A short overview of the state of play in "Nature-Based Solutions"

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In the past decade, the rubric of Nature-Based Solutions (NbS) has gained traction in global environmental agreements and the research literature, from 2008 where the phrase was in the title (but never actually used in the text) of a major World Bank report (MacKinnon et al., 2008) on its biodiversity and climate change portfolio, to the point today where it is now a key strategy of the IUCN and increasingly cited in the Convention on Biological Diversity (CBD), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), and the Global Environment Facility (GEF) activities. Whilst the simple idea of NbS as "working with and enhancing nature to help address societal challenges" (Seddon et al., 2020) is intuitive, the research literature is probing the scope and limits of the idea helpfully. This document reviews (mainly) eight recent, relatively synthetic papers about NbS to summarise the current state of play as relevant to a GEF context. This is a very selective update to identify some key issues that are well-agreed, as well as some that are still contentious; it is not a comprehensive literature review. The topical importance of NbS is illustrated by the fact that the idea is mentioned as an important priority even in the very political, angry resignation letter[1] of Clare O'Neill, previous UK Minister dismissed from taking the UK lead on the UNFCCC COP21 in 2020!

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[1] See https://blog.felixdodds.net/2020/02/the-letter-of-claire-oneill-to-uk-prime.html: Aim 4 – "Placing nature-based solutions at the heart of the climate recovery agenda…"

1 What are "Nature-Based Solutions"?

1.1 Definitions

NbS are defined by the International Union for Conservation of Nature (IUCN) as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (as cited in Cohen-Shacham et al., 2019). The NbS framework emerged from the Ecosystem Approach, which underpins the Convention on Biological Diversity (CBD) and considers biodiversity conservation and human well-being to be dependent on functioning and resilient natural ecosystems (CBD, 2004). With 168 signatory nations to the CBD, the Ecosystem Approach has helped to shape the current conservation and natural resource management agenda (Cohen-Shacham et al., 2019). Cohen-Shacham et al. (2019) show how NbS broadly encompass a variety of other approaches to biodiversity and nature conservation, notably ecological restoration, ecological engineering, forest landscape restoration, ecosystem-based adaptation, ecosystem-based mitigation, climate adaptation services, ecosystem-based disaster risk reduction, natural infrastructure, green infrastructure, ecosystem-based management, and area-based conservation (see their Fig.1, reproduced as Figure 1 here), and notably excluding approaches related to biomimicry, that is, the creation of interventions inspired by, but not based in, nature.

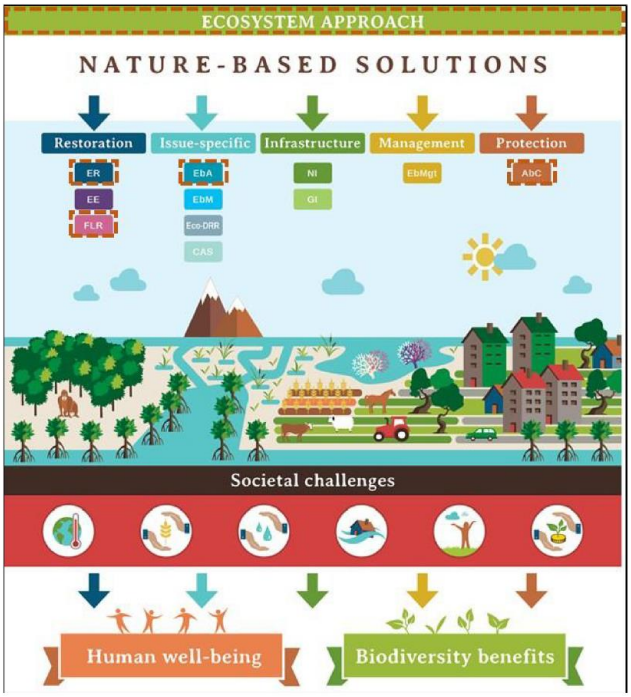


Figure 1: a conceptual representation of how NbS acts as an umbrella for five categories of approach according to Cohen-Shacham et al. (2019) (their Fig.1; see also Table 1 below).

1.2 Key principles and attributes

Cohen-Shacham et al. (2019) list eight principles that IUCN identifies as underpinning an NbS approach:

1. *NbS embrace nature conservation norms (and principles)*. However, they note, while NbS embrace nature conservation, not all conservation actions necessarily qualify as an NbS (Watson et al., 2014)
2. *NbS can be implemented alone or in an integrated manner with other solutions to societal challenges (e.g., technological and engineering solutions)*
3. *NbS are determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge*
4. *NbS produce societal benefits in a fair and equitable way in a manner that promotes transparency and broad participation*
5. *NbS maintain biological and cultural diversity and the ability of ecosystems to evolve over time*

6. *NbS are applied at a landscape scale*, taken to mean large spatial areas, such as watersheds or large forests, which usually combine several ecosystems (agricultural, inland waters, coastal, forest, etc.), and which might in some cases, be transboundary
7. *NbS recognize and address the trade-offs between the production of a few immediate economic benefits for development and future options for the production of the full range of ecosystem services*
8. *NbS are an integral part of the overall design of policies, and measures or actions, to address a specific challenge*.

They compare these principles with key principles from other approaches for which NBS may be an umbrella (above) and found that the NbS framework goes beyond the other approaches in: integrating other types of solutions; matching the scale of the solution to the scale of the problem; and having an explicit focus on integrating NbS in policy and actions. However, NBS is weaker than various of the other approaches in considering: adaptive management and governance; effectiveness of an intervention; change and uncertainty; multi-stakeholder participation; and clarifying the appropriate (especially longer) timeframes over which success should be determined (Cohen-Shacham et al., 2019: Table 3). **Multi-stakeholder participation and long-term durability are notably also major concerns for the GEF**.

2 Issues and challenges

2.1 Scope and strength

The IUCN definition of NBS, like the simpler one cited by Seddon et al. (2020) above, emphasises that NBS must be implemented in such a way as to **support both biodiversity and people**. Despite this agreement, the examples and genres of NBS represented in the papers vary considerably as to how they treat this balance; this highlights the risk of NBS as a concept becoming all things to all people and consequently losing any definitional value, as 'sustainability' or 'resilience' often have. Most of the ideas have emerged from the biodiversity and conservation community, and have a sense of an undervalued sector either pleading or demanding that others take note – even the title, nature-based solutions, emphasises nature in service to social outcomes rather than an equal partnership.

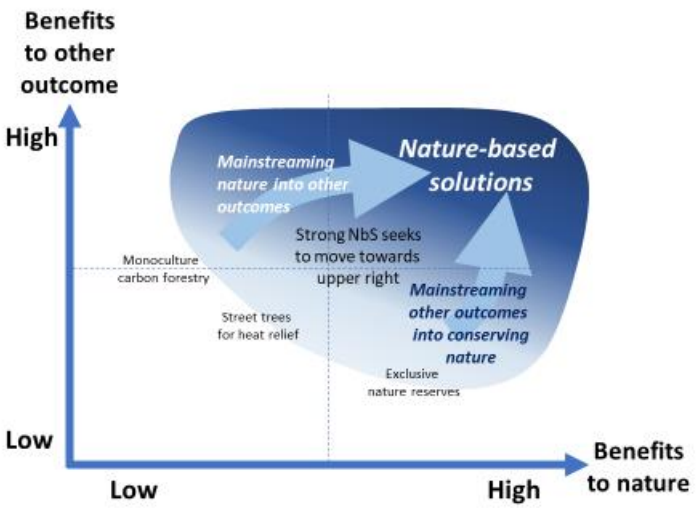
This tension is both lived and recognised in the papers reviewed. For example, Roberts et al. (2020) press for higher environmental protection targets globally, arguing that these will contribute to many other benefits; but these arguments are more rhetorical than quantified and certainly not in an operationalizable form. Griscom et al. (2020), focusing on 'natural climate solutions', geographically disaggregate the cost-effective benefits for net reduction of CO_2 emissions from NbS interventions (see below). This is a valuable decision support analysis (see below), but, as they acknowledge, it does not account for many of the potential ecosystem services benefits. Furthermore, it classifies interventions under the IUCN's categories of 'protect, manage, restore', but it is questionable whether protect actions that involve avoided deforestation or loss of mangroves should be included in any 'strong' definition of NbS. Not only might NbS be constrained to positive, not just neutral, outcomes for nature, but even neutral outcomes must be defended from leakage in other geographies (cf. the issue of leakage under Land Degradation Neutrality, see below).

Wamsler et al. (2020) and Hobbie and Grimm (2020) address nature-based adaptation as a form of NbS in urban environments; both papers note diverse approaches, but Wamsler et al. (2020) question how to ensure these address 'deep leverage points' (sensu Meadows, 2010) rather than

incremental benefits, and Hobbie and Grimm (2020) note the need to determine whether NbS can match the scale of the challenge. They provide plenty of examples of locally valuable nature-based adaptation interventions in cities, but only some of these meet the scale of adaptation challenges, most do not really meet the global scale of mitigation challenges or of biodiversity loss. Whilst providing habitat to species in cities may have local direct value to humans, it will rarely make inroads on the loss of endangered species or large scale restoration of nature. Of course, this may not always be true - Smolders et al. (2020) provide an example where, at least in its final incarnation, a flood control plan addressed both flood surge protection and the restoration of marshes: where such habitats provide migration stepping stones, they could genuinely be of global biodiversity significance, which highlights the importance of context.

In summary though, whilst there is nothing wrong in achieving good societal outcomes with low global biodiversity benefits from street trees in cities or carbon sequestration in monoculture forestry in appropriate places, **for NbS to retain meaning as a true co-benefits intervention it should be seen as delivering significant global benefits to nature, especially in the context of GEF investments**. This suggests the need for a conceptual model that makes the balance between benefits to humans and to nature more explicit. We suggest a first take on this in Figure 2, that could be the basis for elaboration in GEF thinking and development project screening more generally. We would be seeking to **recognise what is 'weak' as opposed to 'strong' NbS, and to identify criteria to help GEF projects push towards the upper right of this figure** (Figure 2).

Figure 2: conceptualising the balance between (global) benefits to nature compared to (global) benefits to human wellbeing ('other outcomes') from NbS interventions. The NbS becomes stronger (in the sense of genuine co-benefits) towards the upper right-hand quadrant. Some examples of interventions which are perfectly legitimate in context but weak in NbS terms are provided in the other quadrants.



2.2 Typologies and context-specificity

Many of the papers reviewed noted the importance of context-specificity in implementing NBS. This is highlighted as a principle of NbS by Cohen-Shacham et al. (2019) (see above), but is also emphasised both as a matter of choosing the appropriate approach for a context, and as being key to engaging stakeholder support (e.g. Giordano et al., 2020). Cohen-Shacham et al. (2019) list five categories of NbS approaches (Table 1; see also Figure 1), but these are based on how others have come to NbS conceptually and are not commensurate or orthogonal in a functional sense – restoration is Restorative, for example, but also relevant to the Issue-specific mitigation and various Management approaches. Hence these do not lend themselves to a useful typology of approaches that could be functionally related to a typology of contexts.

Table 1 Categories of approach under NbS (Cohen-Shacham et al., 2019), based on extant bodies of work, with some of the GEF programs and investment areas that could be associated; however these do not necessarily map simply.

Category	Possible examples in GEF
Restorative (ecological restoration, forest landscape restoration, ecological engineering)	*FOLUR*
Issue-specific (ecosystem-based adaptation, ecosystem-based mitigation, ecosystem-based disaster risk reduction, climate adaptation services)	*CCA and CCM*
Infrastructure (natural infrastructure, green infrastructure)	*Sustainable Cities IP*
Management (integrated coastal zone management, integrated water resources management, ecosystem-based management)	*IW, drylands*
Protection (area-based conservation approaches, including protected area management and other effective area-based conservation measures)	*BD focal area*

In their 2008 report that pre-dates the common use of the term "NbS" (MacKinnon et al., 2008), the World Bank simply classes their biodiversity-related activities as contributing to societal outcomes related to climate mitigation, climate adaptation, or food, water or livelihood securities – that is, a much more functional categorisation related to the co-benefits under consideration (whilst noting that an activity can contribute to more than one).

It is fair to say that none of the papers reviewed provide a useful functional classification of this sort, although they do provide substantial lists of examples of activities that fall under NbS (see especially tables in Griscom et al. (2020), Hobbie and Grimm (2020), so this remains a worthwhile exercise to undertake. In reality, there could usefully be typologies of (i) contexts, (ii) of problems on the nature or social dimensions of Figure 2, and (iii) of the types of NbS solutions, and ideally, some logic linking these to provide guidance. Without trying to create the perfect scheme here, an approach to classification could consider the following points:

i. In the description of contexts, Griscom et al. (2020) consider three national characteristics – the proportional contribution of natural climate solutions (NCS) to balancing the nation's emissions; the quality of political governance; and, the economic cost of and potential revenues from NCS relative to other economic activities. In GEF terms, these could be generalised to (a) the proportional contribution of NbS to the relevant global environmental benefit at the national level (affecting how much attention will be paid to this); (b) the effectiveness of governance systems and institutional arrangements (affecting whether the NbS will be well-governed); and (c) the net costs of the NbS relative to the national GDP (reflecting what the country can afford, even if funded from outside). Other contextual issues could be cultural and how important nature is to the nation's economy (e.g. through tourism, etc).
ii. The World Bank report cited above effectively starts a classification of problems that define both what type of societal benefit is being sought and, broadly, the type of system in which the NbS must be implemented (e.g. to capture carbon, the natural system must be able to affect the carbon cycle; to deliver clean water, it must be part of the water cycle, etc). This could be extended – climate mitigation, water supply, supporting agricultural outputs, moderating urban environments (e.g. heat), protecting coastlines, limiting erosion, managing fire risk, reducing disease risks, etc. (Climate adaptation, in general, is perhaps too broad a category to be useful). It may be useful to subdivide these to (iia) the societal benefit aspects – human safety, emissions reduction, water supply, etc, and (iib) the benefits

to nature – improving ecosystem function, protecting biodiversity, enhancing landscape structure, etc.

iii. Griscom et al. (2020) broadly classify NbS solutions under the three pathways defined by IUCN – protect, manage, and restore (with various specific pathways under each – see their Table 1). As noted above, these could be related to the strength of the NbS response. Seddon et al. (2020), with a focus on climate adaptation, discuss three dimensions – reducing exposure, reducing sensitivity, and supporting adaptive capacity, again with various specific pathways under each (see their Table 1). Hobbie and Grimm (2020) (in *their* Table 1!) structure an approach under the climate change hazards to cities and the possible responses to these. As a start, it might be useful to compile all of these together and explore how much they overlap or inform each other, and whether specific pathways can be arranged on a scale of low to high NbS strength as defined in the previous section.

iv. There may be other useful characteristics to consider, some of which emerge in the following sections, such as whether the benefits to nature and society occur at the same spatial scale or are mismatched in this regard, how likely inequitable outcomes are, whether the NbS is likely to drive major new winners and losers, and what the consequence may be for multi-stakeholder processes, among other possible issues.

In summary, it would be useful to take these ideas and **develop them into a more comprehensive set of classifications to support the implementation of NbS in projects**, and from that devise a simpler but functionally useful typology; but that is beyond the scope of this short review.

2.3 Defining and quantifying co-benefits

A consistent strand of concern in the papers is the need to quantify co-benefits, particularly to the extent that these can be made bankable for market-based sources of finance. Cohen-Shacham et al. (2019) speak of the need for a robust evidence base, Wamsler et al. (2020) highlight the need for more financing, Smolders et al. (2020) note that few studies quantify the effectiveness of storm surge reduction, Seddon et al. (2020) lament the lack of rigorous assessment of the potential of NbS to deliver intended benefits, and Hobbie and Grimm (2020) call for accurate and comprehensive cost-benefit analyses of NbS – clearly a topical concern! Most of these authors also attempt to make headway, either through case studies that quantify specific benefits (e.g. Smolders et al. (2020)'s detailed modelling assessment of the costs and benefits of Scheldt estuary's storm flood 'Sigmaplan'), or through proposing screening approaches (e.g. Hobbie and Grimm (2020) argue for screening on effectiveness, costs and benefits, as well as equity and environmental justice), or through quantifying where investment is best directed (e.g. Griscom et al., 2020).

However, Seddon et al. (2020) caution that there remain challenges in even measuring effectiveness, meaning that it is very hard to mobilise private finance, a result that is in common with financing many other adaptation activities. This is a class of actions that are important now but have long payback times, where it is hard to aggregate value to pay a return, and where success is fundamentally about the absence of something bad happening. Other challenges are raised by Giordano et al. (2020)'s study of inhomogeneous stakeholder perceptions and expectations of the benefits, among other aspects finding a tendency to overestimate short term effects on community well-being.

All this implies the **need for much more attention on the costs and benefits of interventions, assessed comprehensively across outcomes for both society and nature**; and the need to consolidate some sort of evidence base in this regard that is linked to **monitoring and evaluation that might give investors (whether public or private) more confidence of suitable (ie. not always**

economic) 'bankable' returns on investment. The examples of progress provided here are only a very small start.

2.4 Benefits for who?

IUCN's fourth principle is that *NbS produce societal benefits in a fair and equitable way in a manner that promotes transparency and broad participation*, and their 7th principle also touches on intergenerational equity. Simplistic re-forestation for climate mitigation may provide good global societal benefits in ways that destroy local livelihoods (Seddon et al., 2020); this sort of outcome (slightly the tone of Roberts et al., 2020) is driving a rising critique of NbS from NGOs linked to low-income countries that worry about their lands just being co-opted, especially given the experiences of some REDD and REDD+ interventions (e.g. Locatelli et al., 2014; McDermott et al., 2013).

There are a variety of trade-off issues, including:

- **Global vs local benefits** – there may be cases where there is a rationale for saying global benefits (e.g. for reducing carbon emissions whilst sustaining biodiversity) outweigh local disbenefits, but this cannot be argued on simplistic economic grounds. The high-level analysis to map potential intervention locations for 'climate solutions in the tropics' (Griscom et al., 2020), whilst valuable for a first pass and at least considering how the global benefits provide national-level benefits also, runs the risk of being applied in this way as far as more local stakeholders are concerned.
- We know local involvement that results in **local livelihood benefits** enhances the likelihood of locals not undermining investments in reforestation or species protection, and hence the durability of these investment (Seddon et al. (2020); see also next section), so the benefits for global outcomes from having local benefits must be factored in, in addition to any ethical argument for these. If the emphasis is on the production of global benefits (as for GEF), then ways must be found of transferring part of those benefits to local actors equitably. There is now plenty of experience in payment or incentive schemes (e.g. the *payment for ecosystem services* literature, which deserves review), as well as market-based options, each with their pitfalls and potentials to distort outcomes. A conscious focus on diverse social co-benefits in NbS potentially provides some new pathways for less distorting interventions (e.g. looking for a diversity of social co-benefits rather than channelling these all through a payment that is liable to equity distortions).
- **Balancing short and long-term (e.g. intergenerational) benefits**, whether local or global, is particularly hard, and Giordano et al. (2020) show how divergence in perceptions of benefits (both actual and prospective) among stakeholders further complicates this picture; this probably highlights the need for appropriate forms of multi-stakeholder processes to negotiate these different perceptions, that also evolve over time.

Even where there are demonstrable potential benefits for local people, Seddon et al. (2020) note that NbS varies greatly in how much they are designed and implemented by local communities. As they say, some approaches that NbS encompasses, such as ecosystem-based adaptation, *are* explicitly participatory and community-based, but NbS more generally is not necessarily so.

GEF has a focus on delivering global environmental benefits, albeit within frameworks that aim to deliver local benefits for ethical reasons and to help ensure durability of outcomes; **this means that the issue of balancing outcomes for different beneficiaries at different scales in space and time is a genuine challenge for GEF**. There is a growing literature on co-production of ecosystem services that considers these issues of trade-offs and synergies (e.g. Lavorel et al., 2020) and equity (e.g.

McDermott et al., 2013), as well as other aspects of payments for ecosystems services[2], which could deserve **specific review attention to draw out principles for GEF project implementation**.

2.5 Assuring durability of benefits

As noted in section 1.2, durability of outcomes is not a particular focus of the NbS principles**; factors STAP has previously identified as important for durable, transformative outcomes are: stakeholder trust and motivation, enduring capacity and financing, and resilience (including adaptability and transformability)** (GEF STAP, 2019). Ensuring durability is a real concern among stakeholders – as noted in a recent GEF-supported news article[3], "What if the carbon we store in forests doesn't stay there forever? … if we paid people not to deforest – would they just chop down a forest to create agricultural land somewhere else?". Similarly, Seddon et al. (2020) note the risks of maladaptation, for example in the form of monoculture forests as opposed to biodiverse plantings that are suited to providing local forest products to communities. They also highlight concerns over how resilient NbS may be in the face of climate change – that is the risks of losing gains if projects do not plan for this. In the absence of proper policy frameworks, there is also a danger that gains through NbS in one part of a country may be overwhelmed by continued losses elsewhere, that is, there is 'leakage' in the benefits.

The Land Degradation Neutrality approach promotes explicit attention to this issue of leakage, by carefully specifying that 'no net loss' must be achieved by nations within each land category. If properly met, this provides a framework to measure and report on, and hopefully avoid, leakage. Of course, mere 'neutrality' is a weak objective, as noted earlier, but this approach could be combined with a graduated scale of ambition that actively improves outcomes for nature, rather than only avoiding loss (a star rating style of labelling has been suggested in the LDN context, along the lines of energy ratings, to develop a 'race to the top' rather than the bottom).

In reality, benefits on both axes of Figure 1 need to be durable. Ensuring that the social benefits endure will encourage the relevant actors to keep supporting the benefits to nature. Lavorel et al. (2020) emphasises that there are diverse aspects of co-production with local communities that may help with this.

Seddon et al. (2020) also note a diversity of **other barriers to the achievement and durability of NbS outcomes, including notably institutional and governance cultures and norms**. These are worth further investigation, not least as they relate directly to the need to change norms, goals, and cultures when scaling for transformation.

For GEF projects espousing NbS, **assessing durability against climate and other long-term trends is a vital part of project design, as is appropriate engagement of relevant stakeholders**. A useful contribution by GEF could be to **develop a concept like LDN that operates to avoid leakage across all GEBs**, not only land degradation, preferably framed to inspire a greater aspiration than mere neutrality.

[2] Some possibly relevant sources, not all of which aim at a strong NbS approach since they may regard the payment as the main social benefit, could include: Akers and Yasue (2019); Jiang et al. (2019); Kariuki et al. (2018); Wang et al. (2017); Wells et al. (2017); White and Hanley (2016); Narloch et al. (2017); McDermott and Ituarte-Lima (2016); Prager et al. (2016); Robinson et al. (2016); Deng et al. (2016); Addison and Greiner (2016)

[3] https://www.telegraph.co.uk/business/how-to-be-green/nature-and-climate-change/?WT.mc_id=tmg_share_tw

3 For further consideration: challenges and opportunities arising that are GEF-relevant

A few points that are relevant to GEF (and other funders) can be made from this short and very incomplete review:

1. GEF STAP could provide some guidelines for interventions involving NbS to maximise the chances of them being in the upper right quadrant of (a possibly elaborated) Figure 2, both at the design stage and for GEF screening. At the least, proponents could be required to explain how 'strong' a form of NbS they are aiming for, whether nature AND social benefits are really demonstrated, whether nature benefits are really at GEB scale, whether both lots of benefits are credibly durable in the face of long term trends like climate, and not subject to leakage.
2. GEF could seek some more work on creating a useful functional typology of NbS contexts, problems, and responses that may also inform (1).
3. GEF could develop a concept equivalent to LDN that applies to all of its global environmental benefits, and apply it to NbS interventions, and promote discussion of it in the Conventions.
4. GEF could ensure that its projects contribute to a growing global database of quantifiable (even 'bankable') costs and benefits of NbS on both societal and nature dimensions, and explore the links between this evidence and new sources of finance
5. GEF could invest in further spatial planning and prioritisation of true integrated benefits to help target funding, developed to add to the analyses of Griscom et al. (2020); this implies the ability of GEF to take a programmatic approach.
6. A variety of aspects of NbS could be informed by social and behavioural sciences, looking at the deep leverage points for change, understanding the perceptions of winners and losers and how these change over time (cf. Giordano et al., 2020; Wamsler et al., 2020), and for overcoming institutional and governance norms (cf. Seddon et al., 2020) as these all link to transformation and scaling up and deep.

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