

Selecting complementary adaptation measures

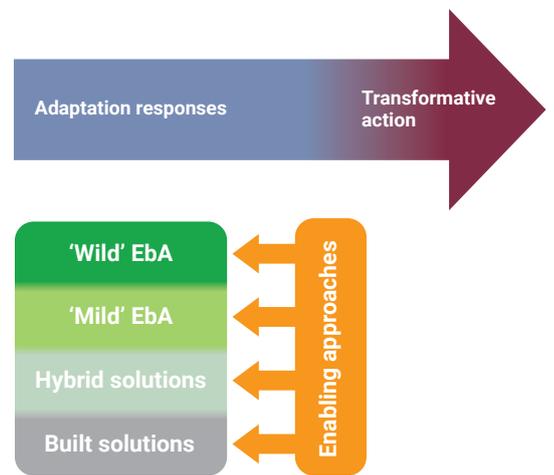
To respond to climate change hazards and impacts, an overall adaptation strategy should be devised drawing on the full range of possible adaptation solutions. This includes ecosystem-based adaptation (EbA), which restores and/or builds on ecosystem goods and services that underpin people's resilience (Briefing Notes 2 and 3), as well as 'hard', or built solutions, hybrid options, and enabling approaches that target changes in markets, institutions, policies and behaviour.



Effective adaptation will often require implementing a mix of different adaptation measures, drawn from a scale of 'grey to green' (Figure 1), to build on the strengths, and compensate for potential weaknesses, of individual measures. The need for such complementarity also applies through time, as some measures may take longer to produce adaptation benefits (e.g. ecosystem restoration) that are ultimately more effective. Importantly, the final selection of adaptation measures should always directly respond to the identified climate change impacts and aim to achieve a primary adaptation goal. Furthermore, the measures and their outcomes must in themselves be robust to climate change.

This briefing note provides an overview of the range of adaptation approaches that can be implemented alongside EbA measures to form a holistic adaptation strategy. It explores complementarities and limitations between measures, as well as how to bring together the various approaches effectively under one strategy.

Figure 1. Adaptation measures vary along a scale from 'grey' to 'green', according to the extent to which they use ecosystems and their services to respond to climate change impacts. The greyest approaches are built solutions, such as sea walls or levees, which rely fully on infrastructure and engineering technologies. In the grey-green space lie hybrid measures, such as green roofs / walls in cities or artificial reefs, which systematically combine built structures with natural elements. Ecosystem-based measures occupy the green zone of the scale, ranging from 'mild' to 'wild' measures, covering man-made to natural ecosystems – all make active use of, and build on ecosystem functions. Contour planting of exotic species to support terracing in fields, for example, lies on the 'mild' side of the spectrum – the approach makes use of nature, but not of the 'wild' natural environment. Restoration of natural forest ecosystems to stabilise slopes and regulate hydrological cycles lies on the 'wild' end of the spectrum. Enabling approaches support the other adaptation responses by improving the enabling environment for adaptation through enhanced information, and changes to policies, regulations, markets, and behaviour. These approaches foster learning and build adaptive capacity. At the far end of the continuum of adaptation responses lie transformative actions. These involve actively moving the system to a new stable state when the current one is close to – or has reached – a threshold / tipping point. Such actions can involve radically transforming political, economic and social structures, as well as ecosystem functioning.



Built solutions

Built, or 'grey', approaches to climate change adaptation use technology or engineered structures to protect people and infrastructure against climate hazards. These include creating physical structures or modifying existing infrastructure to make it more capable of withstanding extreme events, such as by building or reinforcing a sea wall, dam or irrigation system.

Extensive engineering research and experience provide detailed technical specifications for many built approaches, so planners know the circumstances for – and limits to – effectiveness of the engineered measures, and the process and cost of constructing them. In contrast, such information for EbA approaches is often very limited, derived from different disciplines and contained in diverse and dispersed sources – or may not be available at all. Planners therefore often consider engineered approaches as the 'go-to' option for reducing immediate impacts.

Box 1. Implementing built solutions and EbA side-by-side

In Madagascar, construction and rehabilitation of 1 km of sea walls in the cities of Manakara and Tomasina was complemented with rehabilitation and replanting of 1200 ha of mangroves. While the built infrastructure intended to halt coastal erosion trends, the coastal ecosystem restoration aimed to provide ecosystem services as a durable basis for socio-economic development, generating long-term benefits for communities and the environment.

However, engineered approaches are not infallible and may not address certain climate hazards (e.g. increased intensity of cyclones). Furthermore, as they tend to address only one hazard per measure,¹ they can risk increasing vulnerability in the long-term by not adequately considering future climate uncertainty or the interaction of multiple hazards. Due to their permanent and inflexible nature, such engineered structures can then become obsolete in the face of unpredictable climate conditions. For example, a flood mitigation dam built to protect against flood levels anticipated over the next 30 years may fail on longer timescales even though its planned operational lifespan is 60-70 years.² Built solutions are also often very expensive to construct and maintain. Engineered adaptation structures provide few, if any, co-benefits beyond the adaptation goal they were designed to address and can carry environmental risks, such as changing hydrology or disconnecting estuaries and wetlands.³

Working with ecosystems, on the other hand, offers more flexibility in the face of climate variability and strengthens social-ecological resilience more broadly. For example, a forest restoration initiative may adapt its practices over time to respond to emerging climate, ecological and other trends, thereby continuing to provide services to people. However, a more limited knowledge base means planners may find it difficult to know exactly where and when specific measures are most suitable.⁴ Implementing built and EbA measures side-by-side can help build on the advantages and reduce the limitations of each to increase people's resilience and capacity to cope with variable conditions (Box 1).

Hybrid adaptation measures

Hybrid approaches to adaptation go beyond simply putting traditional 'grey' and 'green' measures side-by-side – they systematically combine built solutions and EbA measures to enhance the advantages (or reduce limitations) of using either approach alone. Hybrid options often involve using innovative design approaches, merging ecological principles with engineering and technology. For example, as an alternative to constructing breakwaters for coastal defence, artificial reefs, which are manufactured underwater structures, can be used to restore coral reefs by providing the right foundation and physical conditions for corals to colonise.⁵ Other examples include using infiltration wells, rainwater harvesting techniques, or slope stabilisation measures (e.g. terracing) that blend 'grey' and 'green' features. Hybrid measures have also been used to restore watersheds by re-engineering waterways to prevent flooding in urban areas, using bio-remediation to improve water quality and prevent disease outbreaks, and managing aquifer recharge to increase infiltration while reducing flood risk.

Where the necessary resources and expertise are available, hybrid adaptation measures that deliberately blend built solutions, technology and ecosystem features can provide effective alternatives to more traditional separate uses of 'grey' and 'green' approaches at intermediate cost (Figure 2).

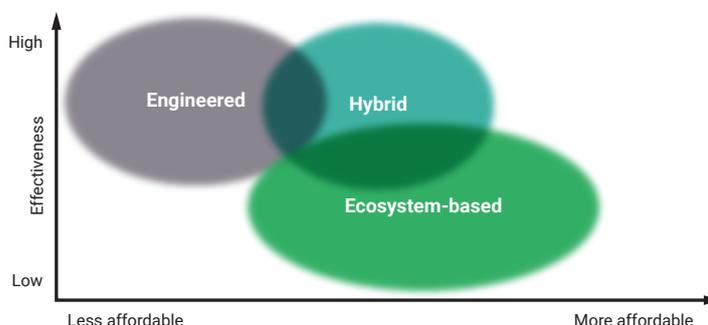


Figure 2. Relative effectiveness and affordability of engineered, hybrid and ecosystem-based measures to reduce the impacts of extreme weather events (redrawn after Royal Society 2014).

Addressing barriers to adaptation

Barriers to successful implementation of adaptation measures commonly arise from gaps in the enabling environment, for example in policies, regulations, markets and planning capacities. Addressing such barriers should form an integral part of any adaptation strategy to support the design, implementation and maintenance of EbA, hybrid and engineered measures. This can be done through enabling approaches that aim, for example, to make the policy and regulatory environment more favourable to adaptation, influencing markets and behaviour and enhancing capacities. Investing in governance systems and human capacity is an important pathway to change and ultimately paradigm shift (see Briefing Note 1).

Many enabling approaches build the adaptive capacity of institutions and communities alike, promote action and help ensure sustainable change. They can, for example, improve access to climate information, help develop policies and regulations that prioritise adaptation, including EbA, and secure funding streams for its upscaling and long-term maintenance. Enabling measures also include

Box 2. Enabling approaches to adaptation

EbA projects in Rwanda, Lesotho and Nepal, alongside other measures, implemented various enabling approaches to build capacity, share knowledge and raise awareness about EbA. These included: conducting training sessions for targeted officials and technical staff, user groups, women's groups, and community-based institutions/social networks; integrating relevant content into academic curricula; raising public awareness through radio shows; and setting up early warning systems.

market-based solutions, such as promoting a transition from climate-vulnerable livelihood activities to ones that are resilient to current and projected changes (e.g. switching from relying on drought-prone agriculture for income to small businesses involving drought-tolerant non-timber forest products or tourism).

Social measures that focus on learning, education, information sharing and awareness raising, aim not only to build capacity, but also to bring long-term behavioural change (Box 2; see also Briefing Note 2). Such measures can increase preparedness to cope with climate change impacts and enable adaptation solutions that benefit communities regardless of those impacts. The resulting institutional, social and behavioural changes not only enhance the effectiveness of other resilience-building options,⁶ but may themselves constitute the strongest component of resilience. Even if physical structures and ecosystems fail to protect people from climate change hazards, strong social and governance structures can allow societies to reform and rebound following extreme events. For example, high levels of social capital and strong leadership have been shown to be key factors determining the quality and pace of recovery following extreme events, such as tsunamis, that have caused major damage to physical infrastructure and to the natural environment.⁷



Fitting the pieces together

Given the diversity of adaptation options, it is important that measures are selected carefully to match the identified climate hazards and the available resources and expertise. Considering the adaptation objective, including avoidance of impact, accommodation of impact and protection from impacts, will aid in choosing appropriate measures. The selection should also be based on detailed knowledge of the local context within the given social-ecological system, including an understanding of the social, environmental and economic values of all relevant stakeholder groups.

It is important to consider both the opportunities that might arise from the selected measures, including any co-benefits, and any potential for maladaptation (Box 3).

Understanding and comparing these factors across different adaptation options depends on identifying the full range of costs, benefits and co-benefits of each measure at different spatial and temporal scales, using appropriate valuation methods (see Briefing Note 5).



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Box 3. Maladaptation

According to the IPCC, maladaptation is 'an action that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future.'^{8,9} Essentially, maladaptation results in unintended negative consequences.

A 'pathways' approach to adaptation (Box 4) can help prioritise and plan for incremental investment in adaptation measures.¹⁰ This approach helps to keep options open and avoid 'path dependency' (risk of lock-in to actions that may not be the best solutions to long-term climate problems), and can also help avoid unnecessary expenditure.¹¹

The 'pathways' approach tracks changing circumstances over time and acknowledges that, while not all decisions can be made in the present, they can be planned, prepared and prioritised by identifying trigger points for future decisions. It is therefore a useful approach for dealing with the inherent uncertainty in any climate change adaptation approach (see Briefing Note 2) and can help in selecting the appropriate combination of EbA, engineered, hybrid and enabling solutions to underpin an overall adaptation strategy.

Box 4. Adaptation 'pathways'

An adaptation 'pathway' is a decision-making strategy made up of a sequence of manageable steps/decision points over time, allowing decisions to be made in a flexible, responsive and iterative way. Generally, the approach involves:

1. Defining and scoping areas of decision making, including determining objectives/vision of success
2. Determining thresholds of the social-ecological system and adaptation measures and trigger points for decision making
3. Determining possible short- and longer-term adaptation strategies and evaluating each against a set of criteria including cost, community acceptability, implementation time, technical complexity, etc.
4. Developing decision pathways and decision points and beginning the journey along the chosen pathway

Key action points

- Explore the range of grey, green and hybrid adaptation measures that could best address the range of climate hazards.
- Use a pathways approach to identify and make incremental, no- or low-regret investments.
- To address uncertainty and enhance resilience, keep options open as information improves.
- To help scale up good practice, include interventions that improve the enabling environment.

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