Global offsetting of the outsourced biodiversity footprint of consumption

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ABSTRACT

International trade outsources environmental impacts of consumption through complex value chains causing biodiversity loss across Earth. There is a need to examine the negative biodiversity impacts and the opportunities to mitigate and offset the impacts, as a global systemic phenomenon. Traditional biodiversity offsetting is used to offset local land use impacts but no means to offset the outsourced biodiversity impacts exist. Here we explore location-independent global offsetting based on biodiversity equivalent, an analogue of the carbon dioxide equivalent, and scrutinize the assumptions behind the suggestion in the context of operationally important planning decisions of traditional biodiversity offsets. We find global offsetting to be operational but emphasize that it should not replace, but rather complement, the traditional offsetting. We conclude that until a global degrader pays -principle has been worked out and adopted, global offsetting is a viable option to offset at least some of the outsourced biodiversity impacts of consumption.

INTRODUCTION

In the global economy, international trade causes ecosystem degradation and biodiversity loss typically far removed from the place of consumption (Lenzen et al. 2012; Hoekstra & Wiedmann 2014). Indeed, unsustainable land use (Winkler et al. 2021; Jaureguiberry et al. 2022) and overexploitation of natural resources (Maxwell et al. 2016) to produce the commodities necessary to satisfy the needs and desires of consumers cause threats to ecosystem integrity to a degree that in many places ecosystems are in risk of losing their ability to support the diversity of life (Cardinale et al. 2012; Willemen et al. 2020; Kortetmäki et al. 2021; Qu et al. 2024). In addition to land and sea use change and direct exploitation of species, climate change, pollution and spread of invasive alien species are the main anthropogenic drivers of biodiversity loss (Bellard 2012; Maxwell et al. 2016; Díaz et al. 2019; Roy et al. 2024). Environmental changes such as biodiversity loss resultant of the drivers are called footprints (Hoekstra & Wiedmann 2014).

International trade outsources the environmental impacts of consumption through complex value chains and causes biodiversity loss all over the planet. Therefore, there is a clear need to examine the negative biodiversity impacts, but also the opportunities to mitigate the impacts, as a global systemic phenomenon. Moreover, while local land use change has been the dominant driver of biodiversity loss (Jaureguiberry et al. 2022), the weight of global climate change as a driver of biodiversity loss is increasing (Pigot et al. 2023; Urban 2024). Thus, we must start thinking biodiversity offsetting more broadly than in the local land use planning context only.

Biodiversity offsetting is one impact mitigation instrument with which the negative impacts of development and other land use are compensated by generating equivalent gains for nature elsewhere (Moilanen & Kotiaho 2018; zu Ermgassen et al. 2019; Maron et al. 2025). Biodiversity offsetting is commonly framed as being the last step of mitigation hierarchy (Arlidge et al. 2018) and it has become a globally popular, albeit controversial (Maron et al. 2016; Damiens et al. 2021) instrument with over 100 countries applying it in thousands of cases (Bull & Strange 2018). Biodiversity offsetting is traditionally applied to compensate for the local project-level impacts only, but the need to extend the logic to addressing all impacts associated with economic activity, including throughout value chains, has sometimes been touched upon (Arlidge et al. 2018; Bull et al. 2020; Milner-Gulland et al. 2021; Balmford et al. 2025; Maron et al. 2025). The shift from targeting no net loss of biodiversity towards targeting net positive impacts for biodiversity (Bull et al. 2020; Moilanen & Kotiaho 2021) can be seen to have evolved the biodiversity offsetting from an impact mitigation instrument to a biodiversity conservation and adaptation instrument (Barral et al. 2025).

A challenge for the traditional biodiversity offsetting in a global value chain setting is that it requires comprehensive and relatively detailed knowledge on the biodiversity values lost on the development site and gained on the offset site (Marshall et al. 2020). In reality it is operationally impossible to do biodiversity offsetting in all the locations around the world the value chains outsource the biodiversity impacts. Thus, when we are interested in mitigating the biodiversity footprint of consumption, we need to consider alternative approaches. One possibility is to focus on life cycle assessments (Hellweg and Milà i Canals 2014; Verones et al 2020), which aim to consider the environmental impacts of products throughout their entire life cycle. A few different biodiversity indicators have been utilized in life cycle assessment (Damiani et al. 2023; Marques et al. 2017; Sanyé-Mengual et al. 2023), and the one we will focus on here is the biodiversity equivalent (El Geneidy et al. 2025a). The biodiversity equivalent is derived from the potentially disappeared fraction of species (PDF), which accounts for the share of species that are potentially lost due to different drivers of biodiversity footprints, and which is customarily calculated separately for the species in terrestrial, freshwater and marine realms (Verones et al. 2017, 2020; Crenna et al. 2020). To arrive at the biodiversity equivalent, the PDFs in the different realms are combined by taking a number-of-species weighted average of biodiversity loss across the realms (El Geneidy et al. 2025a). In essence, the biodiversity equivalent indicates the share of all species on the planet that are likely to go extinct due to human activities, and its utility for biodiversity is like what carbon dioxide equivalent is for climate. Hence, El Geneidy et al. (2025a) suggested that biodiversity equivalent might be used as an indicator for globally offsetting biodiversity footprints anywhere on the planet independent from the location of the biodiversity loss. Bull et al. (2025) have recently estimated the biodiversity footprint of Dutch dairy sector and discussed the need to address biodiversity impacts not only from direct economic activities but also those embedded in global supply chains. They developed a safeguards approach for impact compensation but did not specifically include offsetting in their model despite noting that biodiversity offsets are likely needed in achieving net positive outcomes. Thus, there is a clear need for thorough exploration of how such a global system of offsetting the biodiversity footprint could work.

In this article, we scrutinize the assumptions of global offsetting with the biodiversity equivalent in the context of the operationally important decisions in the planning of traditional biodiversity offsets (Moilanen & Kotiaho 2018; see also Gardner et al. 2013). Furthermore, we explore the consequences of adopting the biodiversity equivalent to offset the global consumption-based biodiversity footprint outsourced through the international value chains.

ASSESSING BIODIVERSITY FOOTPRINT OF CONSUMPTION

While we have been able to quantify and communicate the impact of local land use on biodiversity loss, assessing the impacts of the consumption of individuals and organizations has, until relatively recently, remained more elusive. After the first examinations of the biodiversity impacts of consumption (Lenzen et al. 2012; Wilting et al. 2017), an increasing number of studies are being published concentrating on biodiversity footprint of individual products (Asselin et al. 2020), citizens (El Geneidy et al. 2025b) organizations (El Geneidy et al. 2021; Bull et al. 2022), regions (Crenna et al. 2020), and global consumption (Bjelle et al. 2021).

To assess the biodiversity footprint of consumption four key pieces of information are needed (El Geneidy & Kotiaho 2023; El Geneidy et al. 2025a): We need to know i) what was consumed and how much, ii) the type and amount of environmental impact caused by the consumption, iii) the geographic location of the environmental impact caused by the consumption and iv) the biodiversity loss in each of the geographic locations due to the environmental impact caused by the consumption. These four components are embedded in the Biodiversity Equivalent Impact Assessment (BIOVALENT) methodology (El Geneidy et al. 2025a). Currently there are few emerging tools and databases allowing the assessment of biodiversity loss due to the environmental impact in certain locations. One such database is the LC-IMPACT database (Verones et al. 2020), another is the ReCiPe framework (Huijbregts et al. 2017) and a third the IMPACTWorld+ (Bulle et al. 2019).

Biodiversity equivalent

Potentially disappeared fraction of species (PDF) metric accounts for a fraction of species that are potentially lost due to environmental impact (Goedkoop et al. 1999; Verones et al. 2020). PDF indicates the biodiversity impacts relative to a counterfactual natural state without any human impact. PDF ranges from 0 to 1, where 1 means that all estimated species are at risk of extinction and 0 means that no species is at risk of extinction. The metric is based on species area relationship models, geographic ranges of species, the vulnerability of species to different human impacts, and the extinction risk classification of species. Currently the PDF indicator is derived from data covering vascular plants, mammals, reptiles, birds and fish and it is calculated separately for terrestrial, freshwater and marine realms. Global PDF indicates risk of extinction of species in each of the realms globally while regional PDF indicates the potential biodiversity loss in each of the realms at the regional scale. Openly available characterization factors (also known as impact factors) (e.g., PDF/m^2 or PDF/kg) exist currently e.g. for several different forms of land use, water stress, several pollutants and climate change (Verones et al.

2020). The PDF can currently be calculated for all 804 terrestrial ecoregions and 200 countries/geographical regions.

The biodiversity equivalent is derived from the potentially disappeared fraction of species (PDF). To arrive at the biodiversity equivalent, the PDFs in the different realms are combined by taking a number-of-species weighted average of biodiversity loss across the realms (El Geneidy et al. 2025a). This makes biodiversity equivalent a location-independent common currency accounting for all the species in all impacted ecosystem types as a single global value. As the biodiversity equivalent indicates the share of all species on the planet that are likely to go extinct due to human activities, its utility for biodiversity can be considered to be what carbon dioxide equivalent is for climate (El Geneidy et al. 2025a).

In essence, biodiversity equivalent tells what fraction of the species of the world are at risk of going extinct globally if for example 1 km^2 of land is continuously exploited by a specific driver of biodiversity loss, such as land use for intensive forestry (Verones et al. 2020), in any given country. A feature of the biodiversity equivalent is that the same amount of area occupied by the same driver causes less global biodiversity loss in relatively species poor areas than what it causes in relatively species rich areas. On the other hand, if both areas experienced a loss of the same amount of biodiversity equivalent, this would indicate that the global biodiversity loss is the same. Different species would be lost in different parts of the world, but the fraction of globally potentially lost species would be the same. With global offsetting therefore, it would be possible to offset impacts at any place, but offsetting in a species-poor country would require larger areas for conservation and restoration than in tropics or other species-rich regions.

GLOBAL OFFSETTING WITH THE BIODIVERSITY EQUIVALENT

As the starting point we take the framework that allows systematic and transparent examination of the main biodiversity offsetting design decisions that significantly impact the meaning of, and outcome expected from the traditional biodiversity offsetting plan (Fig. 1) (Moilanen & Kotiaho

2018). This framework is built around the three main dimensions of ecological reality: what biodiversity you lose and gain, where does the loss and gain happen (space), and when does the loss and gain realize (time) (Wissel and Wätzold 2010). In addition, we examine the decisions around objectives i.e. around what do you aim at, and considerations around offset actions.

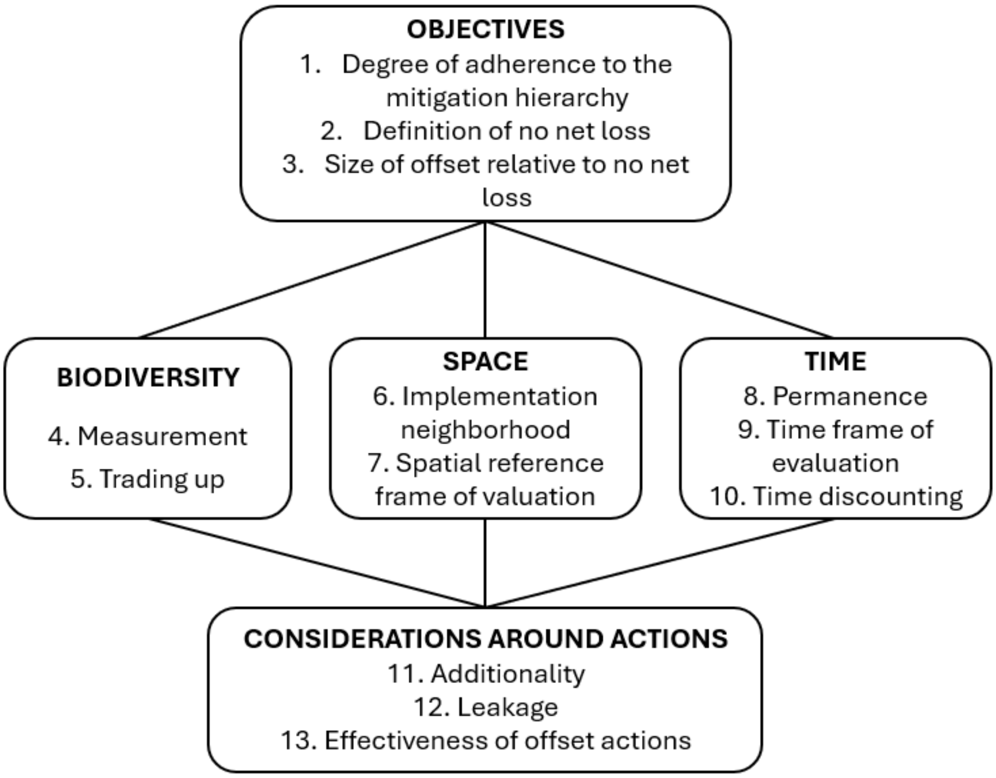

Fig. 1. Important operational design decisions in traditional biodiversity offsetting focusing on biodiversity objectives (what do you aim at), what do we lose and gain (biodiversity), where (space) and when (time). There are also a few important general considerations when implementing the offsetting actions (adapted from Moilanen & Kotiaho 2018).

Degree of adherence to the mitigation hierarchy

Mitigation hierarchy is designed to address local impacts on biodiversity through first seeking to avoid impacts wherever possible, then minimizing impacts and finally repairing the damages by means of restoration either locally or elsewhere (Arlidge et al. 2018; Moilanen & Kotiaho 2021). Policies requiring the mitigation hierarchy are emerging (Bull & Strange 2018), but in practice the implementation of even the first step, to avoid the impacts, is often not considered or implemented in development projects (Phalan et al. 2018; Jones et al. 2022).

To apply mitigation hierarchy successfully, one needs relatively detailed spatial information about the biodiversity values or the location of the priority areas for biodiversity conservation at the minimum. The data on the environmental drivers caused by consumption and their impacts on biodiversity behind the biodiversity equivalent are spatially explicit. However, the resolution of the data is currently too coarse to allow detailed spatial planning of impact avoidance. Moreover, consumers of products manufactured across complex supply chains generally have little if any power to influence production decisions in other parts of the world. Nevertheless, we can think of three ways of employing the mitigation hierarchy as part of global offsetting. The first is to reduce consumption overall, then replace high impact products with low impact products, and finally to avoid products originating from globally biodiverse regions.

Definition of no net loss

At first it might seem that the meaning of no net loss is clear, but it is not. Operationally, fully measuring all components of biodiversity in any given area over any period of time is virtually impossible (Moilanen & Kotiaho 2018). In reality, no net loss cannot mean for example that every species impacted would be fully compensated for. A critical task, therefore, is to determine how biodiversity can best be described and measured to adequately assess the losses and gains of biodiversity (Gardner et al. 2013; Maron et al. 2018). Once the adequate representation of biodiversity is determined, no net loss is simple enough to define as the situation where losses are balanced with equivalent gains.

The logic is similar in global offsets: if we assume that the biodiversity equivalent provides an adequate representation of the global biodiversity, then in a situation where the biodiversity equivalents lost correspond to the biodiversity equivalents gained, the share of species under risk of extinction globally has not changed and therefore there is no net loss of biodiversity.

Size of compensation required relative to no net loss

Biodiversity offsetting is commonly framed such that the offset should deliver no net loss or net positive outcomes for biodiversity (Bull et al. 2020). Despite this convention, where there is no obligation to offset damages, even a partial offset is likely to be better than no offset at all. Whatever the argument for the size of the offset relative to the loss, be it no net loss, net positive or partial, we find the arguments likely to be equally applicable to both the traditional and global offsetting.

Biodiversity measurement

Traditional biodiversity offsetting requires biodiversity assessment at the development and offset sites. The assessment of biodiversity in traditional offsetting is commonly based on habitat attributes reflecting the habitat condition (Marshall et al. 2020; Jalkanen et al. 2025), which is determined relative to the same habitat type in its natural or undisturbed condition (Parkes et al. 2003). As it is impossible to measure all aspects of biodiversity in any focal area at any great detail, the most important design decision in biodiversity measurement is how much simplification is allowed (Moilanen & Kotiaho 2018).

In traditional biodiversity offsetting ecological equivalency i.e. the identity of the lost and gained biodiversity values is often expected to be the same (Bull et al. 2015). For instance, in Finland the Nature Conservation Act (9/2023) requests that the losses and gains are assessed on a biotope type or species habitat level, and losses of condition in each must be offset with gains of condition in the same biotope type or species habitat. Knowing the identity of biotopes and habitats of species allows identifying irreplaceable biodiversity values the degradation of which should not be allowed.

Global offsetting with the biodiversity equivalent operates on a different logic. Biodiversity equivalent tracks but is not concerned about the identity of biodiversity as it operates on the share of the global biodiversity under risk of extinction. Hence, although technically potentially possible, in its' current form the biodiversity equivalent does not allow identifying irreplaceable biodiversity values. Generally, the logic of global offsetting aiming for no net loss relies on keeping the extinction risk of species on the planet constant whereas traditional offsetting aiming for no net loss relies on keeping the condition of each local biotope or species habitat condition constant.

As the risk of extinction globally is generally not zero, keeping it constant with global offsetting means we are likely to lose some species in the future. Similarly, as the local habitat condition is generally degraded already before development, keeping it constant with traditional offsetting means the areas may lose biodiversity locally due to delayed extinctions known as extinction debt (Tilman et al. 1994). Thus, even if the mechanisms are different, both global and traditional offsetting may achieve no net loss only relative to the pre-development baseline.

Trading up

Trading up in traditional biodiversity offsetting refers to a situation where flexibility in ecological equivalence is allowed such that less threatened biotope types or species habitats can be offset with those that are more threatened (Bull et al. 2015). It is worth noting that in this case the value of biotopes and habitats of species are based on human valuation and often on national assessments of the risk of extinction of biotopes and species.

Trading up is possible in traditional offsetting as the lost and gained biodiversity values are identified. In global offsetting trading up is not operational as the biodiversity equivalent is not concerned about the identity of biodiversity. Nevertheless, the biodiversity equivalent does track species distributions and is affected by human valuation of species through the global vulnerability scoring based on the IUCN threat levels. Occurrence of anthropogenic biodiversity loss drivers in an area that has threatened species cause greater loss measured in biodiversity equivalents than the occurrence of the same driver in an area that has the same number but less threatened species. Thus, targeting global offsets to areas with threatened species translates into smaller total area needed for the offsets, but it cannot be considered trading up.

Implementation neighborhood

Implementation neighborhood refers to the distance allowed between the impact and offset area. In traditional offsetting, offsets are advised to be located as close as possible to the impacts to guarantee ecological equivalency (BBOP 2012). As explained above, global offsetting with the biodiversity equivalent operates on a different logic and is not concerned about the identity and thus ecological equivalency of biodiversity. As its name implies, global offsetting expands the implementation area of offset from the local scale to the global scale. When the implementation neighborhood is global, options for offset implementation are increased and consequently the per-unit offset costs are likely to be reduced (Moilanen & Kotiaho 2018).

Spatial reference frame

Spatial reference frame refers to the spatial context where biodiversity is valued. A species can be considered endangered if a national reference frame is adopted even when the same species might be of least concern at the global reference frame. Choice of the spatial reference frame can impact trading up in traditional offsetting, but for global offsetting the choice is not applicable as the reference frame is always global.

Permanence of offsets

Development projects often cause permanent or at least long-lasting local biodiversity loss. Therefore, traditional offsets are often also expected to be permanent or last at least as long as the biodiversity loss drivers remain (BBOP 2012). As the biodiversity footprint of consumption that is outsourced through the value chains translates into local land use and other drivers somewhere around the planet, there is no reason to believe such impacts would be any less permanent. Moreover, as consumption cannot ever be completely ended, some permanent pressure on biodiversity will remain. Therefore, it seems reasonable to consider most losses as permanent and require global offsets to be permanent as well.

Time delays and time discounting

Delayed financial payment is routinely not considered equally valuable to immediate payment and the same logic can be applied to delayed biodiversity gains (Moilanen & Kotiaho 2018). Damage or biodiversity loss is typically relatively fast while ecosystem recovery is slow. In traditional offsetting the timing of the damage is usually known, and the value of delayed gains can be easily adjusted based on a yearly time discounting percentage (Laitila et al. 2014). Additionally, knowing the time of damage can enable offsetting the losses before they occur, which would be ideal for biodiversity. However, the timing of biodiversity impacts of the production of consumables across the value chain is typically unknown. The time lag between the impact and consumption can be especially long in long lasting products. As there are definite time delays, time discounting of the gains could be considered in both traditional and global offsets.

It is worth noting that when we consider the different drivers of biodiversity loss, all losses may not be immediate either. For example, the biodiversity impacts caused by climate change can realize decades after the greenhouse gases were emitted (Pigot et al. 2023; Urban 2024).

Time frame of evaluation

Time frame of evaluation refers to the time frame over which losses should be balanced with offset gains. As the recovery of biodiversity is slow, a shorter time frame implies less gains per area and thus on average larger offset areas and higher offsetting costs. However, very long timeframes decrease the credibility of offsets (Moilanen & Kotiaho 2018). For example, in the Finnish Nature Protection Act (9/2023) an evaluation time frame of 30 years is requested for no net loss to be reached.

In global offsetting, the difficulty is again the international value chain and the uncertainties regarding the timing of the biodiversity impacts. For simplicity, it could be reasonable to assume that the losses occur, and the time frame of evaluation begins at the point of purchasing of the products either by the consumer or the retailer.

Additionality

Additionality means that offsetting actions must deliver biodiversity benefits that would not have been gained without offsetting. In other words, double counting of the ecological gains is not allowed (van Oosterzee et al., 2012). Ensuring additionality is essential in both traditional and global offsetting. Additionality may be tricky to assess in traditional offsetting because of the many national and international obligations to restore and protect nature. In global offsetting we can offset biodiversity losses across many different jurisdictions, which can make assessment of the additionality even more complicated.

Leakage

Leakage happens when instead of canceling the pressures, offsetting actions delivering permanent biodiversity gains cause the pressures to shift elsewhere (van Oosterzee et al. 2012; Moilanen and Laitila 2015). If land use pressures are not cancelled, but shifted fully or in part to another location, then gains through offsetting will be overestimated. Assessing and accounting for leakage is critical in both traditional and global offsetting. In traditional offsetting the risk of leakage can be assessed from historical trends in land use. In principle the same approach can be used in global offsetting. However, if global offsetting is conducted across many different geographical locations assessing leakage is likely to be more challenging.

Effectiveness of offset actions

Offsetting actions in both traditional and global offsetting are predominantly restoration and protection. Traditional offsetting does not typically consider biodiversity loss drivers other than land use change and sometimes direct exploitation of natural resources, such as timber harvesting. It is relatively easy to see that in traditional offsetting for example the land use change needs to be offset once to meet the no net loss requirement.

When we adopt the biodiversity equivalent to offset the global consumption-based biodiversity footprint outsourced through the international value chains, the biodiversity loss drivers considered are generally much more numerous. We have land use change, land occupation, water stress, climate change and pollution to name but a few (Verones et al. 2020; Damiani et al. 2023). Moreover, unlike most development projects on a site that are once off, consumption continues year after year. Land occupation after the land use change and water stress drivers are such that once the impact has been inflicted during the transformation phase, there are generally no great additional losses to be expected provided the consumption causing the drivers stays the same. However, climate change and pollution drivers are cumulative, and the negative impacts increase even if the consumption stays the same. Thus, in global offsetting the offsetting actions need to be considered separately for different sets of biodiversity loss drivers. For drivers like land occupation and water stress offsetting once may be adequate but for the climate change and pollution drivers the offsetting must be continued as long as the emissions continue.

Table 1. Comparison of the operationally important decisions in planning of traditional and global biodiversity offsetting grouped under objectives, the three main dimensions of ecological reality (biodiversity, space, time), and actions.

Decisions	Traditional offsetting	Global offsetting
Objectives		
Degree of adherence to the mitigation hierarchy	Seldomly legislated and difficult to track whether hierarchy is implemented	Hierarchy is based on consumption decisions that may be traceable but not necessarily easy to implement
Definition of no net loss	Losses are balanced with gains in the unit that is decided to be an adequate representation of biodiversity	Same as in traditional offsetting but the unit is different
Size of compensation required relative to no net loss	Depends on what is agreed. Often no net loss or net positive impact	Depends on what is agreed. Similar to traditional offsetting

Biodiversity		
Biodiversity measurement	Based on habitat attributes reflecting the habitat condition, e.g. habitat hectare	Based on biodiversity equivalent reflecting the share of species on the planet that potentially go extinct due to human activities
	Ecological equivalency often requested	Ecological equivalency not applicable
	Allows identifying irreplaceable biodiversity values the degradation of which should not be allowed	Although technically potentially possible, in its' current form the biodiversity equivalent does not allow identifying irreplaceable biodiversity values
Trading up	Possible	Not possible
Space		
Implementation neighborhood	Local, regional	Global
Spatial reference frame	Local, regional	Global
Time		
Permanence of offsets	Permanence required	Permanence required
Time delays and discounting	Time delay known and offsets possible to be established before or after impacts	Time delay difficult to track and offsets established more likely after impacts
	Discounting delayed gains possible	Discounting delayed gains possible
Time frame of evaluation	Timing of losses known, time frame easily defined, e.g. 30 years	Timing of losses often unknown, time frame could be defined as 30 years from purchase
Actions		
Additionality	Complicated because of many restoration and protection obligations	Even more complicated if done across different jurisdictions
Leakage	Can be relatively easily assessed e.g. from historical land use trends	Can be assessed from historical land use trends but is more complex with many geographical regions
Effectiveness of offset actions	Generally considers only land use change driver requiring one-time offsets	Considers various drivers and the required offsets vary from once off to yearly depending on the driver and the impact duration

DISCUSSION

Reducing consumption in the Global North can be argued to be of utmost importance if we are seriously aiming to stop the global biodiversity loss. Indeed, most of the value chains are global, and international trade has resulted in high-income countries outsourcing their negative biodiversity impacts to low-income countries (Bjelle et al. 2021; Koslowski et al. 2020; Marques et al., 2019; Wood et al. 2018). These outsourced impacts are only rarely accounted for never mind offset in any way.

While we agree it to be desirable that the traditional offsetting is done where the negative impact has been caused, offsetting the biodiversity footprint of consumption needs other means and global offsetting as imagined here could provide one option. Even if global offsetting would be adopted, it is important to emphasize that global offsetting should not replace the traditional offsetting but be adopted in addition to it (see e.g. Maron et al. 2025). It may also be worthwhile considering the impact compensation safeguards (Bull et al. 2025). Very recently there was a suggestion that only actions achieving ecological equivalence with low uncertainty should be considered actual offsetting (Bang et al. 2025). As global offsetting described here does not follow the like-for-like principle, based on this suggestion we should not be talking about offsetting but rather compensating for the negative impacts. While it is good to discuss and scrutinize the definition of various concepts, we point out that ecological equivalence is dependent on the accuracy of measurement. No biological community is ever absolutely similar to another, and thus no offset site can ever be absolutely similar to the one impacted.

Considering and comparing the allocation of responsibility in traditional and in global offsetting reveals a hidden paradox: in traditional offsetting it is the developer that is held responsible for the damages, while the perspective of analysis in consumption-based biodiversity footprint assessment, and hence global offsetting, is that of the consumer. The paradox in allocation of responsibility appears when we recognize that all local land use anywhere on the planet is locally caused by some form of development. Should it thus always be the degrader after all, i.e. the producer or the developer, that is held responsible for the damage rather than the consumer? Allocating responsibility between producers and consumers has been considered not to be that straightforward because while the producers exert the impacts and control production methods, consumer choice and demand may nevertheless drive production (Lenzen et al. 2007, 2012). Lenzen et al. (2007) concluded that responsibility may lie with both camps and may have to be shared between them.

To conclude, we suggest that perhaps a global adoption of a degrader pays -principle, an analogue of the polluter pays -principle, would operationalize the allocation of responsibility between the producers and the consumers. If all producers push the cost of traditional biodiversity offsetting downstream to their value-chain, then the responsibility would be automatically shared between all parties in the value chain. It is worth noting that, at the same time, global offsetting would become redundant. Until a global degrader pays -principle has been worked out and adopted, it is better that at least some of the outsourced biodiversity footprints of consumption are offset, and global offsetting as explained here might be a viable option.

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