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Trading deforestation - Why the legality of forest-risk commodities is insufficient

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3 1 **Trading deforestation - Why the legality of forest-risk commodities is insufficient**
4

5 2 **Authors:** Tiago N. P. dos Reis^{1,7*}, Vinicius Guidotti de Faria², Gabriela Russo Lopes³, Gerd
6 Sparovek⁴, Chris West⁵, Raoni G. Rajão⁶, Mariana Napolitano Ferreira⁷, Marcelo M. S. Elvira⁷, Raul
7 S. T. do Valle⁷.
8 4

9
10 5 **Affiliations:**
11

12 6 ¹Earth and Life Institute, Université Catholique de Louvain; Place Louis Pasteur, 3, bte L4.03.08,
13 Louvain-la-Neuve, 1348, Belgium.
14 7

15 8 ²Instituto de Manejo e Certificação Florestal (IMAFLOA); Piracicaba-SP, 13426-420, Brazil.
16 8

17 9 ³Center for Latin America Research and Documentation (CEDLA), University of Amsterdam (UvA);
18 9 1018 WB Amsterdam, the Netherlands.
19 10
20

21 11 ⁴GeoLab, Universidade de São Paulo (USP); Piracicaba-SP, 13418-900, Brazil.
22 11

23 12 ⁵Stockholm Environment Institute York, Department of Environment and Geography, University of
24 12 York; York YO10 5NG, United Kingdom.
25 13

26 14 ⁶Universidade Federal de Minas Gerais (UFMG); Belo Horizonte 31270-901, Brazil.
27 14

28 15 ⁷WWF-Brazil; Brasília-DF, Brazil.
29 15
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31 16 * Corresponding author. Email: tiago.reis@uclouvain.be
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3 **Abstract:**
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5 18 Consumer countries and blocs, including the UK and the EU, are defining legal measures to tackle
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8 19 deforestation linked to commodity imports, potentially requiring imported goods to comply with the
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10 20 relevant producer countries' land-use laws. Nonetheless, this measure is insufficient to address
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12 21 global deforestation. Using Brazil's example of a key exporter of forest-risk commodities, here we
13
14 22 show that it has ~3.25 Mha of natural habitat (storing ~152.8 million tons of potential CO₂
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17 23 emissions) at a high risk of legal deforestation until 2025. Additionally, the country's legal
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19 24 framework is going through modifications to legalize agricultural production in illegally deforested
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22 25 areas. What was illegal may become legal shortly. Hence, a legality criterion adopted by consumer
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24 26 countries is insufficient to protect forests and other ecosystems and may worsen deforestation and
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26 27 conversion risks by incentivizing the weakening of social-environmental protection by producer
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28 28 countries.
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1. The trade of forest-risk commodities

The way we use the land to produce, trade, and consume food is directly connected to social-environmental issues like deforestation, biodiversity loss, human rights violations, climate change, and pandemics (Laroche *et al* 2020, Brancalion *et al* 2020, Curtis *et al* 2018). The production of agricultural commodities is a key driver of deforestation across the globe (Curtis *et al* 2018). However, deforestation embedded in global supply chains is especially acute in the trade routes between commodity-producing countries in the Global South and commodity-importing countries in the Global North. Recognizing their roles as importers and consumer countries, the United Kingdom and the European Union are considering policy measures to address imported deforestation (Bager *et al* 2021). In the context of distant connections in food supply chains (Laroche *et al* 2020), it is crucial to account for GHG emissions, biodiversity loss, and traditional communities' rights embedded in food imports, taking appropriate mitigation measures.

Over the last decade, a wave of voluntary commitments from the private sector and nations (e.g., the Consumer Goods Forum or via the Amsterdam Declarations Partnership) have fallen short in making progress towards deforestation-free supply chains (Garrett *et al* 2019). Hence, at present, there is growing momentum for bolder actions from both government and private companies. Many discussions are in place on what policies could most efficiently halt the environmental degradation driven by agricultural imports (Bager *et al* 2021). Part of this debate favors mandatory due diligence by importing countries to verify compliance with legal criteria from exporting countries (Bager *et al* 2021, Kehoe *et al* 2020). It is essential to highlight that any legislation to tackle deforestation via a legality-based approach is dependent on the efficacy of local governments and legislation and, ultimately, its alignment with downstream deforestation-free objectives.

Considering Brazil as an example of a key agricultural exporter; the country produced around 118 million tons of soybeans in 2018 alone, representing 36% of global soy production (FAO 2021).

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3 55 57% of Brazil's production in 2018 was exported to China and 11% to Europe, including the UK
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6 56 (Trase 2021). The soy-deforestation risk of this Brazilian soy, which includes deforestation and
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8 57 native vegetation loss in the previous five years that became soy up to 2018, was about 61.4 thousand
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10 58 hectares, emitting slightly over 10 million tons of CO₂ (Trase 2021). About 6.3 thousand hectares of
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12 59 this native vegetation loss (~10%) and ~1.1 million tons of emitted CO₂ (~11%) belong to the EU,
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15 60 including the UK. These volumes refer only to 2018 soybean production, with impacts even higher in
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17 61 previous years (Trase 2021).
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20 62 Despite global climate and biodiversity crises, Brazil's current environmental legislation
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22 63 authorizes significant amounts of vegetation loss (Rajão *et al* 2020). This destruction is not necessary
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24 64 from a land-resource standpoint. Brazil has sufficient suitable lands for expanding production
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26 65 without clearing additional hectares of native vegetation (Strassburg *et al* 2014). Moreover,
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28 66 deforestation jeopardizes overall agricultural production and income due to disruptions in local
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30 67 rainfall patterns driven by deforestation (Leite-Filho *et al* 2021). Not even the existing legal
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32 68 requirements are adequately enforced. Roughly 20% of Brazil's soy and at least 17% of beef exports
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34 69 to the EU, produced on the Amazon and Cerrado biomes, may be contaminated by illegal
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36 70 deforestation (Rajão *et al* 2020). Previous studies have shown the limits of Brazil's legislation to
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38 71 tackle illegal deforestation (Azevedo *et al* 2017), and the actual and potential increases in
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40 72 deforestation stemming from bailouts and revisions in the Forest Code (Albuquerque Sant'Anna and
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42 73 Costa 2021, Freitas *et al* 2018b, Sparovek *et al* 2012).
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48 74 **2. Natural habitat at high risk of legal deforestation**

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51 75 Here we build upon and go beyond Rajao et al.'s (2020) study. We estimate the potential legal
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53 76 deforestation and carbon emissions in Brazil that may take place shortly (until 2025). For this, we
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55 77 combine several spatially explicit databases and a spatial model that estimates the probability that
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78 native vegetation will remain until 2025 in the face of several drivers of land use change (*See*
 79 *Methods*).

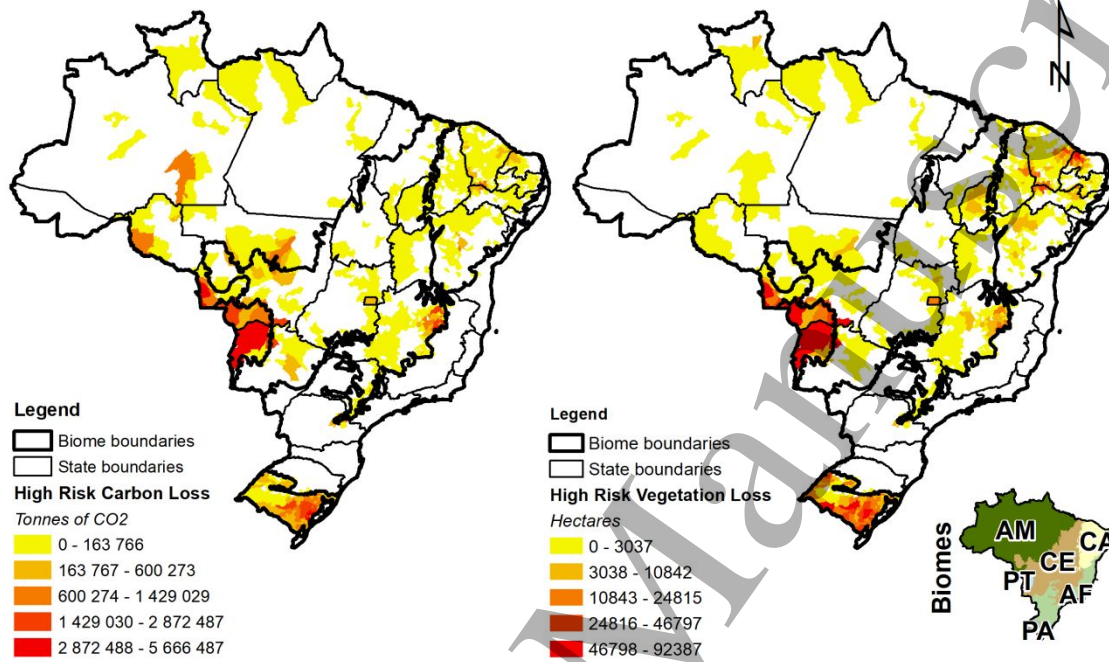
80 We identify 1,114,693 rural establishments holding ~69.2 million hectares of unprotected native
 81 vegetation (*i.e.*, that can be legally deforested), storing ~5.8 billion tons of CO₂ (Tables 1 and S1).
 82 Out of these, ~3.25 million hectares storing ~152.8 million tons of CO₂ are at high risk of
 83 deforestation and native vegetation conversion until 2025. Another ~26.8 Mha storing 1.1 billion
 84 tons of CO₂ are at medium risk (Tables 1, S1, Figures 1, S1, and S2). This is a plausible extent of
 85 short-term future deforestation risk. In 2020 alone, Brazil's Amazon and Cerrado biomes together
 86 lost 1.8 Mha (PRODES-INPE 2021), with about 70% of this occurring in private lands according to
 87 our own estimates based on the properties map of (Freitas *et al* 2018a).

88 Table 1 – Native vegetation and potential carbon dioxide stocks that can be legally cleared and emitted in Brazil until
 89 2025.

Risk of Loss	Number of Rural Establishments	Unprotected Native Vegetation (ha)	Unprotected Carbon (tonnes of CO₂)
1 High Risk	104,145	3,251,961	152,816,882
2 Medium Risk	464,162	26,777,911	1,107,194,477
3 Low Risk	319,808	29,037,483	3,796,246,697
4 No Risk	226,578	10,186,942	782,194,659
Total	1,114,693	69,254,298	5,838,452,715

Figure 1 – Maps showing the largest CO₂ stocks (in tonnes) and native vegetation areas (in ha) at high risk of legal conversion in Brazil until 2025.

All areas coloured here are municipalities holding areas at high risk of legal conversion. The gradient from yellow to red indicates hectares of potential vegetation loss and tonnes of potential CO₂ emissions grouped by municipalities. Pantanal and Pampa biomes appear with the highest risk because these biomes are (i) relatively less protected by public protected areas, such as conservation parks and indigenous lands, (ii) have relatively more private properties than the Amazon, for example, (iii) the Forest Code's mandate for Legal Reserves is smaller in these biomes, setting only 20% of the properties' area aside for conservation. Therefore, 80% of properties' areas are open for legal deforestation. Finally, these areas are closer to agriculturally consolidated regions, near roads and commodity infrastructure and have favourable edaphoclimatic conditions for agricultural commodities cultivation, as considered by Fendrich et al (2020)'s model.



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3. The legal basis of deforestation in Brazil

The legislative framework built to protect native vegetation in Brazil comprises two main instruments: protected areas in public lands and mandatory conservation in private properties. Protected areas include conservation units – such as national parks and forests – and traditional peoples lands – such as indigenous communities. On the other hand, mandatory protection in private property is mainly regulated by the Forest Code, introduced in 1934 and most recently revised in 2012. The Brazilian Forest Code, unlike most European forest laws, was designed within the paradigm of an open agricultural frontier, granting rural owners the subjective right to convert forest land into agricultural areas as long as certain limits are respected (Rajao *et al* 2021, de Toledo *et al* 2017). These limits are legally defined as Permanent Preservation Areas (natural vegetation in riverbanks, for instance, PPAs) and Legal Reserve (LR), a portion of a given property set aside for conservation or sustainable management (Rajão *et al* 2020, Sparovek *et al* 2012).

In the forestlands of the Amazon biome, as a general rule, 80% of any medium-to-large private property is overall considered Legal Reserve (LR). However, this general rule has exceptions since special conditions allow Amazon states and municipalities to reduce this LR area to 50% (Freitas *et al* 2018b), and medium to large farmers who cleared up to 50% of their forestlands prior to 2001, when the Legal Reserve was effectively increased from 50 to 80% in the Amazon forestlands, are allowed to have only 50% LRs. Small holders who cleared any amount of LR up to July 2008 have been granted amnesty, therefore not needing to restore these parts (Stickler *et al* 2013). This level of protection is often used as an example of ambitious legislation, but it also means that 20-50% of these medium-to-large properties can be lawfully deforested. Considering that properties in the Amazon can be as large as 20-thousand hectares, the areas open for legal deforestation according to Brazilian law are far from insignificant. Additionally, elsewhere in Brazil, the Legal Reserve areas range from 20% to 35% in equally important biomes such as the Cerrado savanna and the Pantanal wetlands. The Atlantic Forest is an exception because the *Mata Atlântica* protection law forbids any

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3 127 additional clearing. Therefore any deforestation within this biome is undeniably illegal. These
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6 128 biomes are critical carbon sinks. Their conservation is crucial for tackling climate change and the
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8 129 CO₂ emissions driven by land use change (Rajão *et al* 2020).
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11 130 All in all, the 2012 version of the Forest Code defines at least ~101 Mha of Brazil's biomes as
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13 131 areas open for legal deforestation (Freitas *et al* 2018a). This area is about four times the territory of
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16 132 the United Kingdom. The clear-cut of such regions would mean extra emissions of at least 12.48
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18 133 billion tons of CO₂ – all of which potentially authorized by the current Brazilian legislation (Freitas
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20 134 *et al* 2018a). This amount is almost 34 times the UK's total greenhouse gas (GHG) emissions in
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23 135 2018 alone (UCS 2020). In alignment with our short-term modelled estimates (*See Methods*), this
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25 136 area is what we consider as the *total* amount of possible legal deforestation. Whilst not all of this is
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27 137 likely to be cleared in the near term due to political, biophysical, and infrastructural constraints for
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30 138 deforestation, some areas in Brazil are likely to be at particularly high risk (Figure 1).
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32 33 139 **4. Changing legislation over time**

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36 140 As stated above, Brazil's legislation is permissive enough to allow for a substantial amount of
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38 141 legal CO₂ emissions via land use change. Yet, the legal framework to protect native vegetation has
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40 142 been changing in the recent years to allow more legal deforestation and legalize economic activities
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43 143 carried out in former forests and natural habitat that was illegally cleared. The 2012 Forest Code is a
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45 144 stark example of this situation (Sparovek *et al* 2012). From the 1990s, Brazilian environmental
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47 145 agencies ensured that law enforcement was more stringent than before, and thousands of non-
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50 146 compliant rural producers were fined. This generated political pressure to revise the law, passed in
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52 147 2012, with several amnesties for illegal deforestation carried out before 2008 (Albuquerque
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54 148 Sant'Anna and Costa 2021), thus effectively legalizing previously illegal deforestation. With the
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56 149 changes in 2012 alone, about 41 Mha of deforested and converted lands that should otherwise have
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59 150 been restored to native habitat were granted amnesty (Freitas *et al* 2017). Another ~1 Mha is
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151 estimated to have been deforested between 2012 and 2017 due to the incentives provided by the
152 revisions to law (Albuquerque Sant'Anna and Costa 2021).

153 The Forest Code is not an isolated case. Several bills in Parliament are on the verge of being
154 approved that are likely to bring more amnesties and open additional space for legal deforestation
155 (*See the SI, List of Brazilian Congress Bills*). These bills are part of an overarching movement by the
156 current Bolsonaro administration to re-shape the socio-environmental legal framework in Brazil,
157 incentivizing further legal destruction of natural habitat and carbon emissions and the legalization of
158 agricultural activities that are currently unlawful.

159 This social-environmental legal laxation movement by the current administration, however, does
160 not sit in isolation. Within local political constituencies, pro-development and anti-environmental
161 groups are important supporters of the current government and were determinant forces in the
162 election of Bolsonaro for presidency in 2018 (Raftopoulos and Morley 2020, Russo Lopes and
163 Bastos Lima 2020). They are also influential in elections at local levels, mainly in municipalities and
164 states (Rodrigues-Filho *et al* 2015, Pailler 2018), and are likely to substantially influence the next
165 presidential elections in 2022.

166 5. Ways Forward

167 To effectively implement a legality-based sustainability policy, legal deforestation activity should
168 be monitored by producer-country authorities and by the supply chain itself. In ideal circumstances,
169 Brazilian-based tier-1 companies (i.e. sourcing directly from farmers) would be able to conduct basic
170 verification of their suppliers (i.e. farmers), as they do in arrangements such as the Amazon Soy
171 Moratorium (Austin *et al* 2021, Heilmayr *et al* 2020), cattle agreements (Gibbs *et al* 2015), or the
172 High Carbon Stock Approach (Austin *et al* 2021). However, this verification capacity would not be
173 directly possible for tier-2 or tier-3 companies (e.g. importers, processors and retailers), obliged to
174 meet the incoming United Kingdom's due diligence legislation to place materials on the UK market,

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3 175 since they do not purchase directly from farmers, but from tier-1 companies. Another example of
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6 176 basic verification, in Brazil, is the Federal Environmental Enforcement Agency (IBAMA)'s list of
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8 177 embargoed areas. This list indicates areas that have been illegally cleared. When detected, these areas
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10 178 are embargoed to promote the restoration or regeneration of native vegetation. Nothing can be
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13 179 produced or traded from these areas. Therefore, a basic verification step to be carried out by
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15 180 companies is checking whether their supplying farmers are on that list.
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18 181 Second, companies can undertake supply chain engagement with upstream suppliers (Austin *et al*
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20 182 2021), and request the documentation attesting the legality of production. In Brazil's example, a
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23 183 farmer can only conduct deforestation if they hold an Authorization for Native Vegetation
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25 184 Suppression (ASV, in Brazilian Portuguese acronym), which is issued by state authorities. Therefore,
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27 185 downstream companies might detect deforestation on a supplying-farm by remote sensing and
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30 186 request the presentation of this permit as proof of legality. Importantly, the existence of this permit
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32 187 system implies that achieving zero-illegal deforestation or native vegetation conversion relies
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34 188 substantially on the discretion of the domestic legislation of producer-countries. The robustness of
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36 189 the domestic legislation is therefore worthy of additional attention".
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39 190 In the case of Brazil, for example, to be considered legal, any land use change from native
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42 191 vegetation to agricultural cover in Brazil must be subject to approval by the State Environmental
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44 192 Department before it takes place. The State Environmental Department must assess cases and issue
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46 193 land clearing permits if the requests comply with all legal requirements. Authorizations must identify
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49 194 the geospatial location of the clearance. Nevertheless, most states in Brazil lack any tracking system
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51 195 for these authorizations, which means there is effectively no monitoring of whether the authorized
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53 196 deforestation is being carried out lawfully. Currently, Brazilian agencies lack the technical capacity
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56 197 and political willingness to monitor, verify, enforce and report land use regulation.
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3 198 Without such local information (i.e., the ASVs), and in the context of the global supply chains in
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6 199 which soy is embedded, it is virtually impossible to attest if deforestation has been carried out legally
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8 200 or not (Valdiones *et al* 2021). Companies point out technical difficulties in monitoring and verifying
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10 201 legal deforestation to challenge regulation and enforcement by consumer countries (Lambin *et al*
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12 202 2020). An ideal scenario would be one where buyers could request the legal permits of clearings and
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15 203 production operations from their upstream suppliers (*i.e.*, farmers). However, this is complicated by
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17 204 technical issues related to Brazilian authorities' incapacity or unwillingness to monitor, verify,
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19 205 enforce, and report legal compliance.
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23 206 There are several methods to trace and verify *gross* (i.e. rather than just legal) zero-deforestation
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25 207 and natural habitat conversion in export supply chains at the jurisdictional level of production
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27 208 (Lathuilière *et al* 2021, Green *et al* 2019, Escobar *et al* 2020, Austin *et al* 2021). Platforms such as
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29 209 Trase (Trase 2021) and Mapbiomas (Mapbiomas 2021) are examples of publicly available supply
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32 210 chain and land use data that companies can use for risk assessments. These tools do not yet show
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34 211 deforestation at the individual farm-level in the case of Brazil. This level of detail would, for
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36 212 example, require integration with official government data, such as with the Rural-Environmental
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38 213 Registry (CAR, in the Brazilian-Portuguese acronym), and the ASV state spatial datasets but these
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41 214 datasets are still pending validation and not publicly available in all states (Valdiones *et al* 2021).
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43 215 Despite the limitations of publicly available data that links supply chain activities to *gross* clearance,
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45 216 it is arguably the case that – due to concerns about local monitoring and enforcement necessarily to
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48 217 demonstrate legality - downstream companies can assess risk exposure to gross deforestation at least
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50 218 as easily as to illegal deforestation.
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53 219 Ultimately, companies can – and do – have mechanisms to audit and verify whether their supply
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55 220 chains are deforestation-free via supplier engagement processes, such as voluntary certification
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58 221 schemes such as the Roundtable on Sustainable Soy (RTRS) and the Forest Stewardship Council
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60 222 (FSC). However, a missing link to ensure a level playing field and promote industry-wide action is

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3 223 mandatory regulation that applies to all companies for all forest-risk commodities, with requirements
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6 224 for precise cut-off dates, past, present, or future, to mark when no conversion will be allowed in
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8 225 supply chains (Garrett *et al* 2019). These certification tools can, therefore, be important learning and
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10 226 information experiences to construct new mandatory systems.
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13 227 Since companies and supply chain actors have been failing to define commitments and cut-off
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16 228 dates voluntarily (Garrett *et al* 2019), clear and stringent mandatory regulation demanding zero gross
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18 229 deforestation and natural habitat conversion by consumer-country authorities appears to be an
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20 230 effective measure. While the introduction of downstream legislation covering all forms of
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23 231 deforestation may appear politically infeasible in the short term (Bager *et al* 2021), it should not be
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25 232 dismissed as an ultimate goal. Nor should other potential policy mechanisms which have the
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27 233 potential to encompass broader protections be de-prioritized.
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30 234 In sum, in addition to being insufficient to prevent deforestation activity in all forms, regulation
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33 235 based solely on the criterion of legality carries the risk that it may be detrimental to the protection of
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35 236 forests. In countries where legislation can be easily modified, as is demonstrably the case for Brazil,
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37 237 increased demand for products with legal origins can increase pressure for legislative changes that
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40 238 aim to legalize agricultural activities located in illegally deforested areas. These legislative changes,
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42 239 in turn, also pave the way for more legal deforestation. Therefore, while welcoming the steps made
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44 240 by governments to introduce regulation to respond to the global threat of deforestation, we urge
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46 241 consumer-nation policymakers to consider zero-*gross* deforestation and zero native vegetation
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49 242 conversion criteria in their initiatives to address imported deforestation, GHG emissions, and
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51 243 biodiversity loss, considering that this is technically viable and potentially effective despite the short-
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53 244 term political hurdles that would need to be overcome to implement these advanced measures.
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56 245 **6. Methods and Data**

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3 246 First, we use a property-level boundaries spatial dataset, which includes the amounts of Legal
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6 247 Reserves (LR), Permanent Preservation Areas (PPAs), and the surplus of LRs (i.e., that can be
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8 248 legally cleared) (Freitas *et al* 2018a). Second, we use an aboveground carbon density map at 50m
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10 249 pixel resolution for Brazil (Englund *et al* 2017). Third, we use spatial projections of unprotected
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12 250 native vegetation in private lands, considering rural establishments that can conduct legal clearings,
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15 251 (Freitas *et al* 2018a). Fourth, we employ a spatially-explicit modelling approach that estimates the
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17 252 probability of the existence of native vegetation until 2025 (Fendrich *et al* 2020). This model
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19 253 considers topography, soil properties, climate data, distance to transportation corridors, and legally
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22 254 protected areas, including indigenous lands. This unprecedented combination of spatial datasets
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24 255 allows us to estimate the potential future legal deforestation with different levels of risk. For the
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26 256 purpose of alignment with climate policy, we use the 44/12 conversion factor to estimate the
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29 257 potential carbon dioxide (CO₂) emissions based on the total carbon stocks in the areas at risk of legal
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31 258 deforestation (Federici *et al* 2015). Therefore, we report the results directly in potential CO₂
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33 259 emissions.

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36 260 We adopt a conservative approach, excluding from this analysis the areas that Freitas et al.
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39 261 (2018a) projected as potential private properties to fill spatial gaps in the Brazilian territory. We only
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41 262 consider the rural establishments officially registered and identified at Brazilian land databases.
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43 263 Therefore, while Freitas et al. (2018a) estimated ~101 Mha of unprotected native vegetation within
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46 264 private lands, we only considered ~69.2 Mha. We use Fendrich et al.'s (2020)(Fendrich *et al* 2020)
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48 265 land cover model to classify these unprotected areas according to their risk of conversion.
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51 266 The land tenure database presented in Freitas et al. (2018) (Freitas *et al* 2018a) and updated by
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53 267 Freitas et al. (2018) (Freitas *et al* 2018b) was used as starting point for the analysis presented here.
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56 268 This database comprises public and private properties in Brazil such as Indigenous Lands,
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58 269 Conservation Units, Quilombola Territories, and private rural properties from the Rural
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60 270 Environmental Registry (Portuguese acronym CAR) and the georeferenced properties of the National

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3 271 Agrarian Reform Institute (Portuguese acronym SIGEF). The database also includes information on
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6 272 the compliance of these rural properties with the Brazilian Forest Code. It has information related to
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8 273 the area of native vegetation and the amount of aboveground carbon stock within each rural property
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10 274 (Freitas *et al* 2018a, Englund *et al* 2017). With the existent variables, it is also possible to identify the
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12 275 part of the native vegetation (or its carbon stocks) that is both legally protected or has the potential to
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15 276 be legally deforested (the latter called hereafter as unprotected native vegetation or unprotected
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17 277 carbon stocks).

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20 278 Fendrich *et al.* (2020) (Fendrich *et al* 2020) presented maps of the probability of the existence of
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22 279 native vegetation in a given pixel for the years 2017 and 2025. The probabilities are calculated based
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25 280 on a spatially explicit regression model that explores the relation of land cover maps of the
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27 281 Mapbiomas project (2019)(Mapbiomas 2021) and spatial variables (drivers of land cover change),
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29 282 such as topography, soil properties, climate data, distance to transportation corridors and legally
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32 283 protected areas, including indigenous lands. The land cover maps were reclassified to four classes in
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34 284 the model, namely, native vegetation, pasture, agriculture, and other uses. The existence of these four
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36 285 land cover classes was analyzed for every pixel in the entire period (from 1985 to 2017). The model
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39 286 captured the relation of the land cover classes and the spatial variables. Based on alternative future
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41 287 climate and policy scenarios (S1 - aggressive, S2 - business as usual, and S3 - conservative
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43 288 scenarios), Fendrich *et al.* (Fendrich *et al* 2020) estimated the probability of the existence of native
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45 289 vegetation, agriculture, and pasture in Brazil for the year 2025.

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49 290 The Fendrich *et al.* (2020)'s scenarios are based on the following. The S1 scenario, aggressive,
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51 291 considers no mitigation policy and additional environmental protection is adopted in Brazil.
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53 292 Furthermore, transport and energy national expansion plans are fully implemented, the population
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56 293 and the economy grows untapped according to national projections. The S2, business as usual,
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58 294 considers some environmental policies and decisions are implemented in Brazil, competing with
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60 295 economic growth. The S3, conservative, assumes that in Brazil there are large-scale and active

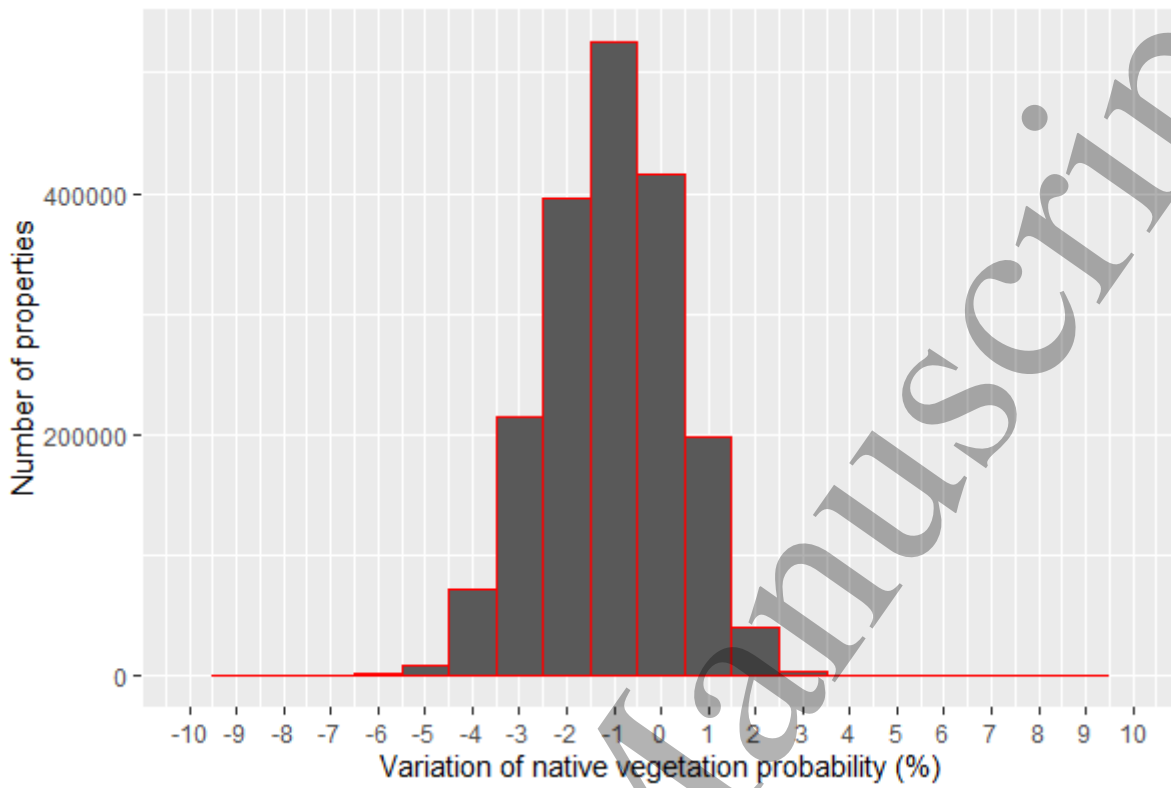
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3 296 restoration of native vegetation and significant improvements in environmental policies (Fendrich *et*
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6 297 *al* 2020).

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9 298 Here we used the S2 - business as usual scenario, to generate a map of the variation of native
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11 299 vegetation probability (VNVP map) between 2017 and 2025, where positive values represent pixels
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13 300 with an increase in the probability of native vegetation existence until 2025. In contrast, negative
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15 301 values represent pixels with a decrease in the probability of native vegetation existence until 2025.
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18 302 Further, we have combined the rural properties with unprotected native vegetation and the VNVP
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20 303 map to extract the average probability for each of these properties. These probability values are
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22 304 relative and averaged over all pixels per property. Therefore, this value presents the average
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25 305 probability of natural vegetation occurring on properties with Legal Reserve surpluses being lost. For
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27 306 example, if the Legal Reserve surplus of a property is composed equally by pixels with VNVP of 2%
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29 307 and 5%, then its average VNVP is 3.5%, therefore it has not risk of being lost until 2025. If the value
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32 308 is negative, then there is risk of legal deforestation. Fig. S1 expresses the distribution of the average
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34 309 probabilities within rural properties.

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37 310 The distribution of the VNVP shows that 99.6% of the properties with unprotected native
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39 311 vegetation have VNVP between -5% and +5%, with the majority of the properties (79,2 % of the
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42 312 total) presenting negative values (Fig. 2). Based on the distribution of the VNVP, we defined four
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44 313 classes of risk of the deforestation of unprotected native vegetation:

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47 314
- Properties with VNVP lower than -3% = High risk
 - Properties with VNVP between -3% and -1%= Medium risk
 - Properties with VNVP between -1% and 0% = Low risk
 - Properties with VNVP higher or equal than 0% = No risk
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3 319 Fig. 2 - Distribution of the average variation of native vegetation probability (VNVP) between 2017 and 2025 within
4 320 rural properties with unprotected native vegetation. Positive values represent pixels with increase in the probability of
5 321 native vegetation existence until 2025 whereas negative values represent pixels with decrease in the probability of native
6 322 vegetation existence until 2025.
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469 Conceptualization: RSTV, TNPR, VGF, GS, MMSE.

470 Methodology: TNPR, VGF, GS.

471 Investigation: TNPR, VGF, MMSE.

472 Visualization: VGF, TNPR, GS.

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475 Writing – original draft: TNPR, GRL, CW, GS, RSTV, MMSE.

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