Integration: to solve complex environmental problems

A STAP document

June 2018

STAP
SCIENTIFIC AND TECHNICAL ADVISORY PANEL
An independent group of scientists that advises the Global Environment Facility

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ABOUT STAP

The Scientific and Technical Advisory Panel (STAP) comprises seven expert advisors supported by a Secretariat, who are together responsible for connecting the Global Environment Facility to the most up to date, authoritative and globally representative science. http://www.stapgef.org

ABOUT GEF

The Global Environment Facility (GEF) was established on the eve of the 1992 Rio Earth Summit, to help tackle our planet's most pressing environmental problems. Since then, the GEF has provided $14.5 billion in grants and mobilized $75.4 billion in additional financing for almost 4,000 projects. The GEF has become an international partnership of 183 countries, international institutions, civil society organizations, and the private sector to address global environmental issues. http://www.thegef.org

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CONTENTS

SUMMARY

Science indicates that several planetary boundaries have already been breached, including genetic biodiversity, biochemical (nitrogen and phosphorus) flow, land-system change and climate change. Large scale, transformational change is needed to deal with these problems, and without a stable and healthy Earth system the Sustainable Development Goals will not be achieved.

In the World Economic Forum's Global Risks Report 2018, 6 of the 10 greatest risks, in terms of likelihood and impact, are environment-related. Food and water crises are both intertwined with the environment, and also in the top 10 risks. A deteriorating global environment poses significant threats to environmentally sustainable development.

Environmental challenges are complex and interlinked, not only in themselves but also with social and economic issues. Better human well-being, for example, poverty reduction, improved human health, energy access and economic growth, are linked to ecological factors. Solutions for one problem can lead to unintended negative consequences, or create new environmental or socio-economic problems. For example, increasing food production in ways that deplete soils, waste water, kill pollinators and increase desertification and deforestation, would eventually prove self-limiting.

Addressing these interconnected and interacting environmental and social challenges requires systems thinking; this is fundamental to better integration. Systems thinking examines the relationships between the different parts of a system, for example, the food supply system, or a commodity supply chain, especially cause and effect relationships, and positive or negative feedback mechanisms, between the biophysical and socio-economic features of the system. Systems thinking also considers the interactions between components of a system across different locations and organizational levels, as well as over time. Many of these relationships are non-linear. Understanding the connections between variables helps to identify points for effective intervention.

Since its inception in 1992, the GEF has recognized that environmental benefits and socio-economic development objectives can be achieved simultaneously. Integration was built into the design of the GEF: it is specifically tasked with integrating global environmental concerns with national objectives in the framework of national sustainable development strategies.

The GEF has made considerable progress in successfully designing and implementing integrated projects: in biodiversity, international waters, land degradation, and in multi-focal area projects. In 2014, the GEF further cemented its efforts on integration with the three Integrated Approach Pilot programs on food security, commodity supply chains, and sustainable cities, conceived in response to the GEF's 2020 Vision.

The Independent Evaluation Office's OPS6 report, "The GEF in the Changing Environmental Finance Landscape", recommended a continued focus on integration: "The GEF should continue pursuing an integrative principle in its programming based on scientific and technical merits. A strong, cogent rationale for designing integrated programs and multi-focal area projects – based on demonstrated additionality, GEF experience, GEF comparative advantage, innovative contributions, environmental need, and national relevance – must be the basis for such interventions."

Balancing complexity and efficiency as the GEF seeks transformational change and lasting outcomes remains a challenge. Nevertheless, STAP encourages the GEF to continue pursuing integrative projects based on systems thinking. These actions will lead to more efficient and effective approaches to planning, monitoring and implementing projects addressing complex human-environment interactions.

To improve integration further in the design of future GEF projects, STAP recommends:

1. **Apply systems thinking:** i.e. address inter-connected environmental, social, economic, and governance challenges across sectors with an eye towards resilience and transformational change.

2. Develop a **clear rationale and theory of change** to tackle the drivers of environmental degradation through assessing assumptions and outlining causal pathways – and have a 'Plan B', should desired outcomes not materialize.

3. Assess the potential **risks and vulnerabilities** of the key components of the system, to measure its resilience to expected and unexpected shocks and changes, and the need for incremental adaptation or more fundamental transformational change.

4. Devise a logical sequence of interventions, which is responsive to changing circumstances and new learning (**adaptive implementation pathways**). Develop clear indicators that will be monitored to determine progress and success in achieving lasting outcomes.

5. Develop explicit plans and funding for **good quality knowledge management** including: sustainable databases; simple, useful and usable common indicators; face-to-face consultations; and building stakeholder capacity. This is essential for 'lessons learned', and scaling up.

6. Apply **exemplary stakeholder engagement**, including with local communities, not just government officials, from inception and design, through to project completion. This is crucial for identifying diverse needs and managing trade-offs.

7. **Allow flexibility in project preparation** to accommodate the additional transactions costs and time required to tackle complex issues through multi-agency teams.

Transformational change necessarily entails risk. Risk and transformational change are intertwined, and lie at the core of building the GEF's capacity to respond to change and making it resilient. The GEF can strengthen its organizational capacity to deal with change, and to deal with uncertainty through experimentation and innovation. The GEF could also encourage a greater diversity in the risk profile of projects.

The GEF is uniquely placed to lead the way in applying and strengthening evidence on the science of integration and systems thinking to deliver global economic, social and environmental benefits.

1. WHAT IS THE ISSUE?

"When you are living in a globalized economy and a globalized world, you cannot live in isolation; all the problems and solutions are interconnected…" Kailash Satyarthi, Nobel Peace Prize winner

"When we try to pick out anything by itself, we find it hitched to everything else in the Universe." John Muir

The ecosystems, biomes and processes that regulate the stability and resilience of the Earth system are under severe pressure[1]. Science indicates that several planetary boundaries have already been breached, including genetic biodiversity, biochemical (nitrogen and phosphorus) flow, land-system change and climate change[2,3]. At its quadrennial replenishment in 2018, it is timely for the GEF to reflect on how our understanding of tackling environmental problems has shifted, and what factors make for successful outcomes. Large scale, transformational change is needed to deal with these problems, and without a stable and healthy Earth system humanity will not achieve the Sustainable Development Goals (SDGs)[4].

In the World Economic Forum's *Global Risks Report 2018* [5], six of the ten greatest risks, in terms of likelihood and impact, are environment-related[6]. There is increasing recognition that a deteriorating global environment poses significant threats to future economic growth and development. Standard risk management approaches will not be sufficient to address the complex societal, environmental, and economic systems and their interactions, that characterize nations across the world[7].

The notion that environmental problems can be dealt with in individual silos is long gone. Reducing the loss of biodiversity simply by establishing protected areas will not succeed, when much biodiversity is found in areas under production, both in agriculture and in the seas. Furthermore, as the climate changes, habitat fragmentation restricts species to smaller spaces, reduces genetic variability and stresses or dramatically alters ecosystems[8]. Protected areas are important – but are only part of the answer. Innovative ways are needed to integrate development and biodiversity protection. There is a risk of inadvertently making things worse, for example, by expanding agriculture in ways that deplete soils, waste water, kill pollinators and increase desertification and deforestation. Otherwise, efforts to increase food production will eventually prove to be self-limiting.

Biodiversity loss, pollution of land and water resources, land degradation, and poverty are interrelated problems that result from multiple interacting causes, and are further exacerbated by climate change and its impact on the environment and livelihoods. Some factors are synergistic, while others are antagonistic, leading to trade-offs[9]. Food, energy, and water are closely interrelated and need to be considered simultaneously, along with maintaining the biophysical resource base – the land, soil, hydrological and biological resources – to ensure the sustainable delivery of ecosystem services.

There are many important interconnections at different scales, and levels: across different driving factors; across socio-economic and environmental objectives; across environmental issues; across spatial scales; across different parts of systems; and across stakeholder groups[10]. Greater understanding of these connections is required to address environmental and development objectives simultaneously, including the SDGs[11].

2. WHAT DOES THE SCIENCE SAY?

a. The need for integration

Environmental challenges are complex and interlinked, not only in themselves but also with social and economic issues. Solutions for one environmental problem, for example climate change, can, and often do, lead to unintended negative consequences, or create new environmental or socio-economic problems[12]. For example, establishing monoculture plantations to sequester carbon could diminish biological diversity and downstream water availability, and affect diets and nutrition[13]. On the other hand, it is possible to find synergistic solutions that can help solve two or more environmental challenges. For example, mitigating climate pollutants such as black carbon[14], methane, and tropospheric ozone will help mitigate climate change while also improving human health, increasing agricultural productivity (providing greater food security), and creating economic benefits[15]. Furthermore, all social-economic goals and targets aimed at improving human well-being, for example poverty reduction, improved human health, energy access and economic growth, are linked to ecological factors, and require a functioning planetary life support system[16]. Addressing these interconnected and interacting environmental and social challenges requires systems thinking[17]. See Box 1.

The Global Risks Report, 2018, argues that "…humans have become skilled at addressing conventional risks – risks that can be easily identified and managed through standard risk management approaches. As the world becomes increasingly integrated and is faced with a rapid evolving landscape, new challenges are arising when dealing with complex risks in systems. These risks are usually defined by feedback loops, tipping points and unclear cause-effect relationships[18]." Systems thinking encourages consideration of a system's capacity, its knock-on effects on other systems, and whether incremental or transformational change is needed to mitigate risks[19].

A lack of integration is a major detriment to achieving sustainability[20]. For example, a review[21] of progress in achieving global environmental goals, including those Multilateral Environmental Agreements (MEAs) supported by the GEF, underscored fragmentation as a major cause of slow progress. The review emphasized the need for integration: between types of problems and identified solutions; between the responsibilities and resources available to implementing institutions; and in governance and institutional structures. An earlier study on the success of global environmental governance attributes the lack of improvement in the overall state of the environment, despite significant efforts, partly to the lack of integration in global environmental objectives[22]. This assertion is supported by a UN Environment analysis[23] that highlights several factors responsible for failure to achieve the Millennium Development Goal on environmental sustainability, including:

- neglect of the interconnectedness between environmental objectives and their social and economic aspects;
- not targeting the root causes of problems; and
- lack of coordination between design, implementation and monitoring.

Furthermore, several analyses of natural resources management and biodiversity conservation also show that the non-integration of ecological, socio-economic and cultural aspects is a major reason for their failure[24].

Integrated approaches can deliver multiple benefits by bringing together the objectives of different Multilateral Environmental Agreements (MEAs) in a more comprehensive approach to planning and management. This can enhance synergies while managing trade-offs at the local, sub-national, and national level, and in sectors, for example, by increasing food production without degrading land, increasing greenhouse gas emissions, or polluting water resources. Integrated approaches can also untangle complexity, so that root causes can be identified and managed through focused interventions, while also anticipating feedbacks and building whole-system resilience[25].

BOX 1.
Global risks interconnections map 2018

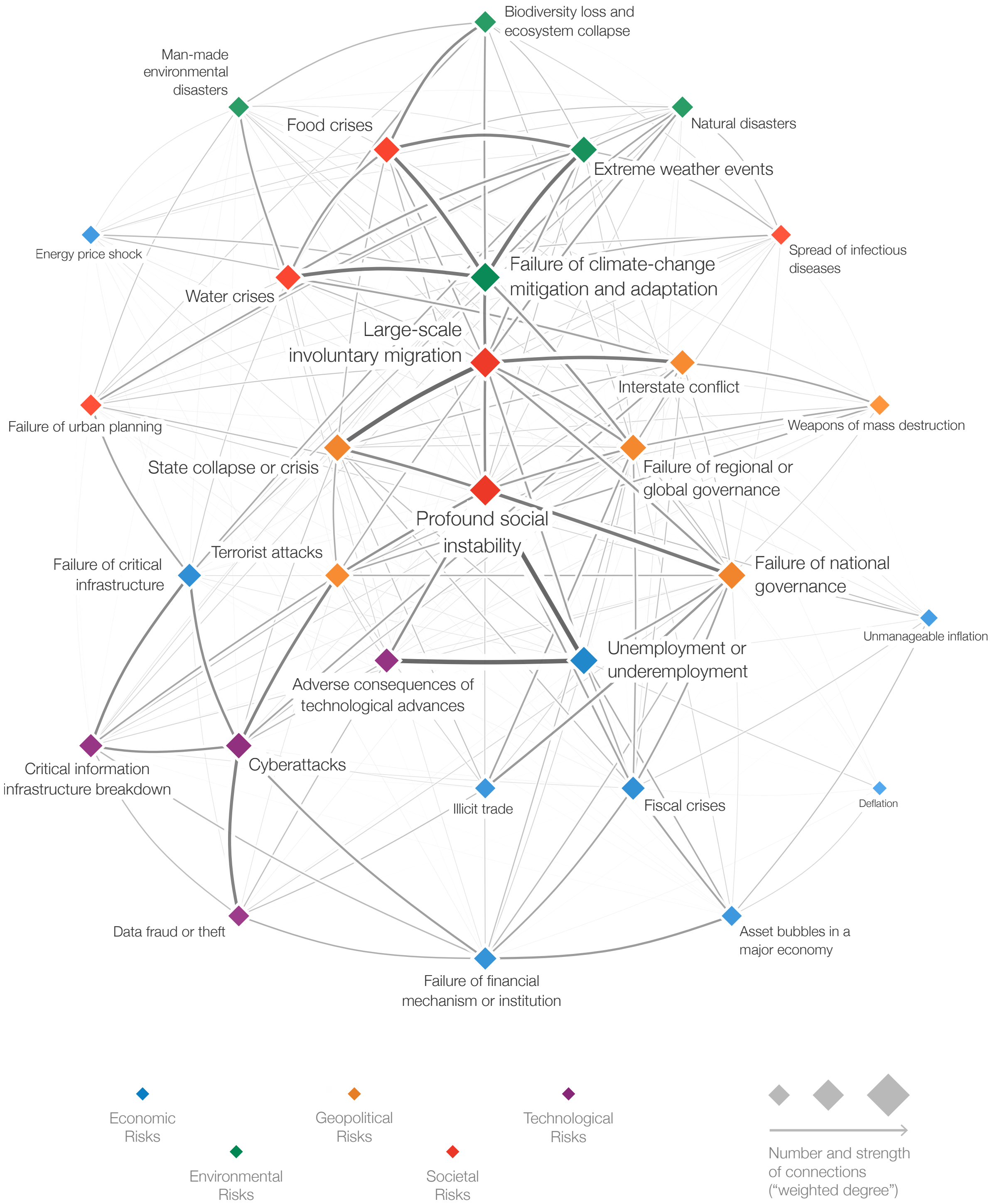


Figure 1. The Global Risks Interconnections Map shows the linkage and complexity of global challenges and associated risks. The top ten risks, in terms of their impact, feature several environmental risks: extreme weather events, natural disasters, failure of climate change mitigation and adaptation, biodiversity loss, and ecosystem collapse. Two further societal risks (food and water crises) are closely intertwined with the environment, and are also in the top ten. (Adapted from The Global Risks Report 2018, 13th Edition.)

Integrated approaches which use systems thinking have proved effective in solving problems with complex and varied interactions, for example[26]:

- problems that require stakeholders to grasp the "big picture", beyond their own role;
- problems that recur or have been exacerbated by previous interventions;
- problems where an action affects the surrounding environment; and
- problems without an obvious solution.

Table 1 provides further examples of benefits of system integration *(adapted from Liu et al., 2015)*

Benefits of system integration	Example
Understanding complexity	Agricultural intensification schemes are assumed to lead to the sparing of land for conservation. However, when other socio-economic factors (including the resulting improved yield, increased agricultural rents, greater consumption, as well as increased economic activities and diversification) were considered, intensification was shown to lead to further agricultural expansion and deforestation over the long term. This highlights how system integration can expose hidden interactions and complexities[27].
Understanding policymaking	Using an integrated assessment model, the cost of delayed climate change mitigation action was estimated, taking into account geophysical, technological, social, and political factors. Political choices were shown to have the largest effects, followed by geophysical and social factors. Availability of technological solutions had the least impact. This can help in thinking about the relative importance of each factor for informed policy-making[28].
Addressing multiple issues simultaneously	Systems integration can help in examining different technological and policy measures which yield multiple benefits simultaneously in the climate change-health-food security nexus, for example in climate change mitigation, reduced premature deaths, and improved agricultural productivity[29].
Assessing the feasibility of multiple and conflicting goals	Integrated coastal zone management allows for multi-organizational management for competing interests such as recreation, fisheries and biodiversity conservation[30].
Identifying complementary policies and management strategies	Analysis of the interaction between the global economy, energy security, health and the impacts of climate change (the air-climate-energy nexus), shows that integrating energy security policies with optimal climate and air pollution policies would decrease oil consumption compared to implementing energy policies alone[31].
Maximizing economic gains and minimizing environmental costs	Integrated soil-crop management systems can maximize grain yields, while minimizing applications of fertilizers and greenhouse gas emissions[32].

b. How to achieve integration

Systems thinking is fundamental to better integration. Systems thinking considers the relationship between the whole socio-ecological-economic system and its various components, as well as their interactions across space, time, and organizational levels. Many of these relationships are non-linear. Systems thinking applies understanding of connections between variables to identify effective intervention points[33].

The core concepts of systems thinking include[34, 35]:

- interconnectivity: the relationships between system elements across scales in social-ecological systems;

- feedback loops: the sequence of cause and effect that can amplify, or lessen, the effects of change;

- resilience: the ability of a system to absorb shocks and reorganize to retain the same functions, structure and feedbacks;

- adaptive capacity: the capacity of stakeholders to respond to shocks and stresses and manage resilience. Adaptive capacity involves continuous learning, adaptive management and use of knowledge to deal with change; and

- self-organization: is the ability of a system to self-organize after a shock and to transform to a new identity, based on learning, to deal with change.

STAP's work on the science of integration is informed, *inter alia*, by its work on "resilience thinking", presented in the Resilience, Adaptation Pathways and Transformation Assessment (RAPTA) framework[36]. Resilience thinking refers to the inter-related concepts of resilience, adaptation and transformation (see Annex 1).

STAP commissioned a study, Integrated Approaches to Natural Resource Management[37], which: reviewed systems thinking literature; reviewed 28 completed projects[38], and 10 in-depth case studies of integrated programs and projects; and analyzed key aspects of integration and assessed their implementation in GEF natural resource management projects in biodiversity, international waters, and land degradation.

The study concluded that integrated approaches need to be flexible and not become a 'straitjacket' or simply a 'check-list'. Attempts at embedding learning and adaptive management were included in all the projects studied, but slightly less than half of the projects did this adequately. All the projects included stakeholder consultation but few projects practiced 'coproduction of knowledge' where local stakeholders are engaged from start to finish. All projects took knowledge management into consideration, but there was not a clear indication that learning and adaptive knowledge management was taking place during project implementation.

Overall the projects showed some benefits from integration, but there is room for improvement. The study identified factors for successful integration including: articulation of a clear theory of change; a clear description of the system boundaries to enable a strong focus on the root causes of environmental degradation; support of innovation at the local level; better equipping projects to address learning, innovation and adaptive management; enhanced stakeholder interactions, communication and partnerships.

A second study, Integrated Approaches to Climate Change Mitigation and Chemicals and Waste Projects[39] reviewed complex adaptive systems literature to understand how this influenced transformational change. The study analysed 32 GEF climate change mitigation and chemicals and waste management projects. The findings suggest that projects which incorporate complex systems thinking are more successful in achieving their long-term goals and more likely to deliver social and economic benefits, including benefits across focal areas – and are ultimately more transformational.

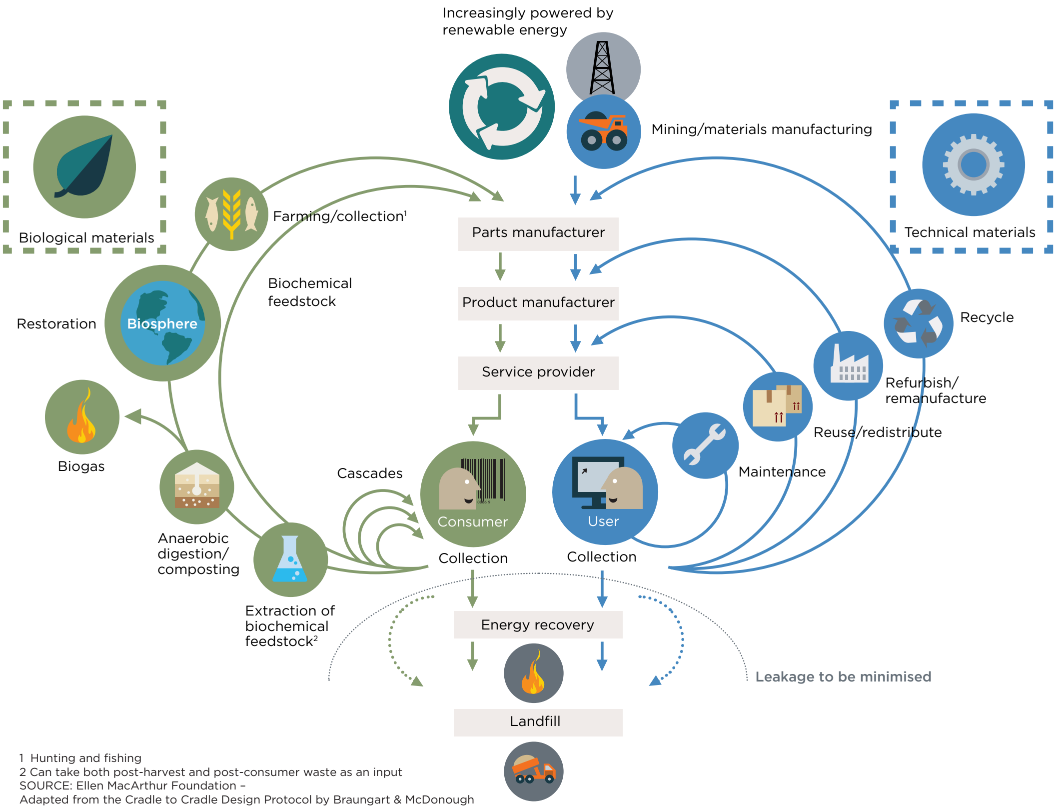
The paper identified some key elements of successful projects including: fostering conditions for behavioural change across domains and scales; demonstrating the comparative advantage of an innovation or new technology; ensuring sustainability by building on-going processes, and strengthening capacities to support the project's continuity after funding ends; and planning for further adoption by including mainstreaming, replication, and scaling-up in project design.

There are several frameworks that can be used to implement an integrated approach including, integrated landscape management, integrated natural resource management, integrated urban planning and management, integrated water resource management, integrated coastal zone management, life cycle assessment, the circular economy concept, and integrated supply chain analysis. Boxes 2, 3 and 4 provide examples of integrated frameworks.

BOX 2.
Integrated landscape management in China

A landscape approach addresses competing land uses by implementing policies and integrated management practices that ensure equitable and sustainable use of land[40]. It aims to integrate social and economic development with ecological issues including climate change, biodiversity conservation, and land restoration through coordination across various scales and spaces[41]. The approach can facilitate sustainable agriculture, contribute to climate change mitigation, promote afforestation and reforestation. This will reduce erosion and land degradation, protect water resources, reduce flood risks, provide potable water, and conserve biodiversity[42]. The achieved ecological improvements enhance livelihoods, health, security and resilience to climate variability and change[43]. The approach has been adopted in the implementation of several landscape restoration programs with reasonable successes. For example, the adoption of the landscape approach in the Loess Plateau of China led to perennial vegetation cover increasing from 17% to 34% across the plateau in 10 years. This diminished erosion and dust storms and reduced sediment flow into the Yellow River by 100 million tons a year. Adopting the landscape approach also increased employment, yielded a 62% growth in grain output, increased food security and nearly tripled household incomes[44, 45].

BOX 3.
The circular economy concept



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input
SOURCE: Ellen MacArthur Foundation –
Adapted from the Cradle to Cradle Design Protocol by Braungart & McDonough

The circular economy concept aims to change the linear economic model which is based on 'take, make, use, and dispose,' to a more sustainable production and consumption model that is restorative and regenerative by design[46]. The concept ensures that the value of products, materials, and resources is maintained in the economy at their highest value and usefulness for as long as possible while minimizing waste[47]. This builds asset recovery (after use) and waste prevention pathways into product design, and underpins product and service delivery with energy and materials from renewable sources[48]. Applying circular economy principles (see above figure) through a systems approach could help to achieve objectives in:

- Climate, for example, recycling one tonne of plastic could avoid one tonne of CO_2 equivalent emissions, while also providing societal benefits worth more than USD 100 per tonne of recycled plastic[49];
- Chemicals, for example, alternatives to toxic chemicals and encouraging the redesign of products to increase their longevity, and to prevent wastage and pollution; and
- Land, water, and biodiversity, for example, redesigning the food system to be circular can save nutrients and water, help reduce land degradation, prevent marine pollution and improve biodiversity[50,51].

A circular approach will also yield socio-economic gains. The World Economic Forum reported that material cost savings of up to $1 trillion could be achieved per year by 2025 by implementing the circular economy concept[52]. Transitioning to the circular economy in five European countries by 2030, apart from reducing carbon emissions by two-thirds, would also lower business costs and increase the workforce by about 4%, creating more than 1.2 million jobs[53].

3. WHY IS THIS IMPORTANT TO THE GEF?

The GEF was established to support the implementation of the Rio Conventions on climate change, biodiversity and desertification, which emerged from the 1992 Rio Earth Summit; this Summit initiated global efforts to deliver environmentally sustainable development. Since its inception in 1992, the GEF has recognized that environmental benefits and socio-economic development objectives can be achieved simultaneously. Integration was built into the design of the GEF: it is specifically tasked with "integrating global environmental concerns with national ones in the framework of national sustainable development strategies"[54]. Sustainable development is central to the delivery of global environmental benefits. STAP has stated that "an integrated approach has to be followed from the outset, where the synergy between development and environment is pursued, and the generation of multiple benefits is promoted vigorously"[55].

In 2000, the GEF began to implement crosscutting initiatives with Operational Program 12 (OP12) on "Integrated Ecosystem Management." This program pre-dated the land degradation focal area and served as the entry point for land degradation projects, combined with integrated investments in biodiversity, international waters, and climate change. Socio-economic benefits were a key part of OP12 projects because they were expected to integrate ecological, economic, and social goals to achieve multiple benefits[56]. Following OP12, multiple focal area projects were specifically encouraged through the creation of the multifocal area portfolio in 2002. Cross-focal area integration has been promoted by the STAP[57], and has been increasingly adopted across the GEF; this is reflected in the increasing proportion of multi-focal area projects, which now comprise 52% of the GEF portfolio[58].

In 2014, the GEF introduced large-scale integrated programming with three Integrated Approach Pilot (IAP) programs, on food security, commodity supply chains and sustainable cities[59]. This integration modality was conceived in response to the GEF's 2020 Vision that focused on addressing drivers of environmental degradation and supporting broad partnerships to implement innovative programming[60]. From the inception of each of these IAPs, there has been a strong focus on understanding the scope of the full 'system' where change is to be effected and on stakeholder engagement, from local to regional.

In 2015, policy makers reaffirmed the need to make progress across economic, social and environmental dimensions of sustainable development through the adoption of the "2030 Agenda for Sustainable Development", articulated as the Sustainable Development Goals (SDGs). GEF interventions are expected to contribute to delivering the SDGs[61], and the GEF is seeking to help countries coordinate their planning to deliver on their MEA commitments and relevant SDGs. Applying integrated approaches will contribute to a science-based analysis of the trade-offs between actions targeting the various SDGs and MEA priorities, which is necessary to deliver a cohesive plan of action and achieve long-lasting, sustainable development outcomes[62].

In considering programming for 2018-2022, the GEF again recognized the need to apply "…integrated approaches for transformational change in economic systems"[63] to address drivers of environmental degradation, as it had in its 2020 Strategy.

Integration in the GEF portfolio

Recognizing the evolving science of integration, STAP has supported increased 'systems thinking' within GEF's portfolio – within Focal Areas (FAs), in Multi-Focal Area (MFAs) Projects, in Programs, and in the Integrated Approach Pilots (IAPs). While clearly relevant to the design and implementation of MFA projects and the IAP programs, lessons have also been learned from integration in FAs.

Source: Adobe Stock

The Independent Evaluation Office (IEO) highlighted examples of FA integration, in its recent OPS-6 report, "The GEF in the Changing Environmental Finance Landscape"[64]. Their findings in three focal areas are summarized below:

Biodiversity: "Mainstreaming (biodiversity) activities are associated with better outcomes and sustainability"; and "review of the terminal evaluations suggests that PA projects receive more satisfactory ratings when they have mainstreaming components" (p42). (The GEF's mainstreaming strategy includes: developing policy and regulatory frameworks; spatial and land use planning; encouraging biodiversity-friendly production practices; and piloting financial mechanisms to incentivize the encouragement of biodiversity.)

International Waters: "The international waters focal area was the first to shift toward a program modality, and demonstrated successes in that regard". The IEO notes that IW serves as a catalyst for integration with other focal areas and places significant emphasis on learning and knowledge sharing (pp 55, 56, 57).

Land Degradation: The IEO notes that the land degradation focal area "has been gradually moving toward integrated approaches aimed at delivering global environmental benefits in multiple focal areas while generating local environmental and development benefits". It "has an opportunity to address complex interrelated drivers and generate local socioeconomic benefits", and "the potential to increase food production, mitigate GHG emissions, and increase climate resilience through adaptation" (pp 58, 62, 63).

In support of integration and systems thinking, STAP has offered the GEF guidance on improved MFA design and incorporating resilience into project design and implementation.

Multi-focal Area: STAP evaluates each full-size project proposal to be sure it has a sound "Theory of Change" (TOC) and that there is a sound basis for the proposed actions leading to identified outputs and durable outcomes. In the last few years, STAP has encouraged improved TOCs so that the actions chosen are clearly thought through to possible endpoints. Better quality TOCs were needed especially in MFAs because some of the early MFAs did not discuss synergies or trade-offs across focal areas. To that end, STAP provided MFA guidance in 2016[65].

STAP identified the following essential characteristics of good MFA projects:

- the project objective would not be achievable by addressing a single focal area;
- there are linkages and drivers of environmental degradation common to several focal areas;

- integration of the different focal areas contributes to maximizing environmentally sustainable development and minimizing trade-offs in relation to the project's objective; and

- the project has a realistic theory of change which will allow for robust monitoring and assessment of each of the focal area outputs and specific indicators contributing to the project's objective.

Progress is being made. At the June 2017 Council meeting, the STAP chair reported that the recent MFA projects reviewed had better TOCs and scientific justification for proposed actions, that integration is improving at the site or country level, there is an increased focus on governance, and that resilience thinking is being incorporated. In the August 2017 OPS-6 report, the IEO concluded[66], "The multi-focal area portfolio reflects global trends toward integration across sectors and between environmental and socioeconomic goals as stated in the three Rio Conventions and the SDGs." "The great majority of multi-focal area projects respond to convention guidance, as well as to both global trends and national priorities" (p69). "Multi-focal area projects have the potential for producing synergies and mitigating trade-offs" (p71).

Resilience: Recognizing that there could be synergies in achieving goals of more than one MEA, the UNCCD asked STAP to develop a common indicator for agro-ecosystem resilience. This was supported by the CBD, and was also relevant to the UNFCCC[67]. In response to this, STAP commissioned and produced a number of reports on "resilience thinking" including the RAPTA framework[68]. An adaptive management and learning component can be critical to successful GEF projects, as many conditions (including climate, demographics, and policies) may change over the course of a project. STAP guidance on embedding resilience thinking into projects was developed at GEF's request in 2016[69]. The RAPTA framework applies adaptive management during implementation, uses results from monitoring and assessment to revise strategies, and tests hypotheses underlying the project design. Agencies have been asked by the GEF to consider this guidance in future project designs.

At the May 2017 Council meeting, the STAP chair noted that the IAPs had demonstrated good progress on elements key to the science of integration[70]. In particular advances in knowledge management have been made by including a coordinating budget and dedicated management team, by having many face-to-face consultations, building databases, developing common indicators and exchanging learning. There has also been broad stakeholder engagement and consultation – including at the local level, and coordination across contributing projects.

The IEO OPS-6 report concludes that the IAP programs: "are broadly coherent in terms of their objectives"; "emphasize knowledge exchange through dedicated platforms for collaborative learning"; have emphasized "broader adoption" in their design, and there are "innovative features beginning with the Theory of Change", but that "considerable efforts will need to be made to realize their potential" (p89).

The GEF has made considerable progress in designing and implementing integrated projects and programs. Applying the evolving science of complex systems will help the GEF achieve even more in the coming years.

4. HOW CAN THE GEF RESPOND?

The next generation of integrated projects in GEF-7 should build on the lessons learned from its own experience, as well as that of the practitioner and scientific worlds. STAP strongly encourages a continued focus on integration within FAs, across MFAs, in Programs, in IAPS, and in future IPs. This should include strong elements of a theory of change, adaptive management, integration of resilience thinking, indicators of progress, and KM.

The IEO, in OPS6, recommended a continued focus on integration: "The GEF should continue pursuing an integrative principle in its programming based on scientific and technical merits. A strong, cogent rationale for designing integrated programs and multi-focal area projects—based on demonstrated additionality, GEF experience, GEF comparative advantage, innovative contributions, environmental need, and national relevance — must be the basis for such interventions"[71]. However, the IEO also noted that ''with their emphasis on integration, programmatic approaches and multi-focal area projects are relevant in addressing drivers of environmental degradation; however, complex program designs have implications for outcomes, efficiency, and management" (Conclusion 3, p132).

STAP acknowledges that, as identified by the IEO, complex projects targeting multiple environmental issues, crossing focal areas, involving multiple agencies and countries tend to have higher management costs, and slower progress in project preparation (IEO, 2017). Nevertheless, STAP encourages the GEF to pursue integrative projects and to apply integration science, based on systems thinking, which will lead to more efficient and effective approaches to planning, monitoring and implementing complex projects.

Balancing complexity and efficiency as the GEF seeks transformational change and lasting outcomes remains a challenge. There are many elements of integration that can be improved across the temporal, spatial, institutional, and governance contexts. Building learning and adaptive management into project design, conducting serious mid-term evaluations and planning for long-term knowledge management will improve efficiency and integration while delivering global environmental benefits.

Drawing from the theory of integration and management of complex projects, and learning from GEF projects and programs that have applied integrated approaches[72], STAP recommends the following to improve integration in future GEF project design[73].

STAP makes the following recommendations:

1. Develop a good understanding of the social-ecological system in which the project will be implemented. Describing the system helps to identify the key environmental, social, economic and governance issues to be addressed, and how these are interconnected, with an eye towards resilience and transformational change (**system description, and systems thinking**).

2. Articulate a clear rationale for the project, its goals and what the proposed interventions are expected to achieve. The expected environmental, social and economic objectives of the project should be clearly identified and a pathway for achieving them presented. A realistic **theory of change** should be made explicit. This should tackle the drivers of environmental degradation by assessing assumptions, outlining causal pathways, as well as including a 'Plan B' should desired outcomes not materialize. It should be informed by previous efforts in the same geographical or disciplinary area.

3. Assess the potential **risks and vulnerabilities** of the key components of the system, to measure its **resilience** to expected and unexpected shocks and changes, and the need for incremental **adaptation** or more fundamental **transformational change**.

4. Devise a logical sequence of interventions, formulated as an implementation plan, which is responsive to changing circumstances and new learning (**adaptive implementation pathways**). Develop clear indicators that will be monitored to determine progress and success in achieving lasting outcomes.

5. Develop explicit plans and dedicate funding for **good quality knowledge management and learning** including: sustainable databases which endure beyond life of the project; simple, useful and usable common indicators; face-to-face consultations; and building the capacity of stakeholders. Good knowledge management is essential for adaptive management, developing 'lessons learned' to inform future investments, and for 'scaling up'.

6. **Engage stakeholders**, including local communities, civil society networks, industry associations or other key private sector actors as appropriate (not just government officials) from project inception and from design

Source: Adobe Stock

through to completion. This is crucial to identifying diverse needs, achieving buy-in, and managing trade-offs. It should:

a. use a participatory process to refine the system description and devise the theory of change, so developing a common understanding of the problem and its most promising solutions;

b. form multi-disciplinary teams with wide expertise to assess proximity to thresholds and, consequently, whether the need is for adaptation or transformation;

c. involve stakeholders in characterizing and prioritizing actions to build, or maintain, resilience or achieve transformation;

d. establish multi-stakeholder platforms and institutional partnerships to facilitate knowledge sharing and data collection for monitoring progress; and

e. apply strategies starting at the local level to produce a shared vision for effective transformational change.

7. Acknowledging the additional effort involved in this approach, STAP suggests that GEF could improve integration by **allowing flexibility in project preparation** to accommodate the additional transactions costs and time required to tackle complex issues through multi-agency teams. (One approach would be to allow the detailed project plan to be further developed after approval, as the first stage of project implementation, to enable meaningful stakeholder engagement in devising the system description and assessment and the design of implementation pathways.)

Transformational change necessarily entails risk. Risk and transformational change are intertwined, and lie at the core of building the GEF's capacity to respond to change and making it resilient. The GEF can strengthen its organizational capacity to deal with change, and to deal with uncertainty through experimentation and innovation. The GEF could also encourage a greater diversity in the risk profile of projects.

The GEF is uniquely placed to lead the way in applying and strengthening evidence on the science of integration and systems thinking to deliver global economic, social and environmental benefits. The recommendations in this paper, developed from review of the GEF's own experience, commissioned research and published literature, provide guidance on applying integration to improve the management of complex systems.

Annex 1: Scientific approaches to achieving integration

Simple, narrow, linear approaches are not sufficient to address the complexities of the inter-connected environmental and social challenges that all countries face. Several concepts and theories related to management of complex social-ecological systems and sustainable development can be applied to enhance integration and assist the GEF in navigating complexity. This list draws from O'Connell et al. (2016)[74], Berbés-Blázquez et al. (2017)[75], Tengberg and Valencia (2017)[76], and Zazueta (2017)[77].

Systems thinking examines relationships between the different parts of the targeted system, especially cause and effect relationships and positive or negative feedback mechanisms, between the biophysical and socio-economic features of the system. The system is defined by boundaries that describe the spatial scale and biophysical and social components inside the system. The environment surrounding the system should also be considered, as it influences problem-solving within the system. It is important to manage the fundamental "slow variables" – e.g. soil organic matter content – that control the state of the system and respond gradually to change, and to be aware of non-linear responses.

Resilience thinking refers to the inter-related concepts of resilience, adaptation and transformation. It is the basis for building the capacity of systems to withstand expected and unexpected shocks and stresses, including climate change and also socio-economic stresses such as conflict. Resilience thinking examines the risks and vulnerability of key components of the system, including proximity to thresholds that could lead to regime shifts. It evaluates the need for adaptation (incremental change) or transformational change, to cope with anticipated shocks and meet desired goals. Resilience thinking supports intentional transition to desired systems and reduces the probability of unplanned transitions to undesired systems.

Theory of change describes the impact pathways through which a project expects to meet its goal (Weiss, 1995)[78]. The Theory of Change may be devised in a participatory process involving key stakeholders and includes these elements: "1. the context for the initiative, including social, political and environmental conditions, the current state of the problem the project is seeking to influence and other actors able to influence change; 2. the long-term change that the initiative seeks to support and the ultimate beneficiaries; 3. the sequence of events anticipated (or required) to lead to the desired long-term outcome; 4. the assumptions about how these changes might happen, and about contextual conditions that may affect whether the activities and outputs are appropriate for influencing the desired changes; 5. a diagram and narrative summary that represents the sequence and captures the discussion[79]."

Effective stakeholder engagement requires involving the right people, in the right way, at the right time, using ethical and transparent processes. It requires defining the roles, responsibilities and accountabilities of stakeholders involved in project design, implementation and governance. Stakeholders' participation ensures that local and contextual knowledge informs the system assessment, including local perspectives, needs and cultural values which enhance the relevance and acceptability of the outputs. Stakeholder engagement in project implementation enhances effectiveness and learning.

The ***system description*** is a record of the current understanding of the social-ecological system and the assumptions and evidence which underpin it. It is built from stakeholders' diverse perspectives. It is a dynamic description that details what is changing and why, the connections between the different elements, and the cross-scale interactions with higher, e.g. national and lower scales, e.g. household. It creates a fundamental base to assess the system's resilience, the need for adaptation or transformation and for devising interventions.

System assessment is a central component of resilience thinking. It identifies potential risks, points of no return and key influencing factors (controlling variables) associated with anticipated future shocks or changes, as well as opportunities for adaptation or transformation to meet project goals. System assessment considers whether the system is currently on a trajectory towards a desirable or undesirable future. It considers the factors that confer general resilience, enabling the system to cope with unexpected shocks, and it analyzes the risk of crossing thresholds associated with known risks, shocks or trends.

Adaptive implementation pathways provide a strategy for planning and sequencing interventions. They use the theory of change to identify options and develop an implementation plan that is adaptable, based on the circumstances, learnings from project implementation and the consideration of alternative pathways. Interventions should focus on root causes and vulnerable elements identified through the system assessment. The implementation plan should present a logical sequence of interventions to build resilience or achieve transformation. During the implementation phase, adaptive management should be used to respond to information gathered and new learning. Implementation plans should include review points, to assess the need for revising the plan. Monitoring and assessment enables project managers to track project progress and reflect on successes and failures during project implementation so the necessary adjustments can be made to achieve goals.

Adaptive management applies knowledge, including results from monitoring and assessment, iteratively to refine interventions over time, to improve their effectiveness as conditions continue to change, and to revise Theory of Change, to inform future projects.

Learning and innovation. A structured approach that utilizes systems thinking should guide learning (e.g., data collection and interpretation) and testing of the Theory of Change. The results of learning should be captured to inform future phases of the project and program, as well as future projects. The engagement of stakeholders, e.g. government policymakers, NGOs, community members, in learning is essential to enhance self-assessment, awareness of their roles and their capacity to influence future action. Leveraging knowledge from the design stage through to the implementation of projects, as well as from past experiences through successful knowledge management, spurs innovation. Engaging stakeholders in project design, implementation, and governance encourages innovation and transformative change at the local level where niches of innovation, experimentation and learning occur. Strengthening communication across stakeholder groups (local communities, practitioners, and policy-makers) involved in multiple sectors fosters learning, adaptive management and induces innovation related to integration. Learning through monitoring and assessment and adaptive management should be documented and systematized in the project to form the basis of the project's knowledge management strategy. This requires that the project cycle build learning and knowledge iteratively, based on the project's successes and failures.

Transformational change is required to tackle many deep-seated complex global problems. The need for transformation of a social-ecological system is identified through the system assessment. Different strategies may be required at different levels: transformation may be required for some components of the system to maintain resilience of the whole. Effective transformation requires a shared vision among stakeholders, and starts at the local level: niches of innovation, experimentation and learning are scaled up through regime shifts that lead to wider adoption at the landscape level.

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