

Transformative changes are needed to support socio-bioeconomies for people and ecosystems in the Amazon

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Authors: Rachael Garrett^{a*}, Joice Ferreira^b, Ricardo Abramovay^c, Joyce Brandão^a, Eduardo Brondizio^{d,e}, Ana Euler^f, Daniel Pinedo^g, Roberto Porro^h, Emiliano Cabrera Rocha^a, Oscar Sampaio^{a,l}, Marianne Schminkⁱ, Bolier Torres^j, Mariana Varese^k

*Corresponding author rg711@cam.ac.uk

^a Department of Geography and Conservation Research Institute, University of Cambridge, Cambridge UK

^b Embrapa Amazônia Oriental, Rede Amazônia Sustentável, Belém, Brazil

^c Environmental Science Program, University of São Paulo, São Paulo, Brazil

^d Department of Anthropology, Indiana University-Bloomington, USA

^e University of Campinas, Environment and Society Program (UNICAMP-NEPAM), Campinas, Brazil

^f Embrapa, Brasília, Brazil

^g Universidad Nacional Mayor de San Marcos, Lima, Peru

^h Embrapa Amazônia Oriental, Belém, Brazil

ⁱ Latin American Studies, University of Florida, Gainesville, USA

^j Faculty of Life Sciences, Universidad Estatal Amazónica, Puyo, Ecuador

^k Wildlife Conservation Society, Lima, Peru

^l Federal University of Mato Grosso, Cuiaba, Brazil

Abstract:

Current social-technical and political conditions threaten the integrity of the Amazon biome. Overcoming these lock-ins requires structural transformations away from conventional economies toward “socio-bioeconomies” (SBEs). SBEs are economies based on the sustainable use and restoration of Amazonian ecosystems, as well as indigenous and rural livelihood systems in the region. They include sustainable eco-tourism as well as diversified production and innovative processing of fruits, nuts, oils, medicines, fish and other products deriving from socio-biodiversity. Using a sustainability transitions perspective, we argue for multi-scalar policy changes to sustain, enhance, and scale out and up SBE initiatives. To nurture niche SBE activities, we advocate for improvements in infrastructure, value chains, and social organisations. To dismantle structural barriers, we call for an end to harmful subsidies, greater representation of marginalised communities in territorial planning, enhanced rural-urban and intersectoral linkages, international collaboration, shifts in demand, and changes in conservation and production narratives. Policies for SBEs must also use clear definitions, participatory processes, and a multi-biome approach to avoid perverse outcomes.

43 **MAIN**

44 Half a century of deforestation, commodification, and exploitation of ecosystem goods and services
45 in the Amazon has not brought widespread development and now threatens the economic value of
46 already deforested areas as well as global climate and water security (1). While the export of
47 commodities linked to deforestation can lead to regional and national economic improvements
48 though infrastructure jobs, interstate movement taxes, and foreign exchange, the positive effects are
49 fleeting and the value generated from forest clearing activities is largely captured by international
50 actors and domestic elites (2–4). This unequal context is characterised by underinvestment in
51 education, innovation, and sustainable infrastructure to add value to regional products (5). Despite
52 conversion of large amounts of natural capital into material exports, energy, and food over the last
53 fifty years, income, life expectancy, and educational attainment in Amazonian municipalities remains
54 below other regions within the same countries and significantly lower than the region’s largest
55 trading partners (6).

56 The development of existing and emerging (7) *socio-bioeconomies* (SBEs) offers an alternative to
57 conventional economies based on ecologically degrading processes and low-value commodity
58 production. SBEs are defined here as systems of production, management, processing, distribution,
59 recreation, and consumption based on the sustainable use and restoration of healthy forests and
60 rivers (see Figure 1 for examples). The actual land uses these SBEs are based on are often referred to
61 as “nature-based solutions (NbS)” (activities compatible with healthy ecosystems for climate
62 mitigation, resilience, biodiversity protection and healthy livelihoods). The NbS we refer to are land
63 uses that are often pursued by indigenous or traditional communities and smallholders in the
64 Amazon and take advantage of the unique genetic, chemical and physical resources of the region
65 (8,9). For instance, Ecuadorian Kichwa peoples have long used agroforestry systems (called
66 “Amazonian Chakra”) with products like cocoa (*Theobroma cacao* L.), guayusa (*Ilex guayusa* Loes.),
67 vanilla (*Vanilla* spp.), and rubber (*Hevea brasiliensis*) (10).

68 As a modification of the conventional bioeconomy concept, the term SBE places *justice* as a core
69 value. SBEs enact *procedural justice* by ensuring participation of women, youth, and ethnic-territorial
70 diversity. As such it pursues inclusive development and protection of knowledge, rights, and
71 territories of Indigenous people (IP) and local or traditional communities (LCs), inclusive of former-
72 slave communities (11). SBEs enact *restorative justice* by foregrounding Indigenous populations’
73 ethical-normative values captured in the concept of *Buen Vivir* (good living) that highlights the
74 intrinsic relationships between nature and people in local ecosystems, and the need to safeguard
75 biological, cultural and social diversity (12,13). Indeed, a longer terminology for SBEs should read as
76 “indigenous, traditional, and local economies based on socio-biodiversity” so as not to further
77 invisibilise the presence of pre-existing models. These value-based approaches are recognized in the
78 constitutions of Bolivia, Colombia, Ecuador, Brazil and Peru. Finally, SBEs aim for *distributive justice*
79 by prioritising (re)investment and budget increases in health, education, and food distribution
80 centres for both rural and urban people. As such, they include revitalised urban economies with
81 manufacturing and service industries that add value to the products coming from NbS to better serve
82 the vast majority of the Amazonian population.

83

84

SBE COMPATIBLE



Inclusively managed native forest conservation and restoration



Native nut cultivation, harvesting, and processing through cooperatives



Diverse cultivation in mosaic and agroforestry systems processed into high-value, transportable products



Harvesting plants and oils for cosmetics and medicines with fair property rights



Sustainable community-based management of fisheries



Community-based ecotourism

SBE INCOMPATIBLE



Fortress conservation and green grabbing



Deforestation for cattle ranching



Large-scale crop monocultures and biofuel production



Large hydropower projects



Formal and informal mining



Overfishing and introduction of non-native species

Figure 1: Examples of activities that are compatible with the socio-bioeconomy (SBE) concept. These include not only specific land use and aquatic activities, but also the governance and value chains these activities should be embedded in. Modified from (14), original credit to Dêde Paiva.

How to strengthen socio-bioeconomies

Bioeconomy concepts are gaining traction in Amazonian political agendas. A National Socio-bioeconomy Plan (17) and bioeconomy is prominent in Brazil's international climate announcements (18). Discussions about SBEs were also prominent during the Belem meeting of Amazonian countries' presidents and included in the Belem Declaration for inter-Amazonian cooperation. Yet, it remains unclear how to achieve the ambitious goals of strengthened SBEs in Brazil and policies to support SBEs have yet to be developed in other Amazonian countries.

Here, we use a socio-technical transitions lens developed by Geels (7) to conceptualise the barriers and opportunities for more sustainable development in the Amazon. The socio-technical transitions framework views existing lock-ins through a multi-level perspective (MLP). The MLP describes the "regime" as the dominant mode of production, sourcing, value accumulation and consumption in the system. It also includes the policy goals and narratives, and scientific and technological paradigms (19,20). The "landscape" is the set of external factors influencing the system. "Niches" are the alternatives to the behaviours and practices embedded in the current regime (21).

104 Within this context, we can consider most sustainable-development initiatives (including SBEs) as
105 niches that struggle to scale amid significant structural constraints and pressures (see Figure 2a). The
106 current Amazonian regime is characterised by economies based on timber, mineral and oil extraction,
107 low-value agriculture, and over-fishing. It was derived from neoliberal, modernist, and colonial
108 political narratives inherited and sustained by governments, international development banks, and
109 consuming countries (12,22). Increasingly it is also influenced by growing energy demand and
110 electrification, leading to widespread damming of Amazonian riverways (23,24). The socio-technical
111 landscape includes: i) an acceptance of increasing global consumption of tropical commodities; ii)
112 insufficient pricing of these commodities given their social and environmental costs to society; iii) a
113 failure to sufficiently value climate stability, biodiversity, and the rights and livelihoods of people
114 living in the tropics (25); and iv) a lack of fair-trade conditions or equitable international cooperation.
115 Recent changes in the landscape are creating new markets and finance for carbon and biodiversity,
116 or increased pressure for zero-deforestation through global commitments and international trade
117 due diligence policies. Yet, their impacts are highly limited within the existing regime.

118 Kanger et al. (26) propose several policy intervention points to achieve socio-technical transitions,
119 simplified and adjusted here as: 1) accelerate niches; 2) destabilise the regime; 3) tilt the landscape;
120 and 4) provide safeguards (Figure 2b). Niche stimulation and acceleration refers to providing the
121 financial and other policy resources to encourage and scale technologies to address sustainability
122 crises. In the MLP framework, the niches are expected to remain trapped without regime
123 destabilisation, which involves disrupting the system of incentives arising from the incumbent
124 economic systems, narratives, and power dynamics to allow niches to emerge and scale. Tilting the
125 landscape refers to changes in demand, trade, and international agreements and targets that can
126 help shift the regime by influencing the politics of national governments and change financial flows.
127 It's also critical to establish safeguards around the SBE concept and processes to avoid misuse and
128 co-option (each policy step and specific actions are summarised in Table 1).

129

a) The existing system locks-in conventional activities (blue)

Socio-technical landscape:

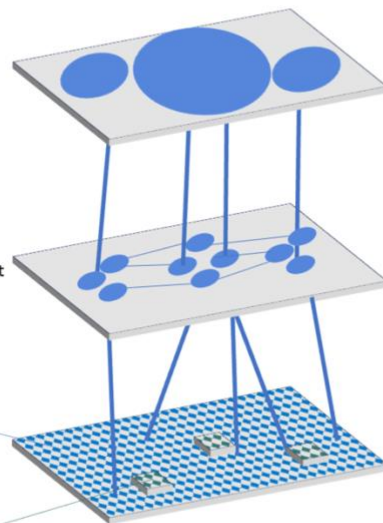
Increasing consumption & isolated sustainability targets creates goal tensions.

Regime:

Extractive economies & flawed development logics support the status-quo.

Degrading practices are **locked-in**.

Sustainable development **Niches** like SBE struggle to thrive.



b) Changes are needed to scale & support SBEs (green)

Trade regulations open windows but more collaboration on shared goals is needed to **harness & tilt the landscape** toward regime changes.

Fundamental changes to the food systems, value accumulation, rights, & narratives will **destabilise the regime** to support & scale SBEs.

Finance, infrastructure, marketing, social organization improvements can help **accelerate SBE niches**.

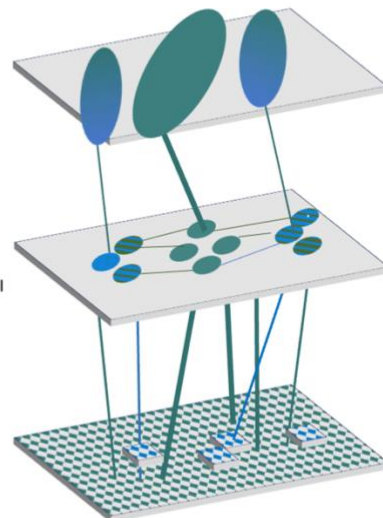


Figure 2: Proposed policy interventions to support socio-bioeconomies. Small blue diamonds represent conventional practices locked into place by the existing regime and landscape. Green diamonds represent the development of SBEs. Blue ellipses are conditions (e.g., networks of reinforcing actors, institutions, etc.) in the landscape and regime that support conventional activities. Green ellipses are conditions in the landscape and regime that could help scale up SBE initiatives. Panel a) shows how existing regime and landscape lock-in conventional degrading activities and block SBEs. Panel b) summarises why policy changes are needed at the niche, regime, and landscape scales to support SBEs. Modified from Geels (27).

1. Niche acceleration:

Transformation cannot happen merely by supporting SBEs niche activities, but nevertheless niche acceleration is an important part of the picture that can occur immediately. The growth of niches can also help shift narratives by providing evidence of their feasibility as alternatives. For all the below recommendations it is essential to ensure that the cultural values of IPs and LCs, developed over millennia, are respected and protected.

1a) End harmful subsidies

Finance must be redirected from activities that harm existing SBEs to activities compatible with SBEs (28). Low-interest loans and tax-advantages for agribusinesses (29) that skew heavily towards larger producers or producers with existing credit histories have helped prop-up activities like cattle ranching and soy production (30–32). It's necessary to immediately phase out credit programs for conventional agriculture in areas with high forest cover and more gradually scale down any subsidized credit to conventional agriculture that is not accompanied by sustainability criteria.

1b) Redirect finance & research

153 International and national (or blended) finance should instead be directed to conservation for
154 ecosystem services (e.g. via carbon and biodiversity markets) and to research, innovations, and
155 scaling of production and processing of SBE compatible activities. The development of state or
156 Amazon-level portfolios for investable SBEs activities would be useful for connecting small-scale
157 projects to distant climate and development fund investors. Funding must prioritize IP and LCs with
158 sustainable management plans, and other vulnerable land use actors.

159 Existing financing mechanisms should be improved by: i) allowing smallholder land users and
160 community-based enterprises to obtain loans without formalized tenure arrangements, ii) reducing
161 interest rates to zero for the more vulnerable families, iii) providing capacity for business model
162 development and iv) establishing longer-time horizons for repayment to accommodate the long-
163 term nature of socio-bioeconomy investments.

164 Funding for research on agricultural commodities typically dwarfs investments in diversified
165 agricultural systems, non-timber forest products and sustainable fisheries in Amazonian countries.
166 Funding for conventional systems (e.g., direct planting, pasture recuperation) is also 500 times
167 greater than organic production and agroforestry in the Brazilian “Low Carbon Agriculture” credit
168 disbursements (33). Considering that indigenous and traditional epistemologies are often excluded
169 from science and decision-making, producing knowledge to support SBEs necessarily includes
170 indigenous and traditional frameworks from the initial phase of defining the aims and methods of
171 research. Redirected funding could support activities that bring together indigenous experts,
172 ethnobotanists, agronomists, and other scholars to co-create a sustainability science agenda driven
173 by and responsive to local needs. Part of this agenda could include collaboration to better
174 understand current and potential uses of forest products. While one study estimates that Brazil
175 alone could generate 8.2 billion (USD) per year by 2050 relative to existing economic activities by
176 investing in SBEs (34), many more studies on the potential scale, scope, and inclusivity are needed/

177 These must be coupled with ecological studies to better understand thresholds and practices for
178 sustainable harvesting, water and residue management, and feedback with soil health and
179 biodiversity in different management approaches. A renewed focus is needed on IP and LC
180 knowledge with respect to sustainable practices, ecological feedbacks, and governance. Research on
181 climate resilience is a priority given the combined climate impacts of global greenhouse gas emissions
182 and regional deforestation and degradation on the regional climate which threaten IP and LC
183 livelihoods. On the socioeconomic side, there is a need to better understand market bottlenecks and
184 logistical constraints, identify mechanisms and policies that can overcome these constraints, and
185 document and test governance arrangements that support just use and marketing of SBEs products.

186 *1b) Build the infrastructure*

187 Sustainable infrastructures are needed to improve the welfare of Amazonian populations and
188 enhance Amazonians’ access to information, energy, sanitation, and markets (35). Infrastructure
189 needs specifically related to the SBEs include low-impact transportation, storage and cold-storage
190 facilities, food processing, digital connectivity and information technology to address challenges of
191 perishability, seasonality, and low species abundance without losing the decentralized and equitable
192 nature of SBEs (36). Many of these forest-product processing technologies are crucial to exporting
193 with sufficient value.

194 Electrification and development of distributed (&/or small-scale) renewable energy are crucial to
195 help Amazonians reduce their dependence on diesel oil and support multi-purpose small scale

196 industrialization. They may also support and should go hand in hand with investments that consider
197 the changing climate and the additional risks it brings to ecosystems through changes in water stress
198 and fire severity (37). In urban areas, there needs to be realistic planning to control sprawl and
199 improve access to public transport and markets for rural products with sufficient infrastructure to
200 reduce spoilage. Appropriate waste infrastructure needs to be established to reduce water pollution
201 to protect indigenous communities and aquatic biodiversity. This could include capturing human
202 refuse for nutrient extraction to be used for fertilisation for agroforestry systems.

203 Moreover, it is necessary to foster new lines of technological education in innovative systems with a
204 high practical curricular content and focusing on these SBEs topics, as well as small financial
205 incentives for access to appropriate equipment, such as extraction of essential and vegetable oils,
206 tinctures, resins, fibres, etc., processing of value-added products (in at least two links in the value
207 chain).

208 *1c) Support community organizations and small-scale enterprises, especially for women and youth*

209 Cooperatives and community enterprises play a decisive role in supporting SBEs. The lessons learned
210 from positive examples should be analysed and discussed with other Amazonian communities to
211 identify potential models for successful cooperative production, processing, and management. A
212 challenge faced by community enterprises is their low access to finance or training in management
213 and business. In parallel to research innovations, investment must forecast mechanisms by which
214 small enterprise and cooperative businesses can be incubated for technological improvement and
215 stable market access (38). Since women play a disproportionate role in the collection and sale of SBE
216 products it is particularly crucial to support women's collective organization and social movements.
217 These can help improve their material outcomes, as well as their visibility, environmental and political
218 awareness (39). As youth are also on the forefront of SBEs, particularly within social media and other
219 digital spaces, efforts should be made to support these communities through seed funding for
220 physical gatherings, including youth conferences.

221 *1d) Enhance marketing pathways*

222 To reach new markets it is necessary to further develop SBE product brands and labels and coordinate
223 national and international tax incentives and trading policies. Access to the internet and literacy
224 about fair prices and direct marketing opportunities will allow greater buying and selling power.
225 Media campaigns are also needed to show the large-scale/long term benefits of strengthened SBEs
226 and related products in the Amazon basin. Public purchase programs and price guarantee policies
227 could create a stable and circular market for forest products. Create a Pan-Amazonian trade
228 organization with the objective of encouraging cooperation around international trade in products
229 and services from SBEs, including developing quality standards, sharing market information and
230 statistics; participating in joint marketing campaigns, and regularly discussing priorities, problems,
231 and concerns.

232

233 **2. Regime destabilisation:**

234 Existing regimes only allow for incremental changes that place conservation at odds with
235 development (26). More transformative regime change can reconcile these tensions through new
236 synergistic pathways that change structures and paradigms enabling synergies between ecosystem
237 conservation, climate stability, and improved wellbeing (40).

238 *2a Stop deforestation and degradation*

239 Ongoing ecosystems loss and degradation threaten IPs and LCs, and [low-income] urban residents,
240 hinder the potential of the socio-bioeconomy, while also supporting the beneficiaries of the existing
241 regime. For these reasons improvements in efforts to reduce forest and river degradation are critical
242 to regime destabilisation. Such improvements include, among others: turning undesignated forest
243 lands and other areas into protected and sustainable use areas; expanding conservation and water
244 pollution regulations; scaling up ecosystem restoration; expanding and improving systems to monitor
245 deforestation-risk supply chains; strengthening community-level ecosystem monitoring systems;
246 cancelling and blocking efforts to register public or private lands illegally or in Indigenous areas;
247 assessing, avoiding, and remediating the impacts of any new infrastructure on deforestation, forest
248 degradation, and river connectivity; and the creation of a central intelligence hub for all deforestation
249 and degradation control activities. It is also essential to improve regulation of illegal economies and
250 organized crime (e.g., land invasions; illegal gold mining and fisheries; drug and wildlife trafficking)
251 via improved enforcement, reduced corruption, and protection of 'environmental defenders' (e.g., IP
252 and LC leaders, journalists).

253 *2b) Rethink the prevailing food systems*

254 Existing food systems in the Amazon are dominated by production strategies oriented towards long
255 supply chains benefiting distant consumers. They are underpinned by high and growing global
256 demand for the products that contribute disproportionately to the destruction in the Amazon.
257 Meanwhile many people in Amazonian countries struggle with either hunger or obesity and other
258 food related health challenges (41–43). Programs to stimulate and support the consumption of a
259 diverse and nutritious diet will directly benefit SBEs as they favour a more diverse production
260 landscape. Policies should also aim to reduce beef consumption outside of the Amazon, since pasture
261 for cattle drives the largest share of deforestation in the biome. This can be done with sensitivity,
262 acknowledging that meat is critical to poorer households. A greater focus on recycling and recovery
263 of minerals as part of developing more circular supply chains for technologies like batteries and
264 smartphones could help reduce demand for damaging land use activities like gold mining.

265 *2c) Develop synergistic cross-sectoral rural-urban linkages*

266 A shift to inclusive development requires a greater focus on distributed economic opportunities,
267 improved connections with urban centres, and synergies between multiple sectors of the economy
268 (environment, industry, health, and education). Strengthened SBEs can bring benefits for rural and
269 urban communities in public health and food security domains, including the availability of healthy
270 and nutritious foods such as fish, fruits, and nuts. Urban-rural linkages provide key investment
271 opportunities for both urban and rural agroecological and production activities (44). Existing SBEs are
272 already linked with Amazonian cities, and peri-urban areas show great promise for further expansion,
273 adaptation, and added-value. Developing various value-added and service activities in Amazonian
274 urban areas through tax breaks and targeted finance can help diversify and increase the number of
275 jobs in SBEs (45).

276 *2d) Strengthen IP and LC rights and representation in state & federal government*

277 There are 2.2 million IPs and LCs in the Amazon accounting for 4.6% of the population on 27% of the
278 area (46,47). These communities' livelihoods and cultural survival depend on healthy standing forests
279 and flowing rivers for access to clean water, food, good health, and spiritual values (42,48–50).

280 Protected areas, including those under Indigenous management, have fared significantly better than
281 other governance approaches to reducing deforestation in the Amazon (51). Yet >50% of Indigenous
282 lands are facing threats from cropland and pasture expansion, incursions for large-scale fisheries and
283 infrastructure, land invasions, fossil fuels and mining prospecting and extraction (52). Strengthening
284 Indigenous land rights means enacting laws, or enforcing existing ones, that provide official
285 recognition to the rights they have over their territories and improve communities' abilities to
286 monitor and deter deforestation and forest and aquatic degradation.

287 One of the best ways to do strengthen these rules is by establishing or strengthening the ministries
288 of indigenous affairs and improving representation of IPs and LCs in congresses via improved
289 campaign financing and training of those groups. This is especially needed to counteract the growing
290 share of agrobusiness interests in national congresses (53). IP and LC representation groups should
291 be established and heard within every major rural development and conservation related planning
292 processes, with due attention to enforce the Indigenous and Tribal Peoples Convention of the
293 International Labour Organisation (ILO Convention 169).

294

295 *2e) Change the narratives around conservation and development*

296 *Shift 1: Stop framing conservation and development as necessary tradeoffs*

297 Conservation policy discussions in the Amazon (and elsewhere) often focus on estimating the
298 foregone profits from cropland or pastures as a cost of deforestation control (54). Many studies aim
299 to identify the most cost-effective activities considering these high forgone profits (55–59). Yet, there
300 is little quantification of the societal and tributary costs and inequalities associated with existing
301 activities or emphasis on the low returns of existing food and mineral commodities (60). A focus on
302 opportunity costs also feeds into narratives about the 'sacrificeability' of certain regions to
303 deforestation due to their higher perceived agricultural profits (e.g., the Cerrado and dryland forests)
304 (61,62). Greater emphasis is needed on the missed development opportunities of not investing in
305 ecosystem conservation.

306 *Shift 2: Stop framing the bioeconomy as something new and advanced and start focusing on how to*
307 *support existing initiatives through structural changes*

308 Proponents often frame SBEs as a radically new idea that is yet to be realised and dependent on
309 advanced technologies (63). These framings implicitly position richer countries as having the best
310 capacity to lead the transition to SBEs and ignore the intellectual contributions of bottom-up
311 movements on which SBEs thinking builds (64). Such 'promissory' and future-oriented approaches
312 tend to ignore or unintentionally cast existing initiatives as 'backwards' despite their potential for
313 technologies to be more equitable, feasible, and effective than technologies developed outside of
314 the Amazon. A more inclusive and productive approach would diversify ideas about SBEs technology
315 to include new and traditional technologies (65).

316

317 ***3. Harnessing new landscape windows and further tilting the landscape***

318 Changes in the global landscape, including the growth of biodiversity and carbon markets and a move
319 toward due diligence in global sourcing, can provide new windows for strengthened SBEs, yet further
320 efforts are needed to tilt the landscape toward SBEs, including improvements in the scope of global

321 sustainability targets and international cooperation efforts to highlight justice, transparency and
322 accountability.

323 *3a) Seize policy windows from due diligence regulations and international commitments*

324 The global climate and biodiversity crises are leading to the creation of new markets and sources of
325 finance that can support SBE scaling under the caveats included above (66). Similarly, international
326 commitments like the New York Declaration of Forests and UN Sustainable Development Goals
327 include the various targets with respect to protecting and restoring forest ecosystems, that can be
328 leveraged to attract new development aid and finance. The new UK and EU deforestation regulations
329 (67,68) require companies that sell into the UK and EU to map their supply chains and understand
330 their deforestation risks, and accordingly to undertake due diligence to ensure that no deforestation-
331 linked products are sourced and sold.

332 These policies offer new leverage to support the deforestation control activities that underpin regime
333 destabilisation. Policy makers should reference these changes in international policies when lobbying
334 for additional national and regional policies. Actors at all scales should seek finance from actors
335 engaged in global conservation and development commitments to support national and regional SBE
336 initiatives.

337 *3b) Advocate for alignment of international goals with internal visions rather than vice versa*

338 Existing global targets represent a scattershot of ambitious, yet disjointed sustainability ambitions
339 (e.g., achieving zero-deforestation, conserving 30% of the planet, planting one trillion trees) and
340 don't provide much of a blueprint for building a sustainable economy. Therefore, we encourage
341 international actors to listen, support, and amplify Amazonian visions and targets, rather than
342 encouraging replication of external visions. The text of the Kunming-Montreal Global Biodiversity
343 Framework of the UN Convention on Biological Diversity is promising in this sense as it contains text
344 on transformative actions relevant to SBEs, but it should not fall back on over-simplified targets (69).
345 The Global Biodiversity Framework Fund (GBFF) of the Global Environmental Facility is also mobilising
346 significant funding targeted to IPs and LCs for inclusive conservation (70).

347 *3c) Strengthen institutions for cross-scale and regional learning and cooperation*

348 The time is ripe to strengthen international institutions to support cooperation and learning across
349 different visions and experiences of SBEs across countries. Building on the Amazon Cooperation
350 Treaty Organization, the 2019 Leticia Pact, and the 2023 Amazon Cooperation Treaty Organization
351 Amazon Presidents' Summit, the creation and improvement of pan-Amazonian institutions could
352 help enhance market opportunities, enable policy coherence and reduce negative spillovers across
353 countries. The support of existing and creation of cross-scalar and inter-community networks to help
354 identify and magnify bottom-up experiences within SBEs will require a sustained effort.

355 Greater emphasis must be channelled to cross-learning from research and development, sharing data
356 intelligence, monitoring, and policies that support SBEs (71). IPs and LCs must be active participants
357 in this effort, as should women, given their historical marginalization and prominent leadership of
358 regional initiatives and organizations. Given their engagement with social and visual media, youth
359 could be important leaders and amplifiers of media campaigns. Within countries, allocations of
360 national research budgets should improve the geographic distribution of educational and innovation
361 research institutes to enhance the capacity of Amazon-based organizations (rather than historical
362 centres of wealth and power) (72).

363

364 **4) Establishing safeguards**

365 *4a) Clear definitions and guiding processes for socio-bioeconomies*

366 The SBE concept is far from simple or unanimous. In fact, some people and local organizations even
367 have reservations about using the term at all. The 'bio' label gives the bioeconomy a 'green' aura
368 which is not necessarily reflected in practice. This can be used for 'greenwashing', i.e. using only the
369 rhetoric of sustainability without substantial commitment. SBEs also have the potential for both over-
370 exploitation and misinterpretation. Monocultures and single aquaculture species should not
371 substitute diversity under the guise of "bio" production (73) and investments and control of SBEs
372 must not go to a narrow set of multinational companies or domestic elites. Clear definitions are
373 needed around what SBEs entail. It is also important to emphasise the processes inherent in SBEs as
374 a guiding value system. This includes addressing power and policies asymmetries and maximizing the
375 diversity of social organizational forms (e.g., cooperatives, family agriculture, Indigenous
376 associations) that participate in SBE initiatives (74).

377 It would be problematic to frame SBE initiatives around visions and promises of economic growth
378 based on per hectare profits and GDP. Such narrow efficiency metrics do not account for the multiple
379 contributions and societal benefits, including economic, generated by strengthened SBEs; nor do
380 they account for the costs and erosion of the resource base. The development of truly sustainable
381 Pan-Amazonian SBEs requires narratives emphasising the goals of economic justice and democratic
382 economies, as well as growth-agnostic metrics centred on the wellbeing of people and their
383 environments. A longer-term, more inclusive wealth perspective should focus on the need to
384 safeguard the environmental and social support systems underpinning our well-being and securing
385 IP and LC rights to food security, clean water, and good health.

386

387 *4b) Participatory and transparent processes*

388 Participatory processes are needed to gather input, understand values, and weigh trade-offs in the
389 creation of land and water use, community, and economic development plans. Research initiatives
390 must be defined in collaboration with Amazonian peoples and regional research institutions, ensuring
391 that they benefit from it. It's also crucial to ensure public engagement in science and open access to
392 research results for the public, following the principles of open and collaborative science (75).
393 Infrastructure and marketing arrangements must be planned and implemented with the active
394 participation of the local populations that will benefit from it, not just external consumers. The
395 private sector and international development banks could be used as a source of financing, but only
396 with strong safeguards for co-creation and rights protections for Amazonian communities.

397 *4c) A multi-biome approach*

398 Economic incentives for Amazonian deforestation are linked to other national and international
399 regions. SBE-based conservation focused exclusively on the Amazon risks overlooking both distant
400 sources of deforestation incentives and how they could 'leak' elsewhere (e.g., if efforts are exclusively
401 focused on the Amazon, incentives for environmental degradation might migrate to other biomes of
402 Amazonian countries (76)). A holistic approach seeks to support SBEs in all biomes of Amazonian
403 countries. This implies supporting the economies of all biomes to transition to increase their regional

404 sufficiency, strengthening the ‘domestic’ economy of each biome, and thus protecting the livelihoods
 405 and population of each region from excessive exposure to the fluctuations of export-oriented
 406 economies.

Table 1: Key recommendations by level

| Level | Actions | Examples | Audiences |
|---|--|---|--------------------------------|
| Niche | | | |
| <i>1a) End harmful subsidies</i> | <ul style="list-style-type: none"> • Phase out credit programs for conventional agriculture in areas with high forest cover. • Scale down subsidized credit to unsustainable agriculture. | <ul style="list-style-type: none"> • Measure 22 in the Declaration of the “Povos da terra pela Amazônia”(77) • Brazil’s credit moratorium and blacklisting programs in high deforestation properties/areas • Elements of Brazil’s Low Carbon Agriculture scheme (though the scheme as a whole still skews towards traditional practices) | DGOV, DEV, IF, NGO, PS, |
| <i>1b) Shift finance and research</i> | <ul style="list-style-type: none"> • Improve and adapt existing financing mechanisms to be more smallholder and common property friendly. • Fund research on: i) thresholds and practices for sustainable harvesting & feedbacks with soil health, water and biodiversity, ii) climate resilience of SBEs, iii) market bottlenecks and logistical constraints and solutions, iv) governance arrangements that support SBEs, and v) science and policy-making centred in IP and LC knowledge. | <ul style="list-style-type: none"> • Guyana’s Low Carbon Development Strategy • Green Climate Fund’s Amazon Bioeconomy Fund • Cross scale and thematic Research fund for science & innovation, such as Amazonia +10 Initiative (78) • Private Social Investment (ISP) platform for the Amazon | DGOV, DEV, IF, NGO, PS |
| <i>1c) Build the infrastructure</i> | <ul style="list-style-type: none"> • Build low-impact transportation, storage, cold-storage, and food processing facilities. • Improve digital connectivity, electrification, and small-scale renewable energy. • Develop better sanitation and nutrient reuse capacities. • Control sprawl and improve access to public transport. | <ul style="list-style-type: none"> • Brazil/Amazon nut phytosanitary investments in Bolivia and Peru • COOPERACRE – a cooperative of cooperatives that has built processing and marketing infrastructure for SBEs (www.cooperacre.com) • Multipurpose forest biorefineries (fruit and nut-biocompounds) • Small-scale renewable energy in reserves in Brazil (79) | DGOV, DEV, NGO, PS, AC, IP, LC |
| <i>1d) Support associations and small enterprises</i> | <ul style="list-style-type: none"> • Invest in technological development and marketing efforts of small enterprise. • Support women’s organizations. • Provide funding for youth organisations and conferences. | <ul style="list-style-type: none"> • Origins Brasil network to support enterprises of IP and LCs in Brazil (www.origensbrasil.org.br/) • “Agroemprende cacao” investment to support cocoa agroforestry cooperatives in Colombia (80) • Corporation of Amazonian Chakra Associations (fosters small associative | DGOV, DEV, NGO, PS, AC, IP, LC |

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| | | <ul style="list-style-type: none"> enterprises and inclusion of young people and women) (81) • Restaura Amazonia - Fundo JBS & Solidaridad LatinoAmerica (82) • Arapaima fisheries in Amazonas Brazil (83) • Babassu-palm value chains in Maranhão, Brazil (84,85) • Latex and brazil nuts (CooperAcre) in Acre Brazil (86) • Brazil's National Socio-bioeconomy Plan | |
| <i>1e) Enhance marketing pathways</i> | <ul style="list-style-type: none"> • Develop SBE product brands and labels. • Coordinate national and international tax incentives and trading policies. • Media campaigns to show the benefits of the SBE. • Public purchase programs and price guarantee policies. | <ul style="list-style-type: none"> • Food Security programs in Brazil (PAA and PNAE) • Pre-natal food subsidy in Bolivia • Veja advertising Fair trade Amazonian native rubber as a sustainable leather substitute (87,88) • World Economic Forum and Mongabay videos on nuts like Sacha and Amazon nut (https://www.weforum.org/videos, https://www.youtube.com/watch?v=qh_b19Ozu038) • Minimum Price Guarantee Policy for Sociobiodiversity Products in Brazil (PGPM-Bio) | DGOV, NGO, PS, IP-LC |
| Regime | | | |
| <i>2a) Stop activities that threaten IPs and LCs and socio-bioeconomies</i> | <ul style="list-style-type: none"> • Expand protected and sustainable use areas, and conservation and water pollution regulations. • Scale up ecosystem restoration. • Improve company and community deforestation monitoring systems. • Cancel and block efforts to register public and private lands illegally or in Indigenous areas. • Assess, avoid, and remediate impacts of new infrastructure. • Create a central intelligence hub for all deforestation and degradation control activities. • Improve regulation of illegal economies and organized crime. | <ul style="list-style-type: none"> • Brazil's Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm) • Peru's National Forest Conservation Program (NFCP) • Bolivia's constitution (Arts. 1, 211, 289, 403), and Authority of the Rights of Mother Earth • Ecuador's constitution (Art. 71-74 Rights of Nature) • Soy Moratorium & G4 Agreement | DGOV, IF, PS |
| <i>2b) Reduce demand</i> | <ul style="list-style-type: none"> • Promote diet diversification away from cattle meat, especially in wealthy communities outside of the Amazon. • Recycle gold and other minerals to reduce overall demand. | <ul style="list-style-type: none"> • Good Food Institute-Brazil's collaborations for plant-based innovations • Gold recycling programs for electronic waste | DGOV, IGOV, NGO, PS, AC |

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| <i>2c) Develop synergistic urban-rural and intra-sectoral linkages</i> | <ul style="list-style-type: none"> • Develop tax breaks and targeted finance various value-added and service activities in Amazonian urban areas. • Develop urban green belts IPs and LCs | <ul style="list-style-type: none"> • Zona Franca de Manaus (free trade zone to develop manufacturing) • Brazil's National Bioeconomy Strategy – Article 4, prov. III, and Article 5, prov. XVII aiming to link w/ food and health sectors | DGOV, IGOV, NGO, PS, AC |
| <i>2d) Strengthen IP and LC rights and representation</i> | <ul style="list-style-type: none"> • Increase finance and capacity building for electing indigenous leaders. • Create national and state IP and LC ministries. • Secure IP and LC rights within territorial conservation and development governance processes. | <ul style="list-style-type: none"> • Brazil's Ministry of Indigenous People • Bolivia's Authority of the Rights of Mother Earth • Ecuador's Jurisdictional Guarantee of Rights in the government organisation of the Amazonian Special Territorial District | DGOV, NGO, IP-LC |
| <i>2e) Shift narratives</i> | <ul style="list-style-type: none"> • Stop using language that frames not clearing land as an opportunity cost. • Put greater emphasis on the missed development opportunities of not investing in conservation and the SBEs. • Stop framing the SBEs as new. • Highlight ancient and existing SBEs initiatives. | <ul style="list-style-type: none"> • Statements by Fernando Haddad Minister of the Economy around the Ecological Transformation Plan (18) • Working papers/reports: Costa et al. (45), Cheston et al. (89) • Levis et al. (90); Brondizio et al. (91) • Bolivia's National Assembly of Agroecological Production. | DGOV, NGO, AC |
| Landscape | | | |
| <i>3a) Seize policy windows</i> | <ul style="list-style-type: none"> • Reference supportive changes in international policies when lobbying for additional national and regional policies. • Leverage global finance to support national and regional initiatives. | <ul style="list-style-type: none"> • Bonn Challenge; Glasgow Declaration; NY Declaration on Forests Goal 1&5; Kuming-Montreal Global Biodiversity Framework Target 2&3; UN Strategic Plan for Forests; UN SDG 15.1-15.3 • EU, UK, and US Deforestation Regulations • EU and France Due Diligence Laws • Accelerator programs for agroforestry and restoration in the Amazon as part of companies' net-zero pledges (92,93). | DGOV, NGO |
| <i>3b) Align international goals</i> | <ul style="list-style-type: none"> • Listen, support, and amplify Amazonian visions and targets, rather than encouraging replication of external visions. | <ul style="list-style-type: none"> • Belem Declaration – “Cross-cutting principles and objectives” • Brazilian Ecological Transformation Plan | IGOV, NGO, UN |
| <i>3c) Build and strengthen institutions for cross-scale and regional learning and cooperation</i> | <ul style="list-style-type: none"> • Improve pan-Amazonian institutions. • Improve cross-scalar and inter-community networks. • Improve distribution of educational and innovation research institutes to Amazonian regions. | <ul style="list-style-type: none"> • 2019 Leticia Pact • Amazon Cooperation Treaty Organization Amazon Presidents' Summit • Belem Declaration of 2023 – “Amazon Indigenous People Mechanism & Observatory of Rural Women for the Amazon Region” | DGOV, IGOV, NGO, IP-LC |
| Safeguards | | | |

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| 4a) <i>Clear definitions</i> | <ul style="list-style-type: none"> • Establish clear definitions around what SBEs entail, including what values they represent. • Do not include monocultures and single aquaculture species. • Do not allow investments and control of SBEs to go to a narrow set of multinational companies or domestic elites. that participate in SBEs (74). | <ul style="list-style-type: none"> • This paper • Costa et al. (45) • Brazil's National Bioeconomy Strategy – Article 2 | DGOV, NGO, AC, IP-LC |
| 4b) <i>Participatory and transparent processes</i> | <ul style="list-style-type: none"> • Define research in collaboration with Amazonian peoples and regional research institutions. • Ensure public engagement in science and open access to research results. • Plan infrastructure and marketing arrangements with active participation of the local populations | <ul style="list-style-type: none"> • Brazil's National Bioeconomy Strategy, Article 8 • Pará State Bioeconomy Plan (94) | DGOV, NGO, IP-LC |
| 4c) <i>A multi-biome approach</i> | <ul style="list-style-type: none"> • Develop plans and policies for SBEs in all biomes, not just the Amazon. | <ul style="list-style-type: none"> • Brazil's National Bioeconomy Strategy, Article 7 | DGOV, IGOV, NGO, IP-LC |

Notes: DGOV= Domestic state and national governments; IGOV= International governments, DEV= International and national development banks; IF= International financial actors; NGO= non-governmental organisations; PS= private sector; AC= Academics; UN= United Nations General Assembly and other institutions; IP-LC= Indigenous people, Quilombolas, and traditional or other vulnerable local communities. These recommendations stem from a consultative process by the United Nations Science Panel for the Amazon to develop a policy brief on the topic of SBEs in advance of the Amazonian Presidents' Summit, Climate Week NYC, and the UN General Assembly meeting in 2023. The analysis was developed and written by experts from Amazonian countries and the Global North after an initial meeting with review and comment from 25 additional experts.

407

408 Time for action

409 To achieve Amazonian conservation, safeguard its people, and prevent climate and biodiversity
410 catastrophes scientists and policymakers must confront the flawed colonial economic models and
411 development ideas that have led to Amazonian economies that convert the region's social and
412 biological wealth into homogeneous commodities for global markets. Transformation involves
413 disrupting existing economic, political, cultural, and scientific patterns to allow new just and
414 sustainable futures to emerge. SBEs hold significant promise as both an economic approach and a
415 guiding value system for policies and planning in the Amazon. Support for strengthened SBEs through
416 finance, infrastructure, and marketing is a useful part of the picture to stimulate niche activities, yet
417 it is insufficient to achieve structural change. A large shift in policies and development narratives
418 across multiple levels is needed to destabilise the existing regime that supports ongoing activities
419 that degrade forests and rivers in the Amazon. Doing so, decision-makers in the Amazon and beyond
420 can take meaningful and urgently needed steps to promote people's well-being, the conservation
421 and recovery of biodiversity, and provisioning of associated ecosystem services that are vital for

422 flourishing SBEs in the Amazon.

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433 **Competing interests**

434 We have no competing interests to report.

435

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