Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

Conceptual Model to use Citizen Science as a tool to generate public policies for Preservation and Conservation of ecosystems

Sidnei Pereira da Silva
Pesquisador Doutor, UFSCar, Brasil
sidneips@ufscar.br
ORCID 0000-0003-1060-9680

Frederico Yuri Hanai
Professor Doutor, UFSCar, Brasil
fredyuri@ufscar.br
ORCID 0000-0001-8428-0019

Submissão: 21/06/2024
Aceite: 31/08/2024
SILVA, Sidnei Pereira da; HANAI, Frederico Yuri. Modelo Conceitual para Aplicação da Ciência Cidadã como ferramenta de geração de políticas públicas para Preservação e Conservação do Ecossistema. **Periódico Eletrônico Fórum Ambiental da Alta Paulista**, *[S. l.]*, v. 21, n. 1, 2025. DOI: 10.17271/1980082721120255600. Disponível em: https://publicacoes.amigosdanatureza.org.br/index.php/forum_ambiental/article/view/5600.

Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

Modelo Conceitual para Aplicação da Ciência Cidadã como ferramenta de geração de políticas públicas para Preservação e Conservação do Ecossistema

RESUMO

Objetivo – Este estudo propõe um modelo conceitual para implementar a Ciência Cidadã como ferramenta de conservação e preservação dos ecossistemas, com foco no engajamento ativo das comunidades na formulação de políticas públicas.

Metodologia – A pesquisa utilizou revisão bibliográfica sistemática e levantamento de estudos de caso para delinear ideias e possibilidades existentes. O software Vosviewer foi empregado para sistematizar palavras-chave e orientar a construção do modelo.

Originalidade/relevância – O estudo aborda a lacuna teórica relacionada à incipiência dos projetos de Ciência Cidadã no Brasil, que se concentram majoritariamente no modelo de observador cidadão, resultando em conscientização, mas baixo engajamento político.

Resultados – Verificou-se que a regionalização da aplicação da Ciência Cidadã pode promover o envolvimento das comunidades locais na resolução de problemas, gerando dados científicos relevantes e informações para políticas públicas voltadas à conservação da biodiversidade.

Contribuições teóricas/metodológicas – A proposta de regionalização e uso de Ciência Cidadã amplia a abordagem teórica e metodológica no campo, conectando ciência, comunidades e políticas públicas.

Contribuições sociais e ambientais – O modelo sugere caminhos para o engajamento comunitário em ações de conservação e preservação, com impacto potencial na elaboração de políticas públicas e no fortalecimento da biodiversidade.

PALAVRAS-CHAVE: Ciência Cidadã; Modelo Conceitual; Ecossistemas; Políticas públicas.

Conceptual Model to use Citizen Science as a tool to generate public policies for Preservation and Conservation of ecosystems

ABSTRACT

Objective – This study proposes a conceptual model for implementing Citizen Science as a tool for ecosystem conservation and preservation, focusing on the active engagement of communities in public policy formulation.

Methodology – The research employed a systematic literature review and case study analysis to outline existing ideas and possibilities. The Vosviewer software was used to systematize keywords and guide the model's construction.

Originality/relevance – The study addresses the theoretical gap related to the limited development of Citizen Science projects in Brazil, which predominantly follow an observer-based approach, resulting in awareness but limited political engagement.

Results – The findings indicate that regionalizing the application of Citizen Science can foster local community involvement in problem-solving, generating relevant scientific data and insights for public policies aimed at biodiversity conservation.

Theoretical/methodological contributions – The proposed regionalization and use of Citizen Science expand theoretical and methodological approaches in the field, connecting science, communities, and public policies.

Social and environmental contributions – The model suggests pathways for community engagement in conservation and preservation actions, with potential impacts on public policy development and biodiversity strengthening.

KEYWORDS: Citizen Science; Conceptual Model; Ecosystems; Public Policies.

Modelo Conceptual para la Aplicación de la Ciencia Ciudadana como herramienta para la generación de políticas públicas para la Preservación y Conservación del Ecosistema

RESUMEN

Objetivo – Este estudio propone un modelo conceptual para implementar la Ciencia Ciudadana como herramienta de conservación y preservación de ecosistemas, enfocándose en el compromiso activo de las comunidades en la formulación de políticas públicas.

Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

Metodología – La investigación empleó una revisión bibliográfica sistemática y análisis de estudios de caso para delinear ideas y posibilidades existentes. Se utilizó el software Vosviewer para sistematizar palabras clave y orientar la construcción del modelo.
Originalidad/relevancia – El estudio aborda la brecha teórica relacionada con el desarrollo limitado de proyectos de Ciencia Ciudadana en Brasil, que siguen mayormente un enfoque basado en la observación, generando concienciación, pero un bajo compromiso político.
Resultados – Los hallazgos indican que la regionalización de la aplicación de la Ciencia Ciudadana puede fomentar la participación de las comunidades locales en la resolución de problemas, generando datos científicos relevantes e información para políticas públicas dirigidas a la conservación de la biodiversidad.
Contribuciones teóricas/metodológicas – La propuesta de regionalización y uso de la Ciencia Ciudadana amplía los enfoques teóricos y metodológicos en el campo, conectando ciencia, comunidades y políticas públicas.
Contribuciones sociales y ambientales – El modelo sugiere vías para el compromiso comunitario en acciones de conservación y preservación, con impactos potenciales en el desarrollo de políticas públicas y el fortalecimiento de la biodiversidad.

PALABRAS CLAVE: Ciencia Ciudadana; Modelo Conceptual; Ecosistemas; Políticas públicas.

Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

1 INTRODUCTION

Citizen Science is recognized as part of Open Science, one of the pillars of the current research and innovation policy of the European Union (EU). It is also a vital aspect of Horizon Europe, the main funding program for research and innovation in the EU, with a budget of €95.5 billion until 2027 (LAIHONEN et al., 2023; van der WENDE, 2024). The main objectives of Open Science are to make science more efficient, transparent, and interdisciplinary and to enable broader social impact and innovation, with Citizen Science mentioned as a fundamental tool in this scenario, opening up the scientific process, promoting best practices, and increasing knowledge contribution.

Citizen Science has long been considered to have vast potential in the field of education and scientific learning (BONNEY et al., 2009). It is also a rapidly growing research field in its own right, with increasing prominence in areas such as astronomy, ecology, meteorology, and medicine (LEWANDOWSKI et al., 2017). Besides being a distinct research field (Jordan et al., 2015), it can also transcend individual academic disciplines to attract broader public participation in research, advancing scientific knowledge overall (BONNEY et al., 2009). Citizen Science has broad transdisciplinary capacity and integrates natural, physical, and health sciences with humanities and social sciences (PYKETT et al., 2020; TAUGINIENE et al., 2020). It is, therefore, an excellent method to harness non-traditional data sources that address social challenges and contribute to various United Nations Sustainable Development Goals (FRITZ et al., 2019; FRAISL et al., 2020).

Engaging citizens in the production, discussion, and public use of scientific knowledge has become a major challenge has become a major challenge, particularly in the conflicts that exist in the participation and social organization of the actors involved, especially in their representation and in the production of knowledge and educational actions (Andreolli; Dutra-Ludgens, 2015; Jesus; Silva, 2019). An active form of citizenship, which implies a more direct participation of citizens in political life, i.e. through public deliberation on political decisions, is a key element in social innovation and public policy-making, as part of the process of attributing scientific knowledge to the public. Further, public deliberation on political decisions is often difficult due to the frequently documented increase in distrust or indifference of populations towards participatory democracy, in its various forms (ROJON; PILET, 2021). However, at least in principle, the successful articulation of the democratic demand for participation with the central role of scientific knowledge as a governance tool depends on citizens' ability to form solid opinions based on the best available scientific evidence and on discussing them in the political arena.

As a possible solution to this challenge, expanding citizens direct participation in the production of scientific knowledge has become a priority for national and supranational European research institutions and agencies (EUROPEAN COMMISSION, 2016; OSTP, 2019). In particular, “Citizen Science”, defined as “the non-professional involvement of volunteers in the scientific process,” including “data collection, quality assurance, data analysis and interpretation, problem definition, and dissemination of results” is increasingly seen as “a unique opportunity to involve the public in EU policy-making” (EUROPEAN COMMISSION, 2020).

Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

Citizen Science encompasses a wide variety of practices (BEDESSEM; RUPHY 2020) in many scientific domains, particularly in environmental sciences (TURRINI et al., 2018). This article aims to theoretically analyze the integration of Citizen Science with public policies, highlighting its transformative potential in environmental management and proposing a conceptual model to implement participatory Citizen Science for awareness and community organization as means to generate ecosystem preservation and conservation policies.

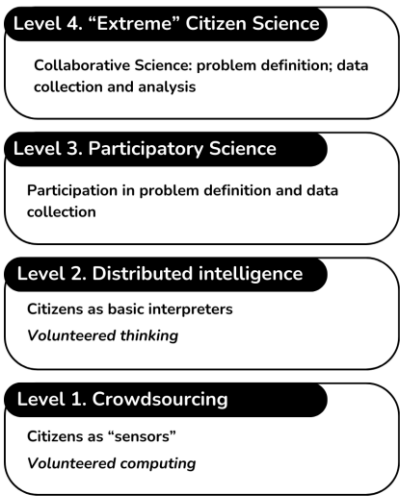
2 THEORETICAL FUNDAMENTATION

2.1 Citizen Science

Citizen Science refers to the active involvement of the public in scientific research. It is a growing practice in which scientists and citizens collaborate to produce new knowledge for science and society (VOHLAND et al., 2021). Citizen Science is used in a wide range of research fields, including ecology, biology, and conservation, health and medical research, astronomy, media and communications, and information science (KULLENBERG et al., 2016).

In general, citizens can participate in the scientific process at different levels, such as the development of research questions and hypotheses, data collection, data analysis, drawing conclusions, and data dissemination. The levels of participation were coined by Haklay (2013): crowdsourcing, distributed intelligence, participatory science, and extreme Citizen Science. According to Haklay, the levels range from 'citizens as sensors' (crowdsourcing) and 'citizens as interpreters' (distributed intelligence) to levels where participants are more involved in defining problems and collection protocols (participatory science) or even part of the entire development of the scientific process (extreme Citizen Science) (Figure 1).

Figure 1. Four levels of participation and involvement in Citizen Science.



Adapted from Haklay, 2013

Citizen Science projects yield genuine scientific outcomes capable of addressing research questions or even generating information for conservation actions, management

decisions and environmental policies (TWEDDLE et al., 2012). Citizen Science is research like any other, carrying out all the regular stages of the research process. However, Citizen Science has some additional opportunities that stand out from general research processes. It is important that research in which citizens play an active role is designed according to the principles of Open Science, with high-quality scientific practices. Citizen Science projects require thoughtful approaches and time, especially in the fields of communication, data management, and ethics (KUNST; NASTASE; BOGERT, 2021).

In extreme Citizen Science projects (HAKLAY, 2013) for instance, participants have a more active role in the development of the project itself. They can engage in sessions where results are discussed and interpreted by participants, defining future actions and also disseminate results to other stakeholders. Citizen policy-making can be another outcome of Citizen Science initiatives; after all, those most affected by public policies should decide which policies are implemented and how they will influence their lives. For this reason, it is extremely important that they are well-informed about scientific and technological processes and aware of their capacities to influence decision-making processes.

2.2 Public Policy

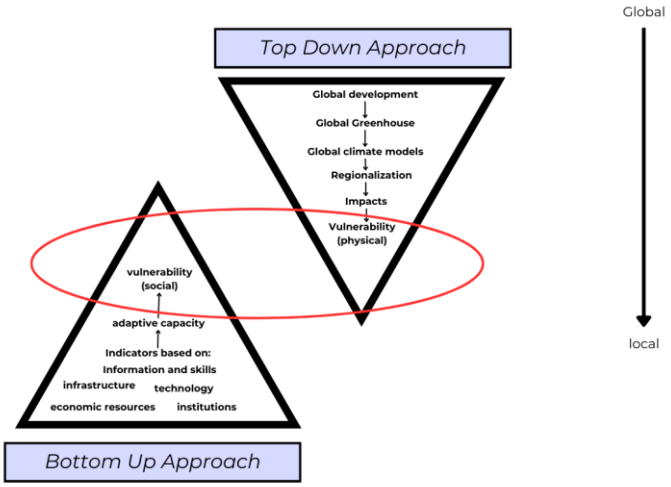
Public policies comprise the set of actions and guidelines adopted by the government to address specific issues (MARTINEZ, 2022). The development of policies involves a technical and political process of articulating and aligning objectives and means of the actors. Policies are therefore actions that contain objectives and the means to achieve them, however well or poorly identified, justified, articulated, and formulated. These policies are created and/or enacted on behalf of the public, typically by a government agency (Top-down), they can be made collectively by non-profit organizations (RINFRET et al., 2018), co-produced with communities or citizens (BOVAIRD et al., 2023; BRANDSEN et al., 2018), and may include experts (BLOMKAMP, 2018), scientists, engineers, and other stakeholders.

Public policy focuses on decisions that create outcomes of a political system, such as transportation policies, the management of a public health service, the administration of a school system (ANDERSON, 2003). The development of public policies can be characterized as a dynamic, complex, and interactive system through which public issues are identified and resolved by creating new policies or reforming existing ones (PETER, 1998).

There are two ways to implement policies: Top-Down and Bottom-Up (Figure 2). The former means that a central government or legislature imposes a decision made without direct citizen participation. The Bottom-Up approach suggests that implementation should start with the "target audience" since they are considered the true implementers of the policy (GIRWOOD, 2013).

Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

Figure 2. Schematic representation of Top-Down and Bottom-Up implementation in climate adaptation policies.



Source: Adapted from Dessai; Hulme (2003)

3 METHODOLOGY

The methodology adopted for this study consisted of a critical systematic review of existing literature on Citizen Science, public policies, and ecosystem preservation. Additionally, case studies exemplifying the successful implementation of Citizen Science as public policy in different geographical and socioeconomic contexts was explored.

3.1 Systematic Review

A systematic review is one that uses a systematic method to summarize evidence on issues with a detailed and comprehensive study plan. Despite the growing guidelines for conducting an effective systematic review, we find that the basic steps often begin with formulating the question and then developing criteria and searching for articles, evaluating the quality of included studies, summarizing the evidence, and interpreting the results (KHAN et al., 2003; Rys et al., 2009). Four principles are attributed to a systematic review: (1) marked focus, (2) detailed plan to find all relevant literature, (3) evaluation of the articles found, and (4) synthesizing a knowledge base (WILLIAMS et al., 2020).

The method selected for conducting this systematic review was Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (MOHER et al., 2020). PRISMA is often used to report systematic reviews and meta-analyses of studies evaluating healthcare interventions. The aim of this method is to establish a structured literature review framework in four main stages: (1) Identification, (2) Screening, (3) Eligibility, and (4) Inclusion.

3.1.1 Eligibility Criteria

Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

In order to conduct a systematic review on the implementation of Citizen Science in ecosystem conservation and preservation, clear criteria must be established to ensure the selection of relevant and high-quality studies. Here are some eligibility criteria:

Publication type: Peer-reviewed articles, conference proceedings, reports, theses, and case studies were considered. There were no restrictions on the publication year, journal title, or number of citations. Regarding languages, preference was given to English due to its universal use in scientific literature. Concerning case studies, priority was given to those conducted within the Brazilian territory.

Study design: Primary research studies, reviews, and case studies investigating the role of Citizen Science in ecosystem preservation and conservation were included. Studies not focusing on the specific relationship between Citizen Science and ecosystem preservation and conservation were therefore excluded.

Ecosystem conservation and preservation outcomes: Studies reporting results related to climate change and adaptive governance, such as building community resilience, nature-based solutions, adaptive urban planning, and policy-oriented resilience, were included.

Quality assessment: Study design, methodology, and reporting standards were considered. Both qualitative and quantitative studies were included due to the diversity of methods used in climate resilience studies. Only full-text articles were eligible. Studies lacking sufficient details on Citizen Science activities, studies with limited relevance to ecosystem conservation and preservation, or those with methodological deficiencies will be excluded.

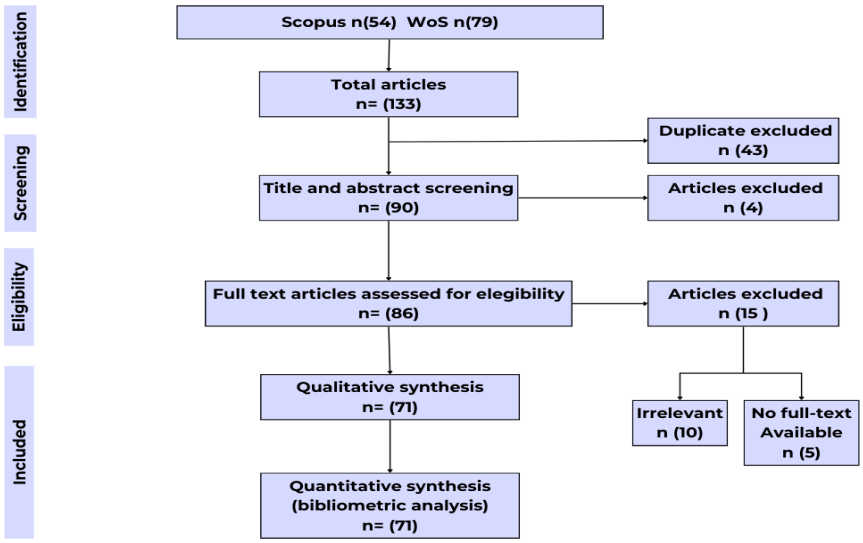
3.1.2 Study Selection

The phrases used to search the Scopus and Web of Science databases, for the systematic literature review, are provided below. They were combined and appropriately crafted to cover the topic, applying suitable restrictions to avoid producing a large number of results. This is a crucial component of the systematic literature review study, impacting the final results. Clearly defining the search term is an important aspect of a research article. The method and results are presented in Figure 3.

SCOPUS - TITLE-ABS-KEY ((“citizen science”) AND (“public policy”) AND (“ecosystem”) AND (“conservation” OR “preservation”))
WOS (Web of Science) - ALL=((“citizen science”) AND ((“public policy”) AND (“ecosystem”) AND (“conservation” OR “preservation”)))

Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

Figure 3. Flow diagram of the systematic review process.



Source: Adapted from PRISMA (2020).

3.2 Case Studies

Maine – USA

In the 1990s, in the north eastern region of the United States, a partnership between a university, a non-governmental organization, and local regulators identified the need to understand the ecology of vernal pools for potential regulation (JANSUJWICZ; CALHOUN, 2010; JANSUJWICZ; CALHOUN, 2017). Stakeholders initiated a Citizen Science program to provide more information about pool ecology to natural resource managers and to increase public awareness about the local ecosystem (MCGREAVY et al., 2016). Vernal pools in New England are relatively small seasonal wetlands (often <0.2 ha) embedded in forested landscapes. They typically dry up every year, are replenished by spring rains, and provide breeding grounds for a suite of invertebrates and amphibian species adapted to life in temporary waters (COLBURN, 2004). During this period, Citizen Science was a relatively new approach to engaging "non-professionals" in scientific investigations, who were tasked with administering surveys, collecting data, and interpreting results. Experts turned to Citizen Science because this approach could increase the size and scale of long-term data sets on ecological and social systems (DICKINSON; BONNEY, 2012). A growing body of research demonstrates how Citizen Science programs can positively impact learning, attitudes about the environment, and ecological literacy (BONNEY et al., 2009). Given these social and ecological characteristics, scientists and regulators identified the desired goal of maintaining or creating landscapes with interconnected vernal pool complexes; human communities that understand and appreciate the multiple ecosystem services and values associated with vernal pools; and conservation policies and strategies that preserve private property rights and opportunities for economic development (CALHOUN et al., 2014).

As a result, collaborators identified potential threats, such as stressors like unplanned landscape development, lack of regulatory policies considering pools as interconnected ecosystems, and unknown changes related to climate change, invasive species, and demographic shifts (KNEITEL, 2014). Connectivity and diversity were identified as key characteristics shaping the system's capacity to respond to changes (FOLKE et al., 2005). In social terms, the diversity of participants and the degree of connection between them influenced the flow of information, learning, and development of problem-solving perceptions (CRONA; BRODIN, 2012).

Brazilian Cases

In Brazil, Citizen Science is still in its early stages. However, ongoing studies can be found. Some of these projects are presented in the following Table 1.

Table 1- Citizen Science Projects in Brazil

Projects	Description
Brydes do Brasil	Addresses a participatory monitoring program of urban rivers in the mountainous region of Espírito Santo in partnership with teachers and students from basic education schools.
A água desse rio é boa? Quem vive nele te conta!	A network about the Bryde's whale in Brazilian jurisdictional waters. It is a voluntary initiative of a team of researchers interested in gathering as many photo-identified Bryde's whale records as possible.
BioTiba – Projetos de Biodiversidade	A proposal to raise awareness among the population about the importance of knowing and preserving biodiversity that promotes the engagement of people in bioblitz activities (a short-duration event for observing, identifying, and recording as many species as possible in a specific area) associated with the use of the iNaturalist platform.
eBird Brazil	The goal is to gather information in the form of bird lists, archive it, and share it freely to provide data for science, conservation, and education.
Recreio Limpo Lab	A project with two objectives: (1) to turn the beach into a research laboratory and mobilize users to investigate the presence of microplastics and characterize litter on beaches, and (2) to investigate participants' environmental perception and possible behavior changes regarding litter.
Que lama é essa?	It is formed by research groups, communities, and volunteer researchers aiming to investigate the situation of water, flood mud, and soils after the rains in January and February 2022, at points in the basins of the Rio das Velhas, Rio Paraopeba, and Rio Doce in Minas Gerais.
AquaRiparia formando sentinelas das águas	Aims to raise awareness and empower communities living in rural and urban areas in the Federal District regarding the preservation of watersheds and the sustainable use of natural resources.
Observando os Rios	A project that brings together communities and mobilizes them around the water quality of rivers, streams, and other water bodies in the localities where they live.
Dados à prova d´água / Waterproofing Data	Investigates the governance of water-related risks, focusing on the social and cultural aspects of data practices. Typically, data flows from local levels to scientific "centers of expertise," and then flood-related alerts and interventions return to local governments and communities.

Source: CIVIS, 2024.

A more detailed description of some citizen science projects developed in Brazil is presented below:

Pantanal – MS

The "Busca ao Lifer – birding festival" is an activity of bird watching and (re)connection with nature, characterized as experience-based ecotourism and a tool of citizen science, promoting experiences in nature, species knowledge, environmental education, and ecotourism in natural environments rich in biodiversity. The event, along with various collaborative platforms such as Biofaces, Wikiaves, eBird, and Táxeus, was held in the Pantanal Biosphere Reserve from 2013 to 2015, in the following Conservation Units: Parque Nacional das Emas (2013), Reserva Particular do Patrimônio Natural Vale do Bugio (2014), and in the Área de Especial Interesse Turístico (AEIT) Estrada Parque do Pantanal (2015). The activities consisted of: primary data collection in the field, photo recap (photo review and sharing of the experience), sharing experiences and "lifers" (first encounter with an unknown species and enjoyment of the experience), compilation of the checklist, and data analysis. During the period, 32 people participated directly and over 500 indirectly, identifying 390 species.

In the researchers' view, the proposal to involve and stimulate active citizen participation can bring multilateral benefits for conservation and sustainability purposes. The results obtained from ecotourism expeditions gather evidence of citizens' commitment and support in generating knowledge about regional biodiversity, bringing a critical transformation of thoughts and conduct, important pillars of critical and transformative environmental education, and also fulfilling some of its objectives, such as the conservation of natural environments and their socio-biodiversity and the development of public policies.

Parque Nacional da Serra dos Órgãos (PARNASO) - RJ

The Parque Nacional da Serra dos Órgãos (PARNASO) is a federal full protection Conservation Unit (UC), which currently covers an area of 20,024 hectares, located in four municipalities in the state of Rio de Janeiro: Magé, Guapimirim, Teresópolis, and Petrópolis. The ConsCiência-Cidadã program (SPAZZIANI et al., 2021) had as its main target audience the residents of communities surrounding the park, tourist guides, scouts, students of Biology, Ecology, Tourism, Physical Education, Environmental Engineering, Agronomy, and Forestry Engineering or related areas, from the municipalities in the region. Registrations were also made online, with a total of 706 participants.

Prefeitura de Quatis – RJ

The municipality of Quatis/RJ through its Secretariat of Sustainability and Environment, launched a decree in 2021, Decree 3019/21, dealing with biodiversity monitoring through citizen science. The purpose of the document is: 1) to foster scientific research; 2) generate information and knowledge about biodiversity in the municipality's Conservation Units; 3) provide visibility of scientific knowledge to the population; and 4) practice environmental education from the

Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

construction of collective knowledge and bring the population closer to academic knowledge. There are 4 areas for research development in the municipality: PNMRSJ - Parque Natural Municipal Ribeirão de São Joaquim; REVISQ – Refúgio da Vida Silvestre; PNMHQ - Parque Natural Municipal Horto dos Quatis; and APA Carapiá. It is a political initiative to introduce citizen science in ecosystem preservation; however, there is no data on ongoing research and studies.

4 METHODOLOGY

4.1 Bibliometrics

Table 2 presents all the keywords obtained in the analysis of occurrence and co-occurrence using the VOSviewer software with the application of citizen science in line with ecosystem conservation and preservation through policies. Cluster 1 focuses on the application of technical activities aimed at data collection and treatment by models; in citizen science, these data are collected by participants through mobile applications, which can be used to identify native or invasive species, environmental quality, among other types of monitoring. Cluster 2 focuses on two aspects: coastal and marine zones, highlighting habitat conservation, and environmental policies and directives related to habitat preservation. Cluster 3 presents the participatory aspect of activities and the social perception of citizen science, the engagement of organizations, and the need for a transdisciplinary approach. Finally, Cluster 4 addresses adaptive governance in search of a dynamic process in the face of the unpredictability of climate change.

Table 2 - Clusters of occurrence and co-occurrence of keywords obtained in VOSviewer.

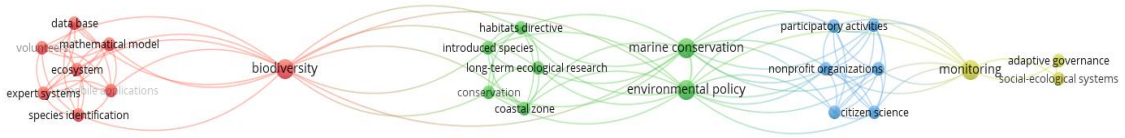
Cluster 1	Cluster 2	Cluster 3	Cluster 4
Ecosystems	**Conservation**	**Citizen Science**	**Adaptive governance**
Biodiversity	Coastal zone	Non-profit organizations	Monitoring
Database	Environmental policy	Participatory activities	Socio-ecological systems
Specialized systems	Habitat directives	Social perception	
Mathematical models	Introduced species	Transdisciplinary approach	
Mobile applications	Long-term ecological research		
Species identification	Marine conservation		
Volunteers			

Source: own authorship

Figure 4 shows the occurrence/co-occurrence keyword network based on the 71 publications included from Scopus and WoS. 4 groups of keywords were formed based on their co-occurrence frequencies. These clusters represent different research themes on the topic of applying Citizen Science, as discussed previously.

Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

Figure 4 depicts the keyword occurrence/co-occurrence network based on 71 publications from Scopus and WoS. Four keyword clusters were formed based on their co-occurrence frequencies. These clusters represent different research themes on the application of Citizen Science, as discussed earlier.



Source: VOSviewer (2024)

The results of the systematic review were used to construct the conceptual model for the application of Citizen Science in ecosystem conservation and preservation supported by public policies.

4.2 Conceptual Model: Implementation of Citizen Science Through Public Policies for Ecosystem Conservation

Once the main concepts and variables were identified after the systematic literature review, a conceptual model was developed on how to apply Citizen Science in the process of ecosystem preservation and conservation supported by policies. Relationships between key concepts and variables were established, and a visual representation of these relationships was created (Figure 5). This conceptual model aims to provide a comprehensive and integrated view of implementing Citizen Science through public policies for ecosystem conservation, considering theoretical, practical, ethical, and long-term aspects.

The pillars of the model are based on active and equitable participation, community engagement, open communication channels, and broad dissemination, providing adequate technologies, creating monitoring tools such as mobile applications, training and capacity building, continuous monitoring through performance indicators, including the use of artificial intelligence in the process.

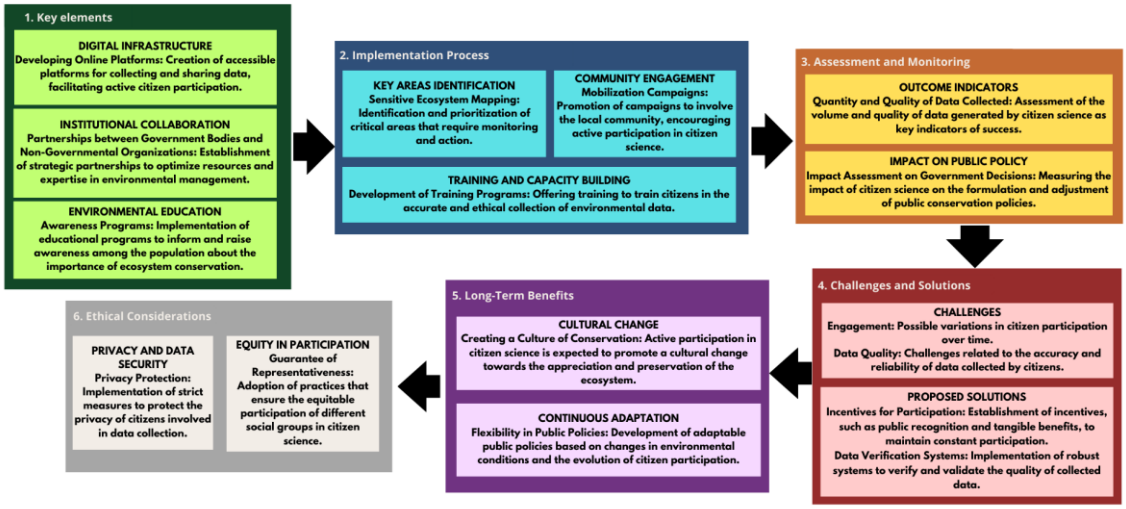
The fundamental principle of this model is that information should be produced, analyzed, and shared widely and openly. It starts from the principle that common knowledge is established when intellectual and cultural resources are collectively managed, shared, used, and governed by all or the majority of members of a community. According to Hess & Ostrom (2005), "rules related to knowledge, epistemic communities, and information technologies must be continuously adapted as these technologies and communities change and grow." The rules need to be flexible and adaptable to create an effective institutional design and ensure resource sustainability. Structures must be inclusive and promote equitable collaboration, regardless of culture, gender, socioeconomic status, or language, enhancing individuals' and communities' capacity to act on their own behalf and contribute to the well-being of their communities.

Citizen Science is embedded as a tool of Open Science, which in turn is the idea that knowledge from different domains should be shared openly as soon as possible in the research process (Nielsen, 2011). Beyond the discourse on Open Access, which has focused on free online access to research results (Chan & Gray, 2014), Open Science sets out to expand access and participation in the processes and results throughout the research lifecycle (Bartling & Friesike,

Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

2014). This also implies that a wide range of actors, including "citizens," can participate in the production of knowledge, from agenda setting to research design, and from dissemination and acceptance of research to subsequent policy influence (Chan et al., 2015).

Figure 5. Conceptual model for the application of Citizen Science in ecosystem conservation and preservation through supportive policies.



Source: own authorship

One of the best practices for stakeholder governance in Citizen Science is effective communication among all parties. This involves establishing open and honest communication channels between researchers, community members, government officials, and industry representatives to ensure that everyone is informed and involved in project design and decision-making processes (Bonney et al., 2014). This can be achieved through regular meetings, workshops, and other forms of communication such as newsletters, social media, and websites.

Volunteer training and continuous feedback are two of the most obvious ways to improve quality, but numerous approaches have been developed, such as comparison with professionally collected data, validation by experts, peer review, filtering out outliers through automated processing, consensus-based methods including weighting by volunteer performance, and the use of standardized and calibrated measurement tools (Fritz et al., 2019). Additionally, artificial intelligence and data mining are now increasingly used to enhance quality (e.g., providing volunteers with tips based on automatic species recognition from photographs) (Koch et al., 2023). Systematic bias can be addressed using the same statistical methods applied to professionally collected data, while approaches are being developed to deal with volunteer bias (Fritz et al., 2019), which is particularly relevant to Citizen Science.

5 POLITICAL SUPPORT FOR CITIZEN SCIENCE AND CITIZEN SCIENCE SUPPORT IN POLICY FORMATION AND OPERATION

The success in bridging science with decision-making is a hallmark of effective natural resource management and policies (Palmer, 2012). To achieve this goal, policies need to address natural resource issues as complex socio-ecological systems (SES) and rely on science that is informed by multiple perspectives to produce credible and useful evidence to key stakeholders (Berkes & Folke, 2000; Boyd & Folke, 2012). Engagement of diverse stakeholders can generate useful knowledge and create support for the regulation of difficult-to-conserve natural resources (Hart & Calhoun, 2010).

Starting from the premise of "thinking globally and acting locally," policy implementation at the city scale can be advantageous when it comes to participation and effectiveness in ecosystem preservation. Locally, the process of citizen education, training, and preparation will be facilitated and can increase engagement, mainly through the sense of ownership, as these are community projects. Local institutions and experts can assist in projects, training, and technical knowledge. Thus, cities, now regionally and collectively, can provide the "backdrop for a patchwork quilt" of diversified monitoring, each made as a result of different concerns but with the possibility of using accumulated data for a broader view (Haklay, 2015).

The process of designing Citizen Science programs to promote specific policies and outcomes related to ecological literacy and socio-ecological system resilience for example, is still in its infancy (Phillips et al., 2015; Shirk et al., 2012; Jordan et al., 2015). In the conception of these projects, resilience refers to the "capacity to respond and adapt to environmental changes in order to sustain and develop the same fundamental function, infrastructure, and identity" (Chapin et al., 2009:5). This definition aligns with the evolving objectives of regulatory efforts for ecosystem preservation and conservation. The conceptual model seeks to show how Citizen Science fits into this resilience and conservation puzzle contributing to the formation of adaptive governance. Although the role of environmental legislation has been well studied and documented in relation to governance (Bodin & Prell, 2011; Boyd & Folke, 2012), this work, through systematic review and model construction, examined the specific relationship between Citizen Science and the emergence of adaptive governance forms.

Thus, it is highlighted the importance of establishing a regulatory infrastructure that supports Citizen Science as public policy. Collaboration platforms need to be created among scientists, government officials, and citizens, enhancing the effectiveness of environmental preservation actions. Additionally, Citizen Science promotes transparency and accountability, crucial elements for policy effectiveness. Another highlight is that Citizen Science can play a crucial role in environmental awareness, encouraging changes in individual behavior and habits. This cultural transformation is vital for the long-term success of public policies aimed at ecosystem preservation and conservation.

6 CONCLUSIONS

Many Citizen Science programs focus on understanding the complex interactions between humans and the environment (Crain et al., 2014) and improving ecosystem

management (Couvet et al., 2008). A growing body of research demonstrates how Citizen Science programs can positively impact learning, people's attitudes toward the environment, and ecological literacy (Bonney et al., 2009). Most Brazilian cases involve citizens as observers or "ecotourists," which, in Haklay's terms (2013), would be crowdsourcing, the simplest mode of Citizen Science application. Undoubtedly, this model generates relevant data for ongoing research, but it does not create the community engagement that a problem would generate for a community, especially in the long term.

Initiatives such as those in Maine demonstrate that Citizen Science can be effective in proposing public policies for biodiversity preservation and conservation. Further, what was proposed by the municipality of Quatis/RJ is an excellent opportunity to bring together academic science and Citizen Science to demonstrate that there is no difference between them and that they are part of the same process. In this process of searching for cases of Citizen Science application in Brazil, we noticed the application is still incipient, and also that the concept is used incorrectly; in many cases, data sets are not made available, unlikely what is expected of an open science process, a premise of Citizen Science. In addition to contributing to scientific research, fundamental projects in Citizen Science drive collective critical thinking, serving as a tool in the formulation and implementation of public policies.

The systematic review and case studies show that when people come together to produce knowledge, as in Citizen Science, the process does not occur in a vacuum but instead "tends to evolve with working rules and dynamic organizations" (Olsson et al., 2004:76) that create the social order in which knowledge is used (Jasanoff, 2004). Processes where participants are nested, diverse, and partially redundant sets of institutions are involved in robust deliberations on problems and policies can promote the formation of adaptive governance (Dietz et al., 2003). This refers to the ability of actors and institutions to address complexity, uncertainty, and change by developing rules that are flexible and can evolve to suit a specific situation (Dietz et al., 2003, BOYD; FOLKE; 2012). This governance approach "appears to have been preceded by the emergence of informal networks that help facilitate information flows, identify knowledge gaps, and create nodes of expertise important for ecosystem management that can be leveraged at critical junctures" (Olsson et al., 2006:12). Flexible networks have played a crucial role in promoting governance in a wide range of ecosystem management contexts (Anderies et al., 2006; Goldstein, 2008; Sendzimir et al., 2008).

Citizen Science as public policy not only contributes to the immediate resolution of environmental problems but also builds a solid foundation for long-term sustainability. Its inclusion in governmental agendas represents a significant step towards a more balanced future, where active societal participation is recognized as a vital force in preserving ecological diversity and promoting global well-being.

7 REFERENCES

ANDERIES, J.M., B.H WALKER, AND A.P. KINZIG. **Fifteen weddings and a funeral : case studies and resilience-based management**. Ecology and Society 11(1): 21. 2006. http://www.ecologyandsociety.org/vol11/iss1/art21/

ANDERSON, J. E. **Chapter 1: The Study of Public Policy. Public Policymaking**: An Introduction. 2003. Boston: Houghton Mifflin Company.

ANDREOLI, F. C; DUTRA - LUTGENS, H. ANÁLISE DO SIGNIFICADO DAS ÁREAS PROTEGIDAS DE ITIRAPINA (SP) E SUA RELAÇÃO COM A COMUNIDADE URBANA DO ENTORNO COMO SUBSÍDIO ÀS AÇÕES DE EDUCAÇÃO AMBIENTAL. **Periódico Eletrônico Fórum Ambiental da Alta Paulista**, *[S. l.]*, v. 11, n. 4, 2015. DOI: 10.17271/1980082711420151268.

BARTLING, S.; FRIESIKE, S. eds. **Opening Science: The Evolving Guide on How the Internet Is Changing Research**. 2014. Collaboration and Scholarly Publishing. Berlin: SpringerOpen. http://www.openingscience.org/get-the-book/.

BEDESSEM, B. RUPHY. S. **Citizen Science and Scientific Objectivity**: Mapping Out Epistemic Risks and Benefits''. Perspectives on Science 28(5): 630-54. 2020.

BERKES, F., FOLKE. C. **Linking social and ecological systems for resilience and sustainability**. Pages 1–25 in F. Berkes, C. Folke, and J. Colding, editors. Linking social and ecological systems: management practices and social mechanisms for building resilience. 2012. Cambridge University Press, Cambridge, UK.

BLOMKAMP, E. **The Promise of Co-Design for Public Policy**: The Promise of Co-Design for Public Policy". Australian Journal of Public Administration. 77 (4): 729–743. 2018. doi:10.1111/1467-8500.12310. hdl:11343/283557.

BODIN, Õ., PRELL. C. **Social networks and natural resource management. Uncovering the social fabric of environmental governance.** 2011. Cambridge University Press,
Cambridge, UK.

BONNEY, R, SHIRK, J.L., PHILLIPS, T.B., WIGGINS, A., BALLARD, H.L., MILLER-RUSHING, A.J. PARRISH. J.K. **Next Steps for Citizen Science**. Science. 343 (6178): 1436–37. 2014. https://doi.org/10.1126/science.1251554.

BONNEY, R., C. B. COOPER, J. DICKINSON, S. KELLING, T. PHILLIPS, K. V. ROSENBERG, AND J. SHIRK. 2009. **Citizen science: a developing tool for expanding science knowledge and scientific literacy**. BioScience 59:977–984. http://dx.doi.org/10.1525/bio.2009.59.11.9.

BOVAIRD, T., LOEFFLER, E., YATES, S., VAN RYZIN, G., ALFORD, J. **International survey evidence on user and community co-delivery of prevention activities relevant to public services and outcomes**. *Public Management Review*, *25*(3), 657-679. 2023.

BOYD, E.,; FOLKE, C. editors. **Adapting institutions: governance, complexity, and social-ecological resilience**. 2012. Cambridge University Press, New York, New York, USA. http://dx.doi. org/10.1017/cbo9781139017237

BRANDSEN, T., VERSCHUERE, B., & STEEN, T. (Eds.). **Co-Production and Co-Creation: Engaging Citizens in Public Services** (1st ed.). 2018.. Routledge. https://doi.org/10.4324/9781315204956

CALHOUN, A. J. K., JANSUJWICZ, J.S.; BELL, K.P., HUNTER. M.L. **Improving management of small natural features on private lands by negotiating the science-policy boundary for Maine vernal pools**. Proceedings from the National Academy of Sciences of the United States of America 111(3):11002–11006. 2014.

CHAN, L., OKUNE,A., SAMBULI. N. **What Is Open and Collaborative Science and What Roles Could It Play in Development?** In Open Science, Open Issues, ed. Sarita Albagli, Maria Lucia Maciel, and Alexandre Hannud Abdo, 87–112. 2015. Brasília: Instituto Brasileiro de Informação em Ciência e Tecnologia (IBICT). http://livroaberto.ibict.br/bitstream/1/1061/1/Open%20Science%20open%20issues_Digital.pdf.

CHAN, L.; GRAY. E. **Centering the Knowledge Peripheries through Open Access: Implications for Future Research and Discourse on Knowledge for Development**. In Open Development: Networked Innovations in International

Development, ed. Matthew L. Smith and Katherine M. A. Reilly, 197–222. 2014. Cambridge, MA/Ottawa: MIT Press/IDRC.

CHAPIN III. F.S., KOFINAS, G.P., FOLKE. C. **Principles of Ecosystem Stewardship**: Resilience-Based Natural Resource Management in a Changing World. Springer, New York (2009)

COLBURN, E. A. **Vernal pools: natural history and conservation**. 2004. McDonald & Woodward Publishing Company, Blacksburg, Virginia, USA.

COUVET, D., F. JIGUET, R. JULLIARD, H. LEVREL, AND A. TEYSSEDRE. **Enhancing citizen contributions to biodiversity science and public policy.** Interdisciplinary Science Reviews 33(1):95–103. 2008. http://dx.doi.org/10.1179/030801808X260031

CRAIN, R., C. COOPER, J. L. DICKINSON. **Citizen science: a tool for integrating studies of human and natural systems.** Annual Review of Environment and Resources 39(1):641–665.2014. http://dx.doi.org/10.1146/annurev-environ-030713-154609
BOYD, E., AND C. FOLKE. **Adapting Institutions: Governance, Complexity and Social-Ecological Resilience.** Cambridge University Press, Cambridge, UK. 290 p. 2012.

CRONA, B., BODIN. Ô. **Knowledge, social networks and leadership: setting the stage for the development of adaptive institutions?** Pages 11–36 in E. Boyd and C. Folke, editors. Adapting institutions: governance, complexity, and social-ecological resilience. 2012. Cambridge University Press, New York, New York, USA. https://doi.org/10.1017/CBO9781139017237.005.

DESSAI, S.; HULME, M. **Does climate policy need probabilities?** Tyndall centre for climate change research working paper 34. UEA, Norwich. 2003.

DICKINSON, J. L., BONNEY, R. editors. **Introduction: why citizen science?** In Citizen science: public participation in environmental research. 2012. Cornell University Press, Ithaca, New York, USA

DIETZ, T., OSTROM, E., STERN, P.C. **The struggle to govern commons**. Science. 302, 1907–1912. 2003.

EUROPEAN COMMISSION. **Best Practices in Citizen Science for Environmental Monitoring.** COMMISSION STAFF WORKING DOCUMENT. 2020.

EUROPEAN COMMISSION. **Co-creating resilient societies**. Trust. European Research. 2016.

FOLKE, C., T. HAHN, P. OLSSON, J. NORBERG. **Adaptive governance of social-ecological systems**. Annual Review of Environment and Resources. 2005. 30:441-473.

FRAISL, D., CAMPBELL, J., SEE, L., WEHN, U., WARDLAW, J., GOLD, M., ET AL. **Mapping citizen science contributions to the UN sustainable development goals**. *Sustain. Sci.* 15, 1735–1751. 2020. doi:10.1007/s11625-020-00833-7

FRITZ, S., SEE, L., CARLSON, T., HAKLAY, M., OLIVER, J. L., FRAISL, D., et al. **Citizen science and the United Nations sustainable development goals**. *Nat. Sustain.* 2 (10), 922–930. 2019. doi:10.1038/s41893-019-0390-3

GIRDWOOD, J. **Top-down and Bottom-up Approaches within Implementation**. February, v. 21, p. 2013, 2013

GOLDIN, J., SURANSKY, C.; KANYERERE, T., 2023. **Keep the Flow: Citizen Science as Agonistic Learning. Citizen Science**: Theory and Practice, 8(1), p.5.DOI: https://doi.org/10.5334/cstp.515

GOLDSTEIN, B.E. **Skunkworks in the embers of the cedar fire: enhancing resilience in the aftermath of disaster**. Human Ecology 36:15-28. 2008. DOI: 10.1007/s10745-007-9133-6

HAKLAY M, DÖRLER D, HEIGl F, et al. **What is citizen science? The challenges of definition.** In: Vohland K, et al. (eds) The science of citizen science. Cham: Springer, pp. 13-33. 2021.

HAKLAY, M. **Citizen Science and Policy: a European Perspective**. 2015. Woodrow Wilson Center for International Scholars, Washington DC.

HAKLAY, M. **Citizen science and volunteered geographic information**: Overview and typology of participation. In D. Sui, S. Elwood, & M. Goodchild (Eds.), Crowdsourcing geographic knowledge: Volunteered geographic information (VGI) in theory and practice (pp. 105–122). 2013. Dordrecht: Springer.

HART, D. D., CALHOUN. A.J.K. **Rethinking the role of ecological research in the sustainable management of freshwater ecosystems**. Freshwater Biology 55:258–269. 2010. http://dx.doi. org/10.1111/j.1365-2427.2009.02370.x

HESS, C.; OSTROM, E. **A Framework for Analyzing the Knowledge Commons**: a chapter from Understanding Knowledge as a Commons: from Theory to Practice." (2005). Libraries' and Librarians' Publications. 21. https://surface.syr.edu/sul/21

ICMBio. Decreto-Lei n° 1.822 de 30 de Novembro de 1939. Acesso em 12/01/2024.

JANSUJWICZ, J S.; CALHOUN A.J. Editor. **Community-based Strategies for Strengthening Science and Influencing Policy: Vernal Pool Initiatives in Maine**.. Maine Policy Review 26.2 2017 : 33 -42, https://digitalcommons.library.umaine.edu/mpr/vol26/iss2/7.

JANSUJWICZ, J. S., CALHOUN. A.J.K. **Protecting natural resources on private lands: the role of collaboration in land-use planning**. Pages 205–233 in S. Trombulak and R. F. Baldwin, editors. Landscape-scale conservation planning. Springer-Verlag, New York, New York, USA. 2010. http://dx.doi.org:10.1007/978-90-481-9575-6_10.

JASANOFF, Sheila. **States of knowledge: the co-production of science and social order.** London: Routledge, 2004.

JESUS, W. J T., SILVA, S. A A. Educação ambiental e as contribuições na gestão dos recursos hídricos. **Periódico Eletrônico Fórum Ambiental da Alta Paulista**, *[S. l.]*, v. 15, n. 3, 2019. DOI:10.17271/1980082715320192194.

JORDAN, R. C., A. CRALL, S. GRAY, T. PHILLIPS, AND D. MELLOR. **Citizen science as a distinct field of inquiry.** BioScience 65:208211. 2015. http://dx.doi.org/10.1093/biosci/biu217

KHAN KS, KUNZ R, KLEIJNEN J, ANTES G. **Five steps to conducting a systematic review**. J R Soc Med. 2003;96(3):118–21.

KNEITEL, J. M. **Inundation timing, more than duration, affects the community structure of California vernal pool mesocosms**. Hydrobiologia 732:71–83. 2014.

KOCH,W, HOGEWEG, L, NILSEN E. B., O'HARA R B., FINSTAD A G. **Recognizability bias in citizen science photographs.** R. Soc. Open Sci. 2023. 10221063221063 http://doi.org/10.1098/rsos.221063

KULLENBERG, C; KASPEROWSKI, D; DORTA-GONZÁLEZ, P (ed.). **What Is Citizen Science? – A Scientometric Meta-Analysis**. PLOS ONE. 11 (1): e0147152. 2016

KUNST, S.; NASTASE, N.; BOGERT, M. **Citizen Science at TU Delft**.(SK, NN - TU Delft Library; MB - TU Delft Science Centre; REPORT DOI: 10.24404/61baf1840b940e0009447ecd. 2021

LAIHONEN, P. **Comparative Perspectives on School Attendance, Absenteeism, and Preventive Measures in Europe and Beyond** in: The Science of Citizen Science. edited by K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J.

Perelló, M. Ponti, R. Samson, and K. Wagenknecht, Springer, Cham, (Hardcover book), VII/529 pp., ISBN-978-3-030-58278-4.

LEWANDOWSKI, E.; OBERHAUSER, K.S. **Butterfly citizen scientists in the United States increase their engagement in conservation**. Biological Conservation, 208: 106–112. 2017. DOI: https://doi.org/10.1016/j.bio-con.2015.07.029

MAMEDE, S.; BENITES, M.; ALHO, C.J.R. **Ciência cidadã e sua contribuição na proteção e conservação da biodiversidade na reserva da biosfera do pantanal**. Revbea, São Paulo, V. 12, No 4: 153-164, 2017.

MARTINEZ, J. **What is Public Policy?.** civiced.org. Archived from the original on 12 October 2022. Retrieved 12 October 2022.

MCGREAVY, B.; LIEDENFELD, L. BIELUCH, K. SILKA, L. LEAHY, J. ZOELLICK, B. C**itizen Science and Natural Resource Governance: Program Design for Vernal Pool Policy Innovation**." Ecology and Society, vol. 21, no. 2, 2016. JSTOR, http://www.jstor.org/stable/26270395. Accessed 25 Jan. 2024.

MOHER D, LIBERATI A, TETZLAFF J, ALTMAN DG. **Preferred reporting items for systematic reviews and meta-analyses**: the PRISMA statement. Ann Intern Med. 2009;151:264–9, W64. https://doi.org/10.7326/0003-4819-151-4-200908180-00135.

MOILANEN, S. **When to Use User-Centered Design for Public Policy**. Stanford Social Innovation Review. 2019.

NIELSEN, M. **Reinventing Discovery:** The New Era of Networked Science. 2011. Princeton, NJ: Princeton University Press

OLSSON, P., L. H. GUNDERSON, S. R. CARPENTER, P. RYAN, L. LEBEL, C. FOLKE, C. S. HOLLING. **Shooting the rapids: navigating transitions to adaptive governance of social-ecological systems**. Ecology and Society 11(1):18. 2006.

OLSSON,P., FOLKE,C.; BERKES,F. **Adaptive Co-Management for Building Resilience in Social Ecological Systems**. Environmental Management, 34: 75-90. 2004.

OSTP. Office of science and technology policy. 2019. **Implementation of federal prize and citizen science authority**: fiscal years 2017-2018.

PALMER, M. A. **Socioenvironmental sustainability and actionable science**. BioScience 62(1):5–6. 2012. http://dx.doi.org/10.1525/ bio.2012.62.1.2

PETER. J. **Analyzing Public Policy.** London: Pinter. Jones, Bryan, Frank Baumgartner, and James True. 1998.

PHILLIPS, T., BONNEY, R. SHIRK. J. L. **What is our impact? Toward a unified framework for evaluating outcomes of citizen science participation**. Pages 82–95 in J. Dickinson and R. Bonney, editors. Citizen science: public participation in environmental research. 2012. Cornell University Press, Ithaca, New York, USA.,

PREFEITURA MUNICIPAL DE QUATIS. Decreto municipal 3019 de 2021. Acesso em 21/12/2023.

PYKETT, J., CHRISINGER, B., KYRIAKOU, K., OSBORNE, T., RESCH, B., STATHI, A., TOTH, E., WHITTAKER, A. C. **Developing a citizen social science approach to understand urban stress and promote wellbeing in urban communities**. Palgrave Communications, 6(1), 2020. Article 1. https://doi.org/10.1057/s41599-020-0460-1.

RANNEY, F. **Beyond Foucault: Toward a user-centered approach to sexual harassment policy**. Technical Communication Quarterly. 9 (1): 9–28. 2009. doi:10.1080/10572250009364683

RINFRET, S. R., SCHEBERLE, D.; PAUTZ, M. C. **Public Policy: A Concise Introduction.** 2018. Washington, D.C.: CQ Press.

ROJON, S.; PILET, J.-B. **Engaged, indifferent, skeptical or critical? Disentangling attitudes towards local deliberative mini-publics in four Western European democracies**. Sustainability, 13(19), 2021. 10518.

RYS P, WLADYSIUK M, SKRZEKOWSKA-BARAN I, MALECKI MT. **Review articles, systematic reviews and meta-analyses**: which can be trusted? Polskie Archiwum Medycyny Wewnetrznej. 2009;119(3):148–56

SENDZIMIR, J., P. MAGNUSZEWSKI, Z. FLACHNER, P. BALOGH, AND G. MOLNAR. **Assessing the resilience of a river management regime: informal learning in a shadow network in the Tisza River Basin**. Ecology and Society, 13(1): 11. 2008. http://www.ecologyandsociety.org/vol13/iss1/art11.

SHIRK, J. L., H. L. BALLARD, C. C. WILDERMAN, T. PHILLIPS, A. WIGGINS, R. C. JORDAN, E. MCCALLIE, M. MINARCHEK, B. V. LEWENSTEIN, M. E. KRASNY, AND R. BONNEY. 2012. **Public participation in scientific research: a framework for deliberate design.** Ecology and Society 17(2):29. http://dx.doi.org/10.5751/ es-04705-170229

SPAZZIANI, M. L., GHELER-COSTA, C., RUMENOS, N.N. **Ciência cidadã em ambientes naturais** - Botucatu : UNESP-IBB/ITAPOTY. São Paulo: Cultura Acadêmica, 2021, 130p.

TAUGINIENĖ, L., BUTKEVIČIENĖ, E., VOHLAND, K., HEINISCH, B., DASKOLIA, M., SUŠKEVIČS, M., ET AL. **Citizen science in the social sciences and humanities**: the power of interdisciplinarity. *Palgrave Commun.* 6 (1), 89–11. 2020. doi:10.1057/s41599-020-0471-y

TURRINI, T., DÖRLER, D., RICHTER, A., HEIGL, F., BONN, A. T**he threefold potential of environmental citizen science - generating knowledge, creating learning opportunities and enabling civic participation**. Biol. Conserv., 225 (September, 2018, pp. 176-186

TWEDDLE, J.C., ROBINSON, L.D., POCOCK, M.J.O. & ROY, H.E. **Guide to Citizen Science:** Developing, Implementing and Evaluating Citizen Science to Study Biodiversity and the Environment in the UK. Natural History Museum and Centre for Ecology & Hydrology for UK-EOF, London, UK. 2012.

van der WENDE, M. **How Open Can It Be? The Promise of Open Systems and Open Science Under Siege**. In: Engwall, L. (eds) Internationalization in Higher Education and Research. Higher Education Dynamics, vol 62. 2024. Springer, Cham. https://doi.org/10.1007/978-3-031-47335-7_6

VOHLAND, K., LAND-ZANDSTRA, A., CECCARONI, L., LEMMENS, R., PERELLÓ, J., PONTI, M., SAMSON, R., & WAGENKNECHT, K. (Eds.). **The science of citizen science**. Springer International Publishing. 2021.

WILLIAMS, R. I.; CLARK, L.A., CLARK, W. R., RAFFO. D. M. **Re-examining systematic literature review in management research: additional benefits and execution protocols** Eur. Manag. J. (2020), 10.1016/j.emj.2020.09.007

Periódico Eletrônico Fórum Ambiental da Alta Paulista
Electronic Journal Environmental Forum of Alta Paulista
ISSN 2966-2931 Suporte Online / Online Support - ISSN 1980-0827 Suporte CD-ROM / CD-ROM Support
Edição em Português e Inglês / *Edition in Portuguese and English* - v. 21, n. 1, 2025

DECLARAÇÕES

CONTRIBUIÇÃO DE CADA AUTOR

Sidnei Pereira da Silva – responsável pela idealização do trabalho, incluindo a concepção, a definição de objetivos e a metodologia aplicada. Foi responsável pela curadoria e análise dos dados. Foi responsável pela redação inicial e revisão e edição final.

Frederico Yuri Hanai – Responsável pela revisão crítica e revisão final conjunta e supervisão dos trabalhos

DECLARAÇÃO DE CONFLITOS DE INTERESSE

Nós, Sidnei Pereira da Silva e Frederico Yuri Hanai, declaramos que o manuscrito intitulado **"Modelo Conceitual para Aplicação da Ciência Cidadã como ferramenta de geração de políticas públicas para Preservação e Conservação do Ecossistema":**

1. **Vínculos Financeiros**: Não possui vínculos financeiros que possam influenciar os resultados ou interpretação do trabalho.
2. **Relações Profissionais**: Não possui relações profissionais que possam impactar na análise, interpretação ou apresentação dos resultados ou nenhuma relação profissional relevante ao conteúdo deste manuscrito foi estabelecida.
3. **Conflitos Pessoais**: Não possui conflitos de interesse pessoais relacionados ao conteúdo do manuscrito.