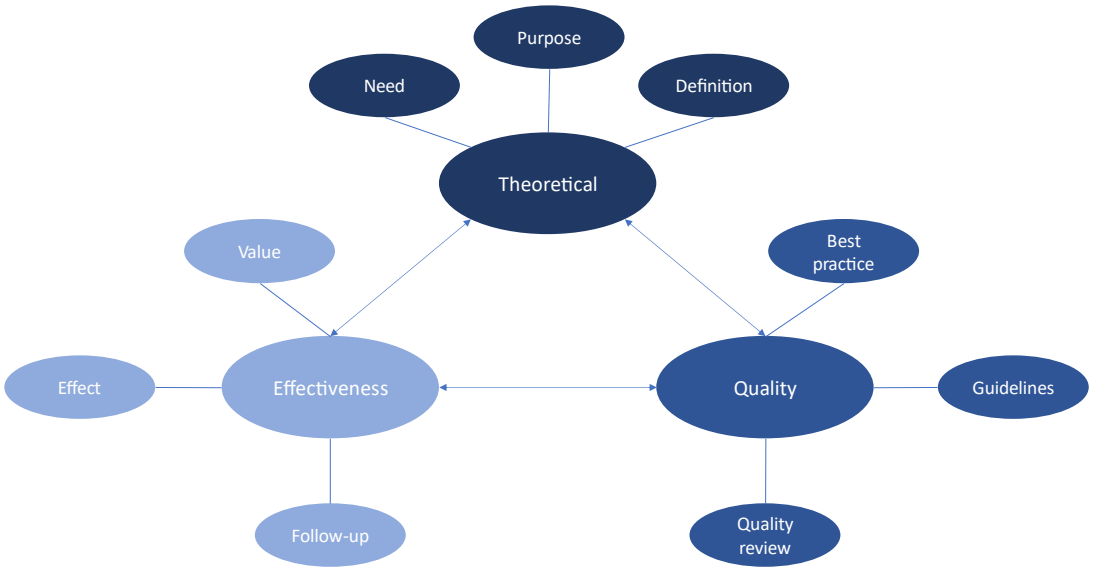
We collected all variables as factors and binary for each category. We categorized the papers accordingly to the framework, disciplinarity, theme, and scientific relevance (**A2. Table 2**). We further discuss the concept of each of these categories. See the Supplementary Material (**SM. Keyword plus categorization**) for detailed information about the keyword categorization into thematic topics.

A2. Table 2. Detailed list of variables by element.

VARIABLES	ELEMENT	DESCRIPTION
Assessment	Theme	Specific assessment methods, tools, and processes.
Biodiversity		Most biodiversity topics and subtopics, including the ones in low frequency.
Challenges		Issues, opinions, problems, and previsions
Conservation		Conservation of biodiversity as a single theme.
Decision-making		Management, decision-making, and policymaking-related topics.
Ecology		Most ecology topics and subtopics, including the ones in low frequency.
Habitat		Specific habitat terms or general habitat references.
Impacts		Cause, element, the effect of impacting action, event, or enterprise.

Other		Every non-correlated or ambiguous topic with single or low frequency.
Region		Geopolitical (macro or micro) area.
Solutions		Technical solutions such as guidelines, protocols, indexes, indicators, models, sampling, and tools.
Multidisciplinary (All)	Disciplinarity	Includes elements of biotic, physical, and socioeconomic components.
Multidisciplinary (Physical)		Includes elements of biotic and physical components.
Multidisciplinary (Socioeconomic)		Includes elements of biotic and socioeconomic components.
Intradisciplinary (Biotic)		Includes only biotic elements.
Effectiveness	Framework	Includes elements from the effectiveness framework.
Quality		Includes elements from the quality framework.
Theoretical		Includes elements from the theoretical framework.
Scientific relevance	Scientific relevance	Calculated accordingly equation 1.

The EIA international debates are centered on three correlated questions (themes) (Retief, 2010) (**A2. Figure 1**). These three frameworks are hierarchically and logically applicable to the methodological structure of EIA. Hence, we adapted it into a) “what is this subject role on EIA?” (Theoretical), b) “how to conduct?” (Quality), and c) “what it is achieved?” (Effectiveness).



A2. Figure 1. *EIA literature discussion frameworks and macro topics (Adapted from Retief, 2010).*

We assessed the disciplinarity according to the environmental components of the main themes. As all the articles mandatory environment is biotic, we checked which ones were intradisciplinary or multidisciplinary with other components within three main categories: socioeconomic, physical, and "all components".

We choose keyword-plus for a more precise thematic classification. These keywords are algorithm-generated terms weighed by co-citation across disciplines and cannot be changed (Clarivate, 2022). Hence, we categorized the keyword-plus into ten topics (**A2. Table 1**). Some topics of our classification are subtopics or closely related to more significant research areas, such as biodiversity conservation. We opted for their division into different themes because of the high frequency of the intradisciplinary discussion of each.

Last, we applied the *InOrdinatio* (IO) method (Pagani et al., 2015) (**A2. Equation 1**) to calculate the relevance of the studies. We considered the α =15, as this value means higher importance to year variables and recently published papers (**A2. SM. Raw Data**). We use the term “scientific relevance” to refer to InOrdinatio in this paper. The scientific relevance is related to the “attention” the article receives rather than its quality.

$$Scientific\ relevance = \left(\frac{IF + CS}{1000}\right) + \alpha * [10 - (RY - PY)] + (\sum Ci)$$

A2. Equation 1. Scientific relevance. *Where:* **IF** – *Impact Factor JCR; CS – Cite_Score;* $\boldsymbol{\alpha}$ *– Researcher attributed weighting factor (15 - Zero);* **RY** *– Research year of the paper;* **PY** *– Publication year of the paper;* $(\sum \boldsymbol{Ci})$ *– number of times the paper has been cited.*

2.4.3 Scientometrics

We assessed the core sources through a Bradford's Law clustering analysis. This law considers a Pareto distribution to group the journals into three categories according to the publication distribution (Bradford, 1985). We checked the authors' productivity through the years with Lotka's Law. This rule assumes a fixed ratio of authors with many publications to authors with just one (Lotka, 1926).

2.4.4 Thematic mapping and evolution

All the scientometrics data was analyzed using the Bibliometrix package (Aria and Cuccurullo, 2017) within R software (R Core Team, 2021). We assessed the evolution of the research area using keywords co-occurrence clustering (Cobo et al., 2011). For both analyses, we used our keyword-plus thematic categorization as the basis for the synonyms and removed all terms in the "Others" category. Moreover, our setup included all keyword-plus (n = 560) with a min cluster frequency (per thousand docs) of 100 and 10 labels for each cluster. We set the clustering algorithm as walktrap (Pons and Latapy, 2005). This algorithm is an hierarchical agglomerative clustering method with good computational and representation performances (Lee et al., 2020). For the thematic evolution analysis, we choose the stability index with a min value of 0,1 as a weight. We opted for three cutting points (2007, 2014, and 2021). We used the development degree (number of publications) and relevance degree (number of citations) to map the themes and its evolution. Hence, we classified the themes into niche (developed; not relevant), motor (developed; relevant), emerging or declining (not developed, not relevant), and Basic (not developed, but relevant). We plotted the results in a strategic diagram map for each time slice in a similar form to Aria et al. (2022). We merged all the five figures from the output into one thematic map. We checked the thematic co-occurrence through a Multidimensional Scaling Analysis (MDS) and a thematic Hierarchical Cluster Analysis (HCA).

2.4.5 Conceptual structure analysis

We calculated a tetrachoric correlation matrix with the disciplinarity, framework, and theme variables to understand the conceptual structure. Tetrachoric correlation matrixes are suited to binary data and more effectively represent its variation (Kalkan and Kelecioğlu, 2016). We used this matrix as input for a PCA to synthesize and explain the components.

2.4.6 Analytical procedures

We opted for a Generalized Linear Model (GLM) to test our hypotheses. The GLM is suited for categorical predictors and exponential distribution types (Gelman and Hill, 2008). This model matches non-linear relations between predictors and response or not normally distributed variables. As our sampling number is low, we selected the GLM variables according to their frequencies. We assessed the response variables' partial control over its predictors through Partial Dependence Plot (PDP). Initially applied for machine learning, it allows categorizing the regression relationship as linear, monotic, or more complex (Friedman 2001). We standardized the Scientific Relevance variable with log(x) +1.

2.4.7 Study risk of bias assessment

The overrepresentation of language and region may bias WoS search results and research areas like engineering and natural sciences to the detriment of social sciences and humanities (SSHs) (Mongeon and Paul-Hus, 2016; Pranckutė, 2021; Vera-Baceta et al., 2019). EIA itself is a multidisciplinary tool and depends equally on all components, including socioeconomic, and, we aimed to do global compliance, our results may also be biased.

The automatized screening process prevents authority biases, as ASReview does not show the paper’s authors or title. Systematic Review software also reduces fatigue-related human error rates (Wang et al., 2020). This semi-automatized screening process has some drawbacks, as it reduces the number of manuscripts which should be screened, does not present a system error rate, or have empirical benchmarks of performance (van de Schoot et al., 2021). There is also bias risk associated with

systematic reviews software due to the naïve Bayes algorithm, as it tends to select similar documents to the ones in the training step (Singh et al., 2018) and is not recommended for small samples without prior knowledge base (Smid et al., 2020). In our research, these biases are reduced, first because the screening process is semi-automated due to the constant participation of humans in the screening and learning steps of ASReview.

We identified a possible temporal bias outcome from some countries which adopted EIA as a policy or decision-making method later than others, like Japan in 1999 (SÁNCHEZ, 2013). To avoid that, we defined a recent period of 23 years for sampling. Publication and temporal biases also affect our outcome since we AIA debate started in the late 70ths. Moreover, in our results, the “assessing” theme has a reductive bias. We do not included articles that discussed alternative assessing methods unrelated to traditional EIA. These biases can be reduced in future adaptations of this paper.

Regarding the review process' limitations, our research is restricted to the biotic component scientific literature. Moreover, environmental managers may base their tasks on both scientific and grey literature. This non-peer-reviewed literature is essential to the stakeholders and includes environmental policies, administrative guidelines and decision-making criteria. Hence, this theoretical grounding may vary accordingly to many factors, such as regional environmental policies, training (Morgan et al., 2012) and scientific research agenda (Cashmore, 2004).

2.5 RESULTS

We reviewed 1891 records and labeled 60.02% until we reached an asymptote (**A2. SM. Figure 1** and **A2. SM. Figure 2**). We marked 231 studies as relevant by their title and abstract, from which we selected 163 after a deep reading the articles and applying our filters. These documents are distributed in 78 sources, from which the most relevant according to Bradford’s Law (Bradford, 1985) are "Environmental Impact Assessment Review", "Journal of Environmental Impacts", "Ecological Indicators", and "Journal of Applied Ecology"). The research on methods for the biotic component of EIA grows at a rate of 12.99% per year. The authorship is assigned to 614 authors, from whom 22.7% co-authored international documents and 13 published single documents. According to Lotka's Law (Lotka, 1926), 94% of the authors will publish only one paper about this

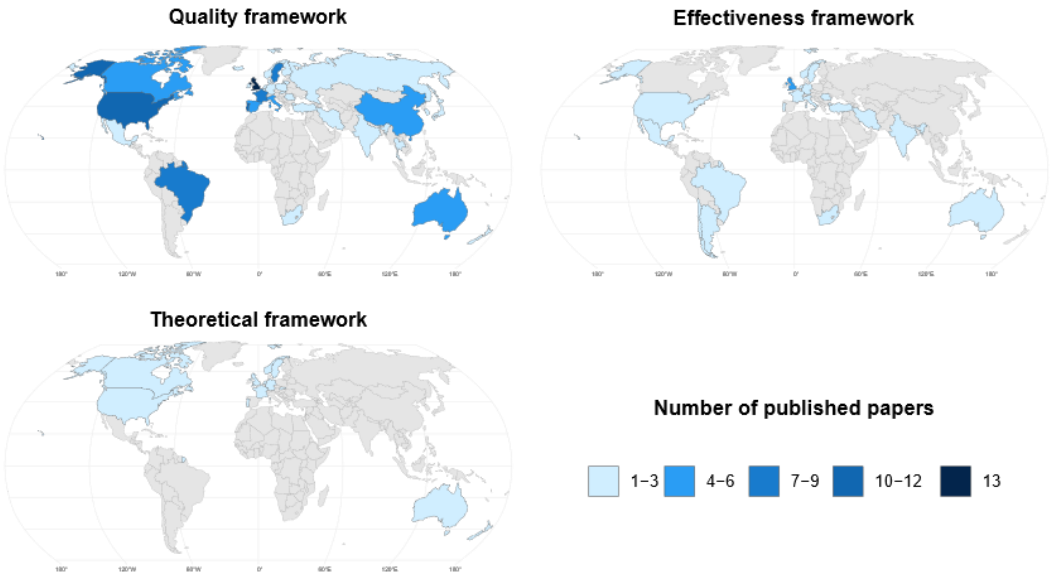
theme (**A2. SM. Figure 3**). We recorded 733 author keywords and 560 Keywords-plus, then classified them into ten thematic categories (**A2. Table 3**).

A2. Table 3. Keyword plus thematic categorization, keyword count, and occurrences by category.

CATEGORY	KEYWORD COUNT	OCCURRENCES
Assessment	25	63
Biodiversity	59	123
Challenges	15	43
Conservation	12	42
Decision-Making	36	62
Ecology	34	72
Habitat	55	91
Impacts	80	146
Others*	177	205
Region	26	33
Solutions	41	61

* We removed “Others” from all analyses.

The central disciplinary component is intradisciplinary (46.6%), followed by the multidisciplinary categories of all components (33.1%), physical (11.0%), and socioeconomic (9.2%). Most papers are within a single framework. We registered a higher number of papers in quality (67.48%), followed by effectiveness (20.24%) and theoretical (4.29%). We classified the multiple framework papers among "effectiveness x quality" (2.45%), "effectiveness x theoretical" (0.61%), and "theoretical x quality" (4.90%). The quality and effectiveness frameworks are produced in all continents, while the Theoretical is not produced on South America, Asia and Africa (**A2. Figure 2**).



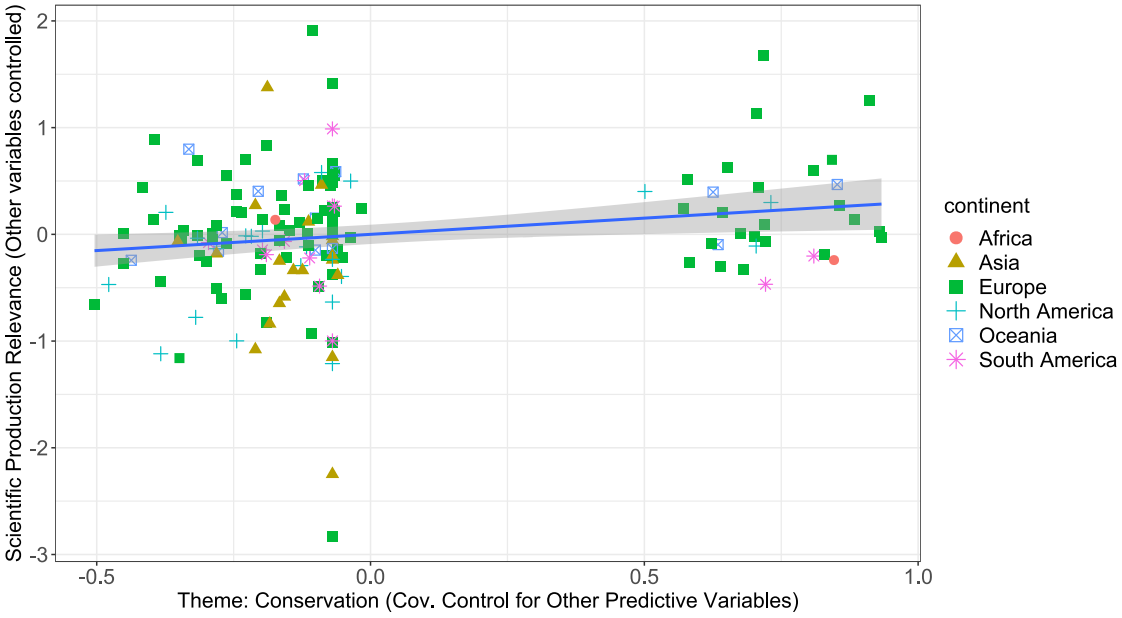
A2. Figure 2. Scientific production by framework and country.

2.5.1 Regional Variation of themes

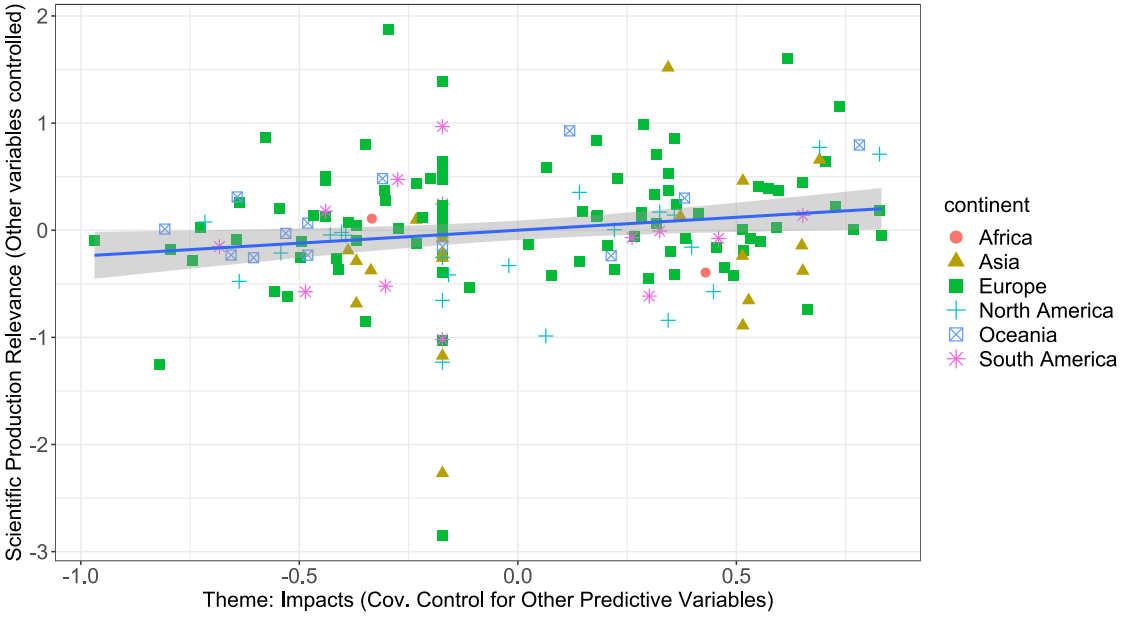
We found that theme – conservation and impacts – is significant to the scientific relevance (**A2. Table 4**; **A2. Figure 3** and **A2. Figure 4**; **A2. SM. Figure 4** and **A2. SM. Figure 5**). Therefore, the linear relationship between these variables is weak. Within the international scenario, Europe, North America, and Oceania are the primary agents, overrepresented rather than other continents. Furthermore, the Framework and Disciplinarity hypotheses were rejected (**A2. SM. Table 1** and **A2. SM. Table 2**; **A2. SM. Figure 5** to **A2. SM. Figure 11**).

A2. Table 4. GLM output. Scientific relevance ~ thematic variables. (Null deviance: 68.178 on 162 degrees of freedom. Residual deviance: 55.074 on 152 degrees of freedom. AIC: 309.71)

Coefficients				
Estimate	Std.	Error	t-value	Pr(>|t|)
(Intercept)	*321.582*	*0.087*	*36.769*	*<2e-16*
Assessing	0.15766	0.105	1.494	0.137
Biodiversity	-0.05831	0.111	-0.523	0.601
Challenges	0.11935	0.117	1.020	0.309
Conservation	0.30393	0.124	2.439	**0.015**
Decision making	0.13916	0.110	1.265	0.207
Ecology	0.20256	0.111	1.814	0.071
Habitat	0.09406	0.117	0.799	0.425
Impacts	0.24136	0.106	2.257	**0.025**
Region	-0.01200	0.143	-0.084	0.933
Solutions	0.104	0.110	0.950	0.343



A2. Figure 3. Partial dependence plot: scientific production relevance with other variables controlled x Theme conservation as a covariance control for other predictive variables.

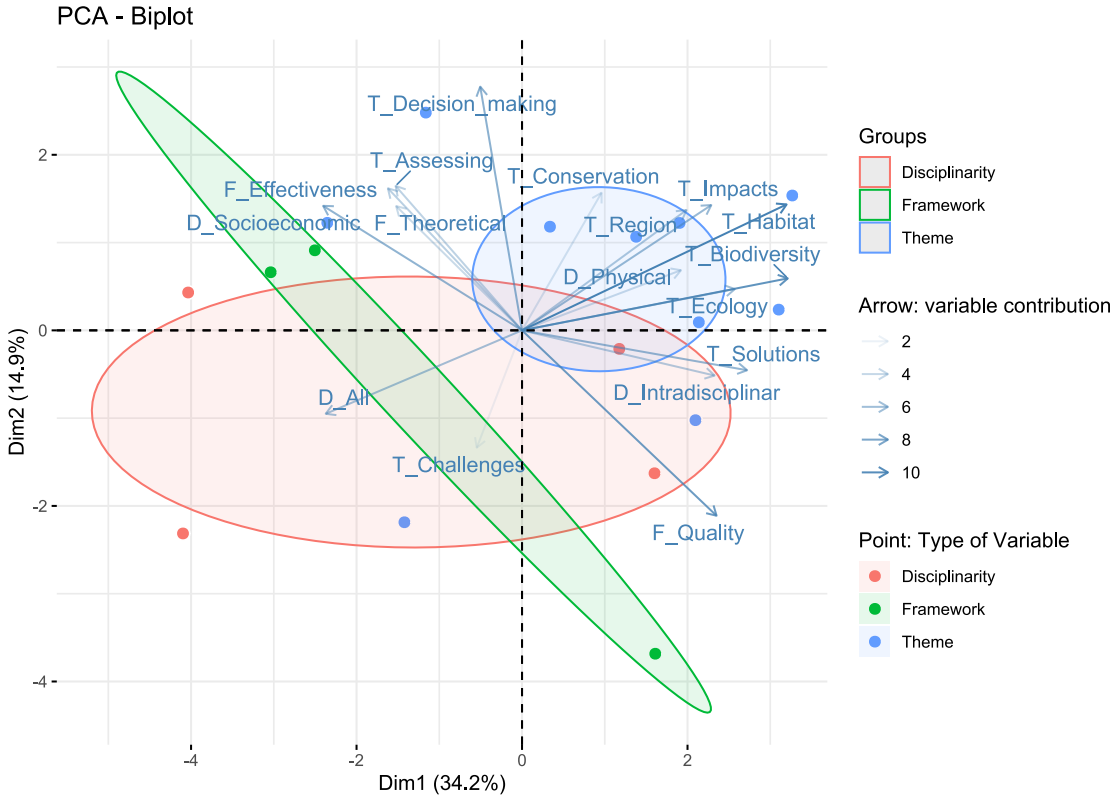


A2. Figure 4. Partial dependence plot: scientific production relevance with other variables-controlled x Theme impacts as a covariance control for other predictive variables.

2.5.2 Conceptual structure

The tetrachoric correlation matrix (**A2. SM. Figure 12**) core themes of biotic components methodology are correlated to interdisciplinarity. Moreover, there is a

negative correlation between multidisciplinary articles – all components and socioeconomic components – with the core biotic themes, even with all of them being mandatory and linked to the biotic component. Nevertheless, the physical component slightly correlates with the same themes and negatively correlates with challenges, effectiveness, and theoretical grounding. On the PCA (**A2. Figure 5**) first dimension, the biotic core themes are related to physical and socioeconomic components and discussed within theoretical and effectiveness frameworks. Nevertheless, intradisciplinary or multidisciplinary publications often discuss challenges, quality, and solutions. Moreover, the second dimension shows a multidisciplinary approach to the challenges with the EIA Core themes. This debate is considered within the effectiveness and theoretical frameworks.

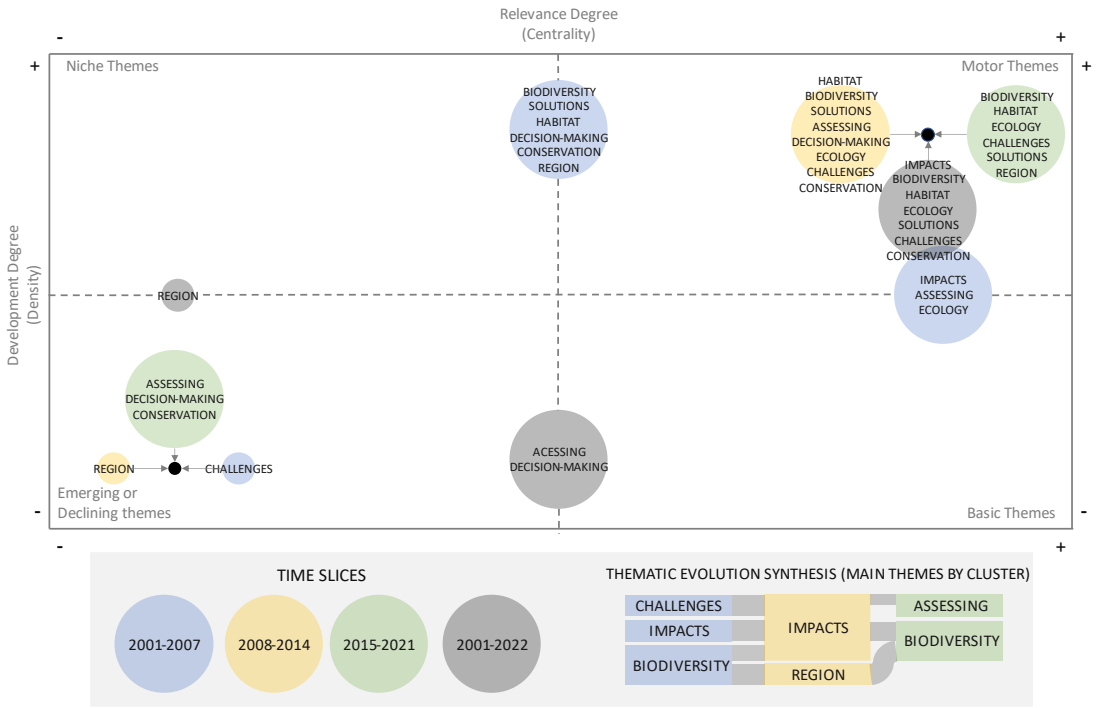


A2. Figure 5. Principal Component Analysis plot of Disciplinarity, Framework, and Theme. Input: Tetrachoric correlation matrix. Ellipse: Confidence (Variable type)

2.5.3 Thematic mapping and evolution

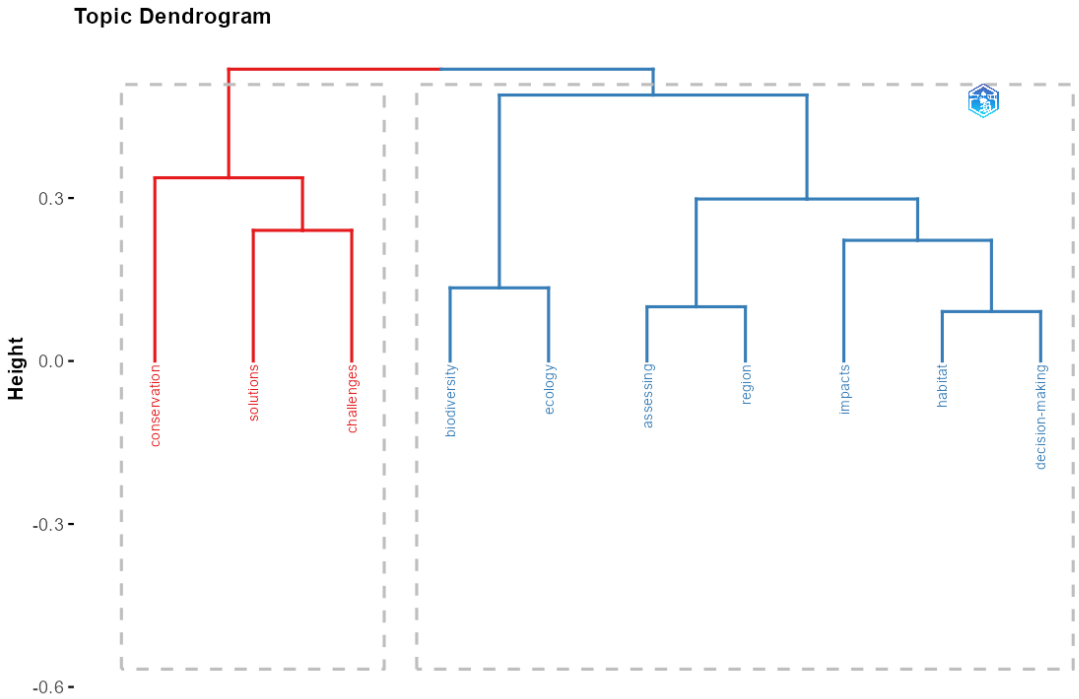
Within the first period (2001-2007) (**A2. Figure 6**), there was no motor theme for EIA's biotic component methodology debate. Both niche and basic themes were ascending. Moreover, challenges were an emerging theme. The presence of region in the most developed cluster indicates specific local discussion. Moreover, the basic cluster

includes assessing issues, general impacts and ecology. During the second period both clusters merged into a motor group which included the challenges topic. The debate about region declined, which indicates a wider concern about EIA, rather than specific area problems. Despite of this, the discussion about specific places turned into a motor theme again during the last period (2014-2021). In parallel, assessing, conservation and decision-making declined. Moreover, assessing and decision-making are basic and declining topics in the general thematic mapping (2001-2022). Furthermore, area specific topics are also declining. In a wider frame, there is a thematic simplification. We present this figure input (relevance and development degrees, clustering and coordinates data) on the supplementary material (**A2. SM. Table 3** to **A2. SM. Table 6**)



A2. Figure 6. Thematic evolution map in time slices (2001-2007, 2008-2014), Thematic map (2001-2022) and thematic evolution synthesis (main themes by cluster for each time slice). Increment towards right mean higher relevance (centrality). Increment towards above means higher occurrence (Density) of papers.

Regarding the thematic co-occurrence (MDS and HCA), the general topic discussion is within two main clusters (**A2. Figure 7**, **A2. SM. Figure 13**). The first includes conservation, solutions, challenges, and the second covers the other seven themes. There is a pairing between biodiversity and ecology; assessing and region; and impacts, habitat and decision making.



A2. Figure 7. Thematic topic dendrogram of co-occurrence. Height closer to zero means a higher co-occurrence rate.

2.6 DISCUSSION

The procedural issues (quality) were the motor theme of this field as noted in 1997 (Frost, 1997), 2002 (Wood, 2002) and 2010 (Retief, 2010). The theory was a neglected framework on EIA 26 years ago, with an unbalanced multidisciplinary background (Lawrence, 1997, 1994). Our results show the scenario is the same. Although the high growth rate of the literature production in this field, there are no substantial changes to distribution of the EIA's three frameworks (quality, theoretical and effectiveness) production ratio, even tapering into biotic components. Furthermore, the discussion on effectiveness of EIA's biotic component is lesser if compared with the multicomponent scenario from 1996 (Sadler, 1996). Moreover, the EIA's biotic component quality framework negatively correlates to the effectiveness framework. This situation should be the inverse. The effectiveness of a method, tool or guideline may be better assessed with a before and after effect analysis. It is also possible compare effectiveness data between places where the method was used and with a control site. Hence, as times passes, more comparative data is available for both goals.

Therefore, an unbalanced ratio between the three frameworks may indicates there is no sufficient research about the effects or theory behind the procedural proposals and discussion (quality). As a possible result of this uneven ratio between the theoretical, quality and effectiveness framework of EIA's biotic component literature, administrative components of EIA, such as decision-making, management, and policymaking, may have been jeopardized regarding biotic components. Within our results, these themes were not often debated along the biotic component's methodology. Despite being crucial to EIA on many levels (Cashmore, 2004), these themes stayed as basic or declining for most of the two decades we explored. Moreover, our results show most authors publish only one paper relate to them, which may represent only opportunistic contributions. Despite the literature results being pointed as potential implementation to EIA, we noticed it is not usual discuss its importance to the thematic decision-making window. Hence, most proposals or advancements may not be implemented as part of the EIA system. The absence of a link with scientific production could threaten EIA efficacy, as the development of scientific basis are crucial to the improvement of policymaking and decision-making (Malik and Bartlet, 1993).

Following this thread, the EIA research for the biotic component methodology should present material such as the results' “implications for practice, policy, and future research”. This approach is a standard topic on PRISMA protocol for metanalysis or systematic reviews (Page et al., 2021).

Therefore, framework, disciplinarity, and most themes are “accessory” elements to the discussion of conservation and impacts. The significative effect of these themes over the scientific relevance is intrinsic to these areas. Both themes were already discussed in 2001 (Marques, 2001), and their focus and development were inherited by EIA. Impacts are the main subject of EIA itself. Moreover, ecology and biodiversity conservation are directly or indirectly related to each of its components (Treweek, 1996). This indicates that the methodology discussion is well-centered, but the thematic derivation still needs improvement. Our results may give an evidence base for further research in a broader range of the biotic component elements or the physical or socioeconomic environment. However, this is a long-time change, primarily because of the uneven frameworks of EIA. Although the extensive availability of studies, the multidisciplinary theoretical grounding of EIA is unbalanced. It is also essential to highlight the time required for stakeholders and policymakers to implement the peer-reviewed material. It is also crucial to investigate if the scientific products for EIA are achieving their goal as reference materials for these objectives.

2.7 CONCLUSION

Unsurprisingly, the EIA's biotic component methodology literature is casual and focused on problems. It grows at a high rate but without any substantial changes to the three frameworks publication proportion. Much is said, little is done as the effectiveness framework has a reduced publication number. Moreover, the discussion is mainly about quality rather than theoretical grounding and effectiveness follow-up. Within this scenario, further investigation into using peer-reviewed material as a reference for EIA is crucial. Furthermore, it is crucial to discuss science's role and inclusion in decision-making and policymaking processes. This debate should be integrated into every EIA research. From these conclusions, we propose the development of a protocol for EIA scientific research. This product guide further research discussion to include framework and thematic – specially about policymaking, decision making and management – discussion.

2.8 ACKNOWLEDGMENTS

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2.9 COMPETING INTERESTS

The authors declare no competing interests for or from any stakeholders.

2.10 REFERENCES

Aria, M., Cuccurullo, C., 2017. bibliometrix : An R-tool for comprehensive science mapping analysis. J. Informetr. 11, 959–975. https://doi.org/10.1016/j.joi.2017.08.007

Aria, M., Cuccurullo, C., D'aniello, L., Misuraca, M., Spano, M., 2022. Thematic Analysis as a New Culturomic Tool: The Social Media Coverage on COVID-19 Pandemic in Italy. Sustain. 14. https://doi.org/10.3390/su14063643

Bindra, N., Karim, M., 2019. Balancing between Two Extremes during Environmental Impact Assessment: a Case Study. Environ. Process. 6, 283–307. https://doi.org/10.1007/s40710-019-00357-y

Bond, A., Retief, F., Cave, B., Fundingsland, M., Duinker, P.N., Verheem, R., Brown, A.L., 2018. A contribution to the conceptualisation of quality in impact assessment. Environ. Impact Assess. Rev. 68, 49–58. https://doi.org/10.1016/j.eiar.2017.10.006

Bradford, S.C., 1985. Sources of information on specific subjects 1934. J. Inf. Sci. 10, 176–180. https://doi.org/10.1177/016555158501000407

Cashmore, M., 2004. The role of science in environmental impact assessment: Process and procedure versus purpose in the development of theory. Environ. Impact Assess. Rev. 24, 403–426. https://doi.org/10.1016/j.eiar.2003.12.002

Cashmore, M., Richardson, T., Hilding-Ryedvik, T., Emmelin, L., 2010. Evaluating the effectiveness of impact assessment instruments: Theorising the nature and implications of their political constitution. Environ. Impact Assess. Rev. 30, 371–379. https://doi.org/10.1016/j.eiar.2010.01.004

Centre for Evidence-Based Conservation - CEE, 2013. Guidelines for Systematic Reviews in Environmental Management, Version 4.2. Bangor, United Kingdom. https://doi.org/www.environmentalevidence.org/Documents/Guidelines/Guidelines4.2.pdf

Clarivate, 2022. KeyWords Plus generation, creation, and changes [WWW Document]. Clarivate. URL

https://support.clarivate.com/ScientificandAcademicResearch/s/article/KeyWords-Plus-generation-creation-and-changes?language=en_US

Cobo, M.J., López-Herrera, A.G., Herrera-Viedma, E., Herrera, F., 2011. An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the Fuzzy Sets Theory field. J. Informetr. 5, 146–166. https://doi.org/10.1016/j.joi.2010.10.002

DAGILIŪTĖ, R., JUOZAPAITIENĖ, G., 2015. SOCIO-ECONOMIC ASSESSMENT IN ENVIRONMENTAL IMPACT ASSESSMENT: EXPERIENCE AND CHALLENGES IN LITHUANIA. J. Environ. Eng. Landsc. Manag. 23, 211–220. https://doi.org/10.3846/16486897.2015.1002842

Dias, A.M. da S., Fonseca, A., Paglia, A.P., 2017. Biodiversity monitoring in the environmental impact assessment of mining projects: a (persistent) waste of time and money? Perspect. Ecol. Conserv. 15, 206–208. https://doi.org/10.1016/j.pecon.2017.06.001

Ferraz, G., 2012. Twelve guidelines for biological sampling in environmental licensing studies. Nat. a Conserv. 10, 20–26. https://doi.org/10.4322/natcon.2012.004

Fonseca, A., Rivera Fernández, G.M., 2020. Reviewers' perceptions of the volume of information provided in environmental impact statements: The case for refocusing attention on what is relevant. J. Clean. Prod. 251. https://doi.org/10.1016/j.jclepro.2019.119757

Fonseca, A., Sánchez, L.E., Ribeiro, J.C.J., 2017. Reforming EIA systems: A critical review of proposals in Brazil. Environ. Impact Assess. Rev. 62, 90–97. https://doi.org/10.1016/j.eiar.2016.10.002

Frost, R., 1997. Monitoring and audit, in: Planning and Environmental Impact Assessment in Practice. Routledge - Taylor & Francis Group, London, UK, p. 216.

Gannon, P., 2021. The time is now to improve the treatment of biodiversity in Canadian environmental impact statements. Environ. Impact Assess. Rev. 86, 106504. https://doi.org/10.1016/j.eiar.2020.106504

Gelman, A., Hill, J., 2008. Andrew Gelman - Data Analysis Using Regression and Multilevel Hierarchical Models, 1st ed. Cambridge University Pres, New York.

Hatami, R., 2018. Development of a protocol for environmental impact studies using causal modelling. Water Res. 138, 206–223. https://doi.org/10.1016/j.watres.2018.03.034

Hironaka, A., 2002. The globalization of environmental protection: The case of environmental impact assessment. Int. J. Comp. Sociol. 43, 65–78. https://doi.org/10.1177/002071520204300104

International Association for Impact Assessment, 2021. IAIA - International Association for Impact Assessment: The leading global network on impact assessment [WWW Document]. Website. URL https://www.iaia.org/index.php (accessed 4.14.21).

José de Oliveira, O., Francisco da Silva, F., Juliani, F., César Ferreira Motta Barbosa, L., Vieira Nunhes, T., 2019. Bibliometric Method for Mapping the State-of-the-Art and Identifying Research Gaps and Trends in Literature: An Essential Instrument to Support the Development of Scientific Projects. Sci. Recent Adv. https://doi.org/10.5772/intechopen.85856

Kalkan, Ö.K., Kelecioğlu, H., 2016. The effect of sample size on parametric and nonparametric factor analytical methods. Kuram ve Uygulamada Egit. Bilim. 16, 153–171. https://doi.org/10.12738/estp.2016.1.0220

Khangura, S., Konnyu, K., Cushman, R., Grimshaw, J., Moher, D., 2012. Evidence summaries: The evolution of a rapid review approach. Syst. Rev. 1, 1–9. https://doi.org/10.1186/2046-4053-1-10

Lawrence, D.P., 1997. The need for EIA theory-building. Environ. Impact Assess. Rev. 17, 79–107. https://doi.org/10.1016/S0195-9255(97)00030-9

Lawrence, D.P., 1994. Designing and adapting the EIA planning process. Environ. Prof. 16, 2–21.

Lee, Youngho, Lee, Yubin, Seong, J., Stanescu, A., Hwang, C.S., 2020. A comparison of network clustering algorithms in keyword network analysis: A case study with

geography conference presentations. Int. J. Geospatial Environ. Res. 7, 1–16.

Lotka, A.J., 1926. The frequency distribution of scientific productivity. J. Franklin Inst. 202, 271. https://doi.org/10.1016/S0016-0032(26)91166-6

Malik, M., Bartlet, R. V, 1993. Formal guidance for the use of science in EIA: analysis of agency procedures for implementing NEPA. Environ. Prof. 15, 34–45.

Marques, J.C., 2001. Diversity, Biodiversity, Conservation, and Sustainability. Sci. World J. 1, 534–543. https://doi.org/10.1100/tsw.2001.101

McCullough, A., 2017. Environmental Impact Assessments in developing countries: We need to talk about politics. Extr. Ind. Soc. 4, 448–452. https://doi.org/10.1016/j.exis.2017.07.002

Middle, G., Middle, I., 2010. The inefficiency of environmental impact assessment: Reality or myth? Impact Assess. Proj. Apprais. 28, 159–168. https://doi.org/10.3152/146155110X498825

Mongeon, P., Paul-Hus, A., 2016. The journal coverage of Web of Science and Scopus: a comparative analysis. Scientometrics 106, 213–228. https://doi.org/10.1007/s11192-015-1765-5

Morgan, R.K., Hart, A., Freeman, C., Coutts, B., Colwill, D., Hughes, A., 2012. Practitioners, professional cultures, and perceptions of impact assessment. Environ. Impact Assess. Rev. 32, 11–24. https://doi.org/10.1016/j.eiar.2011.02.002

Pagani, R.N., Kovaleski, J.L., Resende, L.M., 2015. Methodi Ordinatio: a proposed methodology to select and rank relevant scientific papers encompassing the impact factor, number of citation, and year of publication. Scientometrics 105, 2109–2135. https://doi.org/10.1007/s11192-015-1744-x

Page, M.J., Mckenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M.M., Li, T., Loder, E.W., Mayo-Wilson, E., McDonald, S., Mcguinness, L.A., Stewart, L.A., Thomas, J., Tricco, A.C., Welch, V.A., Whiting, P., Moher, D., 2021. The PRISMA 2020 statement: an updated guideline

for reporting systematic reviews. Syst. Rev. 10. https://doi.org/10.1186/s13643-021-01626-4

Pons, P., Latapy, M., 2005. Computing Communities in Large Networks Using Random Walks. pp. 284–293. https://doi.org/10.1007/11569596_31

Pranckutė, R., 2021. Web of Science (WoS) and Scopus: The Titans of Bibliographic Information in Today's Academic World. Publications 9, 12. https://doi.org/10.3390/publications9010012

R Core Team, 2021. R: A Language and Environment for Statistical Computing.

Retief, F., 2010. The evolution of environmental assessment debates: Critical perspectives from South Africa. J. Environ. Assess. Policy Manag. 12, 375–397. https://doi.org/10.1142/S146433321000370X

Sadler, B., 1996. Environmental assessment in a changing world: evaluating practice to improve performance, First edit. ed. CANADIAN ENVIRONMENTAL ASSESSMENT AGENCY, Quebec, Canada.

Sánchez, L.E.L.H., 2013. Avaliação de Impacto Ambiental: Conceitos e métodos, 2ª. ed. Oficina de Textos, São Paulo, SP.

Singh, G., Thomas, J., Shawe-Taylor, J., 2018. Improving active learning in systematic reviews. arXiv.

Smid, S.C., McNeish, D., Miočević, M., van de Schoot, R., 2020. Bayesian Versus Frequentist Estimation for Structural Equation Models in Small Sample Contexts: A Systematic Review. Struct. Equ. Model. 27, 131–161. https://doi.org/10.1080/10705511.2019.1577140

Thuy, P.T., Tuan, P.T., Huyen, D.T.T., Khai, N.M., 2020. Insights of environmental impact assessment reports for industrial parks: wastewater quantity prediction aspect. Environ. Monit. Assess. 192. https://doi.org/10.1007/s10661-020-8217-2

Treweek, J., 1996. Ecology and Environmental Impact Assessment. J. Appl. Ecol. 33, 191. https://doi.org/10.2307/2404742

United Nations Environment Programme, 2018. Assessing Environmental Impacts - A

Global Review of Legislation.

van de Schoot, R., de Bruin, J., Schram, R., Zahedi, P., de Boer, J., Weijdema, F., Kramer, B., Huijts, M., Hoogerwerf, M., Ferdinands, G., Harkema, A., Willemsen, J., Ma, Y., Fang, Q., Hindriks, S., Tummers, L., Oberski, D.L., 2021. An open source machine learning framework for efficient and transparent systematic reviews. Nat. Mach. Intell. 3, 125–133. https://doi.org/10.1038/s42256-020-00287-7

Vera-Baceta, M.A., Thelwall, M., Kousha, K., 2019. Web of Science and Scopus language coverage. Scientometrics 121, 1803–1813. https://doi.org/10.1007/s11192-019-03264-z

Wang, Z., Nayfeh, T., Tetzlaff, J., O'Blenis, P., Murad, M.H., 2020. Error rates of human reviewers during abstract screening in systematic reviews. PLoS One 15, 1–8. https://doi.org/10.1371/journal.pone.0227742

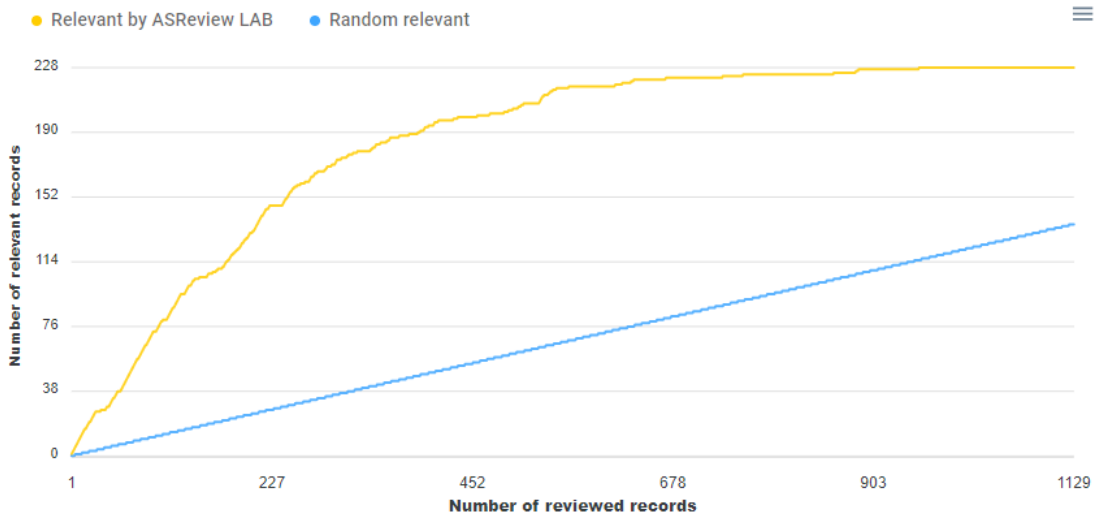
Wood, C., 2002. Environmental Impact Assessment: A compartive review, Second edi. ed. Routledge - Taylor & Francis Group, London, UK.

Woznicki, S.A., Nejadhashemi, A.P., Abouali, M., Herman, M.R., Esfahanian, E., Hamaamin, Y.A., Zhang, Z., 2016. Ecohydrological modeling for large-scale environmental impact assessment. Sci. Total Environ. 543, 274–286. https://doi.org/10.1016/j.scitotenv.2015.11.044

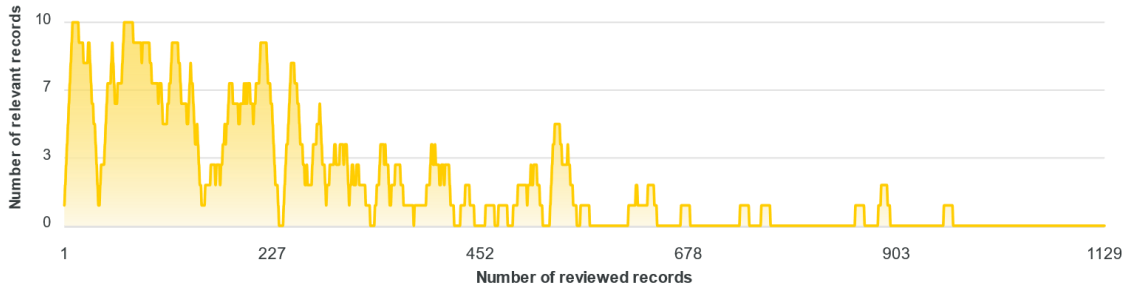
Zeleňáková, M., Fijko, R., Diaconu, D.C., Remeňáková, I., 2018. Environmental impact of small hydro power plant—a case study. Environ. - MDPI 5, 1–10. https://doi.org/10.3390/environments5010012

Zhuang, Y., Hong, S., Lin, H., Niu, B., 2011. Global environmental impact assessment research trends (1973-2009). Procedia Environ. Sci. 11, 1499–1507. https://doi.org/10.1016/j.proenv.2011.12.226

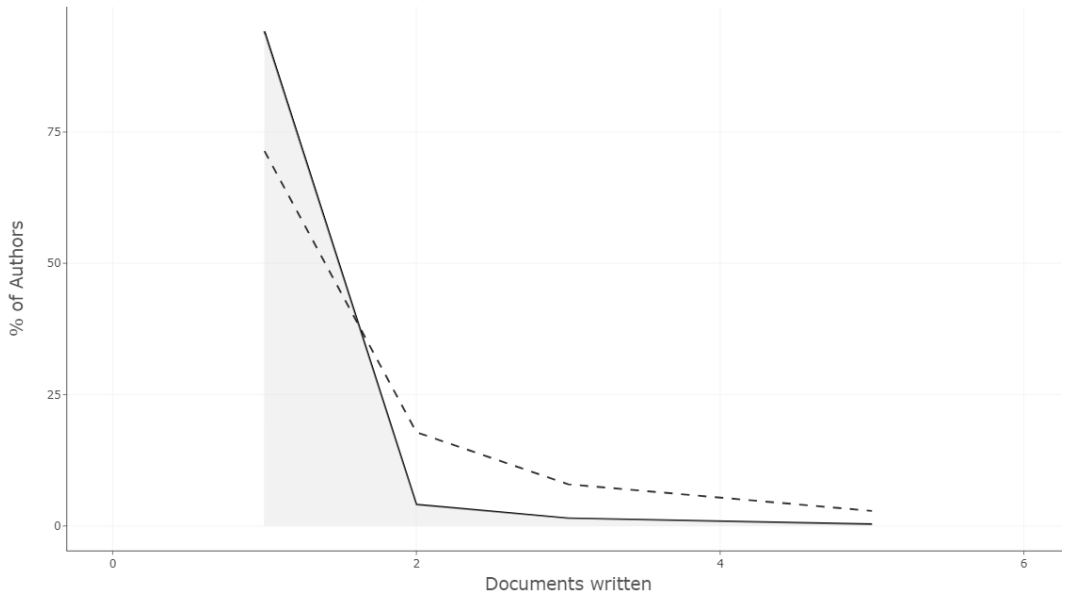
2.11 SUPPLEMENTARY MATERIAL PAPER 2



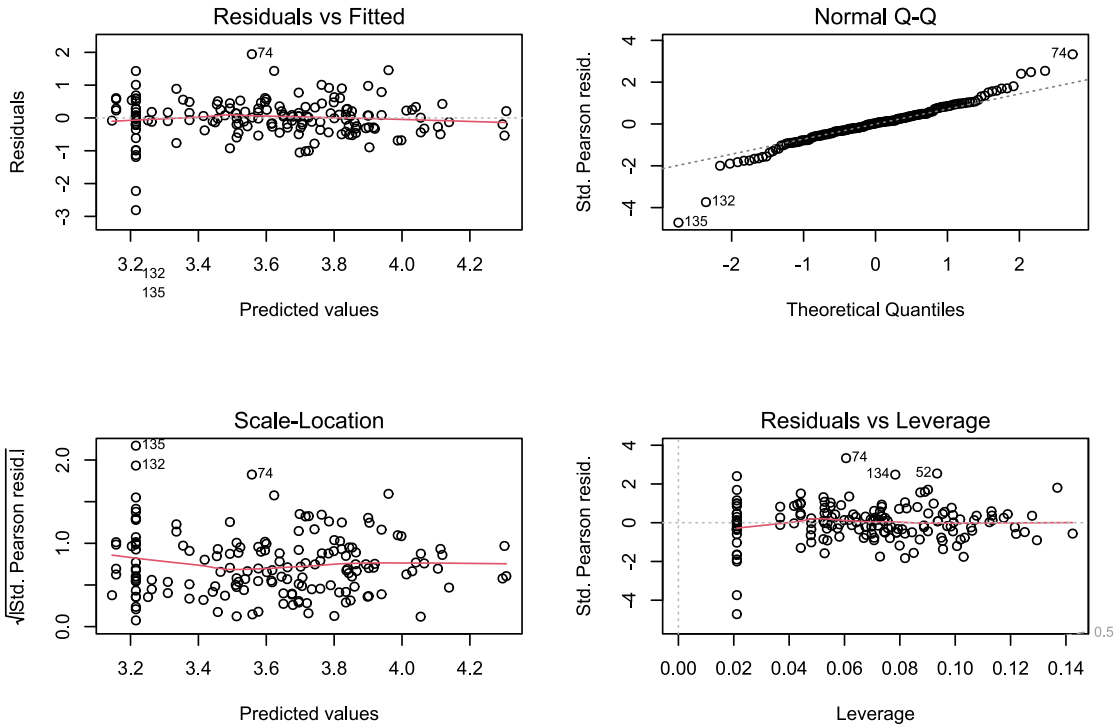
A2. SM. Figure 1. Screening process recall on AsReview.



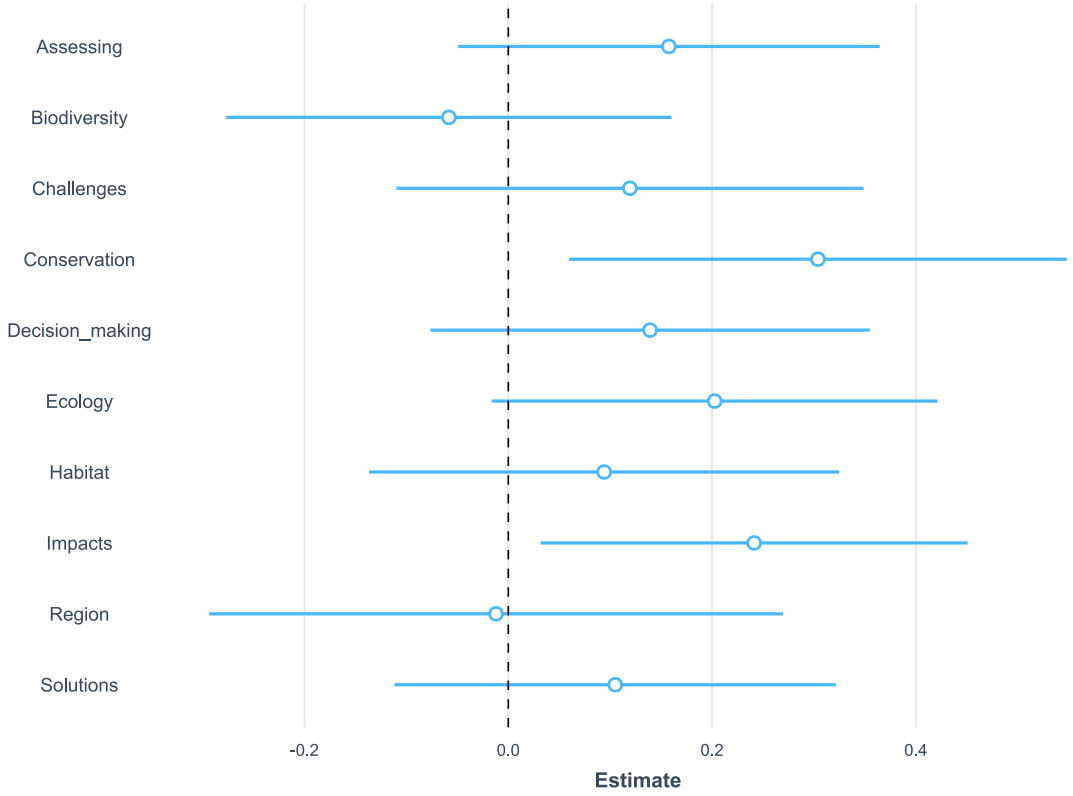
A2. SM. Figure 2. Screening progress on AsReview



A2. SM. Figure 3. Lotka's Law for biotic aspect's methodology literature.



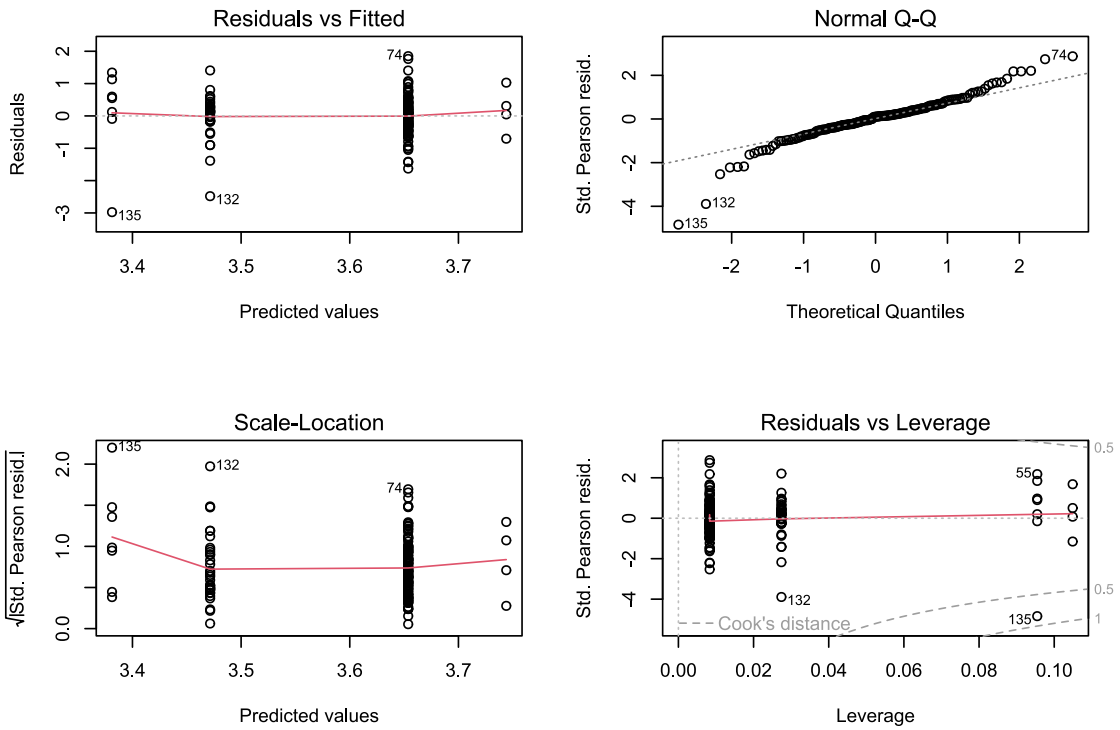
A2. SM. Figure 4. Residuals. Glm Scientific relevance ~ thematic variables.



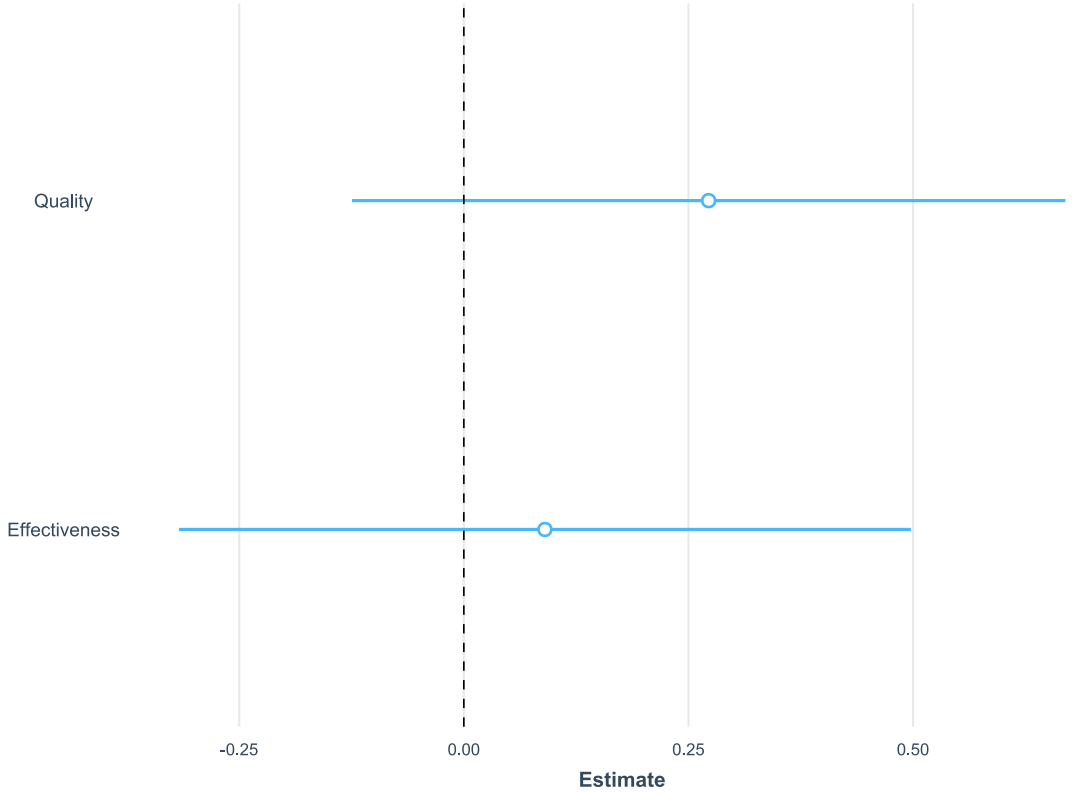
A2. SM. Figure 5. Regression summary plot. Glm Scientific relevance ~ thematic variables.

A2. SM. Table 1. *GLM outpu.t Scientific relevance ~ framework variables. (Null deviance: 68.178 on 162 degrees of freedom. Residual deviance: 66.863 on 160 degrees of freedom. AIC: 325.33.)*

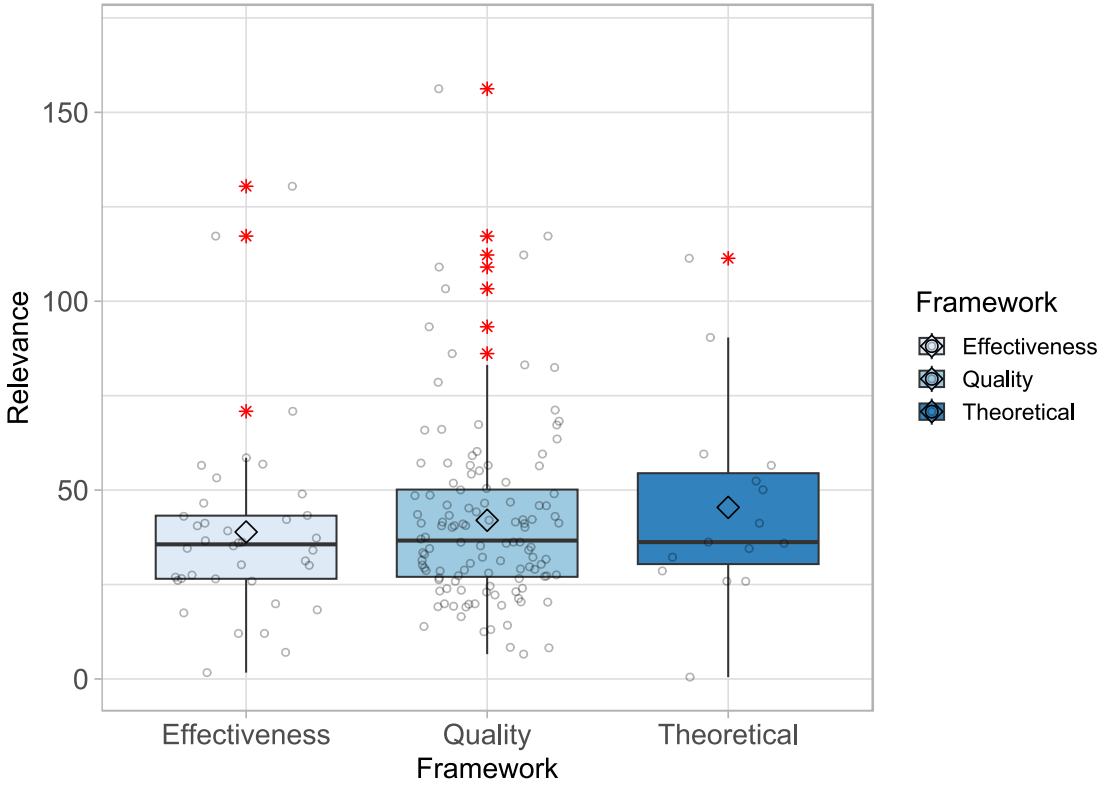
Coefficients				
Estimate	Std.	Error	t-value	Pr(>|t|)
(Intercept)	338.121	0.19975	16.927	<2e-16
Quality	0.27255	0.20254	1.346	0.180
Effectiveness	0.09026	0.20784	0.434	0.665



A2. SM. Figure 6. Residuals. Glm Scientific relevance ~ framework



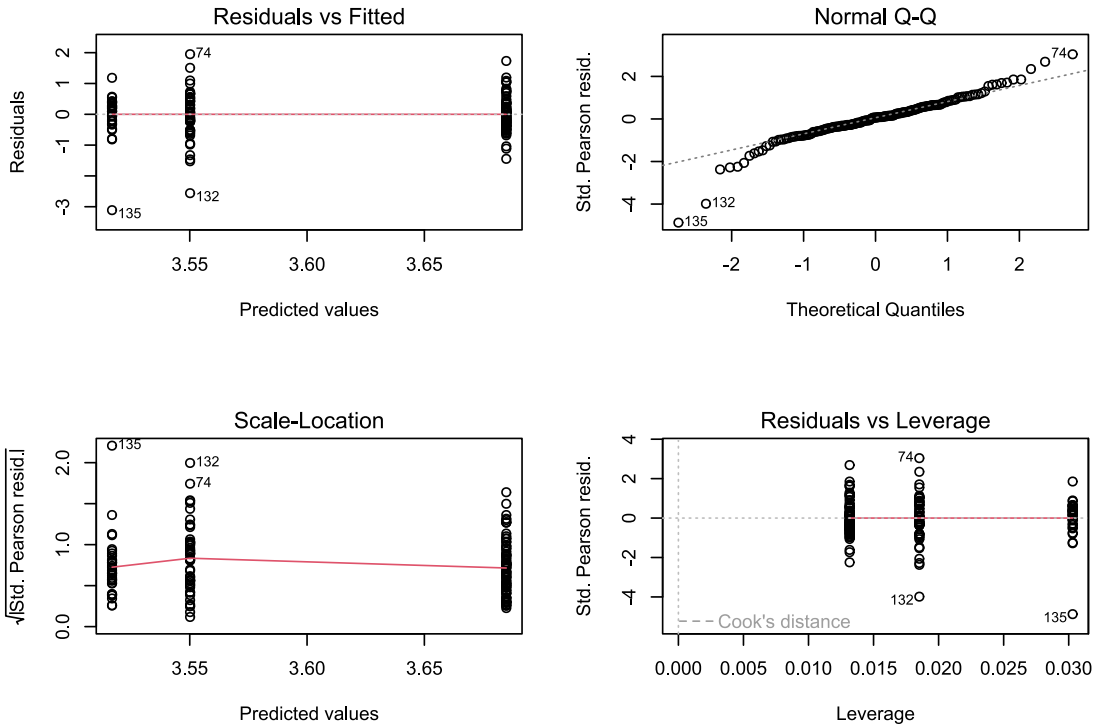
A2. SM. Figure 7. Regression summary plot. Glm Scientific relevance ~ thematic variables.



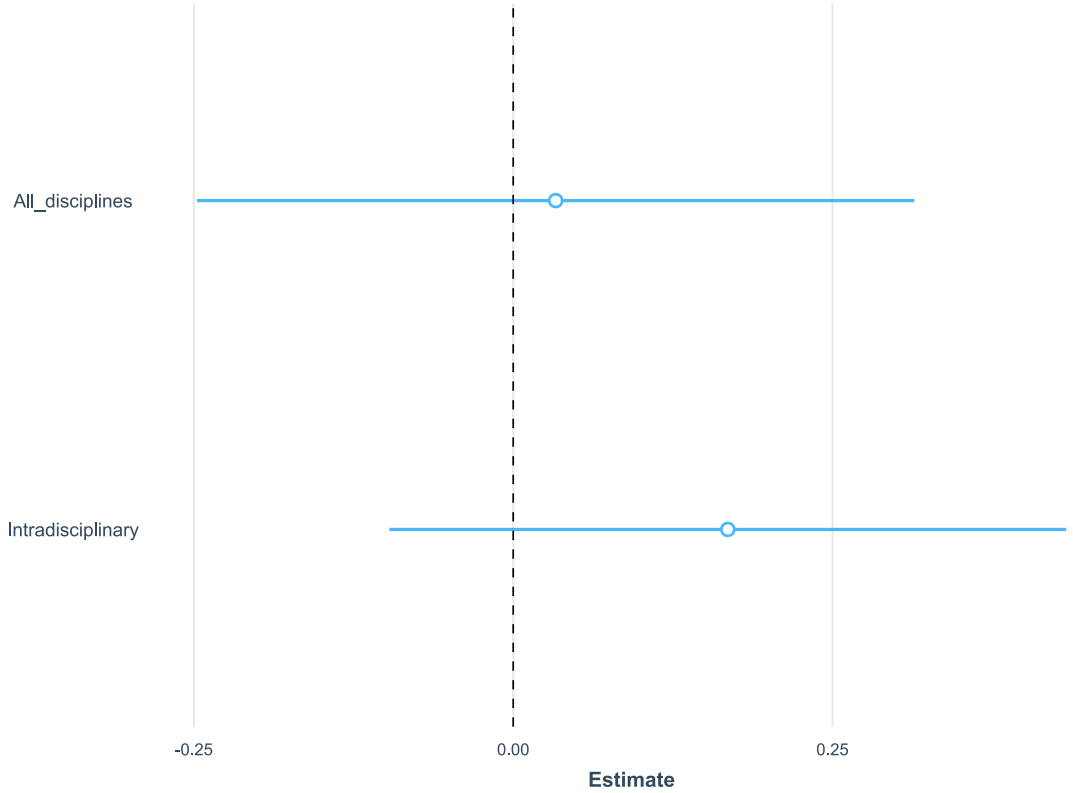
A2. SM. Figure 8. Boxplot of scientific relevance x Framework.

A2. SM. Table 2. GLM output. Scientific relevance ~ disciplinarity variables. (Null deviance: 68.178 on 162 degrees of freedom. Residual deviance: 67.138 on 159 degrees of freedom. AIC: 327.99.)

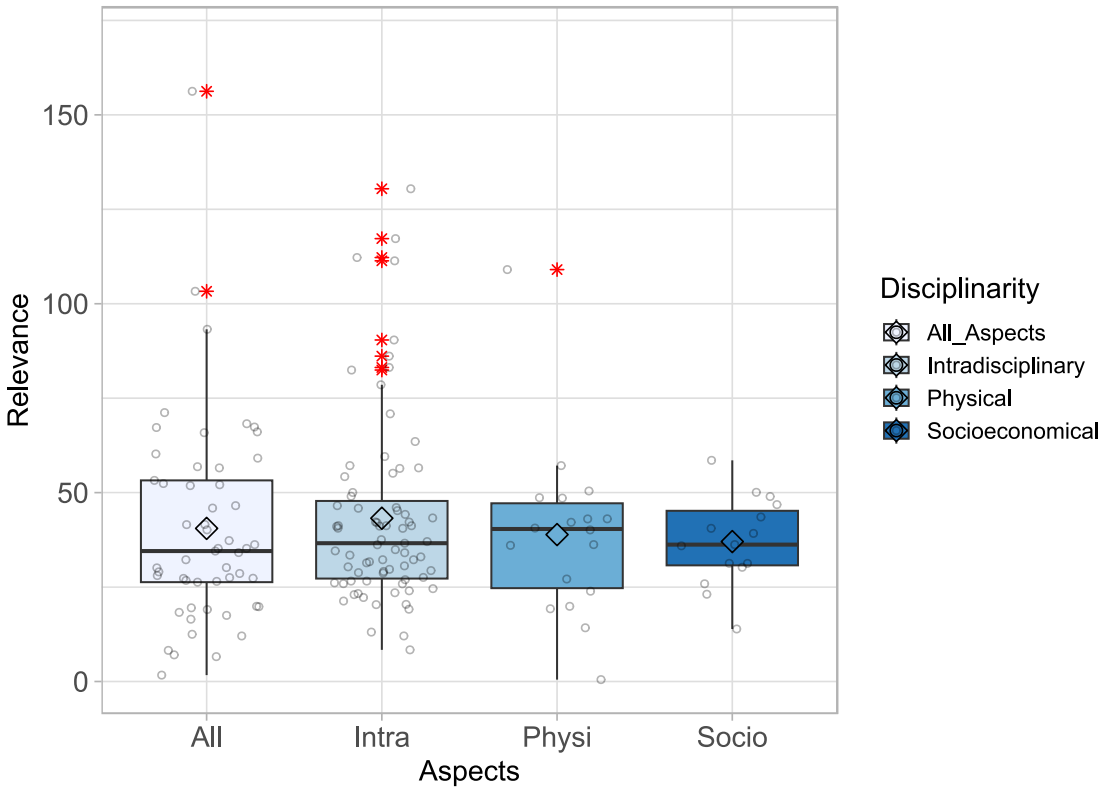
Coefficients				
Estimate	Std.	Error	t-value	Pr(>|t|)
(Intercept)	3.51688	0.11288	31.157	<2e-16
All disciplines	0.03327	0.14327	0.232	0.817
Intradisciplinary	0.16803	0.13518	1.243	0.216



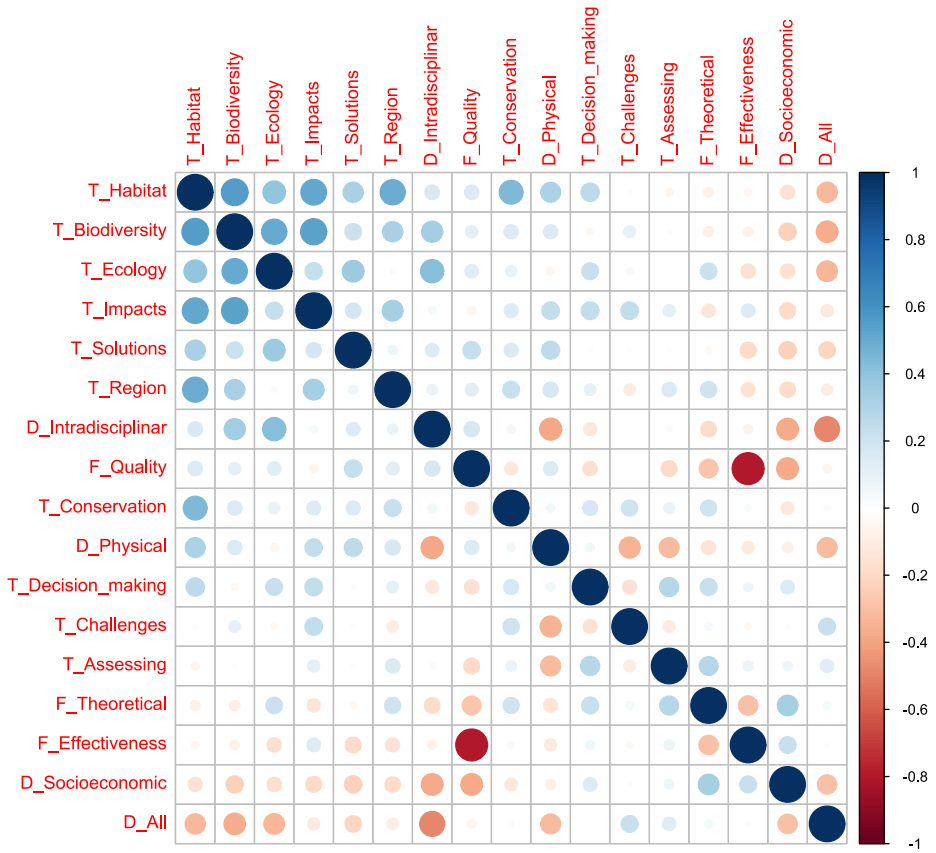
A2. SM. Figure 9. Residuals. Glm Scientific relevance ~ framework



A2. SM. Figure 10. Regression summary plot. Glm Scientific relevance ~ Disciplinarity



A2. SM. Figure 11. Boxplot of scientific relevance x Disciplinarity.



A2. SM. Figure 12. Tetrachoric correlation matrix. Themes (T_) x Disciplines (D_) x Frameworks (F_).

A2. SM. Table 3. Thematic evolution mapping data. Time slice clustering 2001-2007. Walktrap algorithm. Minimum frequency of hundred per thousand. Wight 0,1. Stability index. Labels: 10.

Occurrences	Words	Cluster	Cluster Label	Btw centrality	Clos centrality	Pagerank centrality
9	impacts	1	impacts	73,808	0,020	0,101
6	assessing	1	impacts	52,998	0,021	0,075
5	ecology	1	impacts	58,154	0,021	0,060
9	biodiversity	2	biodiversity	30,672	0,016	0,087
6	habitat	2	biodiversity	41,592	0,021	0,072
7	solutions	2	biodiversity	17,570	0,015	0,063
3	region	2	biodiversity	5,596	0,018	0,038
4	conservation	2	biodiversity	9,137	0,018	0,042
5	decision-making	2	biodiversity	32,122	0,020	0,056
4	challenges	3	challenges	17,926	0,019	0,022

A2. SM. Table 4. Thematic evolution mapping data. Time slice clustering 2008-2014. Walktrap algorithm. Minimum frequency of hundred per thousand. Wight 0,1. Stability index. Labels: 10.

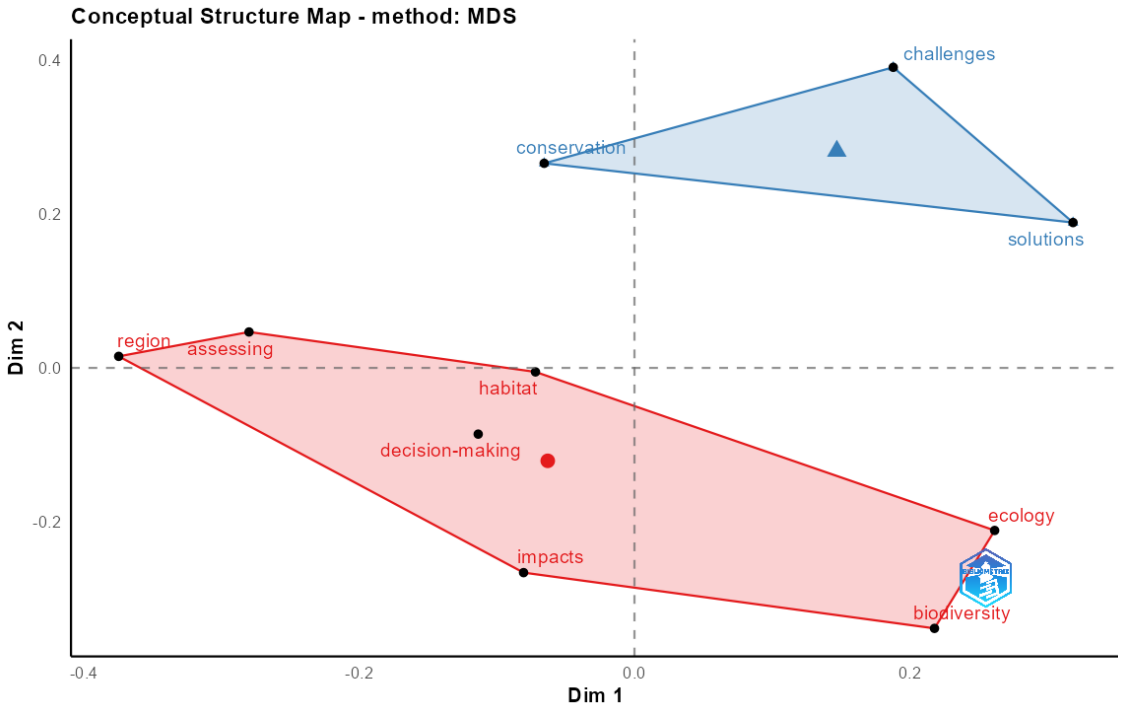
Occurrences	Words	Cluster	Cluster Label	Btw centrality	Clos centrality	Pagerank centrality
24	impacts	1	impacts	142,669	0,012	0,111
15	habitat	1	impacts	64,813	0,010	0,082
15	biodiversity	1	impacts	189,777	0,012	0,092
12	decision-making	1	impacts	99,621	0,010	0,063
13	assessing	1	impacts	63,811	0,009	0,059
14	solutions	1	impacts	123,559	0,011	0,080
12	ecology	1	impacts	161,891	0,012	0,069
7	challenges	1	impacts	27,123	0,010	0,029
7	conservation	1	impacts	34,705	0,010	0,033
5	region	2	region	58,385	0,010	0,033

A2. SM. Table 5. Thematic evolution mapping data. Time slice clustering 2015-2021. Walktrap algorithm. Minimum frequency of hundred per thousand. Wight 0,1. Stability index. Labels: 10.

Occurrences	Words	Cluster	Cluster Label	Btw centrality	Clos centrality	Pagerank centrality
40	biodiversity	1	biodiversity	1349,844	0,006	0,094
36	impacts	1	biodiversity	765,927	0,005	0,080
32	habitat	1	biodiversity	494,510	0,004	0,075
29	ecology	1	biodiversity	518,637	0,004	0,070
19	solutions	1	biodiversity	513,635	0,004	0,050
22	challenges	1	biodiversity	284,433	0,004	0,045
11	region	1	biodiversity	26,475	0,003	0,024
28	assessing	2	assessing	327,035	0,004	0,053
27	decision-making	2	assessing	573,113	0,004	0,062
18	conservation	2	assessing	74,939	0,00	0,039

A2. SM. Table 6. Thematic evolution mapping data. Time slice clustering 2021-2022. Walktrap algorithm. Minimum frequency of hundred per thousand. Wight 0,1. Stability index. Labels: 10.

Occurrences	Words	Cluster	Cluster Label	Btw centrality	Clos centrality	Pagerank centrality
3	challenges	1	challenges	42,355	0,0212	0,0430
3	conservation	1	challenges	14,727	0,0204	0,0400
9	impacts	2	impacts	43,087	0,022	0,104
8	biodiversity	2	impacts	58,474	0,022	0,095
7	ecology	2	impacts	72,737	0,023	0,087
7	habitat	2	impacts	27,866	0,02	0,080
4	solutions	2	impacts	12,683	0,018	0,042
4	region	2	impacts	48,752	0,022	0,057
2	assessing	2	impacts	4,111	0,018	0,025
3	decision-making	3	decision-making	4,684	0,017	0,036



A2. SM. Figure 13. Multidimensional scaling conceptual structure map of the themes

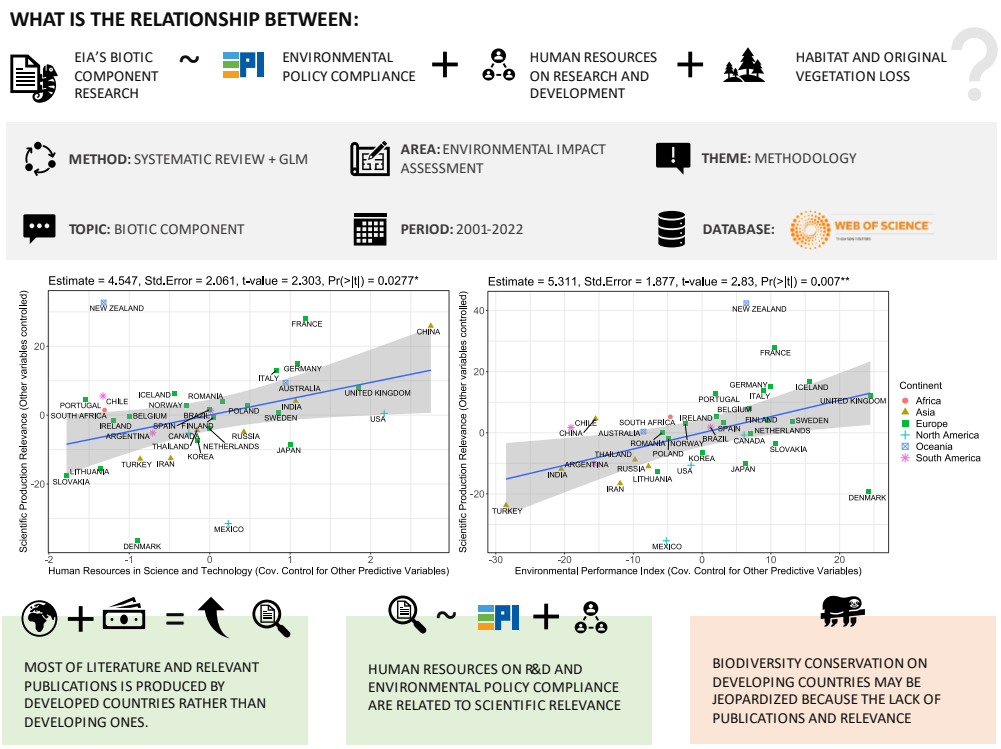
3 ECONOMIC AND ENVIRONMENTAL CONSTRAINS ON SCIENTIFIC PRODUCTION OF ENVIRONMENTAL IMPACT ASSESSMENT

Journal: Perspectives in Ecology and Conservation

3.1 HIGHLIGHTS

- The EIA's biotic component methodology literature is mostly produced by developed countries rather than developing ones.
- The most relevant literature is also concentrated on developed countries.
- The low scientific production and relevance of EIA's biotic aspect methodology on developing countries may jeopardize biodiversity conservation.
- The scientific relevance of literature is related to environmental policy compliance (Environmental performance index) and Human resources on Research & Development.

3.2 GRAPHICAL ABSTRACT



A3 Figure 1. Graphical Abstract

3.3 ABSTRACT

Environmental Impact Assessment (EIA) is crucial for the biodiversity conservation. Furthermore, the scientific literature regarding EIA's quality is outstanding. Within this framework, the EIA's biotic aspect literature discusses sampling, misrepresentation, unspecific guidelines and inefficient policies. These issues may potentially hinder the biodiversity conservation. In face of this possibility, developing countries may be the most jeopardized, as they are megadiverse and need EIA improvements. Within this context, it is expected that the EIA research effort is focused on these places. Hence, we used a systematic literature review to sample the scientific product about EIA's biotic component methodology. We used a Generalized Linear Model analysis to assess if habitat loss, original vegetation loss, environmental policy compliance and research & development resources are drivers to the scientific relevance on this area. Our results show that the is concentrated on developed countries with well-stablished EIA systems. Therefore, the main drivers of the scientific production are human resources in science & development and well stablished environmental and sustainability policies. Furthermore, we discuss the importance of channeling the research effort to this subject and areas, and the importance of increasing the research founding and strengthening environmental policies on developing countries.

Keywords: Environmental Performance Index, Biodiversity Habitat Index, Environmental Impact Assessment, Methodology, Biodiversity conservation

3.4 INTRODUCTION

Environmental impact assessment (EIA) is a worldwide decision-support reference for conservation (Gontier et al., 2006), management and sustainable development (Jay et al., 2007). Moreover, the EIA is a multidisciplinary process which includes detailed analysis of the biotic, physical and socioeconomic aspects (Sánchez, 2013). In the 2000's decade more than 100 countries in the world had already adopted this instrument (Lee and George, 2000). Therefore, the number of scientific publications about this subject increased (Cashmore, 2004), and the main discussed theme was the quality framework (Retief, 2010). Within this scenario, there is a wide methodology discussion about the biotic component, which includes sampling (Ferraz, 2012), indexes (Dyer et al., 2017), modelling (Hatami, 2018) and biodiversity (Mandai and Souza, 2021). Biodiversity conservation is a worldwide concern (Rands et al., 2010), with a significative focus on biodiversity hotspots (Marchese, 2015). These places concentrate a unique diversity and are mostly distributed along the equatorial line, in developing countries (Fisher and Christopher, 2007; Veech, 2003).

Although the high biodiversity, developing countries are usually emerging on their environmental policies and conservation efforts (Adenle et al., 2014; Barber et al., 2014). Moreover, in the spite of the growing industrialization and demand for energy, the EIA is a critical issue for biodiversity conservation (Mandelik et al., 2005). Hence , it is important to know if the methodology literature about EIA's biotic component covers the developing countries, which most need of it. Furthermore, it is essential investigate if the economic, political and environmental conditions of these countries are drivers to this scientific production. Hereby we investigate the environmental and social pressure on relevance given to each classification within the EIA scientific production frameworks.

Given these circumstances, our main goal here is to explore the relationship between scientific production on EIA and some possible constraints and demands for this knowledge in our modern societies. We assume the scientific production is important to the proper development of EIA methods and reasoning and that it is relevant to deal with the inherent challenges of this field. Otherwise, it is expected that

specialized human resources will be crucial to favor the increase of relevant literature in well-funded scientific groups. Moreover, well developed environmental policy, here represented by Environmental Performance Index (EPI), should reflect this literature development. Furthermore, there is an positive correlation between Gross Domestic Product (GDP) to EPI (Wolf et al., 2022) and human resources on research and development (R&D) (Meo et al., 2013). Otherwise, it is possible that this not necessarily reflect the distribution of the real challenges of EIA among countries. Some megadiverse countries with huge EIA challenges may do not have large scientific communities. Thus, we also tested if the distribution of scientific production is related to the distribution of major threatened systems. Finally, we also use an estimation of scientific relevance and impact to evaluate if there is an association with the distribution of those major possible EIA demands.

Here, we aim to verify if factors such as environmental performance, biodiversity habitat loss, vegetation coverage loss, research & technology staff and Tertiary education percentual exerts pression on the research relevance. Our main hypotheses are the most relevant methodology literature for EIA is being produced on developing countries which have great original vegetation cover loss; and, Environmental Performance Index (EPI), Human Resources in Research and Development and Tertiary Education Enrolment Percentual are equally significative indicators for the scientific relevance. The EPI measures development of environmental policy and goals on 180 countries. This index ranks 40 indicators to measure the sustainability and identify the best policy practices, and it is related to environmental impacts. The Tertiary Education Enrollment and the Human Resources in Research and Development can measure the research potential of each country and indicates the educational role in this research field.

3.5 METHODS

3.5.1 Systematic review

We used an approach of the PRISMA protocol (Page et al., 2021) as guidelines to systematize the replication. The main database was Web of Science (WoS), as it represents well articles for the biotic aspects, rather than Scopus as it is well suited for physical and socioeconomics subjects. Our eligibility criteria are year (2000-2023), document (peer-reviewed papers) and Language (English). Our search string includes motor theme variations, method synonyms and biotic component keywords: *"biotic*" OR "biologic*" OR "ecologic*" OR "Biodiversity"*. We choose these keywords arbitrarily.

We used the machine active learning tool ASReview to label the relevant papers (ASReview Core Development Team, 2020). This software reduce biases and speed up the process (van de Schoot et al., 2021; Wang et al., 2020). Our labelling setup is naïve Bayes classifier; random selection query strategy; full sample all the labelled records. This process followed by using ASReview to screen the abstract and titles, until we reached 60% of the papers. Therefore, we read the articles, collected the variable data and excluded irrelevant registers based on content. We only included other articles about other assessment processes – like Life Cycle Assessment (LCA) and Strategic Environmental Assessment (SEA) – when the subject was compared, discussed or analyzed within EIA. After the selection, we applied the *InOrdinatio* (IO) method (Pagani et al., 2015) (***A3. Equation 1***) to classify the scientific relevance of these papers. In our paper we refer to this index as "Scientific relevance" in which regards the discussion density about this literature.

$$Scientific\ Relevance = \left(\frac{IF + CS}{1000}\right) + \alpha * [10 - (RY - PY)] + (\sum Ci)$$

A3. Equation 1. ***Scientific Relevance Equation.*** *Where:* ***IF*** *– Impact Factor JCR; CS – Cite_Score;* $\boldsymbol{\alpha}$ *– Researcher attributed weighting factor (15 - Zero);* ***RY*** *– Research year of the paper;* ***PY*** *– Publication year of the paper;* $(\sum \boldsymbol{Ci})$ *– number of times the paper has been cited.*

We choose the Environmental Performance Index (EPI) (Wolf et al., 2022) and its categories Grassland Cover Loss, Wetland Cover Loss, Tree cover loss and Biodiversity Habitat Index (BHI) as explainable variables to the scientific relevance of the article. The EPI is a scientific based metric developed by the Yale University and summarizes the

environmental policies performance of countries (Wolf et al., 2022). The BHI represents the total original habitat loss. The data for Education in Tertiary Levels and Human resources in Research & Development variables was collected from “The UN Data” (United Nations Statistics Division, 2023), then consolidated with bibliometric data from the Systematic accordingly the country of each study. For a wider discussion, we classified the countries in “developing”, “transition” and “developed” (Department of Economic and Social Affairs of the United Nations Secretariat, 2014).

A3. Table 1. Details of variables: element category, date of sampling, data year and metadata.

VARIABLES	ELEMENT	DATE	YEAR	R	METADATA
Environmental Performance Index	Sustainability	02/01/2022	2022	1	1-100
Wetland Cover	Habitat	02/01/2022	2022	1	1-100
Grassland Cover		02/01/2022	2022	1	1-100
Treeland Cover		02/01/2022	2022	1	1-100
Biodiversity Habitat Index		02/01/2022	2022	1	1-100
Research & Development Human Resources	Education	02/01/2022	≤ 2018*	2	Number
Tertiary Education Enrollment		02/01/2022	≤ 2020*	2	Accumulated gross%
ordinatio_jcr_citescore	Scientific relevance	NA	NA	3	Continuous (Mean by country)

LEGEND: VARIABLES: **HDI** - *Human Development Index*, **References:** 1: 2: (United Nations Statistics Division, 2023); 3: Calculated by the authors (Supplementary Spreadsheet 3). * We replaced missing or unaltered data values with by the most recent data on record.

3.5.2 Analytical procedures

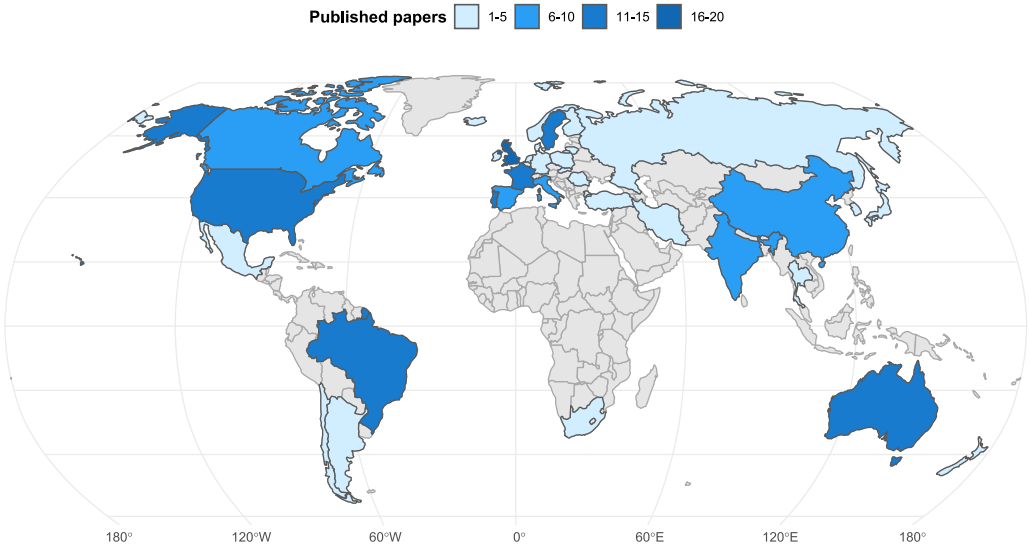
We used Generalized Linear Model (GLM) as it is matches with non-linear relations and is suited for diverse distribution types and categorical predictors (Gelman and Hill, 2008). We verified the dependent variables' partial control over its predictors through Partial Dependence Plot (PDP), which allows a linear regression relation to be linear (Friedman 2001). We standardized the Human Resources on Research & Development variable with log(x) +1. We used the first author address country as a factor on the analyses, hence, there is a chance of area (local) bias. However we assume the literature mainly as a local production, as most of EIA practice is made at project level (Wood, 2014), and the system differs among countries (Wathern, 1998). We also used a boxplot for exploratory goals.

3.5.3 Study risk of bias assessment

There is a risk of overrepresentation bias of language (English), country and research areas in detriment to social sciences and humanities (Mongeon and Paul-Hus, 2016; Pranckutė, 2021; Singh et al., 2018; Vera-Baceta et al., 2019). The possible misrepresentation biases are historical, publication, temporal, and language (non-English). These biases will be reduced in further improvements of this research. The causes are the database (WoS), language filter, time window, active learning algorithm, and the exclusion of grey literature.

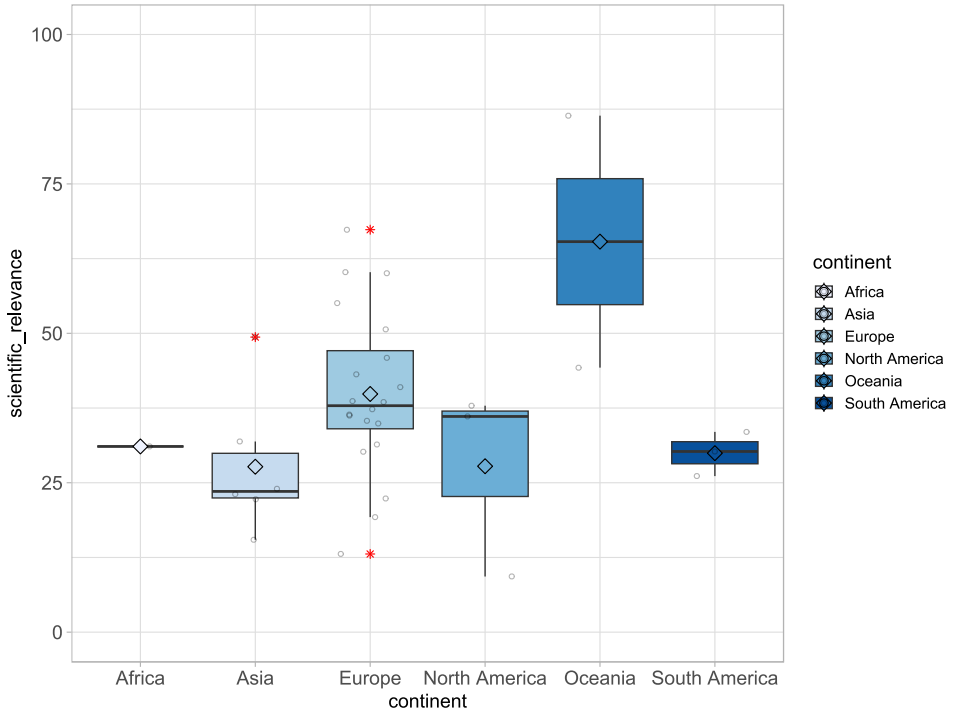
3.6 RESULTS

Most of the scientific production about Environmental Impact Assessment (EIA) is concentrated on Europe (75) and North America (22), followed by South America (14), Asia (11), Oceania (10) and Africa (4) (**A3 Figure 2**).



A3 Figure 2. Number of published papers by country.

Therefore, within developed nations continents, the most relevant research is developed by Oceania, Europe and North America (**A3 Figure 3**). South America and Africa have less relevant research.

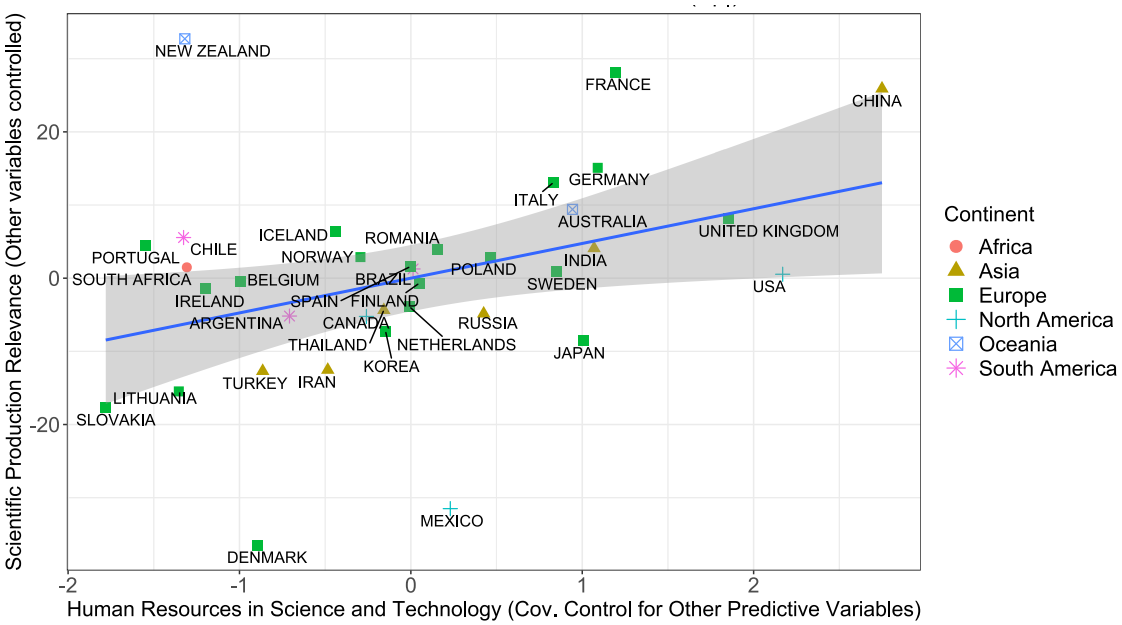


A3 Figure 3. Boxplot of Scientific relevance (mean) by continent.

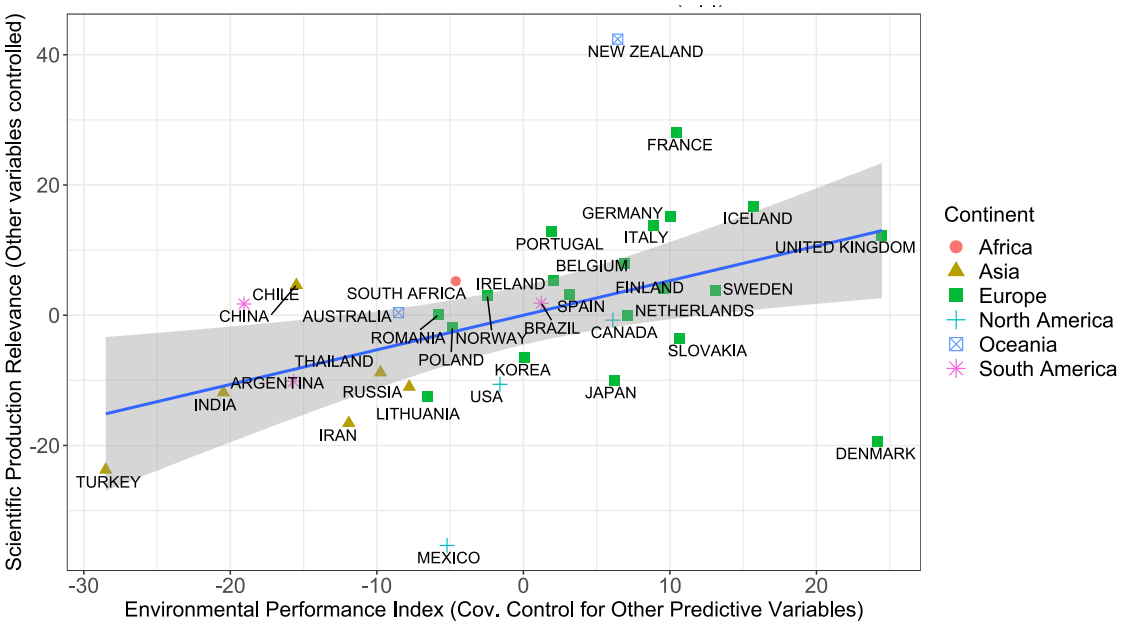
EPI and R&D Human Resources were significative to scientific relevance (**A3. Table 1**; **A3. SM. Figure 1** and **A3. SM. Figure 2**). The PDP confirms the significance of these variables a covariance control to the other predictive measures (**A3 Figure 4** and **A3 Figure 5**). The PDPs also show articles from New Zealand, Denmark and Mexico as common outliers to both scenarios. China appears as an outlier to R&D human resources PDP. New Zealand is in both cases a scientific relevance upper outlier, while China stands out in human resources, and Mexico and Denmark are lower outliers for scientific relevance.

A3. Table 2. GLM output. Scientific relevance ~ *(Environmental variables + education variable + research variables)*. (Null deviance: 8526.9 on 34 degrees of freedom. Residual deviance: 5743.6 on 27 degrees of freedom. AIC: 295.84)

Coefficients				
Estimate	Std.	Error	t-value	Pr(>|t|)
(Intercept)	-42.975	31.481	-1.365	0.183
Biodiversity habitat index	-0.296	0.241	-1.225	0.231
Environmental performance index	0.531	0.207	2.559	**0.016**
Wetlands cover loss	0.237	0.131	1.811	0.081
Tree cover loss	-0.129	0.197	-0.658	0.516
Grassland cover loss	-0.009	0.147	-0.062	0.950
Tertiary education enrollment	-0.002	0.134	-0.018	0.986
R&D human resources	4.746	2.278	2.083	**0.046**



A3 Figure 4. Partial dependence plot: scientific production relevance with other variables controlled x Human resources in Science and Technology as a covariance control for other predictive variables.



A3 Figure 5. Partial dependence plot: scientific production relevance with other variables controlled x Environmental Performance Index as a covariance control for other predictive variables.

3.7 DISCUSSION

Not unexpectedly, our results show that biotic component methodological literature is produced mostly on developed countries. Furthermore, these countries also produce the most scientific relevant papers. Moreover, this relevance is associated with higher EPI and Human Resources on R&D rather than habitat and vegetation loss. These results reflect an uneven response to EIA's biotic component challenges among nations. The EPI measures the compliance of environmental policies based on indicators such vegetation cover loss, habitat protection and others (Wolf et al., 2022). Logically, these measures are partially related to EIA role into the decision-making process of impact-mitigation. Hence, the EPI reflects EIA's policy framework. Moreover, EPI is strongly positive correlated with the Gross Domestic Product (GDP) of countries (Wolf et al., 2022).

However the EIA's policy and practice should be based on scientific evidence (Cashmore, 2004). Furthermore, nations which destiny higher percentual of GDP to R&D have more universities, journals, publication and citation (Meo et al., 2013). Therefore, R&D is a driver for the scientific relevance, while the EPI is a reflex of environmental policy compliance – as it was intended to be –, including EIA. Within this context, developing countries conservation efforts may be jeopardized as EIA quality research is lacking. These countries are usually megadiverse (Scheffers et al., 2012), faces other biodiversity challenges (Rands et al., 2010) and need improvements on EIA policy (McCullough, 2017) and practices (Wood, 2003). Furthermore, the EIA practices may affect sustainable development and biodiversity conservation (George, 1999).

There is no simple solution for this issue. Although the R&D founding may improve the number of publications and consequently the scientific relevance, further research still needs to be implemented as reference for EIA. Furthermore, these investments require these countries GDP improvement, which increase rate is below the goals for least developed countries (UNDESA, 2022). Therefore, short and mid-term interventions require the internationalization of this subject research. However, although the EIA goals are common among the nations, there are still system and policy differences that may represent a challenge. To overcome this issue, the

internationalization should happen through a partnership between developed and developing countries.

3.8 CONFLICT OF INTERESTS

None.

3.9 AKNOWLEDGEMENTS

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3.10 REFERENCES

Adenle, A.A., Stevens, C., Bridgewater, P., 2014. ScienceDirect Global conservation and management of biodiversity in developing countries : An opportunity for a new approach. Environ. Sci. Policy 45, 104–108. https://doi.org/10.1016/j.envsci.2014.10.002

ASReview Core Development Team, 2020. ASReview Software Documentation.

Barber, P.H., Ablan-lagman, M.C.A., Cahyani, D., Crandall, E.D., Ravago-gotanco, R., Juinio-meñez, M.A., 2014. Advancing biodiversity research in developing countries : the need for changing paradigms 90, 187–210.

Cashmore, M., 2004. The role of science in environmental impact assessment: Process and procedure versus purpose in the development of theory. Environ. Impact Assess. Rev. 24, 403–426. https://doi.org/10.1016/j.eiar.2003.12.002

Department of Economic and Social Affairs of the United Nations Secretariat, 2014. Country Classification: World Economic Situation and Prospects.

Dyer, R.J., Gillings, S., Pywell, R.F., Fox, R., Roy, D.B., Oliver, T.H., 2017. Developing a biodiversity-based indicator for large-scale environmental assessment: a case study of proposed shale gas extraction sites in Britain. J. Appl. Ecol. 54, 872–882. https://doi.org/10.1111/1365-2664.12784

Ferraz, G., 2012. Twelve guidelines for biological sampling in environmental licensing studies. Nat. a Conserv. 10, 20–26. https://doi.org/10.4322/natcon.2012.004

Fisher, B., Christopher, T., 2007. Poverty and biodiversity: Measuring the overlap of human poverty and the biodiversity hotspots. Ecol. Econ. 62, 93–101. https://doi.org/10.1016/j.ecolecon.2006.05.020

Gelman, A., Hill, J., 2008. Andrew Gelman - Data Analysis Using Regression and Multilevel Hierarchical Models, 1st ed. Cambridge University Pres, New York.

George, C., 1999. Testing for sustainable development through environmental assessment. Environ. Impact Assess. Rev. 19, 175–200. https://doi.org/10.1016/S0195-9255(98)00038-9

Gontier, M., Balfors, B., Mörtberg, U., 2006. Biodiversity in environmental assessment—current practice and tools for prediction. Environ. Impact Assess. Rev. 26, 268–286. https://doi.org/10.1016/j.eiar.2005.09.001

Hatami, R., 2018. Development of a protocol for environmental impact studies using causal modelling. Water Res. 138, 206–223. https://doi.org/10.1016/j.watres.2018.03.034

Jay, S., Jones, C., Slinn, P., Wood, C., 2007. Environmental impact assessment: Retrospect and prospect. Environ. Impact Assess. Rev. 27, 287–300. https://doi.org/10.1016/j.eiar.2006.12.001

Lee, N., George, C., 2000. Environmental Assessment in Developing and Transitional Countries: Principles, Methods and Practice, First ed. ed. John Wiley & Sons, Ltd., Manchester, United Kingdom.

Mandai, S.S., Souza, M.M.P. de, 2021. Guidelines for the analysis of the inclusion of biodiversity in Environmental Impact Statements. Environ. Impact Assess. Rev. 87, 106523. https://doi.org/10.1016/j.eiar.2020.106523

Mandelik, Y., Dayan, T., Feitelson, E., 2005. Planning for biodiversity: The role of ecological impact assessment. Conserv. Biol. 19, 1254–1261. https://doi.org/10.1111/j.1523-1739.2005.00079.x

Marchese, C., 2015. Biodiversity hotspots : A shortcut for a more complicated concept. Glob. Ecol. Conserv. 3, 297–309. https://doi.org/10.1016/j.gecco.2014.12.008

McCullough, A., 2017. Environmental Impact Assessments in developing countries: We need to talk about politics. Extr. Ind. Soc. 4, 448–452. https://doi.org/10.1016/j.exis.2017.07.002

Meo, S.A., Al Masri, A.A., Usmani, A.M., Memon, A.N., Zaidi, S.Z., 2013. Impact of GDP, Spending on R&D, Number of Universities and Scientific Journals on Research Publications among Asian Countries. PLoS One 8, e66449. https://doi.org/10.1371/journal.pone.0066449

Mongeon, P., Paul-Hus, A., 2016. The journal coverage of Web of Science and Scopus: a comparative analysis. Scientometrics 106, 213–228. https://doi.org/10.1007/s11192-

015-1765-5

Pagani, R.N., Kovaleski, J.L., Resende, L.M., 2015. Methodi Ordinatio: a proposed methodology to select and rank relevant scientific papers encompassing the impact factor, number of citation, and year of publication. Scientometrics 105, 2109–2135. https://doi.org/10.1007/s11192-015-1744-x

Page, M.J., Mckenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M.M., Li, T., Loder, E.W., Mayo-Wilson, E., McDonald, S., Mcguinness, L.A., Stewart, L.A., Thomas, J., Tricco, A.C., Welch, V.A., Whiting, P., Moher, D., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Syst. Rev. 10. https://doi.org/10.1186/s13643-021-01626-4

Pranckutė, R., 2021. Web of Science (WoS) and Scopus: The Titans of Bibliographic Information in Today's Academic World. Publications 9, 12. https://doi.org/10.3390/publications9010012

Rands, M.R.W., Adams, W.M., Bennun, L., Butchart, S.H.M., Clements, A., Coomes, D., Entwistle, A., Hodge, I., Kapos, V., Scharlemann, J.P.W., Sutherland, W.J., Vira, B., 2010. Biodiversity Conservation: Challenges Beyond 2010. Science (80-.). 329, 1298–1303. https://doi.org/10.1126/science.1189138

Retief, F., 2010. The evolution of environmental assessment debates: Critical perspectives from South Africa. J. Environ. Assess. Policy Manag. 12, 375–397. https://doi.org/10.1142/S146433321000370X

Sánchez, L.E.L.H., 2013. Avaliação de Impacto Ambiental: Conceitos e métodos, 2ª. ed. Oficina de Textos, São Paulo, SP.

Scheffers, B.R., Joppa, L.N., Pimm, S.L., Laurance, W.F., 2012. What we know and don ' t know about Earth ' s missing biodiversity. Trends Ecol. Evol. 27, 501–510. https://doi.org/10.1016/j.tree.2012.05.008

Singh, G., Thomas, J., Shawe-Taylor, J., 2018. Improving active learning in systematic reviews. arXiv.

UNDESA, 2022. Sustainable Development Goals Report. New York, New York, Usa.

United Nations Statistics Division, 2023. UNdata [WWW Document]. The United Nations. URL https://data.un.org/ (accessed 1.18.23).

van de Schoot, R., de Bruin, J., Schram, R., Zahedi, P., de Boer, J., Weijdema, F., Kramer, B., Huijts, M., Hoogerwerf, M., Ferdinands, G., Harkema, A., Willemsen, J., Ma, Y., Fang, Q., Hindriks, S., Tummers, L., Oberski, D.L., 2021. An open source machine learning framework for efficient and transparent systematic reviews. Nat. Mach. Intell. 3, 125–133. https://doi.org/10.1038/s42256-020-00287-7

Veech, J.A., 2003. Incorporating socioeconomic factors into the analysis of biodiversity hotspots. Appl. Geogr. 23, 73–88. https://doi.org/10.1016/S0143-6228(02)00071-1

Vera-Baceta, M.A., Thelwall, M., Kousha, K., 2019. Web of Science and Scopus language coverage. Scientometrics 121, 1803–1813. https://doi.org/10.1007/s11192-019-03264-z

Wang, Z., Nayfeh, T., Tetzlaff, J., O'Blenis, P., Murad, M.H., 2020. Error rates of human reviewers during abstract screening in systematic reviews. PLoS One 15, 1–8. https://doi.org/10.1371/journal.pone.0227742

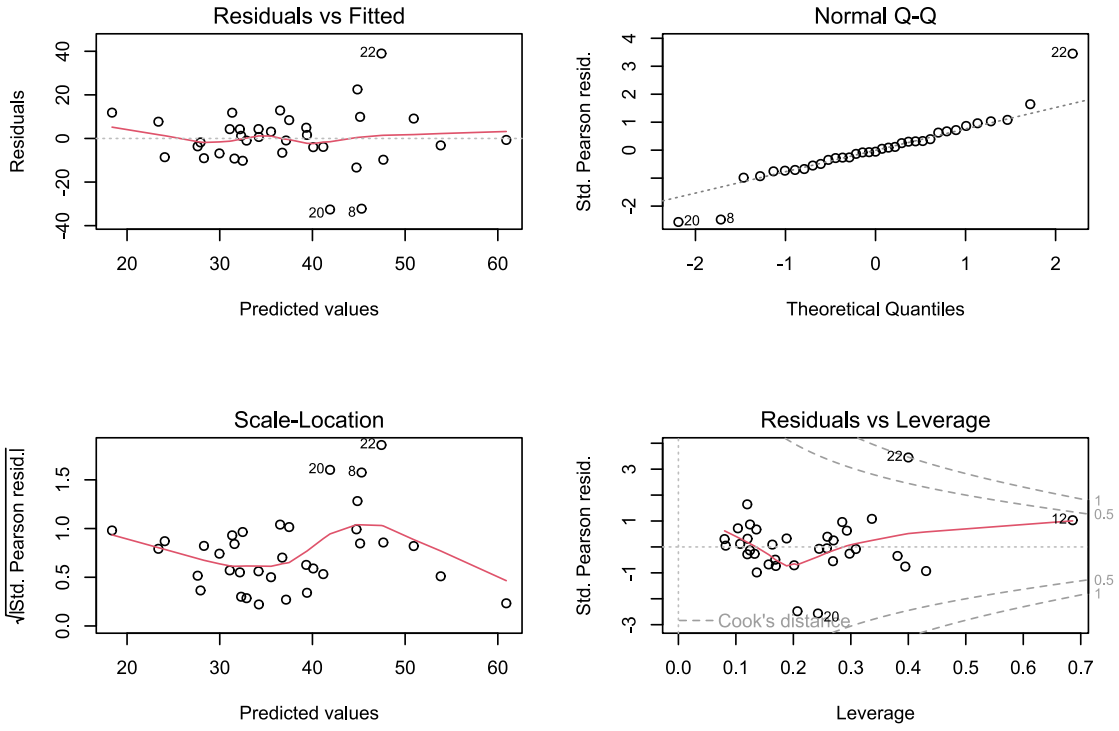
Wathern, P., 1998. Environmental Impact Assessment: Theory and Practice, Revised ed. ed. Routledge - Taylor & Francis Group, London, UK.

Wolf, M.J., Emerson, J.W., Esty, D.C., de Sherbinin, A., Wendling, Z.A., 2022. Environmental Performance Index [WWW Document]. Yale Cent. Environ. Law Policy. URL https://epi.yale.edu/ (accessed 1.19.23).

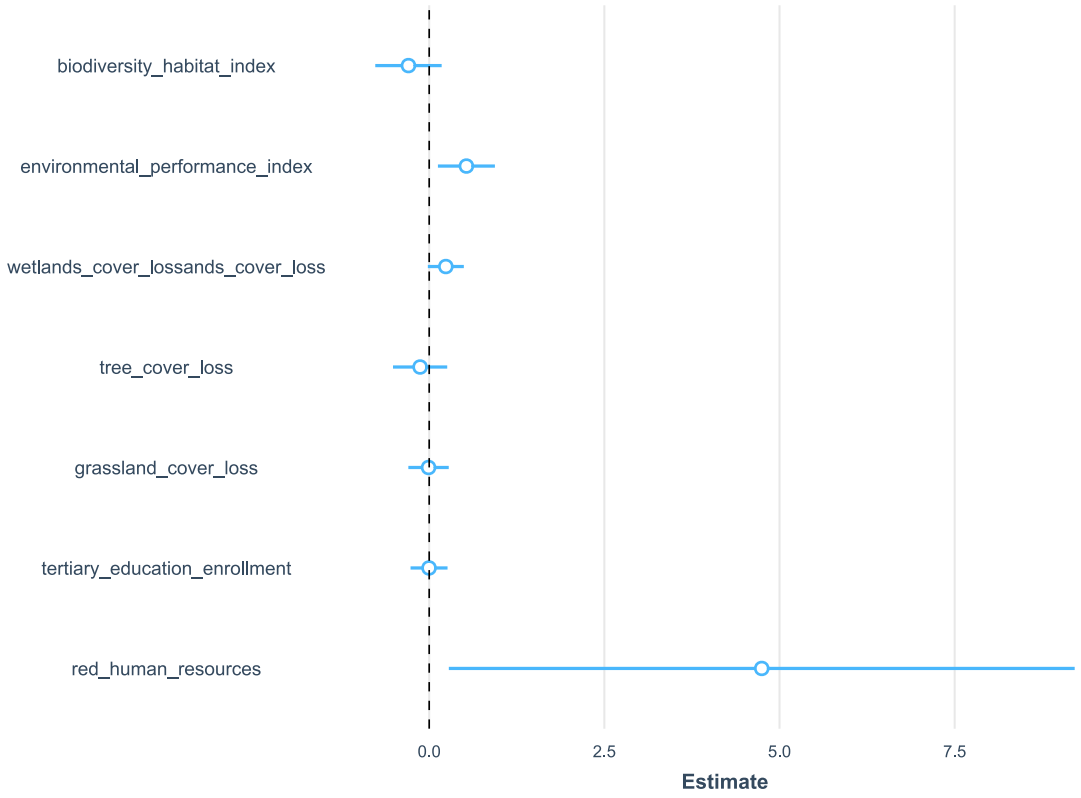
Wood, C., 2014. Environmental Impact Assessment: A Comparative Review, 2ª, Revise. ed. Routledge - Taylor & Francis Group, London, UK.

Wood, C., 2003. Environmental impact assessment in developing countries. Int. Dev. Plan. Rev. 25, 301–321. https://doi.org/10.3828/idpr.25.3.5

3.11 SUPPLEMENTARY MATERIAL – PAPER 3



A3. SM. Figure 1. Residuals. Glm Scientific relevance ~ environmental variable + education variables + research & development human resources



A3. SM. Figure 2. Regression summary plot. Glm Scientific relevance ~ thematic variables.

4 CONSIDERAÇÕES FINAIS

Apesar da importância, a discussão sobre o licenciamento ambiental e a avaliação de impacto ambiental (AIA) está distante do ideal. Isso se estende as esferas popular e acadêmica. O público geral precisa de comunicadores que perfurem as bolhas e os integrem aos processos de tomada decisões e elaboração de políticas ambientais. No que remete a literatura científica, é necessário balancear os resultados entre teoria, qualidade e efetividade. Além disso, os resultados de pesquisa e desenvolvimento (P&D) desta área devem ser discutidos no âmbito de gestão e políticas. Ademais, é essencial que a comunidade internacional volte sua atenção para a AIA nos países em desenvolvimento. Todavia, a academia não é o único mediador para as soluções destes desafios. Logicamente existe uma relação de causa e efeito multidirecional entre a AIA, ciência, gestão e políticas ambientais. Assim, é importante ressaltar o papel dos políticos e gestores na mudança deste paradigma. Apenas um esforço conjunto entre ciência, política e gestão pode fazer frente a estes e os outros desafios.