Making SEA Great Again with Artificial Intelligence[1]

Today, sustainability issues seem to suffer from other global priorities that compete for attention. In that context it also may become more difficult to make Strategic Environmental Assessment matter as a tool for sustainable development planning. In this paper I review how Artificial Intelligence could make SEA strong again. In theory, AI might help humans to deal with the complexity of their development challenges. However, even if that is true, practice could be different than theory. To discover how AI might make SEA stronger, we must first understand what is needed for SEA to deal with complexity in the first place. I summarise the literature on SEA and complex decision-making to that end, deriving how AI could be useful in view of SEA's goals.

Introduction and Method

In this theoretical paper – which is grounded in practice (e.g., Nooteboom 2024b) – I ask how AI can contribute to more effective SEA. A strong SEA is by definition an SEA that creates an effective mechanism to achieve its goal. Therefore I first review literature on SEA's goal, and then I analyse the theoretical expectations of the working mechanism of SEA to reach that goal. I put that in the context of the high complexity of that goal: sustainable development. Theories on social complexity urge to revisit the idea of the working mechanism: what needs to be achieved to make SEA's mechanism stronger if it is to contribute effectively to such a complex goal.

A lot can be learned from theories on cocreation in complex social systems: first SEA must leverage collaboration between SEA practitioners and other practitioners of policymaking, second these practitioners must do this in small groups, and upscale their process to large groups. And third, practitioners must stretch their collaboration by inviting constructive new members, even if these have different interests. These three conditions can only be the work of humans, and AI will only be constructive to SEA's goals if it contributes to these conditions.

Results

A stronger SEA is an SEA that reaches its goal more effectively

The United Nation's SEA protocol defines its goal as 'to provide a high level of protection of the environment (.) to further sustainable development' (UNECE 2003). This brings us right into complexity: sustainable development is much more than only environmental protection. To know which level of environmental protection fits a development that is 'sustainable' in general, extremely complex analysis is needed to 'know' if some plan or programme 'furthers sustainable development'.

Understandably, instead of obliging to make an analysis demonstrating which development is sustainable, the SEA protocol weakens its goal by making it instrumental: 'by ensuring that environmental (..) considerations are (.) taken into account in the development of plans and programmes'. That goal is easier to achieve than sustainable development itself. The protocol doesn't prescribe how this should be done other than by establishing procedures that provide for public participation and that leave the development decision to the authorities competent for planning development.

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The SEA protocol creates a procedural justice: whatever plan or programme is adopted following an SEA procedure is considered to 'further' sustainability enough, despite remaining adverse impacts. One might therefore conclude that simply following such a procedure will ensure that SEA achieves its goals and therefore will make it strong. However, this procedure still leaves room for powerful authorities to ignore many sustainable development issues that have become transparent to the public: many interests and values are not protected by any legally enforceable norms. Complexity forecloses enforcing legal norms for everything. Standardizing all aspects of sustainable development no doubt would make almost all development proposals illegal, as each proposal has adverse impacts on something.

The assumption behind the SEA protocol is no doubt that the public can hold powerful authorities accountable before plans and programmes are adopted and implemented: an incentive for that government to think twice. 'Thinking twice' can be considered in the interest of all as we will see further on when I refer to Daniel Kahneman (2011).

However, this only can work if public opinion has an influence on the powerful interests and values that drive the development of plans and programmes. All governance systems have some historically explainable bias (Biesbroek 2021; Flyvbjerg 2021). The public that is informed by an SEA procedure probably will require the planners to take all interests and values into consideration, not only weaker ones like environmental protection. However, the stronger interests don't need so much a procedure to be protected. The weaker interests may include health, gender equity, 'just transition': anything that is too weak to defend itself against the bias of strong interests pushing for projects, plans and programmes. The public may find it less efficient if the government creates parallel procedures next to SEA for different impacts of the same proposal that matter to the public.

This is the complexity which the UN protocol captures by adding that SEA should 'further sustainable development'. An SEA procedure therefore requires developing authorities to analyse the coherence of proposals with anything the public finds important, some of which is standardized as norms, but much of it is not. However, where there are no norms there can still be a policy goal linked to affected weaker interests and values. Such goals can be set by anyone. The SEA protocol reads 'to ensure that environmental (..) considerations are (.) taken into account'. SEA should therefore stimulate planners to make their plan or programme coherent with as many such goals as they can, whilst political choices also remain unavoidable: you can't have your cake and eat it. Politicians may look for narratives that may seem their policies to be coherent). A government in particular can be held politically accountable if SEA shows that one policy (as embodied in a proposed plan or programme) undermines another policy, which makes them incoherent. It is 'explain or comply'.

Not all definitions of SEA attach it with precisely the same goal and working mechanism as the UN's protocol (see Wikipedia for an overview). Writing about 'stronger SEA', it is important to first determine what is SEA and what isn't. Some authors emphasise more the important role of independent scientific knowledge ('rigour', 'evidence-based') or the linkage between assessments and decision-frameworks: without any formal strategic decision or formally competent authority the law can trigger no SEA procedure in the first place. On the other hand, not all scientific activities that need to contribute to SEA are themselves part of the SEA procedure, and planning decisions that an SEA influences are themselves not SEAs. The literature on SEA covers more than the SEA procedure as such, and therefore it overlaps with other literatures, and SEA practices are influenced by wider practices of governance (Monteiro et al. 2018).

Practitioners of SEA therefore (as we shall see hereafter) also need to be practitioners of cocreation of policies– whilst cocreation can exist without SEA. Practitioners of SEA also need to be practitioners of applied policy analysis (and biology, sociology and other disciplines), which also are sciences outside 'the world of SEA'. Because cocreation and policy analysis are

widely applied without any SEA procedure, it is plausible that they also can be 'strong' without any SEA. Therefore, the strength of SEA has to be evaluated as the strength of the *procedure* only, against a backdrop of cocreation and policy analysis that more or less also may exist without SEA. One question becomes: can a strong SEA make cocreation stronger?

Strong SEA leverages complex synergies

The coherency challenge requires a joint search for coherent and even synergetic development solutions between the responsible authorities and their stakeholders. Such complex collaboration is the subject of a strand of literature on policy coherence, most recently focused on coherence of policies (and plans, programmes) with the UN's sustainable development goals. Strikingly, this literature rarely mentions SEA as a tool for policy coherence (e.g., NCEA 2024).

So, where - in this reasoning - as much policy coherence as possible becomes the *substantial* goal of SEA, its *process* goal is to stimulate planners, by the transparency its *procedure* creates, to look for more coherency. When politicians are forced to choose development options with adverse impacts, they then have arguments to justify their choice. The procedure creates legal checks-and-balances, a power to delay decisions if the procedure is not followed, and these checks and balances stimulate collaboration to discover planning options that are coherent with more goals (Nooteboom 2019).

The most coherency will be achievable if the goals and actions of different authorities are synergetic rather than at odds or neutral. Discovering synergies where at first policies were at odds requires intensive collaboration between many experts working on behalf of many authorities who might be able to take synergetic action.

For anything to make SEA stronger, it would have to facilitate complex collaboration to discover synergies between the actions of different authorities and - for that matter - private actors and civil society. These authorities together would then be able to justify the plans and programmes they propose for adoption in the perception of these private and civil society actors. That might be enough for a majority.

The complexity is overwhelming

The complexity of any full justification of strategic development choices, let alone finding the most coherent sets of policies, however, is overwhelming. SEA to contribute to sustainable development cannot just be about mitigation of the side effects of the existing economy. Global challenges like the energy transition or protection of biodiversity show clearly: we also need to *transform* our economies and our societies (e.g., Pörtner et al. 2023). Strong SEA must show governments how they could transform societies. But such transformations need uncountable decisions by many public authorities and private and civil society actors. Not all these decisions can be subject to an SEA procedure, nor can one SEA procedure deal with all these decisions as each decision would have to trigger its own individual SEA procedure.

One SEA procedure therefore most probably cannot leverage enough scale of collaboration to transform a societal system to sustainable development. But what one SEA can do is to ask decision-makers to voluntarily join up in teams or coalitions to make joint decisions, based on a joint planning process and SEA. Such joined-up processes must be custom-designed and therefore they cannot be legally prescribed and must be voluntary. A convincing argument could be that a competent authority for a plan or programme can expect headwind if it ignores coherency issues out of its mandate, depending on collaboration.

For example, a weaker ministry can convince a stronger ministry that must undertake an SEA to work together for common goals. Practice has shown that weaker authorities sometimes can invite stronger authorities to engage in a voluntary SEA together, the procedure of which they

agree on and publish to create expectations in the public that create obligations to a similar effect as a legal procedure (e.g., in Senegal (Nooteboom 2024a)). If that works, SEA will have leveraged a stretch of collaboration. This may even be possible if interests and values at first sight are not aligned at all (Kahane 2025). It will become possible to discover synergetic actions which otherwise would be out of the scope of the plan or programme to be adopted, and the government will have gained more leverage on sustainable transformations of the economy. 'Stretch collaboration' occurs if mutually dependent actors make their collaboration more inclusive than they normally do. It makes collaboration more complicated, and if successful it makes the quality of the policies higher by increasing synergies. There is no need that different authorities make joint plans and programmes that each may trigger their own mandatory SEA if they justify their plans and programmes by referring to coherence and synergies with other decisions by someone else. That formal justification can be based on an SEA.

There is a science of organizing and moderating such collaboration, in particular theories on the governance of complex systems (the social complexity theories; see e.g., Wielinga, E. and Robijn, S. (2020) for a practical summary). This literature uses terms like joint fact finding and cocreation (e.g., Ansell et al 2022). It is not limited to the context of SEA, and most of this literature doesn't mention SEA as a possible lever for cocreation. But only the result counts: if SEA procedures leverage 'stretch cocreation' to achieve more coherency, it can make SEA stronger.

'Strong SEA' revisited

From the above point of view, a complexity definition of 'strong SEA' may be: 'an SEA that convinces planners to work in more inclusive (stretched) actor networks where each collaborating actor trusts that all actors reason from shared long-term objectives which may require extremely uncertain societal transformations.' No procedure, and certainly no SEA procedure, can *force* strong interests to protect weak interests. Powerful authorities will always find a way if they need to justify their decision if they don't collaborate.

Unless authorities with power are altruistic, 'power' will only care for the 'truth' if it sees some benefit for itself. In other cases, the truth may just be inconvenient to them. In repressive conditions it may even become dangerous to speak the truth (Foucault 2008). In such conditions there is only one countermeasure SEA can take: be harmless. (The metaphor of a Trojan horse is not the best, because a Trojan horse seems harmless but in reality it isn't.) And at the same time: those who implement the SEA procedure should improve their capacity of efficiently working together with others for common goals so that the truth becomes less inconvenient – and here it may benefit from prudent use of AI as we shall see later. According to Homer, the Trojans were seduced by the beauty of the wooden horse the Athenians built for them. Other than beating the Trojans, for SEA, once inside, the biggest question is how to make collaboration for sustainable transformations emerge, and how to make it efficient.

The paradox is of course that if the law forces an authority to undertake an SEA, it may not consider that procedure to be harmless in view of efficiently reaching its own objectives. Practice suggests that authorities who voluntarily undertake an SEA procedure have more sense of ownership and these SEAs leverage more cocreation (Nooteboom 2024b). Such authority announces publicly but without legal obligation that it is planning to make decisions how to deal with certain issues, following steps that make it SEA.

Social complexity theory offers some guidance to this end. First, by making a difference between levels of complexity that SEA can deal with in different ways. Second, by scaling the process of cocreation up from small groups of planners to large groups in the public. And third, by analyzing the public – private – civil governance system to find weak links where investing in stretch collaboration would make the whole governance system more capable of transforming to sustainable development.

These three kinds of guidance are each elaborated hereafter.

SEA: levering cocreation that can deal with extreme complexity

Accepting that to make SEA stronger it should leverage more voluntary collaboration, it helps to be aware of the different degrees of complexity that exist alongside each other in our societal systems. Since societal transformations are extremely complex and once they take off can be highly dynamic, even stretched collaboration will fall short, and there is extreme uncertainty. So, how can SEA be strongest in helping to deal with that uncertainty?

Societies that are not sustainable and therefore must transform to a new order are said to be 'at the edge of chaos' (e.g., McKelvey 1999): a social system like a society may be able to transform into a new more sustainable order, but this is so complex, touching so many authorities and other influential and less influential actors, that nobody can implement an overall plan. All actors doing what they do leads to an unpredictable cumulative result. Individuals choose actions based on knowledge of the past, not knowledge of how the transformation will unfold.

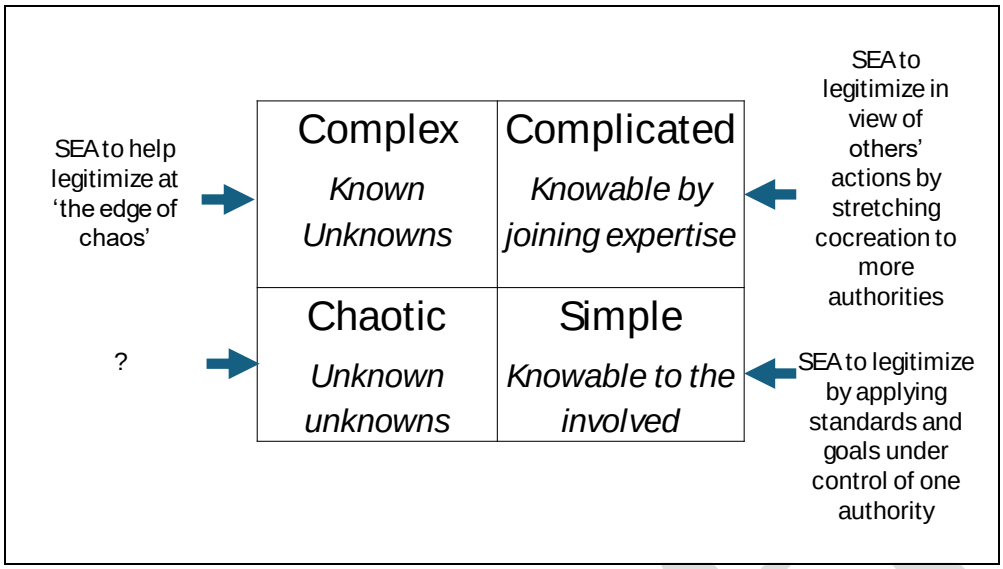
Societal reality is so dynamic that policymakers have to navigate in the fog, as Dutch prime minister Rutte said in his address to the public when the COVID pandemic reached the Netherlands (Rutte 2021). As the transformation unfolds and a new order chaotically develops, some of the old order remains and some of the old order is either replaced by new order or by chaos. If the metaphorical ship comes closer to any obstacles that suddenly become visible, its captain can navigate around them before she or he resumes course to anything that she hopes will be a new sustainable order. The same goes for any emerging rapids (synergies) the ship can benefit from.

Taking the metaphor back, such a captain can be an authority having the power to make decisions that influence societal development. But there are many such authorities all making their own decisions in the fog, each having to survive themselves in the short term – not hitting a rock - before surviving in the long term by saving the society they depend on. There is almost no time to think. There is certainly no time to make an SEA for each urgent decision. There will be some intuition and improvisation involved, but also a general sense of direction, based on available analysis that could easily be outdated. SEAs from the past can be part of that analysis, and these can be updated each time new knowledge emerges on the unfolding transition: each time an obstacle or an opportunity becomes visible.

As fast decisions are necessary, there is no SEA possible for each change of plan, as that requires detailed study, consultations and legal terms. The authority, supposing she or he depends on a mandate from the public, must explain these decisions, and be honest about the fog, like Mark Rutte did when COVID broke out and he felt forced to announce a national lock-down despite extreme uncertainty (the 'fog'). However, this is not only necessary for such drastic interventions in society. All the time decisions must be made that will affect members of the public who may not understand why this is necessary. It may be better to see this coming so that the public has time to learn to understand reality, the need for certain decisions that could be needed in the future, how this is fair to them, or how this is unfair if authorities see no other way to prevent a chaos that would make it worse for all.

What Rutte did was justification of public actions at the edge of order and chaos, two quadrants well-known framework in Figure 1 (based on Snowden and Boone 2007).

Figure 1. Dealing with extreme uncertainty



If a societal system needs to transform, and it doesn't transform in time, it will end up in chaos. That could ultimately be war. If a societal system transforms in time, the new order is not necessarily 'just': it could be an orderly but repressive system. But it could also be a system that generates outcomes that will be experienced as just by more people. To that end, it should balance the powers so that fewer actors can suppress another actor, and it has to reward trust building and cocreation. Those concerned with just transitions should therefore design such systems and wait for opportunities for politicians to implement these designs 'at the edge of chaos' (cf., 'windows of opportunity' (Kingdon 1984)).

Preparing for what may come, action is taken and societies start to change – first in thinking and then their economy. Then, all four quadrants of Figure 1 exist simultaneously alongside each other. However, the people in the system, citizens, only can see and understand a small part of what is happening. The tragedy is therefore that policymakers who try to make honest analysis (the 'truth') matter for decision-making need to be understood by their constituents and other stakeholders: they are forced to simplify to explain themselves to the public. Mark Rutte's press conference mentioned above is an example. Simplification led in the view of many to a dominance of the goal of saving lives over other goals.

The **lower right quadrant** is the simplest: it is the world where everything can be put in a straightforward way and legalized with procedures, standards and measurable goals against which single authorities can be held to account. If these authorities don't have the responsibility or the power to achieve goals, they have an excuse, as long as they conform with the law. If their actions are synergetic with those of other authorities, they can use that as an additional argument to justify their actions. Whereas these simple problems are standard part of SEA, Flyvbjerg (2025), an expert in development programming, asserts that creation of solutions for simple problems will not significantly benefit from AI. In his view, experts will mostly be better capable of doing that in the 'old' way.

However, in order to avoid incoherencies and to discover synergies between their actions, as we have seen above, authorities undertaking SEA may stretch their collaboration with other authorities as far as needed, and if incoherency is unavoidable, share their dilemmas with the public. This is the **upper right quadrant**, the world of experts who combine their knowledge to find common ground and synergetic actions. They need to invest time in getting to understand each other and to trust that others are willing to collaborate – rather than to create chaos and new repressive order. It would be in the spirit of SEA if these experts scale-up their cocreation to have frequent inputs from the affected public. However, such cocreation unfortunately

quickly may become too complicated for the large public to understand, let alone for it to follow the process and give their inputs step-by-step (see hereafter on upscaling). A challenge of the cocreating experts is thus to stay within the mandate they received from their hierarchy and also simplify just enough to make it widely understandable.

Whereas complicated cocreation can be stimulated (not obliged) by SEA, AI may be supposed to serve this cocreation only if the collaborating actors jointly look for facts and that AI can produce on coherencies and synergies, and all have faith that this AI does not leave out any promising options or any important impacts. Flyvbjerg (2025) in any case does not have that faith with the current AI, much like the Economist (2025) believes that AI will predominantly make the powerful more powerful.

However, no cocreation, however complicated, can be stretched so far that it spans the whole complexity of societal transformations. Even if the governance system succeeds in creating synergies in complicated issues, many impacts and alternatives will be overlooked while development goes on everywhere in the societal system. This uncertainty remains in the **upper left quadrant**. This is where authorities must make fast decisions as new order and chaos emerge 'at the edge of chaos'. If any kind of AI in the future might be able to calculate all these risks and opportunities and proposes actions supposed to be in the general interest (think of 'just transitions'), that AI will have taken over governance from the human governance system. If AI proposes actions that some stakeholders don't like and don't understand, will they put their faith in AI? Quite unlikely given the amount of warnings given against biased AI and AI becoming self—aware, developing its own value system drifting away from what human society as a whole may value. Flyvbjerg (2025) asserts that nowhere near in the future we can expect an AI that even has a way to figure out what is true or false as an intrinsic quality rather than as an extrapolation of what others have defined to be true in the past (and which may be biased).

The **lower left quadrant** is chaos: the unknown unknowns that may in no way be predictable based on what is known from the past. Not everything is chaos: some things remain easily predictable, other things can be predictable if we combine enough of our knowledge fast enough. If the scale of societal transformations becomes larger and tipping points are achieved faster, less is knowable and more is chaos. All that can be said about SEA here, is that if SEA prepares us for as many possible futures as we can imagine, it might enable us to make better decisions at the edge of chaos.

There is another way to look at this: Daniel Kahneman (2011), in his seminal work Thinking fast and slow, asserts that there are two systems in the brain making decisions: 'system 1' (thinking fast) and 'system 2' (thinking slow). At a level of a collective 'brain' SEA contributes to thinking slow, which may create an intuition that helps to think fast better prepared when needed. However, looking through the fog at the edge of chaos, previous slow thinking may not always be helpful. Situations can be unprecedented and unimagined. Also, collective brains, like Kahneman shows for individual brains, can be biased in many ways. This reasoning suggests that, whenever we have the chance, it is important to activate system 2 by doing something like an SEA: that can also help system 1 to make unforeseen future decisions. But it does not prepare for everything that might happen.

The SEA procedure may help to efficiently justify decisions on simple and complicated problems, until collaboration stretches more than the human actors can handle (trust being a limit). For the moment it seems unlikely that with the help of AI this can be stretched further: that would require joint trust in AI, whilst trust in cocreation is something that must slowly grow between humans. An AI cannot miraculously create trust overnight. If AI is unbiased, its 'truth' may be inconvenient to decision-makers who then may prefer not to trust it. If AI is biased, it may put experts and the public on the wrong foot.

Upscaling dialogues in small groups closer to chaos to large groups farther from chaos

According to Figure 1, decisions may be legitimized at different levels of complexity at the same time. These are, at increasing distance to chaos: complex, complicated and simple justifications, which may benefit from any SEA done. While these levels represent social processes that all unfold simultaneously, they can influence each other in a coevolution. This coevolution can be deliberately organised, in Kahneman's (2011) terms not only to be guided by fast thinking, but also by slow thinking.

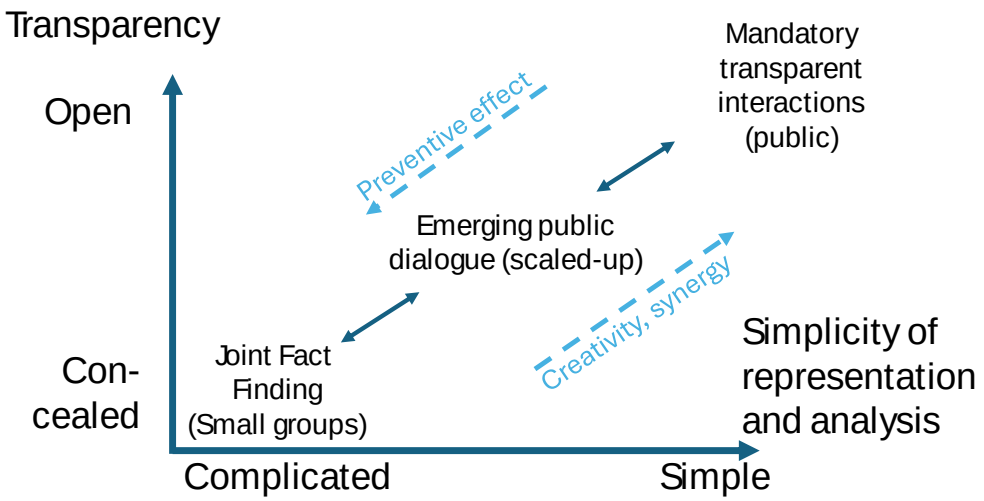
Figure 2 tries to capture the coevolution between cocreation in small groups and forms of dialogue and learning in large groups. The horizontal axis is diminishing distance from chaos (from complicated to simple), and the vertical axis shows degrees of transparency of that process (from concealed to open). **Lower left** are small cocreating groups of experts each of whom represent an authority that can act. To find common ground in complicated issues, experts must understand and trust each other at a personal level ('joint fact finding') before they can be inspired to propose their hierarchy to change their actions with a view to discovered potential synergy. Trust can emerge only in closed settings hidden from the press, and they first must make sense of the complicatedness themselves before they can share their thoughts with others.

Hierarchies of these collaborating experts need support from their constituents, customers, voters, or members. To that end, the small scale dialogue must be upscaled to larger groups, and it at the same time becomes more transparent and less complicated: complicated messages are difficult to communicate in large groups. Simplification is unavoidable. This is **upper right**. Here the questions the collaborating experts ask to large groups are richer, better thought through and more creative than if there had been no small-group cocreation.

SEA can accelerate this coevolution between lower left and upper right because it mandates transparent interactions upper right (publication of draft assessment, formal justification of planning decision). Mandatory transparency means simplification, which automatically puts it in the upper right corner. Authorities, knowing they will have something to explain or otherwise be confronted with more opposition and delay, have an incentive to have their experts sit together in a cocreation before they communicate. This is a preventive effect. It should be noted that in most countries SEA is not the only procedure that creates checks-and-balances with that same preventive effect: any kind of mandatory transparency can have that effect.

This coevolution can be accelerated by organizing non-mandatory interactions with medium-sized groups in the middle of Figure 2. Participants are political spokespersons or members of the public who engage in dialogue with experts and with each other, fed by the ideas coming from lower left. This dialogue can be deliberately made transparent to large groups (on television, for example) to collectively better understand development dilemmas.

Figure 2. Co-evolving dialogues at the edge of chaos



If such dialogue is supported by AI, again, large groups must *trust* that AI, and AI should correct the collective psychological biases Kahneman (2011) describes.

Where to stretch collaboration first?

As societal transformations are so complex – often whole global value chains must transform – the human system that governances such societal systems is also complex. In the upper right corner of Figure 1 not everyone in that system can collaborate with everyone else – even if only for practical reasons. So, where should someone who is undertaking an SEA – or looking for policy coherence for other reasons - stretch collaboration first? The NCEA (2024) proposes a generalised structure of governance systems to help find its weakest links. It defines a governance system as the whole of actors who jointly – not individually - can change a societal system. As a chain is as strong as its weakest link, this is where stretched collaboration would pay off first. But if that is an overstretch perhaps other bridges may be better built first. This approach can help policymakers who want to legitimise their action by showing how they contribute to sustainable transformations. NCEA (2025) has applied this method to the global value chains of critical transition minerals, asking professionals from production countries how their national governance systems deal with complex challenges. Most of these professionals identify as weakest link the collaboration between ministries that is necessary to serve many interests at the same time, including building an interface with society by multi-stakeholder frameworks. So, this is then where collaboration may need stretching first. It is an open question if AI would be capable to make that call better than humans themselves.

Discussion

AI may help to address relatively simple problems of SEA, but it may be tempting to also use AI to replace human thinking if problems increasingly depend on voluntary cocreation. That is a leap of faith. It seems more helpful to make SEA stronger primarily by making it count for cocreation of synergetic actions as such, whether these are called policies, plans, programmes or projects. The challenge is to stretch collaboration to strengthen weak links in the governance systems that must transform for sustainable development (which is SEA's goal). To upscale the cocreation to large groups, simplifying development dilemmas in a constructive, less polarising way. These are all human processes that can still be strengthened in terms of trust and collaboration, increasing the complicatedness we can handle together, before we might run out

of options as complexity rises above our head and we may only have the oracle AI to fall back to – if we trust it.

The emphasis of the UN SEA protocol on environmental protection may reflect that 'environment' is associated with anything other than the developers' own objective. It may also reflect that this kind of legislation is 'owned' by environmental authorities who are not supposed to trespass the responsibilities of authorities in other siloes. Fact remains that opening up planning to the public means SEA can be about any impact the public finds relevant. It might be considered to redefine SEA to remove the emphasis on 'environment'. The other goal, 'furthering sustainable development' seems appropriate as that concerns all relevant public interests and values in the long term, which are easily forgotten if authorities only think fast and not slow, in Kahneman's (2011) words. In that case, SEA could be renamed to Strategic Impact Assessment (SIA). Its main challenge would still remain to convince development authorities to share their strategy development with the public in the first place, and to do that together.

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