Debt for nature swaps – which nature, how much and who pays?

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Abstract

Financially viable means to conserve biodiversity are urgently needed. We analyze how debt-for-nature swaps could conserve currently unprotected biodiversity priority-areas for six biomes in 67 countries under the debt service suspension initiative related to COVID19. Using novel methods and data, we find that the 67 countries hold over 22% of global priority-areas, yet 82.96% is unprotected. For 35 of the 67 countries, swapping 0.1% of public debt could conserve 100% of unprotected priority-areas. By swapping 5.09% of these countries' total public debt (USD26.5 billion) in a pooled swap, 100% of priority-areas could be protected across the countries. Management costs could partly be covered through re-routed interest payments within the countries, with further annual funding of USD0.5-3.5 billion required.

One-Sentence Summary: We develop a framework for efficient application of debt-for-nature swaps to maximize biodiversity conservation.

Main Text

With the upcoming launch of the post-2020 global biodiversity framework, we have an opportunity to evaluate why all Aichi targets on biodiversity conservation failed (*1*). One reason was finance for biodiversity (*2*).

Debt-for-nature swaps (DNS) are a financial tool initially developed in the 1980s to exchange mostly sovereign debt for conserving or restoring nature and thus provide an instrument to finance nature protection. DNS have regained prominence in the aftermath of COVID19 (*3*) driven by two parallel developments: rising national public debt in many economies, without sufficient investments for conservation. DNS could ameliorate both problems: reduce debt burdens, particularly in emerging economies with high external public debt, and direct funds to conservation or restoration in these countries (*4*, *5*).

Successful DNS must maximize national conservation and public debt reduction, while minimizing economic harm to creditors. This requires identification of "which nature" is most in need of protection and "how much" would it cost to acquire and manage nature, and "whose debt" - that is which creditors - to engage for debt swaps.

Nature performance bonds/securities are an alternate approach to recapitalize sovereign debt and protect nature[6]. However, three barriers exist in their successful application: first, they are more relevant for debtor countries with access to capital markets to raise new funds, while for countries in debt distress or default, debt swaps negotiated between existing creditors and the debtor are more applicable. Secondly, nature performance bonds offer debtor countries a choice to accelerate economic development over environmental protection in exchange for higher interest rates on the security. Thirdly, nature performance bonds need to prove nature protection ex-post at the risk of incurring high transaction cost, while DNS require ex-ante agreements on the nature swap and thus enable more effective conservation (*6*). Both mechanisms can, nevertheless, be combined at the debt restructuring and nature protection nexus for 73 eligible countries in the debt-service suspension initiative (DSSI) of the G20 and the Common Framework (*7*).

To explore how DNS could effectively be applied we identify biodiversity priority-areas within 15 biomes nestled within five major ecotones (forests, grasslands, deserts, mangroves and freshwater). We calculate the global share of biodiversity priority-areas and the degree of protection of these biomes in 67 of the 73 debtor countries eligible for the Debt Service Suspension Initiative (DSSI) (*7*) (i.e., "which nature"). We then calculate the acquisition and management cost for priority-areas using best available data (i.e., “how much”); and we identify biodiversity targets to be swapped with different creditors based on World Bank debt data (i.e., “whose debt”).

This article thus identifies national biodiversity priorities that would benefit from DNS. We focus largely on terrestrial ecosystems as these face the most direct threat form of damage and loss (deforestation (*5*), overgrazing (*8*), rapid loss of mangroves (*9*– *11*) and river fragmentation (*12*)), the pressure on which, given the post-pandemic urgency of economic growth, may increase further. We focus on intact but unprotected areas, as these are less challenging to protect and as they are often under government management making them easier to swap for sovereign debt. Furthermore, as these areas are not or little in use, their protection has less risk of access removal from people reliant on them. In addition, protecting intact unprotected yet threatened areas, DNS can reduce habitat loss and degradation prevalent in much of the world, while providing a more cost-effective solution than restoring already degraded land, and are more likely to retain diversity, particularly for species dependent on intact habitat. We focused on terrestrial areas as biodiversity threats in marine areas are often displaced from elsewhere, and some such as pollution, bleaching and acidification cannot be easily countered through spatial efforts in the same way land degradation can (*13*). Thus whilst marine systems are threatened, managing fishing sustainably, reducing pollution and managing climate change may be more effective at reducing marine diversity losses, especially as protection may be undermined by activities outside the protected area in Marine systems (*13*). Accordingly, we specify recommendations how to effectively and efficiently use DNS to establish and manage currently unprotected terrestrial priority-areas of major biomes, which would enable a more representative protection of these key, potentially vulnerable systems, though conditions to monitor performance would be needed to ensure new protected areas were effective.

Swapping debt for nature - from idea to implementation

DNS were first introduced in 1984 in response to the deteriorating tropical rainforests and mounting debt obligations in developing countries (*14*). Through a DNS, the debtor country’s debt stock is reduced in exchange for commitments of the debtor government to protect nature (*15*). The first debt-for-nature agreement was signed in 1987 between Bolivia and Conservation International (CI), in which CI purchased USD650,000 of Bolivia's foreign debt in the secondary market at a discounted price of USD100,000. In exchange, the Bolivian government set aside 3.7 million acres in three conservation areas.(*16*) Since then, DNS have been applied in over 30 countries across all continents(*14*). From 1987 to 2015, the value of debt restructured under DNS agreements surpassed US$2.6 billion, resulting in about US$1.2 billion of transfers to conservation projects(*15*). The latest DNS in the Seychelles in 2018 was worth more than 1.5% of debtor country’s GDP and led to the protection of 30% of the Seychelles marine ecosystem (*17*). Of all DNS agreements from 1987 to 2015, over 93% were DNS involving public creditors (*15*).

By value, most DNS were in Latin American countries. Countries like Mexico signed 12 DNS deals with the US from 1991-1998. Yet huge potential exists in other developing countries, which hold a disproportionate amount of global biodiversity, but in many cases failed to meet Aichi Target 11 of 17% protected area coverage.

After the debt restructurings by the Paris Club (*18*) – (a group of officials from mostly developed countries with the responsibility to coordinate solutions for countries with sovereign debt payment issues) - in the 1980s and 1990s, coupled with a stable global economy, fewer sovereign debt crises surfaced and fewer DNS were applied in the

2000s. Since 2020, sovereign debt issues have accelerated due to COVID19, causing some emerging countries (e.g., Zambia (*19*)) to default on their debt and put more at risk of debt default (*20*). Simultaneously, accelerating environmental destruction (*21*) and the accompanying need to mobilize billions to finance nature protection (*22*) has led to a resurgence of calls to apply DNS (*23*), including from large creditor regions, such as in September 2021 from the European Commission (*24*).

Mechanics of a debt-for-nature swap

If a loan agreement between debtor and creditor government(s) is at risk of default, negotiations can lead to a decision to swap debt for nature: creditors sell outstanding debt at a discount of up to 100% to an environmental trust fund. The trust fund is funded by sponsors (NGOs, donor countries, etc.) and can designate new protected areas (PAs). After the sale of debt, the debtor government can swap parts of the (reduced) outstanding debt for establishing PAs, while the debtor government pays the (reduced) interest rate on the swapped debt to the environmental trust fund. With this consistent revenue, the trust fund can pay for PA management costs (Fig. 1).

Due to continued interest payments, DNS, contrary to other debt restructuring (e.g. debt forgiveness), reduce potential moral hazard, while ensuring local benefits (e.g. unlike debt-for-resources swaps) (*25*) and allow for higher permanence through provision of PA management cost. This therefore provides a financially viable mechanism to reduce debt, and conserve biodiversity, in line with the potential post-2020 global biodiversity framework.

A major obstacle to successful DNS application has been the identification of whose debt can be swapped and who to engage in negotiation (e.g., private lenders, specific sovereign lenders), as well as where/what to conserve. Some sponsors will be interested in specific biomes or specific countries. Currently, this information is scattered or inaccessible, hindering efficient DNS application. By making this information of “which nature” and “whose debt” accessible, we hope to accelerate the application of DNS and to reduce information cost for potential funders in identifying relevant nature and relevant countries.

Optimising debt-for-nature swaps

Which nature

Determining priority-areas for conservation presents a challenge, as there are many alternatives on how they can be identified, and selecting appropriate indices is a continued topic of debate (*26*). Here we set to identify areas which still retain diversity (which is most efficient both on cost, and species retention, as well as not contravening local access rights), but due to rapid rates of deforestation, grazing and other forms of degradation, are likely to be lost (and converted into economically productive land) without intervention. Rates of habitat loss remain high across many global biodiversity hotspots. Ensuring rates of loss are stemmed is paramount to reducing the rate of global biodiversity loss, before considering restoration of areas which have already lost much of their biodiversity.

Species richness indices are frequently used to provide a metric of biological diversity (*27*–*30*), despite many of these patterns resulting primarily from common species (*31*). Yet the quality of available global biodiversity data records of species occurrence are spatially or taxonomically biased (*32*). This makes comparisons between regions or taxa challenging or impossible (*33*). Identifying areas for priorities needs to overcome spatial biases in commonly used datasets, to ensure hotspots are captured, including areas with insufficient data to assess their species composition. To circumvent these issues, we identified areas with low/no disturbance (based on an updated version of the human footprint map (*34*)) and then identified the most productive parts of 15 biomes based on productivity data. Using productivity as a surrogate of available energy for the ecosystem, and therefore diversity, removes spatial errors due to uneven data collection and digitisation efforts (*32*, *33*). By identifying the most productive parts of each intact biome, we highlight the areas with the greatest ability to support biological diversity, as productivity has been shown to be a correlate for species richness in a number of studies (*35*–*37*). To assess the appropriate productivity metric, we compared the overlap with hotspots identified using IUCN and birdlife data for several different productivity metrics. This comparison assesses if hotspots are retained to ensure known hotspots are captured, but areas missed by these datasets (i.e., due to political borders) are encompassed by using an index that is standardized and representative across the planet, as it does not require human decisions compared to species-based indices. Once the most potentially diverse parts and the percentage of priority-areas falling into each country have been identified, the relevant percentages of five major biomes (forest, grassland/savanna, desert, riparian and freshwater, and mangrove) were calculated. To ensure our targets consistently captured known sites of diversity, we compared our results to existing maps of richness for four vertebrate and one invertebrate taxa, whilst avoiding potential biases inherent in many of these maps. These richness maps were also used to determine which productivity was the best potential surrogate for species richness. Finally, we analyze how much of those priority-areas are currently unprotected. This analysis was first conducted at a global level, then for the 67 DSSI countries for detailed analysis.

Overall, the 67 DSSI countries host 22.31% of global biodiversity priority-areas, while only 17.03% of these priority-areas are protected (Table 1, Data S1, Fig. 2A). Notably only 47.7% of protected areas (PA) overlapped with priority-areas in these countries, highlighting the importance of protected area placement: Somalia, Liberia, Djibouti have some of the lowest percentages of national priority-areas protected at 0-0.05%. Even as the area protected increases, protection of priority-areas may not if suboptimal land is protected (e.g., Haiti protects 2.17% of its land, but only 0.28% of its priority). Conversely, some countries with little overall protection protect most remaining priorities (e.g., Bangladesh protects 4.43% of land area and 76.65% of its priority-areas).

Biome-specific debt-for nature swaps

To allow for biome-specific DNS (e.g., in the interest of specific DNS sponsors), we identify priority-areas and assess their protection across biomes (see Table 1). Assessing priorities on a per-biome bases maximizes ecological representativeness, which may otherwise miss regions with low absolute diversity but unique species assemblages.

For forest priorities (based on current forest coverage), the DR Congo is hosts 6.47% of the Earth's priority forest areas (Fig. 2A-B). These areas make up 62% of DR Congo's land area, yet protected priority-areas only make up 9% of DR Congo's area covering 15% of its forest priorities (Fig. 2). A drastic case is Papua New Guinea, which hosts 1.8% of global top priority forest areas, equating to 60% of the islands land area. Yet protected priority-areas only makeup 1.2% of the island, and 2% of national priority-areas.

For grassland priorities, Angola hosts 9.5% of global priority-areas. These priority-areas occupy 78.92% of the country's land area, of which only 4.72% are protected. Similarly, the DR Congo is a major priority for grasslands, with 9.47% of the Earth's priority grassland, of which only 9.51% are protected.

For desert priorities few DSSI countries host desert priority-areas: among those, Madagascar hosts 1.9% of global desert priority-areas, of which 21.91% are protected.

For mangroves, Papua New Guinea hosts 7.41% global priority-areas. These equate to less than 0.4% of Papua New Guinea's land area. Nevertheless, only 4.42% of these mangrove priority-areas are protected. Bangladesh hosts the next greatest mangrove area, (2.32% of global priority-areas), representing 0.4% of the country. Bangladesh protects almost all (98.96%) of its mangroves and would thus not necessarily represent a good choice for mangrove-specific DNS. The Solomon Islands hosts 1.64% of global priority-areas, which make up less than 1.4% of the land area, of which only 5.65% are protected.

For freshwater priorities the DR Congo hosts 7.02% global priority-areas, making up 9.34% of its landmass of which 17.94% are protected. This is followed by Papua New-Guinea which is home to 2.2% global freshwater priority-areas, of which 4.08% are protected.

Country specific debt-for-nature swaps

For country-specific DNS, e.g., to maximize priority-area protection within Aichi target 11 of 17% PA coverage, knowledge of priority-areas relevant for effective protection in each country is required.

We calculate the percentages of unprotected priority-areas for each country and biome, analyzing relevant coverage we identify specific national targets for DNS to maximize national and global priority-area protection (Fig. 2B). DR-Congo has the highest priority-area, which hosted 5.2% of global surface area across all priority-areas, occupying 88% of DR Congo's land area, of which 12.69% are protected. In African countries, DNS has significant potential for grasslands. Tropical countries, like the Solomon Islands, Papua New Guinea and Madagascar, are most in need of mangrove protection. Furthermore, countries like DR Congo have seen rapid rates of deforestation, having lost 8% forest coverage since 2000, and around 0.7% annually for the last four years (*38*) (Data S1).

How much debt for nature?

The 67 countries had about USD522 billion external public debt stocks at the end of 2019. Public external debt as a percentage of GDP varies greatly across the 67 countries: in 10 countries, the ratios are higher than 50%, including Bhutan (104%), Cabo Verde (92%), Mozambique (73%), Djibouti (65%) and Mongolia (60%), Sao Tome and Principe (58%), Lao PDR (57%), Mauritania (56%), Senegal (55%) and Zambia (51%). For most (55/67) countries, the ratio falls between 10% and 50%. 46% of debt held by official multilateral creditors (e.g., World Bank), 34% by official bilateral creditors (e.g., China), 13% by bondholders, and 7% by non-official creditors (Fig. 3A). Some or all of this debt could be used for DNS.

Establishing the amount of debt to be swapped requires specifying the cost to establish and manage protected areas, which is challenging: surveys on acquisition and operating cost for protected areas, as well as their ratios, vary both across and within regions and biomes by factors of 50 (*39*). To nevertheless estimate the cost (see supplement), data provided by James et al. (*40*) were adjusted to 2020 USD, which resulted in higher acquisition cost than some current DNS. As a result, PA acquisition cost per km^2 ranges from USD1,535 in Sub-Saharan African, to USD17,350 in the Pacific. Similarly, annual operating cost is estimated at 15% of acquisition cost (*41*) on average, where operating costs include personnel, vehicles (including boats) and infrastructure, whose values will vary based on the frequency of patrols, the area size and local salaries.

For 35 countries, less than 0.1% of their public debt would allow to acquire all priority-areas, while for four countries even 100% of their public debt would not suffice to acquire unprotected priority-areas (Solomon Islands, Papua New Guinea, Guyana and Central African Republic - Fig. 3).

Using a hypothetical willingness to swap a maximum of 2%/5% of debt in each country to maximize priority-area acquisition, 39/49 countries could protect 100% of priority-areas at a cost of USD4.97/8.44 billion. From a global perspective, this swap would protect 7.8%/12.8% of global priority-areas and 19.7%/32.9% of global grassland priority-areas (Fig. 3C). The 2%/5% debt swap would be equal to an average of 0.4/0.7% of GDP and maximum of 2.31%/3.70% of GDP across the 67 countries and thus be in the range of previous debt swaps.

We approximated the acquisition cost for all priority-areas in the surveyed countries to be USD 26.6 billion, equaling to 5.06% of their total debt. This estimate is comparable to that e.g., of Waldron et al. (*39*). The authors aim at protecting 30% of productive terrestrial and marine surface area, while our study only focuses on protecting terrestrial unprotected priority-areas in a subset of countries for which debt for nature swaps may be available and thus has a smaller scope. Therefore, if a multilateral mechanism were established to pool and distribute DNS across countries depending on protection needs, all priority-areas could be acquired by swapping 5.06% of total outstanding debt, even in countries, such as DR Congo, Central African Republic and Guyana, who hold high shares of global priority-areas but compared to their priority-areas low levels of debt.

Besides acquisition cost, PA management cost need to be covered. Part of these can be paid for through "re-routed" interest payments on original debt. Based on previous DNS, we generously assume a 30% discount on the swapped debt (e.g., the 2018 Seychelles DNS had a discount of only 5.4%). This would raise USD87/147 million annually in the 2%/5% DNS scenario from within the countries. With the assumption of management cost being 15% of acquisition cost, the re-routed interest payments cover about 12% of management cost for each country. The annual management cost gap would amount to USD649 million/USD1.1 billion in the 2%/5% scenario across all countries. In a pooled scenario, annual management cost would amount to USD4 billion, with USD464 million interest payment earmarked for management costs, leaving an annual funding gap of USD3.5 billion that would need to be covered through other domestic or international sources.

Whose debt

Depending on the DNS scenario (2%/ 5%/pooled 5% DNS), different creditors would have to swap different amounts of debt, as each debtor country has their specific pool of creditors.

Assuming an equal participation in the DNS of all creditors, multilateral and official bilateral creditors would have to provide most of the debt for swapping in the three scenarios (Fig. 4: A for 2%, B for 5%, C for pooled 5% DNS), particularly The World Bank (20.13%/18.66%/21.43%), and China (23.15%/24.77%/20.04%). China as a bilateral creditor holds a higher share of debt in countries with high shares of unprotected priority-areas (Fig. 3A), its contribution in the 2% and 5% maximum DNS scenarios would be higher than in the pooled DNS scenario (where each creditor would provide 5% of its total outstanding loans in the 67 countries for DNS independent on the specific debtors' nature).

Debt-for-nature swap application

The COVID19 crisis has provided a unique opportunity to conserve key priorities through applying DNS in many emerging countries. DNS allow debtor countries in debt distress to reduce their debt burdens, while simultaneously establishing protected areas. For successful application, DNS development must also consider social inclusion, particularly to ensure the support of local populations and provision of livelihoods. DNS can also provide an avenue for sustainable livelihood provisions through e.g. providing jobs in conservation and furthermore through developing eco-tourism in these new PAs (e.g. Kenya's ecotourism contributes around 10% of Kenya's GDP) (*42*). Accordingly, if planned well, DNS provide a "triple-win" mechanism to remove financial pressures on a country, to reduce pressures on natural resources, and to support longer-term sustainable economic development through local employment.

While DNS are complex in their implementation, our framework and analyses aim to accelerate application of DNS by bridging two current gaps: first, by highlighting the unprotected priority-areas in countries that are vulnerable to both debt and nature loss we allow for identification of DNS potentials; second, by allowing potential sponsors interested in protecting specific biomes to identify creditor-debtor pairs where DNS would be most effective, we accelerate funding. By bridging these gaps, we enable countries to meet global conservation targets most effectively, while conserving a greater breadth of species and providing livelihood for communities.

To maximize impact of DNS, multilateral negotiation pooling DNS and relevant interest payments, e.g., through a trust fund under the CBD: if creditors and debtor countries can agree to apply DNS to 5% of all public debt, could protect all priority-areas in all 67 countries. This could be implemented as a cost-effective financial contribution mechanism for biodiversity conservation under a potential post-2020 "common but differentiated responsibility" framework. Should a full multilateral approach be too challenging, the other options include multiparty negotiations for each individual DSSI country, or bilateral debt negotiations particularly with those creditors that hold the largest share of debt in individual debtor countries, e.g., China.

By focusing on mostly less developed priority-areas in this article, the introduced framework and data for DNS could provide an effective mechanism to finance conservation of key areas for biodiversity and meet conservation targets on a global scale.

References

1. Secretariat of the Convention on Biological Diversity, "Global Biodiversity Outlook 5" (Montreal, 2020), (available at https://www.cbd.int/gbo/gbo5/publication/gbo-5-en.pdf).
2. A. Seidl, K. Mulungu, M. Arlaud, O. van den Heuvel, M. Riva, The effectiveness of national biodiversity investments to protect the wealth of nature. *Nat Ecol Evol.* **5**, 530–539 (2021).
3. B. A. Simmons, R. Ray, H. Yang, K. P. Gallagher, China can help solve the debt and environmental crises. *Science.* **371**, 468–470 (2021).
4. A. Dibley, T. Wetzer, C. Hepburn, National COVID debts: climate change imperils countries' ability to repay. *Nature.* **592**, 184–187 (2021).
5. J. M. Sommer, M. Restivo, J. M. Shandra, The United States, Bilateral Debt-for-Nature Swaps, and Forest Loss: A Cross-National Analysis. *The Journal of Development Studies*. **56**, 748–764 (2020).
6. F4B-Initiative, "Recapitalising Sovereign Debt - Why Nature Performance Bonds are needed now" (Finance for Biodiversity Initiative, 2020), (available at https://a1be08a4-d8fb-4c22-9e4a-2b2f4cb7e41d.filesusr.com/ugd/643e85_e2f3eccae35c45a8b875a974a8918922.pdf).

7. World Bank, Debt Service Suspension Initiative. *World Bank* (2021), (available at https://www.worldbank.org/en/topic/debt/brief/covid-19-debt-service-suspension-initiative).
8. R. Smith, in *Savannas and Dry Forests: Linking People with Nature*, J. Mistry, A. Berardi, Eds. (Routledge, ed. 1, 2017; https://www.taylorfrancis.com/books/9781351902090), pp. 105–127.
9. L. Goldberg, D. Lagomasino, N. Thomas, T. Fatoyinbo, Global declines in human-driven mangrove loss. *Global Change Biology*. **26**, 5844–5855 (2020).
10. D. R. Richards, B. S. Thompson, L. Wijedasa, Quantifying net loss of global mangrove carbon stocks from 20 years of land cover change. *Nat Commun*. **11**, 4260 (2020).
11. N. Thomas, R. Lucas, P. Bunting, A. Hardy, A. Rosenqvist, M. Simard, Distribution and drivers of global mangrove forest change, 1996–2010. *PLOS ONE*. **12**, e0179302 (2017).
12. G. Grill, B. Lehner, A. E. Lumsdon, G. K. MacDonald, C. Zarfl, C. R. Liermann, An index-based framework for assessing patterns and trends in river fragmentation and flow regulation by global dams at multiple scales. *Environ. Res. Lett.* **10**, 015001 (2015).
13. T. Agardy, G. N. di Sciara, P. Christie, Mind the gap: Addressing the shortcomings of marine protected areas through large scale marine spatial planning. *Marine Policy*. **35**, 226–232 (2011).
14. P. A. Sheikh, “Debt-for-Nature Initiatives and the Tropical Forest Conservation Act: Status and Implementation” (Congressional Research Service, 2018), p. 21.
15. Debt for nature swaps. *UNDP*, (available at https://www.sdfinance.undp.org/content/sdfinance/en/home/solutions/debt-for-nature-swaps.html#mst-1).
16. P. Shabecoff, Bolivia to Protect Lands in Swap for Lower Debt. *The New York Times* (1987), p. 2.
17. Convention on Biological Diversity (CBD), “Seychelles Fact Sheet” (Convention on Biological Diversity (CBD), 2016), (available at https://www.cbd.int/doc/meetings/mar/soiom-2016-01/other/soiom-2016-01-seychelles-01-en.pdf).
18. Club de Paris, (available at https://clubdeparis.org/).
19. E. Smith, Zambia becomes Africa’s first coronavirus-era default: What happens now? *CNBC* (2020), (available at https://www.cnbc.com/2020/11/23/zambia-becomes-africas-first-coronavirus-era-default-what-happens-now.html).
20. S. Cevik, B. Öztürkkal, “Congation of Fear: Is the Impact of COVID-19 on Sovereign Risk Really Indiscriminate,” *IMF Working Paper* (WP/20/263, 2020), (available at https://www.imf.org/en/Publications/WP/Issues/2020/11/25/Contagion-of-Fear-Is-the-Impact-of-COVID-19-on-Sovereign-Risk-Really-Indiscriminate-49903).
21. WWF, “Living Planet Report 2020 - Bending the Curve of Biodiversity Loss” (WWF, Gland, 2020), (available at https://www.zsl.org/sites/default/files/LPR%202020%20Full%20report.pdf).
22. A. Deutz, G. M. Heal, R. Niu, T. Townshend, L. Zhu, A. Delmar, A. Meghji, S. A. Sethi, J. Tobin-de la Puente, “Financing Nature: Closing the global biodiversity financing gap” (The Paulson Institute, The Nature Conservancy, and the Cornell Atkinson Center for Sustainability, 2020), (available at https://www.paulsoninstitute.org/wp-content/uploads/2020/09/CBD-Full-Report-Endorsements-.pdf).
23. United Nations, “Liquidity and Debt Solutions to INvest in the SDGs: The TIme to Act is Now” (United Nations, New York, Geneva, 2021), (available at https://www.un.org/sites/un2.un.org/files/sg_policy_brief_on_liquidity_and_debt_solutions_march_2021.pdf).

24. Lazard, “Debt-for-SDGs swaps in indebted countries: The right instrument to meet the funding gap?” (European Commission, 2021).

25. M. Ferry, The carrot and stick approach to debt relief: overcoming moral hazard. *Journal of African Economies*. **28**, 252–276 (2019).

26. A. S. Kukkala, A. Moilanen, Core concepts of spatial prioritisation in systematic conservation planning. *Biological Reviews*. **88**, 443–464 (2013).

27. M. Jung, A. Arnell, X. de Lamo, S. García-Rangel, M. Lewis, J. Mark, C. Merow, L. Miles, I. Ondo, S. Pironon, C. Ravilious, M. Rivers, D. Schepaschenko, O. Tallowin, A. van Soesbergen, R. Govaerts, B. L. Boyle, B. J. Enquist, X. Feng, R. Gallagher, B. Maitner, S. Meiri, M. Mulligan, G. Ofer, U. Roll, J. O. Hanson, W. Jetz, M. Di Marco, J. McGowan, D. S. Rinnan, J. D. Sachs, M. Lesiv, V. M. Adams, S. C. Andrew, J. R. Burger, L. Hannah, P. A. Marquet, J. K. McCarthy, N. Morueta-Holme, E. A. Newman, D. S. Park, P. R. Roehrdanz, J.-C. Svenning, C. Violle, J. J. Wieringa, G. Wynne, S. Fritz, B. B. N. Strassburg, M. Obersteiner, V. Kapos, N. Burgess, G. Schmidt-Traub, P. Visconti, Areas of global importance for conserving terrestrial biodiversity, carbon and water. *Nat Ecol Evol* (2021), doi:10.1038/s41559-021-01528-7.

28. M. Di Marco, S. Ferrier, T. D. Harwood, A. J. Hoskins, J. E. M. Watson, Wilderness areas halve the extinction risk of terrestrial biodiversity. *Nature.* **573**, 582–585 (2019).

29. C. N. Jenkins, K. S. Van Houtan, S. L. Pimm, J. O. Sexton, US protected lands mismatch biodiversity priorities. *Proc Natl Acad Sci USA*. **112**, 5081–5086 (2015).

30. W. Jetz, J. M. McPherson, R. P. Guralnick, Integrating biodiversity distribution knowledge: toward a global map of life. *Trends in Ecology & Evolution.* **27**, 151–159 (2012).

31. W. Jetz, Geographic Range Size and Determinants of Avian Species Richness. *Science.* **297**, 1548–1551 (2002).

32. A. C. Hughes, M. C. Orr, Q. Yang, H. Qiao, *Global Ecol Biogeogr*, in press, doi:10.1111/geb.13304.

33. A. Hughes, M. Orr, K. Ma, M. Costello, J. Waller, P. Provoost, C. Zhu, H. Qiao, “Sampling biases shape our view of the natural world” (preprint, Preprints, 2020)„ doi:10.22541/au.159419540.02222358.

34. O. Venter, E. W. Sanderson, A. Magrach, J. R. Allan, J. Beher, K. R. Jones, H. P. Possingham, W. F. Laurance, P. Wood, B. M. Fekete, M. A. Levy, J. E. M. Watson, Global terrestrial Human Footprint maps for 1993 and 2009. *Sci Data*. **3**, 160067 (2016).

35. M. L. Hobi, M. Dubinin, C. H. Graham, N. C. Coops, M. K. Clayton, A. M. Pidgeon, V. C. Radeloff, A comparison of Dynamic Habitat Indices derived from different MODIS products as predictors of avian species richness. *Remote Sensing of Environment.* **195**, 142–152 (2017).

36. E. M. O. Silveira, V. C. Radeloff, S. Martinuzzi, G. J. Martínez Pastur, L. O. Rivera, N. Politi, L. Lizarraga, L. S. Farwell, P. R. Elsen, A. M. Pidgeon, Spatio-temporal remotely sensed indices identify hotspots of biodiversity conservation concern. *Remote Sensing of Environment.* **258**, 112368 (2021).

37. N. C. Coops, S. P. Kearney, D. K. Bolton, V. C. Radeloff, Remotely-sensed productivity clusters capture global biodiversity patterns. *Sci Rep.* **8**, 16261 (2018).

38. Global Forest Watch, Democratic Republic of the Congo Deforestation Rates & Statistics, (available at https://www.globalforestwatch.org/dashboards/country/COD/).

39. A. Waldron, V. Adams, J. Allan, A. Arnell, et.al., “Protecting 30% of the planet for nature: costs, benefits and economic implications (Waldron Report 30 by 30)” (Cambridge University, Cambridge, 2020), (available at https://www.conservation.cam.ac.uk/files/waldron_report_30_by_30_publish.pdf).

40. A. James, K. J. Gaston, A. Balmford, Can We Afford to Conserve Biodiversity? *BioScience.* **51**, 43–52 (2001).
41. J. J. Bohorquez, A. Dvarskas, E. K. Pikitch, Filling the Data Gap – A Pressing Need for Advancing MPA Sustainable Finance. *Front. Mar. Sci.* **6**, 45 (2019).
42. Kenya Tourism - Total Contribution to GDP. *Invest in Group*, (available at https://investingroup.org/data/84/kenya-tourism-total-contribution-to-gdp/).

Declarations

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Author contributions: Each author's contribution(s) to the paper should be listed [we encourage you to follow the CRediT model]. Each CRediT role should have its own line, and there should not be any punctuation in the initials.

Examples:

Conceptualization: CN, ACH

Methodology: ACH, MDY, CN

Investigation: ACH, MDY

Visualization: ACH, MDY, CN

Funding acquisition: CN, ACH

Project administration: CN, ACH

Supervision: CN, ACH

Writing – original draft: ACH, CN, MDY

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Competing interests: No competing interests

Data and materials availability: All data used for analysis is cited in text as appropriate and listed in Table S8Data S5, or collated within tables as part of supplementary data. Full tabular results are available as Table Data S1.

Shapefiles of percentage area within a priority and debts are available as Extended data, and high-resolution GIS files for the six biomes plus overall priorities will be made available via an online repository.

Tables

	Total share of global priority-areas in selected 67 countries	Percentage of priority-areas protected within the 67 countries	Percentage of priority-areas protected globally	Top five countries with the highest priority	Highest priority country's share of global priority	Protected priority-area for biome in highest priority country
	22.32%	17.03%	15.14%	1. DR Congo 2. Angola 3. Mozambique 4. Central African Republic 5. Papua New Guinea	5.20%	12.70%
	19.71%	16.93%	18.66%	1. DR Congo 2. Angola 3. Central African Republic 4. Papua New Guinea 5. Cameroon	6.47%	14.81%
d	50.63%	16.61%	13.75%	1. Angola 2. DR Congo 3. Central African Republic* 4. Mozambique 5. Ethiopia	9.51%	4.71%
	5.34%	19.63%	10.25%	1. Madagascar 2. Ethiopia 3. Angola 4. Mongolia 5. Pakistan	1.91%	21.91%
e	20.26%	30.15%	34.46%	1. Papua New Guinea 2. Solomon Islands+ 3. Madagascar 4. Mozambique 5. Myanmar	7.41%	4.41%
ter	21.57%	28.13%	22.92%	1. DR Congo 2. Papua New Guinea# 3. Angola 4. Zambia 5. Guyana	7.01%	4.08%

.

erview of priorities for biodiversity; (* for grassland Zambia would be in 3rd position but as 40.01% ty-area is protected it has not been listed here, + for mangrove Bangladesh would be in second t as 99% of the priority for mangroves are already protected this would not be useful; # for the Republic of Congo would be second, but with 74.8% of the priority protected we have not listed eas with under 1% of global priority for that biome have been italicized.

Figures

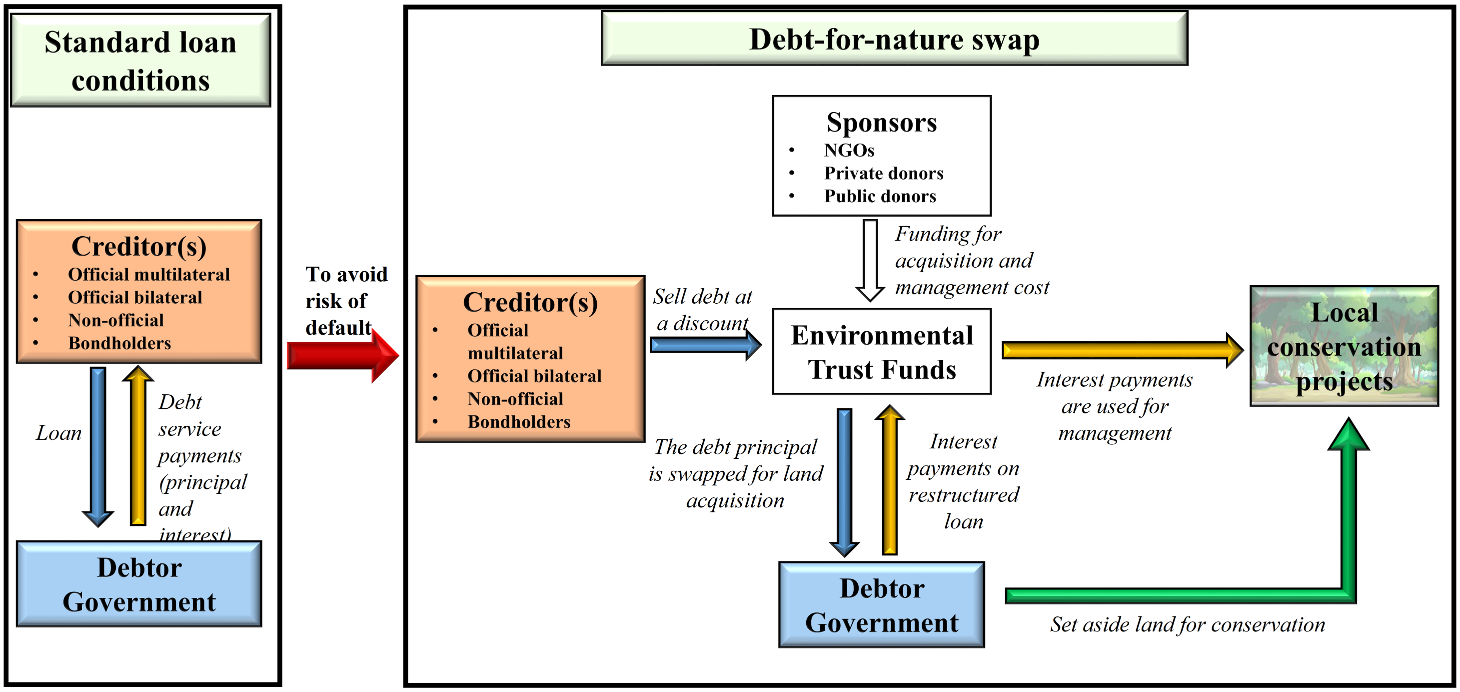

Figure 1

Illustration of Debt-for-Nature Swap. Under standard loan conditions, debtor governments transfer debt service payments (including principal and interests) regularly to creditors. When the debtor government is under financial distress, a debt-for-nature swap could be initiated to avoid risk of default while establishing and maintaining new protected areas.

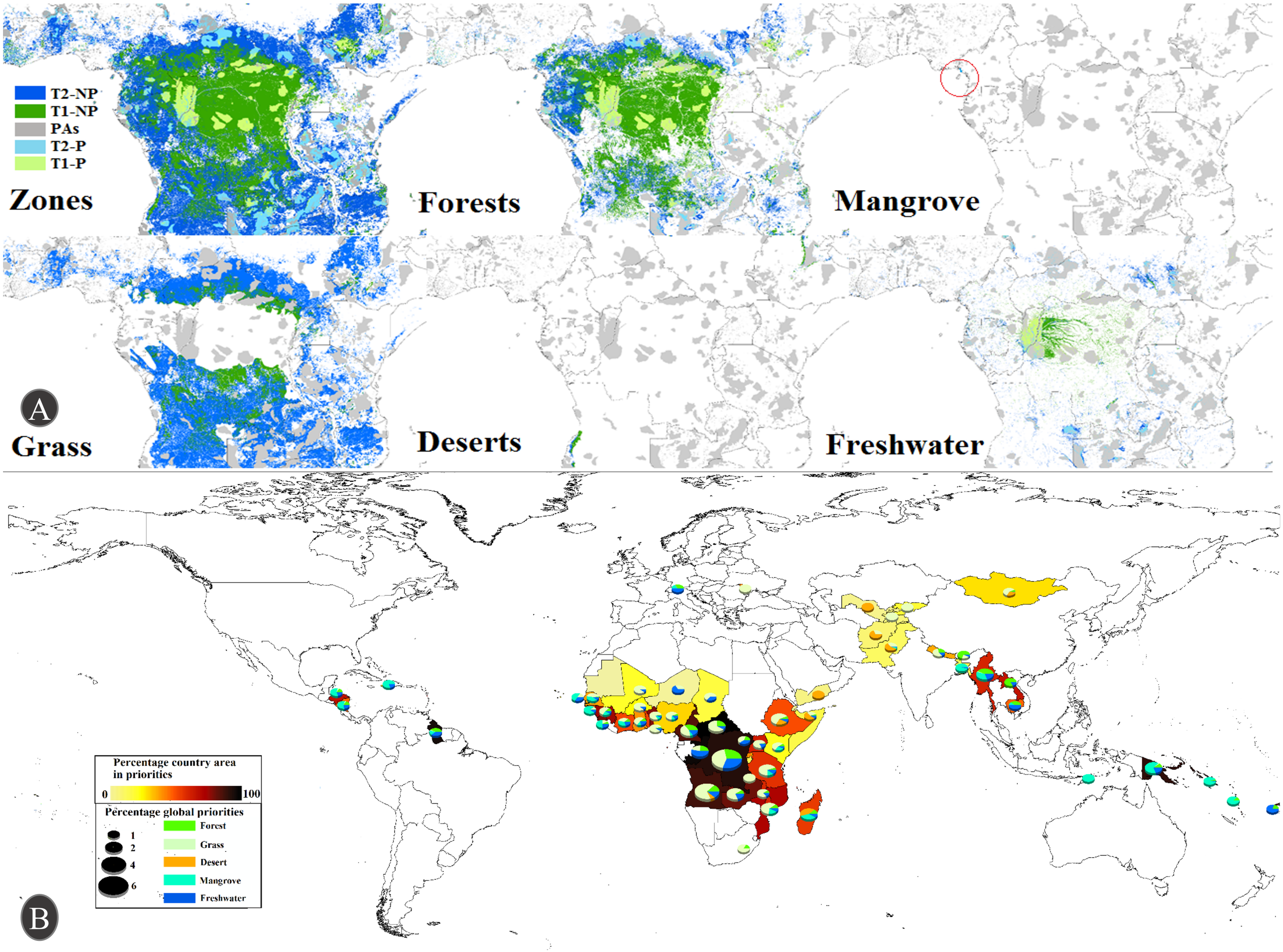

Figure 2

Priorities for conservation. A) High resolution priorities for the different biomes across Central Africa. Note that some habitats are mixed, so may include priorities under more than one "biome" type. Top priority (T1) areas are shown in green, whereas second-level priorities (T2) are shown in blue. Protected priority-areas are shown as paler and grey areas are protected areas that do not cover priority-areas. B) Global priorities for biodiversity within the 67 DSSI countries. Ramp (yellow-black) shows percentage of global priority overall, pie-chart size indicates the priority as a proportion of global priority-areas (so larger pies indicate larger proportions of all global priorities, and the fractions of each colour indicate the percentage from each biome).

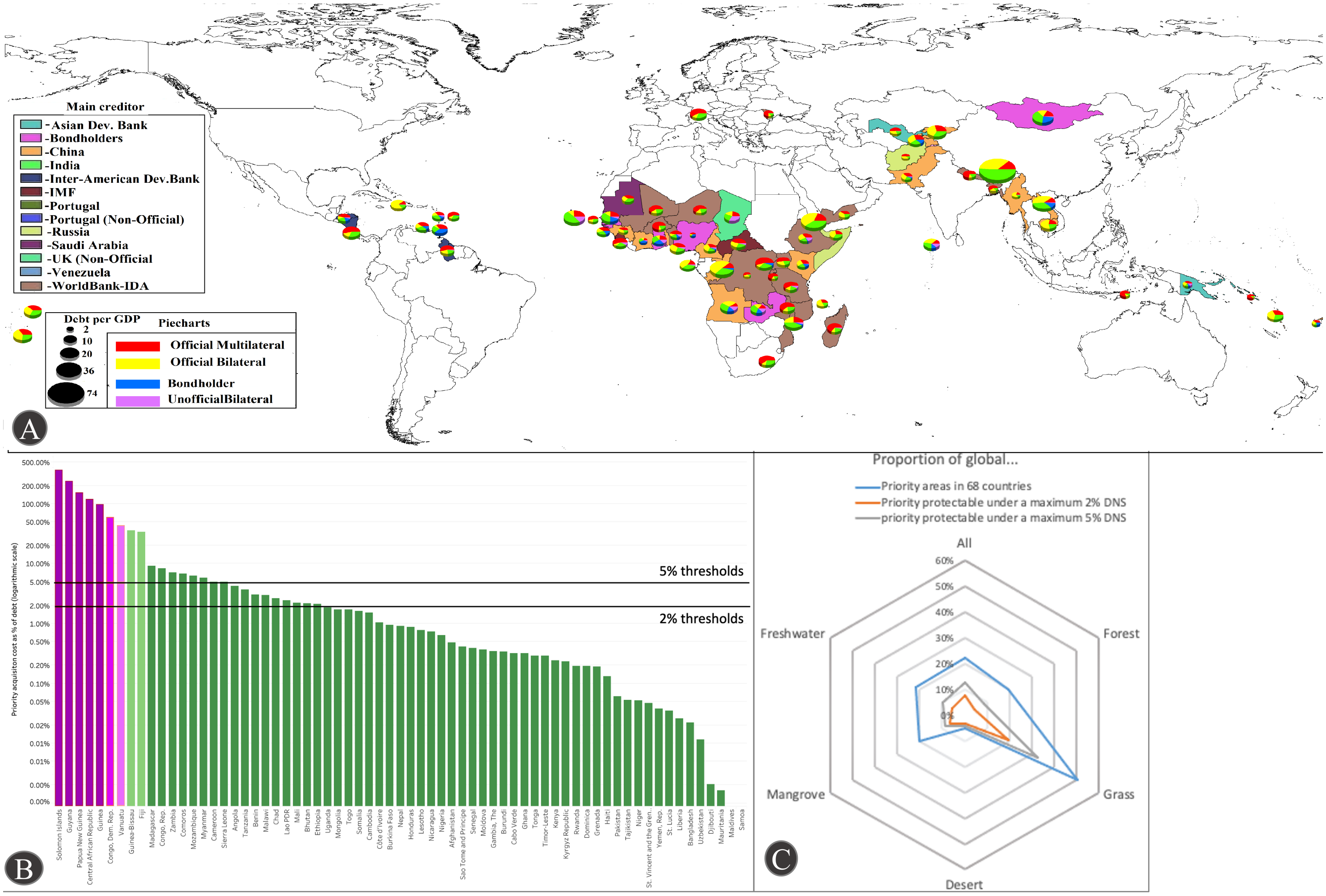

Figure 3

Understanding the cost of protection. A). Public external debt and largest creditor in 67 DSSI eligible countries in 2019. The sizes of pie-charts refer to the overall public external debt-to-GDP ratios (ranging from 2-74%), proportions of debt types are shown in pies, highlighting the degree of debt for each country and the type. Colours of the main-creditors are shown as country colour, notably many African countries are largely credited by the World Bank, followed by China. B). Cost for priority-area acquisition as % of public debt. C). Proportion of global priority-area protection under different scenarios: e.g., the 67 countries host 50.6% of global grass priority-areas, with a maximum of 2%/5% DNS, 32.92%/19.73% of the global grass priority-area could be protected.

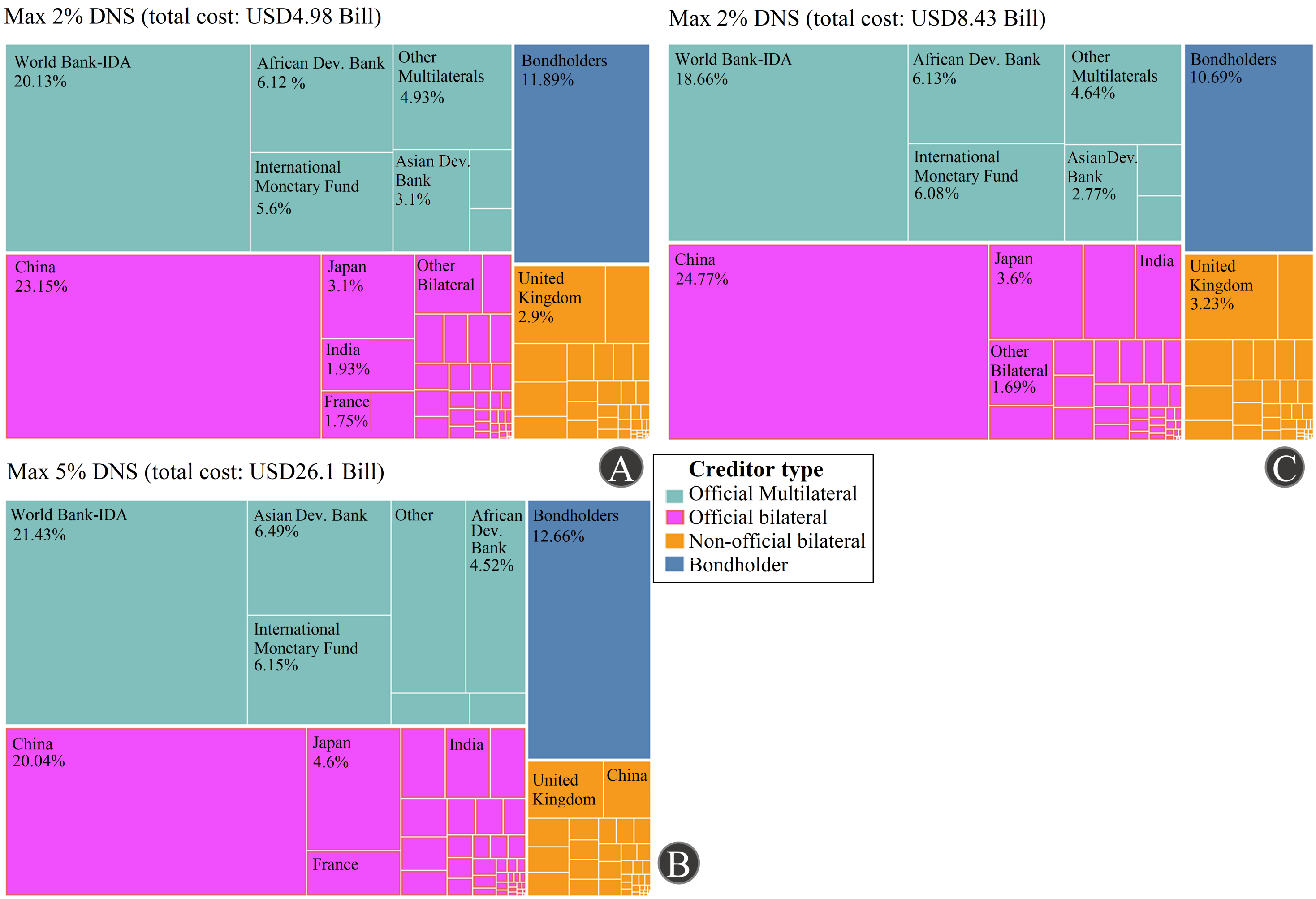

Figure 4

Cost of debt-for-nature swaps in three different scenarios. A). Maximum of 2%, B). Maximum of 5%, and C). Pooled 5% of DNS.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Datas1.xlsx
- DataS2.xlsx
- Datas3.xlsx
- Datas4.xlsx
- DataS5.xlsx
- DataS6.xlsx
- SupplementaryMaterials.docx