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Technical quality of flora baseline surveys in environmental impact assessment: a counterproof study of a mining project in Minas Gerais, Brazil

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ABSTRACT

Biodiversity surveys are essential in Environmental Impact Assessment (EIA), providing baseline information for impact prediction and decision-making. Brazilian legislation requires the identification of scientific, economic, rare, or endangered value, but does not specify methodologies. We evaluated the floristic survey conducted for the EIA of an iron ore mining project in the *Serra de Ouro Preto*, at the entrance of Ouro Preto, a UNESCO World Heritage Site. We conducted a pioneering counter-assessment based on a one-day field survey in *Campos Rupestres* vegetation, depositing vouchers in herbarium, and identifying specimens with taxonomic rigor; additional records were retrieved from virtual herbaria. We documented 93 species, 79 recorded in the field and 14 from herbaria. Of the field-recorded species, 56 (71%) were absent from the EIA report, including four endangered species and one microendemic species (new status at species rank). We also identified 23 medicinal species and seven ruderal species. Herbarium records revealed another microendemic species restricted to the affected area and absent from the EIA report. These findings indicate incomplete legal compliance and inadequate biodiversity characterization, highlighting the need for clearer regulations and stronger technical guidance. Despite the limitations of the case study approach, findings have clear implications to EIA theory and practice.

KEY POLICY HIGHLIGHTS

- A pioneering counter-proof survey of *Campos Rupestres* vegetation recorded 79 vascular plant species, 56 missing from the EIA report, including four endangered species and a new status to science at species level.
- Herbarium data added 14 more species, including a recently described taxon, microendemic to the affected area, also missing from the report.
- The methodology used in the EIA failed to meet legal requirements for identifying the most impacted species – rare, endangered, and microendemic – leading to their exclusion from mitigation and compensation measures.
- Findings underscore the need for clearer regulations and technical standards for floristic sampling and taxonomic identification in EIAs.

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1. Introduction

Accurate environmental baseline studies in Environmental impact assessments (EIA) are essential to ensure accuracy in impact prediction, and, in the event projects are approved, sound implementation of mitigation and compensation measures (Fernandes et al. 2023). The quality and reliability of biodiversity surveys and inventories directly influence the identification of species at risk, the prediction of potential impacts, and the formulation of appropriate conservation strategies. In megadiverse countries such as Brazil, where biodiversity is both vast and fragile, robust floristic assessments are crucial for maintaining ecosystem integrity and guiding sustainable development (Hallatt et al. 2015; Dias et al. 2022).

Brazil has the richest flora in the world, with nearly 47,000 species of algae, fungi, and plants, of which almost 20,000 are endemic (Brazilian Flora Group 2022). Remarkably, a new species of plant is described every two days (Sobral and Stehmann 2009). The Atlantic Forest (*Mata Atlântica*) is a hotspot of biodiversity hosting 15,782 species, of which 45% are endemic to the biome (Myers et al. 2000; Stehmann et al. 2009). *Campos Rupestres* (Rupestrian rocky fields) are composed of mosaics of open vegetation types, associated with quartzite, sandstone, or ferruginous rock outcrops (Azevedo et al. 2024). These vegetation formations typically occur at mountain tops, where

resistant rocks are exposed, giving them an insular and azonal character. They occur throughout almost all biomes in Brazil (Silveira et al. 2016), although they are formally known to be located within a Brazilian type of savanna known as Cerrado (IBGE 2012). Their rich floristic composition is influenced by geological and pedological complexity (Messias et al. 2012; 2013). The extreme environmental conditions of *Campos Rupestres*, with nutrient-poor soils, high solar radiation, wind exposure, and strong seasonality, make these regions important centers of endemism (Echternacht et al. 2011; Colli-Silva et al. 2019). While *Campos Rupestres* occupy a restricted area, estimated at 0.8% of Brazil's surface, they host almost 15% of the country's plant richness (Silveira et al. 2016). The ferruginous *Campos Rupestres*, also known as *cangas*, are very special and highly threatened; composed of rocks such as *itabirite*, their banded iron formation is rare worldwide, and they are a direct target of iron ore mining (Carmo and Kamino 2015).

Scientific collections are essential for documenting biodiversity and plant species occurrence are mainly recorded based on vouchered specimens (exsiccates) deposited in herbaria (Lavoie 2013; Nualart et al. 2017). Exsiccates provide the morphological foundation for defining taxa (e.g. species, genera, families), a task carried out by expert taxonomists, but they can also offer valuable information on genetics, anatomy, phenology, among other biological traits. Taxon circumscription and classification evolve as new data – such as DNA sequences, macro- and micromorphological traits – become available. Without vouchered specimens in herbaria, plant identifications cannot be verified or updated (e.g. Eisenman et al. 2012). Additionally, the morphological traits that distinguish closely related species often lie in minute details, typically in the reproductive structures, making precise identification dependent on careful examination under a stereomicroscope. In megadiverse regions, such as the *Campos Rupestres* of Brazil, species identification is often a complex process that requires long-term learning to train both specialist taxonomists and generalists. It also depends on access to physical fertile specimens and specialized literature. Although artificial intelligence and machine learning offer prospects for the future (Wäldchen and Mäder 2018), their proper functioning depends on databases identified by specialists, and in megadiverse regions their effective implementation is still far from reality. Moreover, certain aspects will always require manipulation and close observation that depends on the human handling and expertise.

Conducting rapid biodiversity surveys in species-rich environments is challenging. The efficacy of such surveys depends on methodological approaches, including sampling effort, seasonal timing, and the taxonomic expertise of the team involved. The

Walking Survey (Filgueiras et al. 1994) is a commonly employed technique, which, when properly executed, allows for the recording of a broad range of species within a given area. However, the success of this method depends on factors such as the observer's ability to identify species in the field, the availability of reproductive structures, and the representativeness of the sampled area. This method also requires that species that cannot be identified in the field should be collected for subsequent identification in the laboratory. In complex ecosystems like *Campo Rupestres*, a poorly executed survey can lead to severe underestimations of species richness and ecological interactions.

Previous studies have pointed out critical gaps in biodiversity surveys and inventories, particularly in the context of environmental impact assessments (Ritter et al. 2017; Gannon 2021; Dias et al. 2022, 2025). Insufficient sampling effort, inadequate methodological approaches, and the failure to consult scientific collections often result in incomplete or inaccurate species lists (e.g. Pimenta and Fonseca 2021). These shortcomings compromise the effectiveness of conservation measures and can lead to the approval of projects that pose irreversible threats to biodiversity. In this context, ensuring that environmental assessments adhere to rigorous scientific and methodological standards is imperative to avoid the underestimation of ecological impacts.

Brazilian environmental legislation often requires flora baseline surveys and post-approval monitoring in environmental impact assessments (Brazil 1981; CONAMA 1986). While the shortcomings of biodiversity surveys and monitoring programs have long been investigated in Brazil, these studies tend to focus on the follow-up stage and draw conclusions and recommendations based on content analysis of EIA-related documents (e.g. Pimenta and Fonseca 2021; Margarido et al. 2025). Despite the importance of verifying floristic data collected for EIAs on the ground, no *in situ* counterproof of floristic inventories had been published in a scientific approach in Brazil prior to this study. This work represents the first attempt to systematically assess the accuracy of an EIA floristic survey by comparing its findings with field observations and herbarium records. While empirically based in Brazil, findings presented here are likely to be relevant to a global audience of practitioners and regulators, given that Brazil's EIA system shares many traits with other international systems (Fonseca and Gibson 2020; Serrano and Fonseca 2024). By highlighting methodological inconsistencies and gaps in the EIA report of a relevant case study, this research underscores the urgent need for more reliable and scientifically robust environmental assessments in megadiverse ecosystems located in Brazil and elsewhere.

2. Material and methods

2.1. Methodological approach and study area

This study adopted a predominantly descriptive investigatory approach, based on content analysis of EIA documents and fieldwork. The research purposefully targeted a specific EIA project conveniently located near the laboratories and research institutions of the co-authors. The area was chosen mainly for its environmental, historical, scenic, and cultural significance to the city of Ouro Preto, a UNESCO World Heritage site. Moreover, this case study is similar to numerous other greenfield case studies worldwide, which makes it relevant to a broader international audience. Finally, a large portion of its affected area has been publicly accessible since the 18th century, allowing for *in situ* verifications by third-parties.

The study area corresponds to the *Serra de Ouro Preto*, which is located within the hotspot of the Atlantic Forest biome, in southeastern Brazil, Minas Gerais state, in the southeastern portion of the *Quadrilátero Aquífero-Ferífero (Iron-Aquifer Quadrangle region)*, within the municipality of Ouro Preto (Figure 1). The region is classified as a highest priority level for biodiversity conservation in Brazil (Drummond et al. 2005, as cited in; IDE–Sisema 2025). It corresponds to the southern limit of the *Cachoeira das Andorinhas* Environmental Protection Area and is part of the Buffer Zone of the *Tripuí* Ecological Station. The area is also part of the Biosphere Reserve of the *Espinhaço* and of the Atlantic Forest (UNESCO, as cited in IDE–Sisema 2025).

As an area of long-standing human occupation, various portions of the *Serra de Ouro Preto* have acquired local names throughout history. Our project was carried out more specifically in the region known as *Serra do Chafariz* or *Pedra/Serra do Amolar*. These areas are located between *Serra do Siqueira* to the west and *Serra do Veloso* to the east (IBGE 1985: Ouro Preto Map SF-23-X-A-III-4). It is noteworthy that the name *Serra de Ouro Preto* has historically been attributed to the northern slope of the Mariana syncline (IBGE 1976: Mariana Map SF-23-X-B-I-3). These mountain ranges can be considered part of the surroundings of the *Santo Amaro do Botafogo* subdistrict. For consistency and standardization, we will refer to the study area as *Serra de Ouro Preto*, as this has been the most currently used name. Extending in an east-west direction, this mountain range spans approximately 12 km, between the coordinates 20°21'54.4'S/43°36'48.0'W and 20°22'06.7'S/43°30'21.5'W.

Serra do Ouro Preto comprises both forest and grassland phytophysionomies. The Seasonally Semideciduous Forest is primarily found in the lower areas with greater soil accumulation, whereas ferruginous and quartzitic rupestrian grasslands (*Campos Rupestres*) are mainly located in the higher portions, where the soil is shallower and oligotrophic.

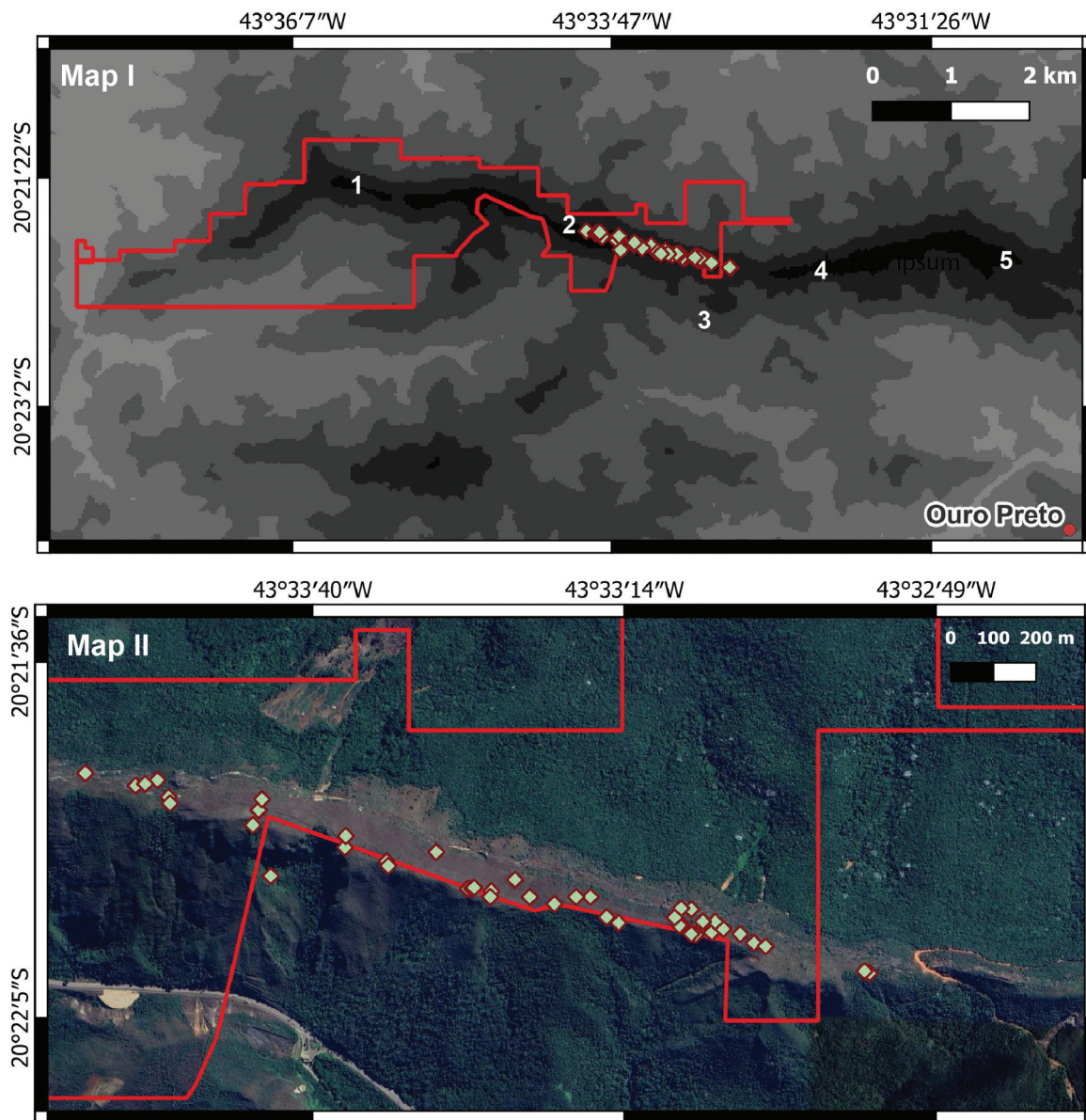
2.2. Counterproof flora survey

Field survey was conducted on 24 January 2025, in the same month as the primary data collection that took place in the EIA of the mining project. Plant collections were conducted in a public and non-protected area along Brazil's Royal Road (*Estrada Real, Caminho Velho*) and registered throughout SisBio (Biodiversity Authorization and Information System, ICMBio, Brazil, number 14,957–2), in accordance with Brazilian regulations for scientific research.

Sampling took place along the historical road that follows the ridge of the mountain, between the coordinates 20°22'00.8'S / 43°32'50.0'W and 20°21'45.9'S / 43°33'55.2'W. The survey was restricted to the *Campos Rupestres*, primarily in the ferruginous phytophysionomy, but also in the quartzitic one (Figure 1). Fertile branches (with flowers, fruits, or spores) were collected for subsequent taxonomic identification. Photographs of the specimens and their environment were also taken. To ensure precise collection locations, geographic coordinates were recorded using online applications and GPS. Additionally, floral and fruiting structures were preserved in 70% ethanol to aid in identification, while field data – including phenology, growth habit, habitat, and the coloration of vegetative and floral structures – were recorded. A vouchered specimen was herborized for each species, following standard techniques (Fidalgo and Bononi 1984), and incorporated into the OUPR Herbarium.

Specimen determination (identification preferably at species level) was carried out using identification keys, consultation of specialized bibliographic references, comparison with previously identified specimens in the OUPR herbarium and virtual herbaria (REFLORA/speciesLink), with a focus on determinations made by expert taxonomists. Whenever necessary, specimens were observed under the stereomicroscope, measured with a ruler and caliper, and flowers were rehydrated and dissected. For each identification, we consulted the *Flora and Funga of Brazil (2025)* to check species distribution, compare descriptions with the physical characteristics of the specimens, and search for diagnostic features. Species occurrence records were also checked through speciesLink. If needed to confirm identification, protologues and type specimens were also examined. Classification adopted for the accepted scientific names follows *Flora and Funga of Brazil (2025)* and/or the *World Flora Online (2025)*.

Field survey was complemented with records for the area identified at species level in the virtual herbaria SpeciesLink, JABOT and GBIF, using the search filters '*Serra do Amolar*', '*Pedra do Amolar*', '*Serra do Chafariz*', and '*Serra do Siqueira*', from *Campos Rupestres* within Ouro Preto municipality. We opted not to filter for '*Serra de Ouro Preto*', because there




Legend

Important local references











- 1 - Serra do Siqueira
- 2 - Serra do Chafariz
- 3 - Botafogo
- 4 - Pedra do Amolar
- 5 - Serra do Velozo

 Counterproof Botanical Records

 Polygonal of the Directly Affected Area sampled in the Environmental Impact Assessment



Altitude (m)

-  600 - 700
-  700 - 800
-  800 - 900
-  900 - 1000
-  1000 - 1100
-  1100 - 1200
-  1200 - 1300
-  1300 - 1400
-  1400 - 1500
-  1500 - 1589

Reference Maps



Geographic Coordinate System DATUM WGS84 - Map I scale 1:65,000 - altitudinal data from TOPODATA.
 Map II scale 1:12,000 - satellite image from Google Earth. Elaborated with QGIS by F. Torres & L. Echternach. July 2025

Figure 1. Map of the counter-assessment botanical records and the directly affected area. Map I: elevation and main toponyms. Map II: satellite image of the one-day field survey area.

are synonymous toponyms within this municipality. The species found were updated according to accepted names in the online Flora and Funga of Brazil (2025).

Endemicity was assessed at the state level using Flora and Funga of Brazil (2025); Borsali (2012) was consulted to identify species endemic to the *Quadrilátero Aquífero-Ferífero*, and Carmo et al. (2018) for those endemics to the ferruginous *Campos Rupestres*. The conservation status of the sampled species was based on the Brazilian Red List of Threatened Flora (MMA Ordinance No. 148, 2022), as well as on the Red List of the National Center for Flora Conservation (CNCFlora, 2025). For species not yet evaluated by CNCFlora, we report assessments by specialists following the International Union for Conservation of Nature (IUCN 2019) criteria, whenever available in the taxonomic literature. Rarity was assessed in relation to species included in the work *Plantas Raras do Brasil* (Rare Plants of Brazil) (Giulietti et al. 2009). The identification of weed species follows Lorenzi (2008). Medicinal potential and use were considered based on specialized literature in the field, cited case by case in the results.

2.3. Analysis of the flora assessment results reported in the environmental impact study

Counterproof was carried out considering the results presented in the EIA report in the region of *Serra do Siqueira* and *Serra do Chafariz* (Brandt Meio Ambiente 2024), for the environmental licensing process by the mining company BHP-BILLITON BRASIL, for Mineral Exploration with Geological Drilling for iron ore (Siqueira-Norte, Phase 1; ANM process 831,546/2002). Regarding flora assessment, the EIA report must comply with the principles and objectives established by the National Environmental Policy (Federal Law No. 6,938 of 31 August 1981) and the applicable environmental legislation, including CONAMA Resolution 01/86. This resolution requires EIAs to identify species of scientific and economic value, including those that are endangered, rare, or endemic. This EIA report stated that it met the requirements set forth in the environmental authority's Terms of Reference from January 2021. The topic 'Flora Diagnosis' of the EIA report (Brandt Meio Ambiente 2024, 158–318) had been based on fieldwork conducted between January 8 and 19, 2024. The inventory collected primary qualitative data in the field through floristic surveys using the method Walking Survey (Filgueiras et al. 1994). The reported method 'was carried out through random searches in the field, aiming to identify the largest possible number of species and thus compile a representative floristic list of the area. The species encountered were identified in the field and/or photographed for later identification through

comparison with herbarium collections and/or with the aid of specialized literature' (Brandt Meio Ambiente 2024, 180, our translation).

The quantitative analysis, through phytosociology, was reported to having been conducted using plots of 1 × 1 m for grassland and savanna physiognomies, following standard procedures for the quantitative assessment of species composition, density, frequency, and dominance. Sampling sufficiency was evaluated through species accumulation curves, rarefaction analyses, and richness estimators (first-order Jackknife), to assess whether the sampling effort in the plots adequately represented the local floristic diversity.

Secondary data were obtained from three studies (Werneck et al. 2000; Pereira 2016; Brandt Meio Ambiente 2022), corresponding, respectively, to the Tripuí Ecological Station, the Chapada de Canga, and the vegetation survey conducted as part of the 'Long-Term Project' by Brandt Meio Ambiente for Samarco in Ouro Preto and Mariana.

The vegetation classification adopted in the EIA report follows IBGE 2012, identifying *Savana Arborizada*, *Savana Gramíneo-Lenhosa*, *Floresta Estacional Semidecidual*, *Campo Rupestre Ferruginoso*, in addition to agricultural cultivation, pasture, forestry and other anthropogenic formations.¹

We compared our results, obtained in the 1-day-field counterproof survey, with those indicated in the EIA report for the same physiognomies —*Campos Rupestres Ferruginoso* and *Savana Gramíneo-Lenhosa*, and their proportion relative to their respective total areas in the project. We excluded the secondary data presented in the EIA report from the comparison, as they do not correspond to the reported affected areas of the project.

3. Results

3.1. Baseline flora counterproof

The *Serra de Ouro Preto* features well-preserved quartzitic and ferruginous rupestrian grasslands in its higher areas, harboring endemic, and endangered species, as well as plants with potential economic value, including medicinal and ornamental species, among others. However, the area also shows signs of disturbance, evidenced by the presence of weed species and recent traces of wildfire, the most recent of which occurred during the dry season of 2024.

The 1-day flora survey identified 79 species in the area belonging to 34 families and 62 genera (Table 1). Eight records were determined at genus level. Four of the species are threatened with extinction according to MMA (MMA) and CNCFlora (2025): *Cambessedesia pityrophylla*, *Cinnamomum erythropus*, and *Solanum viscosissimum* are endangered, while *Evolvulus krameroides* is vulnerable (Figure 2). In addition, two species

Table 1. List of vascular plant species recorded in the ferruginous and quartzitic Campos Rupestres during fieldwork conducted on January 24th 2025.

	Family	Species	Author	Habit	CNCF	MMA	End.	Voucher (OUPR)
1	Amaranthaceae	<i>Pfiaffia gnaphaloides</i>	(L.f.) Mart.	Herb, Sub-shrub	LC	—	N	Pedrosa, L.G. 6611
2	Amaryllidaceae	<i>Hippeastrum glaucescens*</i>	(Mart.) Herb.	Herb	NE	—	N	Alvim, Y. 2
3	Anemaceae	<i>Anemia villosa</i>	Humb. & Bonpl. ex Willd.	Herb	NE	—	N	Anjos, M.B. 2
4	Apiaceae	<i>Eryngium eurycephalum</i>	Malme	Herb	NT	—	BR	Alvim, Y. 4
5	Apocynaceae	<i>Ditassa linearis</i>	Mart.	Vine, Subasrbusto	NE	—	MG	Pedrosa, L.G. 6615
6	Apocynaceae	<i>Mandevilla emarginata</i>	(Vell.) C. Ezcurra	Sub-shrub	NE	—	N	Pedrosa, L.G. 6604
7	Apocynaceae	<i>Mandevilla tenuifolia</i>	(J.C.Mikan) Woodson	Vine, Subasrbusto	NE	—	N	Borum-Kren, E.L.A. 7
8	Araliaceae	<i>Asterostigma</i>	Fisch. & C.A.Mey	Herb	NA	—	NA	Echternacht, L. 3038
9	Araliaceae	<i>Hydrocotyle asterias</i>	Cham. & Schtdl.	Herb	NE	—	MG	Pedrosa, L.G. 6620
10	Asteraceae	<i>Baccharis intermixta</i>	Gardner	Shrub	NE	—	BR	Torres, F. 2
11	Asteraceae	<i>Baccharis punctulata</i>	DC.	Shrub, Sub-shrub	NE	—	N	Anjos, M.B. 3
12	Asteraceae	<i>Baccharis sp1.</i>	L.	Shrub	NA	—	NA	Alvim, Y. 1
13	Asteraceae	<i>Baccharis sp2.</i>	L.	Shrub	NA	—	NA	Alvim, Y. 6
14	Asteraceae	<i>Chaptalia integerrima</i>	(Vell.) Burkart	Herb	NE	—	N	Torres, F. 1
15	Asteraceae	<i>Hieracium comersonii</i>	Monnier	Herb	NE	—	N	Pedrosa, L.G. 6608
16	Asteraceae	<i>Trichogonia villosa</i>	(Spreng.) Sch.Bip. ex Baker	Sub-shrub	LC	—	BR	Borum-Kren, E.L.A. 3
17	Bromeliaceae	<i>Pitairnia flammaea</i>	Lindl.	Herb	LC	—	BR	Pedrosa, L.G. 6602
18	Campanulaceae	<i>Siphocampylus imbricatus</i>	(Cham.) G.Don	Shrub	NE	—	BR	Pedrosa, L.G. 6617
19	Campanulaceae	<i>Siphocampylus westinianus</i>	(Thunb.) Pohl	Shrub	NE	—	BR	Veiga, C. 3
20	Clethraceae	<i>Clethra scabra</i>	Pers.	Shrub, Árvore	LC	—	N	Anjos, M.B. 1
21	Commelinaceae	<i>Dichorisandra hexandra</i>	(Aubl.) C.B.Clarke	Herb, Vine	NE	—	N	Santos, A.A. 104
22	Convolvulaceae	<i>Cuscuta racemosa*</i>	Mart.	Herb	NE	—	BR	Borum-Kren, E.L.A. 8
23	Convolvulaceae	<i>Evolvulus krameroides</i>	Mart.	Herb	VU	VU	MG	Pedrosa, L.G. 6599
24	Convolvulaceae	<i>Evolvulus lithospermoides</i>	Mart.	Herb, Sub-shrub	NE	—	BR	Alvim, Y. 3
25	Convolvulaceae	<i>Jacquemontia prostrata</i>	Choisy	Vine	NE	—	MG	Pedrosa, L.G. 6600
26	Cyperaceae	<i>Bulbosyllis capillaris*</i>	(L.) C.B.Clarke	Herb	NE	—	N	Borum-Kren, E.L.A. 5
27	Cyperaceae	<i>Bulbosyllis juncooides</i>	(Vahl) Kük. ex Osten	Herb	NE	—	N	Borum-Kren, E.L.A. 9
28	Fabaceae	<i>Chamaecrista desvauxii*</i>	(Collad.) Killip	Shrub, Sub-shrub	NE	—	N	Pedrosa, L.G. 6618
29	Fabaceae	<i>Peinandra mediterranea*</i>	(Vell.) Taub.	Shrub, Sub-shrub	NE	—	N	Veiga, C. 5
30	Fabaceae	<i>Zornia reticulata</i>	Sm.	Sub-shrub	NE	—	N	Pedrosa, L.G. 6609
31	Gentianaceae	<i>Calibisianthus pendulus</i>	(Mart.) Gilg	Herb, Sub-shrub	NE	—	BR	Pedrosa, L.G. 6605
32	Gesneriaceae	<i>Sinningia allagophylla*</i>	(Mart.) Wiehler	Herb	NE	—	N	Veiga, C. 6
33	Iridaceae	<i>Neomarica caerulea</i>	(Ker Gawl.) Sprague	Herb	NE	—	BR	Veiga, C. 1
34	Iridaceae	<i>Neomarica glauca</i>	(Seub. ex Klatt) Sprague	Herb	NE	—	BR	Pedrosa, L.G. 6613
35	Iridaceae	<i>Sisyrinchium vaginatum</i>	Spreng.	Herb	NE	—	N	Pedrosa, L.G. 6610
36	Iridaceae	<i>Sisyrinchium weirii</i>	Baker	Herb	NE	—	N	Pedrosa, L.G. 6619
37	Lamiaceae	<i>Ocimum carnosum*</i>	(Spreng.) Link & Otto ex Benth.	Herb, Sub-shrub	NE	—	N	Resende, N.C. 11
38	Lamiaceae	<i>Salvia sp.</i>	L.	Shrub	EN	—	NA	Torres, F. 3
39	Lauraceae	<i>Cinnamomum erythropus</i>	(Nees & Mart.) Kosterm.	Tree	EN	EN	MG	Resende, N.C. 12
40	Lythraceae	<i>Cuphea sp.</i>	Cham. & Schtdl.	Sub-shrub	LC	—	NA	Santos, A.A. 101
41	Malpighiaceae	<i>Bysonima variabilis*</i>	A.Juss.	Shrub	LC	—	BR	Trevisani, N.V. 2
42	Malpighiaceae	<i>Peixotoa tomentosa</i>	A.Juss	Shrub, Sub-shrub	LC	—	BR	Anjos, M.B. 8
43	Malvaceae	<i>Sida glaziovii</i>	K.Schum.	Sub-shrub	NE	—	BR	Anjos, M.B. 6
44	Malvaceae	<i>Sida rhombifolia*</i>	A.St.-Hil.	Herb	NE	—	N	Alvim, Y. 5
45	Melastomataceae	<i>Cambessedesia pityrophylla</i>	(Mart. ex DC.) A.B.Martins	Shrub	EN	—	QF	Pedrosa, L.G. 6598
46	Melastomataceae	<i>Fritzschia sertularia</i>	(Schrank & Mart. ex DC.) M.J.R.Rocha & P.J.F.Guim.	Sub-shrub	NE	—	MG	Santos, A.A. 107
47	Melastomataceae	<i>Leandra cancellata</i>	(DC.) Cogn.	Shrub	LC	—	BR	Resende, N.C. 10
48	Melastomataceae	<i>Leandra melastomoides</i>	Raddi	Shrub, Tree	NE	—	N	Santos, A.A. 106

(Continued)

Table 1. (Continued).

Family	Species	Author	Habit	CNCF	MMA	End.	Voucher (OUPR)
Melastomataceae	<i>Microlígia serpyllifolia</i>	D. Don	Shrub, Sub-shrub	LC	—	BR	Santos, A.A. 105
Melastomataceae	<i>Pleroma cardinale</i>	(Bonpl.) Triana	Shrub	NE	—	MG	Resende, N.C. 13
Melastomataceae	<i>Pleroma dendroides</i>	(Naudin) Triana	Shrub	NE	—	MG	Santos, A.A. 102
Melastomataceae	<i>Pleroma frigidulum</i>	(Schränk et Mart. ex DC.) Triana	Shrub, Sub-shrub	LC	—	BR	Santos, A.A. 103
Melastomataceae	<i>Pleroma heteromallum*</i>	(D. Don) D. Don	Shrub	NE	—	BR	Alvim, Y. 7; Santos, A.A. 100
Myrtaceae	<i>Myrcia sp.</i>	DC.	Shrub	—	—	NA	Trevisani, N.V. 6
Ochnaceae	<i>Luxemburgia octandra*</i>	A. St.-Hil.	Shrub	NE	—	MG	Resende, N.C. 16; Torres, F. 6
Orchidaceae	<i>Epidendrum martianum</i>	Lindl.	Herb	LC	—	BR	Pedrosa, L.G. 6614
Orchidaceae	<i>Epidendrum martianum</i>	(Lindl.) M.W. Chase & N.H. Williams	Herb	NE	—	BR	Pedrosa, L.G. 6622
Orchidaceae	<i>Gomesa ramosa</i>	(Lindl.) M.W. Chase & N.H. Williams	Herb	LC	—	N	Pedrosa, L.G. 6597
Orchidaceae	<i>Pachygenium oestriferum</i>	(Rchb.f. & Warm.) Szlach. et al.	Herb	LC	—	BR	Pedrosa, L.G. 6601
Orchidaceae	<i>Zygopetalum sellowii</i>	Rchb.f.	Herb	LC	—	BR	Pedrosa, L.G. 6606
Phyllanthaceae	<i>Phyllanthus Moltschianus*</i>	L.	Sub-shrub	NE	—	BR	Trevisani, N.V. 8
Poaceae	<i>Andropogon leucostachyus*</i>	Kunth	Herb	NE	—	N	Borum-Kren, E.L.A. 2
Poaceae	<i>Eragrostis sp1.</i>	Wolf	Herb	NA	—	NA	Trevisani, N.V. 9
Poaceae	<i>Eragrostis sp2.</i>	Wolf	Herb	NA	—	NA	Anjos, M.B. 5
Poaceae	<i>Sporobolus metallicolus</i>	Longhi-Wagner & Boechat	Herb	NE	—	BR	Trevisani, N.V. 4
Polygalaceae	<i>Asemeia violacea</i>	(Aubl.) J.F.B. Pastore & J.R. Abbott	Herb	NE	—	N	Pedrosa, L.G. 6616
Polygalaceae	<i>Senega glochidata*</i>	(Kunth) J.F.B. Pastore	Herb	NE	—	BR	Anjos, M.B. 4
Rubiaceae	<i>Borreria verticillata*</i>	(L.) G. Mey.	Sub-shrub	NE	—	N	Borum-Kren, E.L.A. 1
Rubiaceae	<i>Declieuxia fruticosa</i>	(Willd. ex Roem. & Schult.) Kuntze	Shrub, Sub-shrub	LC	—	N	Pedrosa, L.G. 6621
Rubiaceae	<i>Richardia brasiliensis*</i>	Gomes	Herb	NE	—	N	Torres, F. 4; Resende, N.C. 18
Solanaceae	<i>Brunfelsia brasiliensis*</i>	(Spreng.) L.B. Sm. & Downs	Shrub	NE	—	BR	Trevisani, N.V. 1
Solanaceae	<i>Solanum subumbellatum*</i>	Vell.	Shrub	NE	—	BR	Torres, F. 5
Solanaceae	<i>Solanum viscosissimum</i>	Sendtn.	Vine	EN	EN	BR	Echternacht, L. 3039
Solanaceae	<i>Nicotiana sp.nov.</i>	L.	Herb	NA	—	OP	Echternacht, L. 3040
Styracaceae	<i>Styrax maninul</i>	B. Walln.	Shrub	NE	—	MG	Trevisani, N.V. 7
Velloziaceae	<i>Vellozia compacta</i>	Mart. ex Schult. & Schult.f.	Sub-shrub	NE	—	MG	Veiga, C. 2; Anjos, M.B. 9
Verbenaceae	<i>Lantana fucata*</i>	Lindl.	Shrub	NE	—	N	Borum-Kren, E.L.A. 4
Verbenaceae	<i>Lippia hermannioides*</i>	Cham.	Shrub	NE	—	BR	Trevisani, N.V. 3
Verbenaceae	<i>Lippia organoides*</i>	Kunth	Shrub	NE	—	N	Anjos, M.B. 7; Veiga, C. 4

The threat status follows the Official List of Threatened Species of the Brazilian Flora issued by the Ministry of the Environment (MMA 2022) and the Brazilian National Center for Flora Conservation (CNCFlora, continuously updated); CR = Critically Endangered, EN = Endangered, VU = Vulnerable, LC = Least Concern, NE = Not Evaluated, NA = Not Applicable. For endemism (End.): N = Not endemic, BR = Endemic to Brazil, MG = Endemic to Minas Gerais, OF = Endemic to the Quadrilátero Aquifero-Ferrifero, OP = Endemic to Ouro Preto. The cited vouchers correspond to specimens deposited in the OUPR Herbarium. In bold, species that were sampled in the affected area according to the EIA report (Brandt Meio Ambiente 2024). Species with medicinal potential are marked with an *.

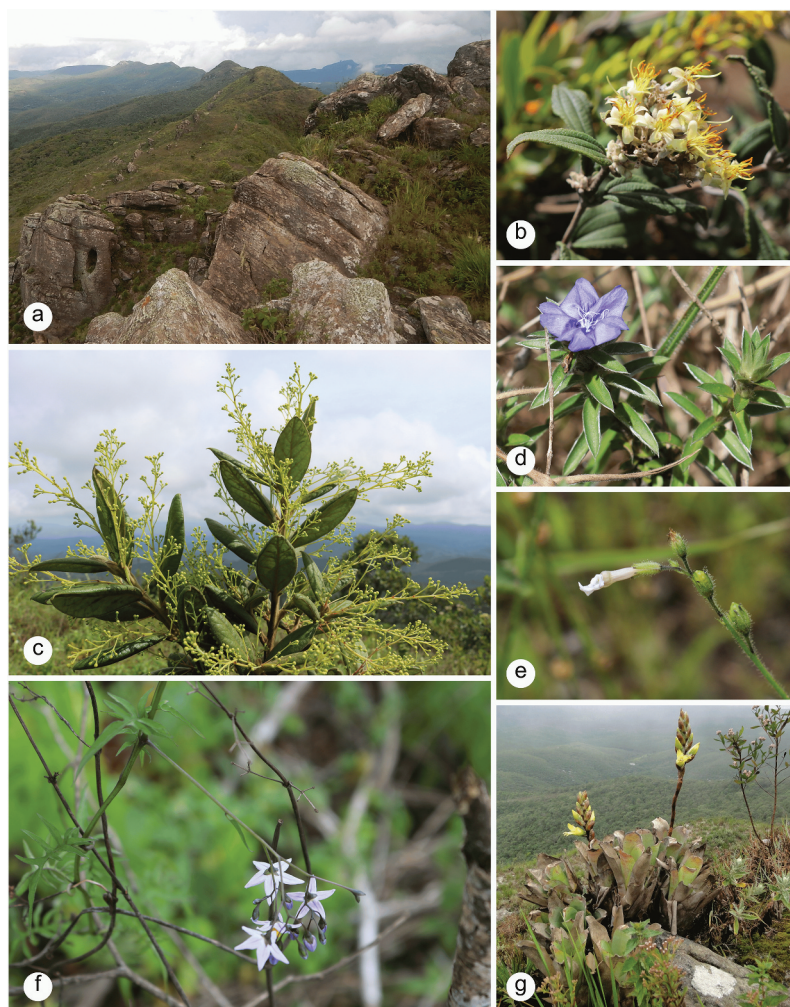


Figure 2. Landscape, phytophysiognomies, threatened and endemic species. (a) Serra de Ouro Preto with *Campos Rupestres* on the upper parts and forest on the slopes and valleys. (b) *Cambessedesia pityrophylla* (Mart. ex DC.) A.B.Martins, endemic to the *Quadrilátero Aquífero-Ferrífero* (qaf), endangered; (c) *Cinnamomum erythropus* (nees & Mart.) Kosterm., endemic from Minas Gerais, endangered; (d) *Evolvulus kramerioides* Mart.; vulnerable (e) *Nicotiana stat. nov.* (= *Nicotiana bonariensis* var. *spathulata*), potentially critically endangered; (f) *Solanum viscosissimum* sendtn., endangered; (g) *Vriesea badinii* Guarçoni, A.F.Costa & Kessous, endemic to the Serra de Ouro Preto, potentially critically endangered. Photos: L. Echternacht (a-f), E. Guarçoni (g).

are classified as 'Nearly Threatened' and 14 as 'Least Concern' (Table 1). We emphasize that the majority of the species (64%) was not assessed for their threat status, which represents a knowledge gap that compromises the effectiveness of the EIA's recommendations for conservation. Additionally, a new status at species level, currently under preparation for publication, belonging to the genus *Nicotiana* L. (Solanaceae), originally described at the variety level and to be elevated in rank (*Nicotiana bonariensis* var. *spathulata*), was recorded, as reported by the taxonomist specialist M. Augsten and J.R.Stehmann (pers. communication).

Among the 42 species found as endemic to Brazil (53%), 13 are exclusive to Minas Gerais (16%). Notably, *Cambessedesia pityrophylla* is endemic to the *Quadrilátero Aquífero-Ferrífero*, and the new status species (*Nicotiana stat. nov.*) is endemic to Ouro Preto. Regarding life habits, the sample revealed a significant diversity of habits in the vegetation of

the study area. Among the 71 taxa identified at species level, 33 (46,48%) are herbaceous, 21 (29,58%) are shrubs, 12 (16,90%) are subshrubs, 3 (4,23%) are vines, and 2 species (2,81%) are trees. Seven species (10%) are classified as weeds.

The records in the virtual herbaria contributed with 14 additional species (Table 2), including the new species *Vriesea badini* endemic to the *Serra de Ouro Preto*, and evaluated by the authors as Critically Endangered (Guarçoni et al. 2025).

The medicinal potential of the Brazilian pharmacopoeia remains only partially explored from an economic perspective, despite the remarkable diversity of native species traditionally used for therapeutic purposes. In Ouro Preto, local peoples and communities make use of several native plant species as medicinal resources, applying them in the treatment of a wide range of conditions according to traditional knowledge transmitted across generations (Messias

Table 2. Records of species obtained from herbaria for the affected area.

Família	Espécie	Autor	Hábito	CNCF	MMA	End.	Voucher
Alstroemeriaceae	<i>Alstroemeria plantaginea</i>	Mart. ex Schult. & Schult.f.	Erva	NE	—	BR	Dias, S. s.n. (OUPR 589)
Alstroemeriaceae	<i>Bomarea edulis</i>	(Tussac) Herb.	Liana	NE	—	N	Dias, S. s.n. (OUPR 597)
Apocynaceae	<i>Mandevilla martiana</i>	(Stadelm.) Woodson	Arbusto, Liana	NE	—	BR	Nogueira, R.E. 141 (OUPR)
Bignoniaceae	<i>Lundia virginalis</i>	DC.	Liana	NE	—	BR	Nogueira, R.E. 153 (OUPR)
Bignoniaceae	<i>Podranea ricasoliana</i>	(Tanfani) Sprague	Liana	NE	—	N	Nogueira, R.E. 167 (OUPR)
Bromeliaceae	<i>Aechmea nudicaulis</i>	(L.) Griseb.	Erva	LC	—	N	Dias, S. s.n. (OUPR)
Bromeliaceae	<i>Dyckia saxatilis</i>	Mez	Erva, Suculenta	LC	—	BR	de Paula, C.C.; et al. 1314 (VIC)
Convolvulaceae	<i>Jacquemontia ferruginea</i>	Choisy	Liana	NE	—	BR	Nogueira, R.E. 142 (OUPR)
Eriocaulaceae	<i>Paepalanthus pubescens</i>	Körn.	Erva	NE	—	BR	Echternacht, L. 2706 (OUPR)
Melastomataceae	<i>Microlicia crenulata</i>	(DC.) Mart.	Arbusto	NE	—	BR	Magalhães, M. 1186 (BHCB)
Myrtaceae	<i>Eugenia sonderiana</i>	O.Berg	Arbusto, Árvore	NE	—	BR	Peron, M.V. 53 (OUPR)
Orchidaceae	<i>Epidendrum secundum</i>	Jacq.	Erva	LC	—	N	Nogueira, R.E. 140 (OUPR)
Pteridaceae	<i>Cheilanthes goyazensis</i>	(Taub.) Domin	Erva	?	—	N	Echternacht, L. 2703 (OUPR)
Bromeliaceae	<i>Vriesea badini</i>	Guarçoni, A.F.Costa & Kessous	Erva	NE	—	QF/OP	Guarçoni, E. 1512 (R)

The threat status follows the Official List of Threatened Species of the Brazilian Flora issued by the Ministry of the Environment (MMA 2022) and the Brazilian National Center for Flora Conservation (CNCFlora, continuously updated). CR = Critically Endangered, EN = Endangered, VU = Vulnerable, LC = Least Concern, NE = Not Evaluated, NA = Not Applicable. For endemism, N = Not endemic, BR = Endemic to Brazil, MG = Endemic to Minas Gerais, OP = Endemic to Ouro Preto.

et al. 2015). Among the twenty-three (23) species with medicinal and pharmacological potential (Table 1), we highlight the following: *Lippia origanoides*, which is used in the treatment of gastrointestinal problems and microbial infections (Pascual et al. 2001; Gomes et al. 2016), followed by *Chamaecrista desvauxii*, also with antimicrobial activity (Silva et al. 2012), while *Solanum subumbellatum* is employed against respiratory diseases (Quaresma 2023). *Periandra mediterranea* has applications in vaccines against leishmaniasis (Santos et al. 1997), and *Pleroma heteromallum* has demonstrated efficacy against the fungus *Candida albicans* (Coyago-Cruz et al. 2024). *Sida rhombifolia* presented antioxidant properties (Dhalwal et al. 2007). Some species exhibit anti-inflammatory and diuretic properties, such as *Cuscuta racemosa*, *Lantana fucata*, *Bulbostylis capillaris* and *Andropogon leucostachyus* (Gavilanes et al. 1993; Julião et al. 2009; Ferraz et al. 2011; Bieski et al. 2012). Others, such as *Borreria verticillata*, show analgesic and antipyretic effects (Moreira et al. 2010), while *Byrsonima variabilis* has demonstrated antiviral activity against *Herpes simplex* type 1 (Moreira et al. 2010). *Lippia hermanioides* has been reported to produce essential oil with antinociceptive properties (Oliveira et al. 2024) and *Brunfelsia brasiliensis* was used as an analgesic and depurative (Plowman 1977). In the field of oncology, *Luxemburgia octandra*, *Sinningia allagophylla* and *Ocimum carnosum* have shown anticancer potential (Daniel et al. 2007; Riva et al. 2012; Agrawal et al. 2025). Furthermore, *Richardia brasiliensis*, traditionally regarded as a weed, is used in the treatment of diabetes and skin diseases (Dornelles 2015). *Senega* spp. (= *Polygala*) has demonstrated neuroprotective properties (e.g. Bettio et al. 2011), and *Phyllanthus klotzschianus* showed activity against the venom of *Bothrops jararaca* (Kuster et al. 1996). Finally, the genus *Hippeastrum*, in addition to its potential as ornamental, contains alkaloids of

medicinal interest (Giordani 2007). The medicinal use of these species has been confirmed in Ouro Preto for *Byrsonima variabilis*, *Ocimum carnosum*, and *Senega* (Messias et al. 2015).

3.2. Comparative studies with the flora survey of the EIA

The EIA report listed 162 species belonging to 51 botanical families in the affected area, during 11 days of sampling in January 2024, considering all phytophysiognomies (Brandt Meio Ambiente 2024). The total number of species reported for *Campo Rupestre Ferruginoso* (CRF) and *Savana Gramíneo-lenhosa* (SGL) is 69. Only 13 species overlap between the EIA report and our counterproof (Table 1). This low congruence is particularly notable considering that both sampling efforts were carried out in the same month, thus capturing species that flower under similar conditions, meaning that both surveying teams likely encountered similar fertile plant communities in the field. Among the 56 (71%) species sampled by us, which are not recorded in the EIA report, four were endangered species and the new status species of *Nicotiana*. Although six of these 69 species have recognized medicinal potential (Table 1), their economic relevance was neither considered nor discussed in the EIA, thereby overlooking the requirements of CONAMA Resolution 01/86 (Art. 6(I)(b)). It is noteworthy that such analysis was carried out for some animal groups within the same EIA.

The secondary data in the EIA report included 444 plant species; however, none of the three areas explicitly correspond to the affected area, and none provide voucher specimens with accession numbers, which are necessary for verification and potential updates to species identification. Curiously, herbaria, which are

the scientific source of information on species occurrences, were not consulted in the preparation of the EIA report.

4. Discussion

4.1 Vegetation and flora methodological approaches

The number of species recorded for *Serra de Ouro Preto*, in the EIA report and in the present counterproof, represents only a fraction of the flora in this megadiverse region, with various plant physiognomies. Nearby mountains with exhaustive surveys and equivalent plant physiognomies were found to have 1,623 species (such as the Itacolomi State Park) (Messias et al. 2017) and 1,689 species (*Serra do Caraça*) (Augsten 2015). Species identification typically depends on the presence of fertile structures (flowers, fruits, or spores). Considering that in tropical regions, each species blooms during a specific period and that fertile plants can be found throughout the year, flora surveys should be conducted covering at least all seasons (Gullison et al. 2015). A representative characterization of the impacted flora depends, therefore, on the sampling methods outlined for each physiognomy, as well as the ability of the professionals to recognize the impacted species (Filgueiras et al. 1994). To verify whether the sampling effort was sufficient, species accumulation curves and other methods can be used (Mota et al. 2014; Gullison et al. 2015). Therefore, adequate temporal coverage combined with taxonomic expertise is essential to ensure that flora surveys reliably capture species richness, minimizing methodological weakness when prolonged and intensive surveys are not feasible.

The EIA report presented a more representative floristic survey in the plots, where species accumulation curve was evaluated, together with first-order Jackknife richness and rarefaction analysis. In these areas, the sampling effort was considered satisfactory. However, the proportion of the sampled area is minimal and incompatible with the physiognomy heterogeneity (about 0.1% of the whole *Campos Rupestres* area). What does satisfactory sampling mean when only 0.1% of a phytogeography is surveyed in a megadiverse tropical region? Clearly, the method was insufficient to sample the species potentially most affected by the project.

The Walking Survey methodology complements the taxonomic information obtained in the plots. However, the results presented are not compatible with the method, as it failed to record species that were locally abundant, with long blooming period, and likely fertile during the EIA survey, such as the endangered *Cinnamomum erythropus* (CNCFlora 2025). Indeed the EIA study reports that no collections were made for the

taxonomic determination of the species, revealing that the Walking Survey method was not properly conducted according to the procedures detailed by Filgueiras et al. (1994). No accumulation curve of species was produced for this method. Moreover, herbaceous and shrub species were underestimated in the EIA, which had a greater sampling effort for tree species, corroborating the bias identified by Pimenta and Fonseca (2021).

The use of secondary data from other locations to complement the vegetation diagnosis should be analyzed with caution, especially in a highly heterogeneous region like the *Campos Rupestres* in the *Quadrilátero Aquífero-Ferífero*. A recent study in the same region demonstrated that the floristic similarity between the *Campos Rupestres* of the *Itacolomi*, *Frazão*, and *Caraça* mountains is only 42%, despite being located at a maximum distance of 16 km (Araújo da Silva et al. [forthcoming]). Even in very close areas, with similar physiognomies and geological formations, the number of shared species can be extremely low. The main source of secondary data should be specimens previously collected for the affected area and deposited in herbaria (Batke et al. 2025). Most herbaria in Brazil are integrated and accessible through virtual platforms, such as speciesLink (<https://specieslink.net/>), JABOT (<https://jabot.jbrj.gov.br/>), SibBr and GBIF (<https://www.sibbr.gov.br/>). The absence of this consultation reveals a scientific disconnect from the studies conducted for licensing purposes.

The taxonomic identification methodology employed in the EIA report presents limitations and inaccuracies that compromise its scientific reliability. The absence of voucher material deposited in public herbaria makes independent data verification impossible. This is well discussed for the prospection of medicinal plant species and for genomic studies (e.g. Eisenman et al. 2012; Buckner et al. 2021), but is also valid for biodiversity in impact assessment. Taxon names are scientific hypotheses that are inherently dynamic, reflecting ongoing advances in phylogenetic research, new data, and shifting species concepts (e.g. Chase et al. 2016; Vaidya et al. 2018). As a result, species and higher taxa are routinely merged, split, synonymized, resurrected, or transferred among genera and families (e.g. Joffard et al. 2022). Updating specimen identifications therefore depends on the analysis of voucher material, and without it a species list may become highly ephemeral. In a region recognized for its high biodiversity and endemism, accurate species identification typically requires access to identification keys, diagnostic details observable only under a stereomicroscope, and specialized literature, in addition to protologues and type specimens. Conducting determinations solely in the field or based on photographs tends to result in lists dominated by common species, which are usually not those most affected by

habitat loss and other environmental degrading drivers. Each species in the list must be linked to a vouchered exsiccate and its respective herbarium to ensure accuracy, traceability, validation, and the possibility of updating identifications. The absence of this standard practice undermines the reliability of the results and the validity of the impact assessment outcomes.

The case of *Vriesea badini* illustrates several points discussed in the preceding paragraphs. This recently described species is evaluated as critically endangered and is microendemic to the affected area (Garçoni et al. 2025). It could go extinct with the destruction of the Serra de Ouro Preto and is likely one of the species most impacted by the project. Specimens with precise geographic coordinates have been available in several herbaria since 2010 (herbaria acronyms are BHCB, BMA, RGN, SP, SPF, VIC). The diagnostic features of the species include a tubular rosette, the upper half of the leaf sheath vinaceous, reddish-brown floral bracts, sepals with an acute apex, and free petals, among other characteristics. The neglect of herbarium records and the lack of consultation with specialists are likely at the root of the underdetection of this species in the EIA. According to the authors, this is the only species of the group that occurs in the Serra de Ouro Preto (Guarçoni et al. 2025). Therefore, it is probable that the species identified as *Vriesea minarum* in the EIA actually corresponds to *V. badinii*; however, the absence of a voucher specimen prevents verification of this determination. The absence of this species invalidates the statement in the EIA – issued under the provisions of Federal Law 11,428/2006—that the intervention does not endanger the survival of this species (Brandt Meio Ambiente 2024, 318).

The EIA report has an important gap, given that it mentions only the ferruginous *Campos Rupestres* and not the quartzitic *Campos Rupestres*. The extreme importance of these ecosystems for conservation requires that they be treated with special attention in the vegetation diagnosis (Fernandes et al. 2012; Silveira et al. 2016). The concept of *Campos Rupestres* considers a mosaic of vegetation, including grasslands, graminoid-woody formations, and even forests, associated with specific geological formations (Caminha-Paiva et al. 2022; Azevedo et al. 2024). Additionally, quartzitic and ferruginous *Campos Rupestres* present distinct floristic compositions and endemisms (Messias et al. 2011, 2012, 2013). The lack of this differentiation raises doubts as to whether the sampling was conducted exclusively in the ferruginous *Campos Rupestres* and whether the *Savana Gramíneo-lenhosa* mentioned in the report indeed refers to the quartzitic *Campos Rupestres*. The intergrading of phytophysiognomies observed in the field does not correspond to the scale of the vegetation map presented in the EIA, which therefore does not clarify these uncertainties

(e.g. Brandt Meio Ambiente 2024, 192). This imprecision undermines the assessment of plant richness and the potential environmental impacts of the project, as the species and their vulnerabilities differ between these two types of *Campos Rupestres*, and they should be considered as distinct units for compensation and offset planning (Silveira et al. 2020; Carmo and Kamino 2023). *Campos Rupestres* should undergo a very robust sampling effort, as they are highly diverse and rich in endemism.

4.2. Legal and procedural aspects and their implications for biodiversity conservation

Brazilian environmental legislation establishes vague guidelines for biodiversity surveys in impact assessments and respective baselines studies. The statutes of CONAMA Resolution 01/1986 (art. 6) require the environmental diagnosis of comprehensive EIA reports to identify species ‘of scientific and economic value, rare and endangered.’ Other regulations at the national level complement this guideline, such as recently approved General Licensing Law (Brazil 2025), the CONAMA Resolution 237/1997, which establishes the procedures and criteria governing environmental licensing, and the Native’s Vegetation Protection Law 12,651/2012, which establishes rules for native vegetation suppression. Decree No. 6,660/2008, which regulates the Atlantic Forest Law, also requires detailed studies before vegetation removal. The Secretary of State for the Environment and Sustainable Development of Minas Gerais provides terms of reference (TRs) for the preparation of the EIA reports (SEMAD). The methods applied in the EIA conducted by Brandt Meio Ambiente for the study area do not fully comply neither with the legislation nor with the TR, as they failed to identify species of scientific value, endangered and rare species, as well as those of economic value. The absence of these species in the EIA report suggests that it should be revised so that mitigation and compensation measures can be properly defined in the environmental licensing process, especially considering that some of them were detected during a single day of fieldwork in our counterproof survey, whereas the EIA survey comprised 11 field days.

We emphasize that we do not interpret the shortcomings identified in this counter-assessment as a reflection of the company’s technical capacity or the conduct of the proponent. It is possible that such methods have become established in a deficient manner and without scientific grounding, due to the lack of qualified on-site technical verification.

The lack of a more detailed protocol in the Brazilian environmental legislation to standardize floristic survey methods contributes to these methodological shortcomings, leaving it up to the discretion of

contracted consultancy companies to define the approach to be used. Apparently, environmental agencies have not been able to identify these gaps and demand better-quality diagnostics, even in the case of projects with virtually unlimited financial capacity, such as this from one of the world's largest mining companies (BHP Billiton). This highlights the need for a review of the regulations governing EIAs, ensuring that more comprehensive methodologies are mandatory so that no essential component of the vegetation is overlooked. Strengthening the licensing agencies, including ensuring technically qualified personnel, is also essential for making the process not only faster, but above all more rigorous, efficient, credible, and based on scientific evidence.

It is important to note that there is a historical road that enhances public access to the studied area, enabling independent research, which is essential to counterproof evaluations such as the one carried out in this study. According to the National Environmental Policy (Law No. 6,938/1981, Article 2, item I), the environment must be regarded as 'a public patrimony that must necessarily be safeguarded and protected, considering its collective use.' (our translation). This principle is also echoed by Article 225 of the Brazilian Constitution. Therefore, the flora, as part of the environment, can be considered a public heritage of diffuse interest (Brazil 1981, 1985, 1988). However, in order to know which species occur in a given area, except for common ones, it is usually necessary for the material to be analyzed by taxonomists. This knowledge, however, may be disadvantageous to landowners since the presence of legally protected species imposes restrictions on land use. As a result, researchers have historically faced obstacles in accessing certain areas. To promote conservation and access to knowledge on species diversity in a given area, research involving the deposit of voucher specimens in scientific collections should be encouraged by the State within environmental licensing procedures, as a means of providing verifiable and independent evidence of species occurrence.

It is important to note an important Brazilian legislative initiative that could prevent some of the problems identified here. Bill 1,993 from 2024, submitted to the Chamber of Deputies (Brazil 2024), seeks to establish the National Policy for Scientific Biological Collections, with the aim of strengthening, expanding, organizing, managing, and maintaining the holdings of scientific biological collections. Scientific collections constitute one of the most important sources of biodiversity information, second only to direct observations in nature; however, in an era of extinction and habitat loss, they may increasingly become the primary source of knowledge for many taxa (e.g. Schatz 2002). This means that species without preserved specimens in these collections could go extinct without ever being known to science, and the diversity of unsampled

environments destined for destruction or degradation will remain forever unknown. The absence of material deposited in scientific collections in an area intended for total vegetation suppression deprives the national and international scientific community, as well as current and future generations, of knowledge about the rich and threatened biodiversity that still inhabits the site.

The new General Environmental Licensing Law (Brazil 2025) is also likely to further weaken the methodological robustness of flora surveys by allowing simplified licensing procedures, reducing requirements for prior environmental impact assessments, and institutionalizing self-declared licensing mechanisms, as highlighted by Fernandes et al. (2026). By eliminating essential stages of the process and exempting a wide range of projects from more detailed studies, the law shortens timelines and weakens the obligation to conduct comprehensive fieldwork, favoring rapid, incomplete, and low-rigor diagnoses – an especially critical issue in megadiverse regions with high levels of endemism. The elimination or reduction of technical oversight and public participation further undermines the capacity to review inadequate methodologies or severe under-sampling, increasing the risk of under-detecting sensitive species and significant impacts. As a consequence, the instruments intended to avoid harm, mitigate impacts, and compensate for losses become less effective, as they rely on fragile species lists and weak baseline diagnoses, preventing proper assessment of required measures and fostering a cycle of progressive environmental degradation.

5. Conclusions

The *Serra de Ouro Preto* harbors high plant richness, with quartzitic and ferruginous rupestrian grasslands containing threatened species, taxa new to science, and species with medicinal potential, including plants used in local traditional medicine. However, the Environmental Impact Assessment (EIA) conducted in the area failed to identify these species, thereby not meeting the minimum legal criteria for environmental diagnosis. Field-based identification methods inflate the study with information about common species while failing to detect the species most sensitive to degradation and that are likely to be most severely affected. The absence of an adequate characterization of the flora has serious implications for the mitigation, compensation, and monitoring actions derived from the EIA.

Despite the existence of laws, regulations and TRs concerning EIA reporting and baseline studies, there remains a methodological gap in terms of guidelines for floristic sampling and taxonomic identification, which can lead to underestimation of the biodiversity present in areas targeted by

development projects. In the context of open pit iron mining – which results in complete degradation and clearing of vegetation, especially of *Campos Rupestres*, ecosystems with high levels of endemism and threat – the lack of samples deposited in scientific collections represents an irreplaceable loss of knowledge about the flora, both for current and future generations.

The fact that this project is located at the entrance to the city of Ouro Preto may even compromise its UNESCO World Heritage status. Considering that the study area is of exceptional relevance for biodiversity, water resources, and historical, cultural, archaeological, and speleological heritage, environmental impact studies must be as rigorous as possible. Because this is a licensing process for a major multinational mining company, financial constraints should not be a limiting factor for applying robust methodologies.

This study was based on a single case study, a methodological approach that, although proven to be useful in numerous scientific fields (Creswell 2009; Babbie 2013), has several limitations, including its limited capacity to yield generalizable findings. However, the case study investigated here reflects many of the common traits of comprehensive EIAs found not only in Brazil, but globally. It is very likely that the implementation of counterproof evaluations in other jurisdictional contexts will reveal similar and even additional weaknesses in biodiversity surveys. It would be important to further investigate if the baseline shortcomings identified here are occurring elsewhere, not only in connection with flora surveys, but also with fauna components. Vagueness in regulations and TRs may be adversely affecting the diagnostic and impact prediction of other biophysical and socioeconomic components.

Despite the limitations of our methodological approach, it is safe to argue that this study identified problems that are common throughout the state of Minas Gerais, given that the current legislation and TRs are applicable to the entire state. In addition, the problems in Brazil are likely to worsen, as the new General Environmental Licensing Law (Brazil 2025) has weakened requirements for impact assessment and baseline studies (Fernandes et al.). We, therefore, urge the scientific community to continue to carry out counter-assessments such as this one to expose the limitations of current surveys, thus pushing for better practices and stronger regulations and guidelines.

Note

1. We highlight an ambiguity regarding the treatment of the grassland formations, as the Ferruginous *Campos Rupestres* are treated as such, but the Quartzitic *Campos Rupestres* were not identified and were apparently considered as *Savana Gramíneo-Lenhosa*.

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Author Contributions

The study was conceived, conducted, and written by Livia Echernacht in collaboration with Alberto Fonseca. The remaining authors are graduate students from the Graduate Programs in Ecology of Tropical Biomes and Environmental Engineering at Universidade Federal de Ouro Preto (UFOP), who attended the course “Plant Identification and Environmental Diagnosis” (2025/1). These students contributed to field data collection, species identification, data analysis and interpretation, and manuscript writing.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

All data generated and analyzed during this study are available within the body of the article and its appendices. Additional occurrence data used in the research are publicly accessible through virtual herbarium databases, including SpeciesLink (<https://specieslink.net/>), SiBBR – Sistema de Informação sobre a Biodiversidade Brasileira (<https://sibbr.gov.br/>), GBIF – Global Biodiversity Information Facility (<https://www.gbif.org/>), and JABOT – Rede de Herbários do Jardim Botânico do Rio de Janeiro (<https://jabot.jbrj.gov.br/>).

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