European Network of the Heads of Environment Protection Agencies (EPA Network) - Interest Group Climate Change Adaptation

Technical Paper

Supporting successful adaptation and limiting maladaptation to climate change

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This technical briefing is the result of the work of the EPA Network's Interest Group Climate Change Adaptation. While it reflects inputs of all participants in the Interest Group, it is only endorsed on this form [including policy recommendations] by those Agencies in the front page.

About this document: *This Technical Briefing is the result of recent technical work done by the EPA IG CCA. In response to the growing interest of researchers and the increasing empirical evidence of maladaptation taking place, the topic of maladaptation has gained the attention of the Interest Group as a relevant issue to national adaptation policies. The purpose of this briefing is to lay the ground for a deeper and shared understanding of maladaptation and to raise attention for its relevance to policymaking and practice. It aims to shed light on the various dimensions of maladaptation, indicate the range of potential adverse effects of adaptation measures, explore the circumstances that may lead to maladaptive outcomes, and to propose solutions for preventing and limiting them. Drafted by a sub-group of IG members, the briefing has been discussed at several meetings of the EPA IG CCA and undergone a review and feedback loop. As such, the Technical Briefing discusses the concept of maladaptation, proposes general assessment criteria, presents illustrative thematic case studies, and derives lessons learnt and recommendations. The case studies, covering infrastructural, institutional, behavioural, and regulatory dimensions, are compiled in the Annex. With this briefing, the EPA IG CCA hopes to contribute to the further development of successful adaptation policies, both at the national and European level.*

Key messages

- **Urgency of adaptation and risks of maladaptation:** Climate change adaptation is essential to manage growing risks, but poorly designed adaptation policies can lead to maladaptation, resulting in unintended adverse outcomes, such as increased vulnerabilities, additional greenhouse gas emissions, social inequities, and conflicts with sustainability goals. Careful planning is crucial to limit and ideally avoid these unintended consequences.
- **Definition and importance of addressing maladaptation:** Maladaptation refers to adaptation measures that inadvertently increase risks, shift vulnerabilities (e.g. to other places or groups), or create inequitable outcomes. Successful adaptation requires addressing maladaptive dimensions by considering long-term impacts, ecological and socio-economic dimensions of sustainability, social equity, and coherence with mitigation goals.
- **Importance of criteria for identifying maladaptation:** Only a few existing policies already consciously address maladaptation. Frameworks and criteria, like the eight assessment criteria suggested and elaborated on in this briefing, could systematically address, assess and prevent maladaptive dimensions in adaptation measures, ensuring alignment with long-term climate resilience and sustainability.
- **Examples highlighting maladaptive outcomes:** The chosen case studies (structural flood protection, green infrastructures, insurance systems, and EU directives) illustrate how adaptation efforts, if not designed in a holistic and cross-sectoral manner, and planned for the long-term, can shift vulnerabilities, lock-in risks, and undermine social equity.
- **Ex-ante assessments of maladaptation risks:** Ex-ante assessments of adaptation policies, based on robust criteria, are essential for detecting maladaptive risks, minimising maladaptation, and enhancing effective and successful climate adaptation, with co-benefits and synergies for sustainable and equitable development. Performing ex-ante assessments as an integral part of adaptation planning and prior to implementing an action can harness choosing the most effective

and sustainable adaptation option with the least unwanted consequences as well as optimising the design and implementation of adaptation measures.

- **Proactive and inclusive adaptation strategies reduce risks of maladaptation:** The highlighted examples also demonstrate that successful adaptation requires integrated policies that take into account anticipatory planning, broad stakeholder engagement, and flexible implementation. Addressing trade-offs and engaging diverse perspectives helps ensure socially just and sustainable outcomes. These principles are important for adaptation planning at all levels, from the European and national to the local level.
- **Recommendations for minimising and preventing maladaptation:** Interdisciplinary planning, based on ex-ante assessment criteria, continuous monitoring and evaluation with a built-in learning cycle, proactive financial incentives, and incorporating lessons from past maladaptation are essential for limiting negative adaptation outcomes. Trade-offs should be acknowledged and managed transparently to optimise adaptation efforts.

1. Introduction

Climate change is a pressing reality, causing increasing risks at a global scale as well as within Europe. In recent years, climate change adaptation[*] has gained urgency to lower the growing risks, impacts and threats. Well-planned and successful adaptation has many co-benefits and synergies with other policy goals. We thus need to strengthen and accelerate the implementation of adaptation policies. But are such policies and measures always effective, adequate, socially just and coherent with overall sustainable development? In this respect, adaptation, like any other policy, can also have significant unintended consequences. For example, air conditioning of buildings reduces thermal stress for residents during heatwaves, but it also increases greenhouse gas emissions (GHG) if cooling systems are fuelled by fossil-based electricity; artificial irrigation can effectively safeguard agricultural yields from climate variability and drought, but through intensive groundwater extraction it may increase water scarcity for neighbouring farms, other water users and natural systems; hard flood defences can protect certain areas from flood risk, but may transfer that risk downstream to other communities. Such adverse effects of adaptation interventions may especially occur if trade-offs and conflicts are overlooked, the planning is poor, or a focus on short-term gains prevails.

In such cases, adaptation can even backfire on climate resilience by shifting vulnerabilities (to other societal groups, regions, or sectors) or increasing vulnerabilities (especially on longer timescales). Adaptation can also lead to trade-offs with existing sustainability goals (e.g. SDG13 on climate change, when it leads to increasing greenhouse gas emissions), eroding preconditions for sustainable development. The guiding concept of climate-resilient development[1], aiming at simultaneous and coordinated implementation of mitigation and adaptation policies to support sustainable development and social equity within planetary boundaries, increases the need to consider trade-offs and conflicts between climate and other policies, and to strive for integrated solutions that avoid adverse side effects and detrimental outcomes.

[*] Hereafter ‘adaptation’.

The Intergovernmental Panel on Climate Change (IPCC) has ascertained growing evidence of unintended outcomes, often referred to as 'maladaptation,' across many regions and sectors, including in sectors like agriculture, urban areas and infrastructure.[1] [2]

The IPCC defines maladaptation as concerning *'actions that may lead to increased risk of adverse climate-related outcomes, including via increased GHG emissions, increased or shifted vulnerability to climate change, more inequitable outcomes, or diminished welfare, now or in the future. Most often, maladaptation is an unintended consequence'.*[3]

The recent European Climate Risk Assessment (EUCRA)[4] emphasises the need to minimise or avoid maladaptation when designing adaptation policies and measures, because even adaptation actions designed with the best intentions may redistribute, shift, reinforce or create new vulnerabilities and inequities now or in the future, generating 'winners' and 'losers', protecting some while neglecting others, or locking in future generations to increased risk or costly action. Attributing maladaptation to reactive or overly narrow (e.g. single-policy) approaches, leading to rigid choices that are not fit for the future in a changing climate, EUCRA addresses maladaptation as a challenge to territorial and social cohesion[4]. Addressing maladaptation is thus also an important aspect of achieving just resilience, which is a core element of the EU Green Deal and related policy instruments.[5] The European Court of Auditors (ECA)[6] also recently reported that some audited projects had little to no impact on increasing adaptive capacity and a few do result in maladaptation. The ECA thus emphasised the need to proactively prevent maladaptation in future projects, improve the effectiveness of EU funds allocated for adaptation purposes, and ensure alignment with long-term resilience goals.

We thus need to better understand how our adaptation actions and efforts affect social groups and regions in different, and sometimes unequal, ways, and take appropriate measures that take this into account.

Importantly, adaptation policies and measures should not be seen as strictly binary, being either wholly successful or entirely unsuccessful. Instead, they must be seen along a continuum (see Figure 1), where the outcomes can be located between transformation towards a climate-resilient pathway on the one side, to irreversibly higher vulnerability and other unintended outcomes on the other.[7] Every adaptation policy and measure can be placed along this continuum. The challenge is to plan, design and implement these policies and measures in such a way that they fall as much as possible on the successful side of the continuum, while limiting risks that push adaptation outcomes to the maladaptive end of the spectrum. It is important to note that successful adaptation and maladaptation may even occur simultaneously, depending on the context and perspective of an actor. For instance, a measure that benefits one group may inadvertently harm another, creating disparities that must be addressed. Therefore, in order to limit the risk of maladaptation, a closer look at the similarities and differences of 'successful adaptation' and 'maladaptation' is needed, which requires a suitable set of criteria to identify maladaptive dimensions. In this briefing, we want to propose such a set of criteria for identifying, tracking and steering maladaptation, and show, by means of illustrative examples, how they can be applied in the adaptation policy arena to support successful adaptation.

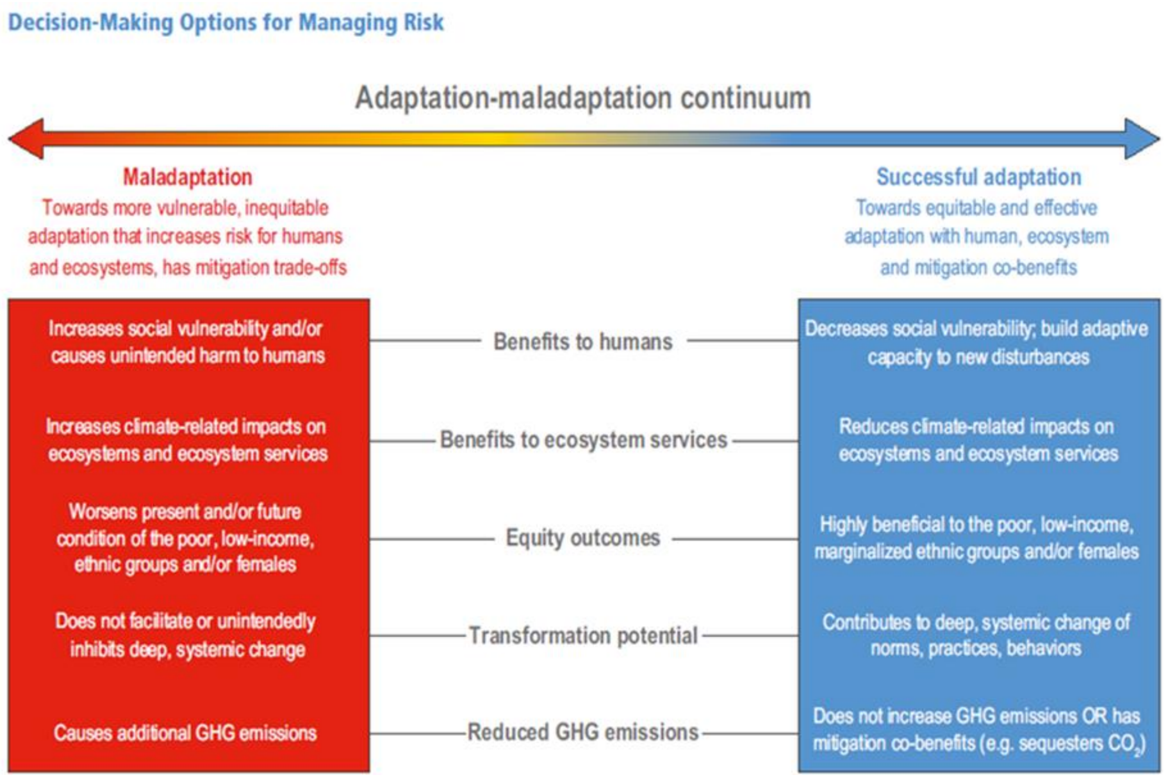

Figure 1: Conceptualisation of successful adaptation and maladaptation as two endpoints of a continuum (IPCC, 2022)[7]

2. Criteria for maladaptation

In contrast to scientific assessment reports, especially by the IPCC[1 2], recognition and coverage of the issue of maladaptation in policy documents is lagging behind. The Paris Agreement (UNFCCC, 2015)[8] addresses the need to avoid maladaptation in a very indirect way by requiring all climate actions to contribute to sustainable development. The EU Strategy on Adaptation to Climate Change[9] mentions the term 'maladaptation' only once and very briefly in a similar context, while the EU guidance document on Member States' adaptation strategies and plans[10] introduces maladaptation as a new area of adaptation policy. Similarly, several national adaptation plans, for example in Finland, Sweden, the United Kingdom and Canada, caution in general terms against maladaptation[11]. The avoidance of conflicts (and the exploitation of synergies) with sustainable development in general and the mitigation of climate change in particular is an established guiding principle of many national adaptation strategies.

So far, however, efforts have focused on calls for preventing maladaptation rather than on giving it a more integral place in national policy documents, let alone assessing whether the desired outcome as outlined in the policies has been met[11]. The Austrian Strategy for Adaptation to Climate Change[12 13] is the only known national adaptation policy document by an EU Member State that explicitly and prominently addresses maladaptation. Framing maladaptation as 'measures that are predominantly reactive, pure symptom control, promising only in the short term, but counterproductive in the long term', the Austrian strategic framework document (NAS) states avoidance of maladaptation as an overarching objective, defines a set of criteria for the avoidance of maladaptation, and provides generic process-oriented guidance for applying them. Moreover, the Austrian Adaptation Action Plan[14] identifies potential conflicts, focussing in particular on maladaptation risks, for each of its recommended actions.[15]

The following list of eight criteria for assessing maladaptation thus follows to a large extent the criteria of the Austrian NAS[12] (except criterion 8), supported by more concrete characteristics derived from acknowledged scientific literature[2 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31] on the issue. Interdependencies and overlaps between the individual criteria exist and are to some extent unavoidable, but altogether they provide a rather comprehensive framework for identifying, assessing and tracking maladaptation, which is open to further operationalisation.

Table 1: Assessment criteria for avoiding and minimising maladaptation (based on the Austrian NAS[12 13] and scientific sources[2 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31])

Criteria		Description, characteristics
1	**Vulnerability increase, vulnerability shift**	Direct or indirect *increase of current or future climate vulnerability or risk* for the intended beneficiary of an adaptation option *('re-bounding vulnerability')*; may include net increase in vulnerability over time (i.e. short-term adaptation benefits outweighed by long-term negative outcomes). *Transfer (re-distribution) of vulnerability* to other places, groups, sectors, or systems *('shifting vulnerability')*.
2	**Conflicts / trade-offs with mitigation of climate change**	*Increase of GHG emissions*, including through direct emissions, higher net emissions over the life cycle of an adaptation measure, or reduction of storage capacities of natural carbon sinks. Impeding or rendering impossible the *feasibility and effectiveness of mitigation options*, e.g. through mono-functional, incompatible use of limited space or land.
3	**Conflicts / trade-offs with environmental sustainability**	Negative externalities on ecosystems, natural resources and environmental goods. Adaptation options leading to: depletion or degradation of biodiversity and ecosystem services; increased consumption of non-renewable resources; non-sustainable use of renewable natural resources; impairment of environmental quality; intensified conflicts over resource use.
4	**Conflicts / trade-offs with social sustainability**	Negative externalities on social justice and equity through inequitable social distribution effects. Unfair distribution of costs and benefits of adaptation options, e.g. disproportional burdening or increased vulnerability of vulnerable groups (e.g. low-income, single parents, children, marginalised ethnic minorities) and/or benefits mostly for privileged groups only. Losses in societal welfare, e.g. through adverse effects on public goods, basic provisioning, or employment. Undermining intergenerational equity, e.g. by transferring higher vulnerability or excessive cost to future generations.

Criteria		Description, characteristics
5	**Detrimental path dependencies**	Adaptation measures that, simultaneously with high future uncertainty, are irreversible or inflexible, i.e. that are impossible or difficult to correct, re-direct, or retract. Measures with high risk of causing vulnerability lock-ins, reducing adaptive capacities and solution space over time, and resulting in high and unavoidable damage and loss, if adaptation limits are reached. Indicative characteristics of adaptation options with elevated risk of maladaptive pathways: structural ('grey') measures with high, returning and accumulating (public) costs; adaptation choices creating self-reinforcing dynamics through capital tie-up and reinforcement of business-as-usual (legal, administrative, mental) regimes. Measures inhibiting transformation potentials, i.e. deep, systemic change, e.g. through narrow focus on single risk for specific sector or by reinforcing the unsustainable status quo of a system.
6	**Inefficiency and ineffectiveness**	Highly unfavourable cost-benefit ratio: measures with excessive public cost (considering entire life cycle) combined with lack of effectiveness. High opportunity cost, especially in comparison with alternatives. Ineffective adaptation measures, if they require high public financing.
7	**Adverse effects on market competition**	Investment-intensive measures that push other competitors out of the market, leading to market concentration, reduced competition and higher cost of living for consumers. Measures that result in the strongest market players prevailing, not the best solutions.
8	**Reduction of incentives for adaptation**	Measures or framework conditions (e.g. regulatory, institutional, market) that inhibit adaptation action or cause perverse incentives by encouraging inaction (e.g. by creating false feelings of security, promoting unnecessary dependence on others, stimulating rent-seeking behaviour).

3. Examples of maladaptation

To better illustrate what maladaptation can look like, four thematic examples have been selected and elaborated on in Annexes 1 - 4, showing how maladaptation can manifest itself along the criteria listed in the Table above. These examples cover different broad categories of adaptation types: (i) flood protection as an example of infrastructural (mal)adaptation; (ii) green infrastructures as examples of institutional (mal)adaptation; (iii) insurances as an example of behavioural (mal)adaptation; and (iv) relevant EU Directives as examples of regulatory (mal)adaptation.

It is important to note that by choosing and exploring these four examples, the intention is not to ignore the clearly proven positive effects of the respective adaptation measures, but to illustrate more fully the range of possible negative effects that can lead to maladaptive outcomes in the long run. Moreover, the choice of examples has a deliberate focus on adaptation options that are challenging to design and implement in a way that adheres as much as possible to the successful side of the adaptation-maladaptation continuum.

4. Reflections and remarks

Adapting to a changing climate is imperative. There is ample evidence showing that investing in adaptation now significantly reduces costs and damages, both in the short- and long term. For adaptation to reach its fullest potential, it is also critical that maladaptation is minimised as much as possible. Minimising maladaptation is nevertheless a challenging task that requires much foresight and flexibility to rethink and revise existing adaptation measures and strategies. Avoiding maladaptation altogether may often be virtually impossible, since many choices and designs related to policies and measures, more often than not, involve trade-offs between objectives (see Annex 4). Minimising maladaptation, however, is possible and does not necessarily require sizeable and costly investments. Instead, as is shown later in this briefing, it can be done without major strains on finances, as it is also about making better use of existing adaptation efforts. Rather, preventing maladaptation early on in the planning process avoids stranded investments and wasted costs. It will often require a willingness to take the lead and support prioritisation between objectives, including accepting that the needs for trade-offs can vary according to scale.

In addition to maladaptation involving cross-sectoral dynamics, we can also identify maladaptation as having important multi-level, cross-scale and temporal elements. For example, in the green urban infrastructure case (Annex 2), the different levels of maladaptation and decision-making become evident. The promotion of nature-based solutions (NbS) to create benefits in multiple sectors, including increasing resilience, has been heavily pushed both at the EU level, including the EU Adaptation Strategy, and at national level. The green infrastructure case shows that, if not implemented in a holistic fashion, NbS that are incentivised by higher levels of government can generate unanticipated negative side effects on social justice at the local level. To what extent these strategies on higher levels of government take into account, can anticipate and mitigate these potential negative side effects thus becomes an important question.

Under certain circumstances, adaptation measures that are effective *in situ* may displace pressures onto neighbouring areas or areas at a larger scale that are ecologically or economically connected. As is demonstrated by the case of flood and coastal protection infrastructure (Annex 1), local adaptation interventions in a specific place can shift vulnerability to other places, cause negative consequences to other environments, increase risk at the scale of entire drainage and runoff areas, and induce maladaptive development pathways in the areas that are protected, with the consequences of residual risk events potentially affecting economies at a much larger scale.

As maladaptation is both a process and a state, it may often unfold along timescales. For instance, infrastructures to protect against floods and sea-level rise can have short-term adaptation benefits, but may increase residual risk and cause lock-ins of exposure and risk over the long term, resulting in unexpectedly high damage and loss when technical protection limits are reached (Annex 1). The temporal development of maladaptation also becomes evident in the insurance case (Annex 3). Developing tools and solutions for increasing resilience for property owners, in this case insurance products, can create benefits for the policy holders in the short term, but also risks becoming a maladaptive practice in the mid- to long term by locking the property owners into unwanted paths, where risks are not properly addressed or shifted to others lacking such insurance. This points to the importance of assuming a time-sensitive approach to maladaptation, where the effects of actions taken now may only materialise in 20 to 50 years' time.

5. Lessons learned and recommendations

Based on the case studies of maladaptation (cf. Annexes 1 - 4) and the literature reviewed, six core lessons learnt and recommendations are provided below. Traceable and operational criteria for detecting, monitoring, evaluating, and minimising maladaptation, which may be based on the assessment criteria presented in Table 1, are a valuable framework supporting all of the following approaches.

1. **Assess risks of maladaptation ex-ante, track them continuously, and adopt a flexible approach to planning**
   - ✓ Plan and design adaptation policies and measures in an anticipatory and forward-looking way, based on comprehensive climate risk and vulnerability assessments, to avoid maladaptation risks typically arising from purely reactive or autonomous responses and from protection systems that do not consider the impacts of future climate change.
   - ✓ Explore a full portfolio of adaptation options and evaluate maladaptation potentials systematically and ex-ante, when identifying and appraising alternative solutions (e.g. by applying assessment criteria for maladaptation) in order to select the most effective option with the least risk of unwanted consequences (e.g. nature-based flood risk reduction, non-structural flood protection measures or managed retreat instead of technical protection systems).
   - ✓ Perform ex-ante assessments prior to implementing an action and integrate them as essential tools into adaptation planning. Ex-ante assessments of adaptation policies are key to minimising maladaptation and enhancing successful climate adaptation. In particular, they allow identifying early on undesired impacts associated with adaptation interventions, determining potential conflicts and trade-offs with long-term climate resilience (e.g. vulnerability lock-ins), environmental (e.g. ecosystem degradation) sustainability, social equity (e.g. physical displacement), climate mitigation (e.g. increasing GHG emissions), negative competition effects (e.g. rising property values), and inverse incentives for adaptation, and re-adjusting actions accordingly.
   - ✓ Take an integrated policy approach considering multiple policy objectives to limit conflicts with other environmental, social and economic policy objectives and to support synergies. A systemic and integrated approach, and careful planning at the project level, are instrumental to avoiding unintended consequences.[4]
   - ✓ Set up a flexible and reflexive framework for implementing adaptation policies and measures over their entire life cycle. Stay vigilant throughout the lifespan of adaptation policies and measures for indications of maladaptation and correct them if needed. Be proactive through learning. This involves monitoring, evaluation, and adjusting interventions based on changing conditions, emerging risks, and new information.
   - ✓ Consider the longevity of policies and measures. The effectiveness and possible maladaptive outcomes of adaptation and related sector policies may depend on their timescale.
2. **Engage stakeholders for inclusive and interdisciplinary planning**

- ✓ Stimulate broad stakeholder involvement of local communities, policy sectors, businesses, governmental agencies, and NGOs in the planning and implementation of adaptation measures. Incorporating a wide range of diverse perspectives helps to better understand the possible side effects and implications of a proposal, and it contributes to building consensus and ensuring the measures meet the needs of all stakeholders, including vulnerable and marginalised groups.
- ✓ Apply participatory and inclusive risk governance processes to strive for consensus-oriented decisions on what levels of disaster risk are acceptable, and which are intolerable, respectively, and always communicate these decisions transparently.

3. **Focus on building adaptive capacity and providing incentives for proactive adaptation instead of employing reactive, incremental and merely damage-compensating measures**
   - ✓ Set up financial schemes to encourage proactive measures to be taken on the ground to reduce vulnerability instead of relying on insurance alone. Insurance is important for safeguarding property owners and agricultural producers to a certain extent, but it does not address the underlying root causes of vulnerabilities and can generate detrimental lock-ins.
   - ✓ Encourage farmers to diversify their businesses, including choice of crops and management strategies, or to adopt more nature-based agriculture to improve their long-term resilience towards climate change, rather than relying on insurance schemes that may inhibit proactive adaptation.
   - ✓ Incentivise individual precautionary measures to manage risk by property owners, rather than raising unrealistically high trust and reliance upon public risk reduction measures or insurance.
4. **Facilitate learning from past experiences of maladaptation**
   - ✓ Collect and evaluate information and experiences from other regions and countries as to how maladaptation has been addressed and minimised. This includes comparing national implementation and interpretation of adaptation-relevant European Directives to avoid conflicts between policy objectives in different policy fields.
5. **Adopt additional compensation measures when maladaptation is unavoidable and generates significant harm**
   - ✓ Implement social policy measures (e.g. rent control, rent stabilisation or anti-displacement policies) alongside greening policies set out to improve urban resilience. This would ensure the creation of green and climate-responsive cities by starting from an equity lens that focuses on long-term health equity, rather than green cities that entrench the dynamics of unequal urban communities.
   - ✓ Adopt risk-oriented approaches in spatial planning policies, as well as regulations (e.g. building codes) for enforcing flood-proof building designs or the re-zoning of undeveloped building land in areas exposed to significant residual risk.
6. **Recognise that maladaptation may be inevitable and provide guidance on how to handle trade-offs in practice**
   - ✓ Recognising the need to accept trade-offs when working with adaptation will allow practitioners to meet adaptation needs more efficiently. This will in turn reduce risks of inefficiency and ineffectiveness, increase incentives for adaptation, and reduce inhibitions over delivery of transformative adaptation.

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Examples of maladaptation

Annex 1: Structural protection measures against flood risk (riverine, coastal) as an example of infrastructural (mal)adaptation

1. Introduction

Structural flood protection measures, such as dykes, levees, straightening of river courses, retention reservoirs, or torrential control barriers, and coastal infrastructures to protect against sea-level rise, coastal storm surges, and beach erosion, are widely practised and well-established responses to the reduction of flood-related, climate-driven risks. Especially when it comes to defending existing settlements, i.e. the stock of buildings and settlement-related infrastructure, against expanding climate-related hazard and risk zones, protection infrastructures are often without an alternative.

2. Establishing the case of maladaptation

Depending on the specific context conditions, however, and if planned and implemented in an isolated 'policy silo' approach focused on short-term, localised benefits, structural flood protection systems can cause a range of severe unintended trade-offs and conflicts and trigger maladaptive pathways that may delay impacts for a time, while increasing residual risk, perpetuating vulnerabilities, and eventually creating damages and losses in the long run. As is supported by empirical evidence from the literature, potential maladaptive outcomes of structural protection measures may cover almost all criteria of maladaptation (cf. Table 1). A common pattern of many of the dimensions of maladaptation described below is that structural flood protection can adversely interact with spatial development in producing higher risk exposure and vulnerability over the long term than before flood protection measures were taken.

- The design of any technical protection system is based on protection standards, expressed as the (exceedance) probability or 'return period' of a flood surpassing a certain water level. The choice of a protection standard (e.g. 100-years return interval) is a policy decision, motivated by availability of resources, technical knowledge and the cost of interventions.[1] However, no matter what the chosen design event of a protection infrastructure may be, it is inevitable that, after its construction, exposure to residual risk always persists, which may lead to unexpected damage and loss in the case of overload or technical failure. Due to climate change, however, statistical return periods are non-stationary, and uncertainties of extreme events and sea-level rise are increasing, thus making it more likely that defined design events will be exceeded and tolerable risk levels lowered in the future.[2] Combined with decreasing protective effects over the life cycle of protection structures and ongoing growth in exposed asset values, this reduces protection levels and causes an *increase in residual risk over time*. If there is a lack of adaptation measures to cope with growing residual risk, this can lead to situations where the erection of structural protection measures has short-term adaptation benefits, but leads to *constant build-up of future vulnerability and risk*, resulting in excessive damage and loss when adaptation limits are reached ***[criterion 1].***[3 4]
- Structural river engineering can accelerate and amplify flood waves and increase flood risk in downstream river sections, thus *re-distributing risk to other places*. Object-related protection

measures against flooding and heavy rainfall, e.g. by geo-engineering terrain features or through technical safety constructions on properties, can increase vulnerability to flooding of neighbouring properties at local scale or, through summation effects, of entire drainage areas and downstream residents[7]. The literature also reports rich evidence that coastal defences, such as seawalls and sand walls, have *shifted vulnerability to places and people elsewhere* along the coast, including by changes in sediment deposits, shifting erosion from protected to unprotected areas or by worsening conditions for riparian habitats and down-current residents ***[criterion 1].***[5 6]

- Failure, be it of public authorities and/or private property owners, to take active adaptation measures or to upgrade existing protective measures in flood-prone areas with heavily exposed assets and returning damage events, especially if combined with 'business-as-usual' development that leads to ongoing expansion of exposed settlement areas, is an example of *inaction* qualifying as maladaptation, because it *increases exposure, vulnerability and risk in the same place over time* ***[criterion 1].***[7]
- Flood and coastal protection systems often involve *major GHG emissions*[8], which can accrue in all stages of the life cycle of a technical measure. GHG emissions are caused by the use of energy-intense building materials (e.g. concrete, steel) and the energy inputs needed for construction, maintenance, and retrofitting. Trade-offs with mitigation goals can also occur if river or coastal regulation *negatively impacts the carbon storage capacity of natural sinks*, such as wetlands, floodplains or riparian forests. Moreover, structural protection measures often induce intensification of land development, including spatial expansion of settlements and urban sprawl, which are the main drivers of GHG emissions ***[criterion 2].***
- In the past, river regulation, artificial water retention reservoirs and other structural measures to protect against river and torrential flooding have contributed substantially to *depletion and degradation of river and floodplain ecosystems, their biodiversity, and provisioning of their ecosystem services*, including for nature-based adaptation functions. Trade-offs between policies for flood protection, the favourable ecological state of water bodies and nature restoration continue to be persistent challenges for coherent, integrated policy implementation, bearing potentials for different dimensions of maladaptation (cf. Annex 4). Similarly, *negative environmental consequences* and threats to marine health have been documented for many examples of coastal infrastructure.[6 8] Both planned coastal infrastructures like seawalls and autonomous flood strategies like sandbags, digging channels and sand walls around homes have caused maladaptive outcomes, including beach loss, coastal erosion, destruction of natural coastal ecosystems, or damage to adjoining reefs ***[criterion 3].***[5]
- Driven by cost-benefit considerations, investments in flood adaptation to sustain tolerable risk are most common in densely populated, urbanised and economically well-developed areas with substantial assets. The high cost of flood protection and other technical adaptation options (e.g., elevating buildings) often forestalls action in sparsely populated regions, with rural and economically disadvantaged areas typically exhibiting lower levels of structural adaptation.[1] If adaptation investments in wealthy communities are prioritised, while poorer and vulnerable communities are left without comparable levels of flood protection, this raises *questions about the fairness of public resource allocation*[1 8] and tends to *entrench existing social and spatial inequalities*. In the case of low-lying coastal systems, many examples of hard coastal infrastructure from the Global South have also been shown to *worsen the situation for marginalised groups*, because they

are often not protected directly, in contrast to wealthy areas and tourist locations[1 8], and often negative environmental consequences were most detrimental to poor informal settlements ***[criterion 4]***.[5]

- Implementation of flood protection measures can trigger zoning of new building land in protected areas and almost inevitably raises property values. If private owners of land and buildings are the main beneficiaries of state-financed protection infrastructure, this shifts the *distribution of private benefits and public burdens* towards an unfavourable ratio for the public, i.e. the collective of taxpayers. Moreover, rising property prices can negatively affect affordability of housing for lower-income groups, thus *putting additional burdens on vulnerable social groups* ***[criterion 4]*****.**
- Depending on context conditions, flood and coastal protection infrastructures can induce *maladaptive development pathways* that are *difficult or impossible to reverse, correct or retrac*t.[9] Often, implementation of protection measures triggers development intensification with new construction activities, expansion of settlement areas and in-migration of residents on supposedly 'protected' land.[10] In conjunction with increasing flood hazards due to climate change, this constantly increases exposure to (growing) residual risk, damage potentials and severity of consequences in case of overload or technical failure ('safe development paradox')[3 4 11 12]. Especially in countries with spatial planning policies that encourage withdrawing of hazard zone maps and associated restrictions for the zoning of building land after the construction of protective infrastructure ('protection-building-spiral', 'building land-revision dilemma'), this can *exponentially increase residual risk exposure, creating irreversible vulnerability lock-ins and inevitable damage and loss when technical limits are exceeded*.[5 13 14] In addition, the reliance on structural protection measures with their associated high, returning and accumulating costs can create *path dependencies with self-reinforcing dynamics* by tying up capital and by shaping the legal, administrative and mental framework conditions, thus displacing other adaptation solutions.[9 15 16] In terms of transformational potential, a majority of coastal protection measures have been found to keep things 'as they are', i.e. to defend the status quo of the areas being protected against changing environmental conditions without substantially changing existing practices and development pathways ***[criterion 5]***.[8]
- Flood and coastal protection infrastructures require high capital costs for construction and significant operating costs for maintenance. At the same time, the protective effects are limited to defined protection standards based on specified design events, e.g. 100-year return intervals, which currently rarely consider the impacts of future climate change on hazard processes.[4] As progressing climate change in many locations increases intensity and frequency of flood events, causing a shift in return periods to shorter statistical intervals[2], regular upgrading of protection structures, and thus permanent and constantly growing public investments are needed in order to maintain protection levels. This can cause the cost-benefit ratio to become highly unfavourable over time, and future trends in extreme events and long-term sea-level rise may even make it inevitable that the limits of adaptation are exceeded in the long run.[3] The combination of *excessive public costs*, vis-a-vis limited availability of financial resources, with *limited effectiveness* can create situations where protective infrastructures become maladaptive, especially in comparison to alternative adaptation options with a more favourable cost-benefit ratio and more beneficial adaptation outcomes (e.g. managed retreat, non-structural flood risk management through preventive spatial planning) ***[criterion 6]***.

- *Unrealistically high trust in public flood protection measures*, combined with lack of awareness about residual risk and reliance on social support in disaster situations can create *false feelings of security*, foster problem-avoiding behaviour and undermine the willingness of private actors (households, property owners) to take individual risk precaution measures.[7 17] In part, investing heavily in protection infrastructure can *inhibit autonomous adaptation action*, increase dependency on public risk reduction measures, and create perverse incentives for people to settle in areas that are only temporarily safe (e.g. flood embankments) or to remain in places and continue with activities that make them vulnerable in the case of a residual risk event happening ***[criterion 8]***.[3 6]

3. How to prevent and limit maladaptive effects

The possible maladaptation risks of hard protection infrastructures can be minimised by better incorporating climate change impacts in the planning and design of structural measures and by avoiding a one-sided focus on technical flood risk management solutions. The latter requires exploring a broad portfolio of alternative adaptation options in order to expand the solution space, which may involve a better distribution of adaptation responsibilities among public and private stakeholders. Strengthening preventive and risk-oriented approaches to land use planning and spatial planning emerges as a key strategy, because non-sustainable spatial development is the main driver of risk exposure and vulnerabilities.

- **Ex-ante assessment of maladaptation:** Screening and evaluating maladaptation risks of structural protection measures from an ex-ante perspective, especially in comparison to alternative solutions, allows choosing the most effective and sustainable risk reduction strategy with the least unwanted consequences, and it contributes to optimising the design and implementation of protective structures by minimizing adverse side-effects and trade-offs.

- **Preference for nature-based solutions:** Giving preference to nature-based solutions for flood risk reduction, wherever possible, avoids maladaptation risks related to capital-intense grey protective structures, while offering richer potentials for environmental, social and economic co-benefits as well as synergies with climate mitigation. Valorising ecosystem-based services for flood hazard prevention requires securing (and restoring) green spaces, such as natural flood runoff and retention areas, by steering them clear of building development.

- **Non-structural flood protection through preventive spatial planning:** Avoiding growth in flood risk exposure by containing expansion of settlement areas into – current and future – hazard zones is the most effective and macroeconomically most cost-efficient strategy for adaptation to risks from flooding and other natural hazard processes. At the same time, compact, inward-oriented and soil-saving settlement structures are key to both sustainable spatial development and reduction of GHG emissions. Limiting increases in spatial risk exposure, excessive land take and urban sprawl often requires more restrictive and enforceable planning regulations and practices, e.g. regarding the zoning of building land, the preservation of green spaces, or the binding implementation of hazard zone maps in spatial planning instruments.

- **Risk-based spatial planning and preventive approaches to coping with residual risk**: Moving from hazard- to risk-oriented spatial planning can contribute significantly to avoiding long-term vulnerability lock-ins and achieving climate-resilient spatial development. This may involve risk-differentiated protection goals and safety levels for different forms of land use, according to their different damage potentials, as well as risk-oriented criteria for zoning decisions and building design to steer land use intensities according to their damage potential, vulnerability and exposure. Reduction of residual risk can be achieved by systematically integrating residual risk in planning legislation, instruments and procedures and may include the maintenance of hazard zones and associated prohibitions for building activities after protection structures have been erected, legal requirements for flood-proof building design in residual risk zones, re-zoning of undeveloped building land in residual risk areas, and exploiting risk reduction potentials of building laws and building development plans.

- **Systematic consideration of climate change in flood risk assessments and in the design and maintenance of structural protection measures:** Coping with shifting return periods and increasing uncertainty of extreme events requires considering the impacts of climate change on flood dynamics in an anticipatory way in hazard zone mapping, protection standards and the design of protective infrastructure. Taking a precautionary approach could involve adding climate change safety margins or buffer surcharges to statistical design events of protection measures, which also reduces residual risk. In addition, it involves ensuring regular maintenance cycles that account for climate-related changes in the risk landscape.
- **Regional perspective to planning of protection measures:** Planning protection systems at regional scale, rather than focusing on individual structures at local scale, are more likely to avoid unintended re-distribution of vulnerability and risk to other places. Setting up cross-sectoral, multi-level coordination mechanisms for protective measures can be helpful in that regard.
- **Managed retreat from areas with high and growing risk:** Especially in high-risk areas with returning damage events and limited feasibility of technical protection, vulnerability lock-ins and inevitable long-term losses can be avoided by favouring managed retreat and relocation, in particular of highly vulnerable land uses and critical infrastructure, over incremental retrofitting of structural protection measures and new development activities. Even if the retreat is ultimately not realised, its discussion offers an opportunity for reassessing a community's readiness to adapt to high and growing risk[18].
- **Residual risk communication and participatory risk governance:** Clear communication of protection standards, safety levels, residual risk, and the limited effects of protection systems is needed to foster risk awareness, incentivise individual risk precaution measures and improve compliance with public risk reduction measures. Participatory risk governance processes should be applied to decide about acceptable vs. intolerable risk levels in a transparent way, and inclusive planning of protection measures can minimise adverse consequences for marginalised and vulnerable groups.

Annex 2: Green infrastructures as an example of institutional (mal)adaptation

1. Introduction

Green infrastructures (GI), including parks, green roofs, green facades, and green corridors, present a strategically planned network of natural and semi-natural areas integrated with other environmental features.[19] These systems are designed and managed to provide diverse ecosystem services, while simultaneously promoting biodiversity.[20] GI are recognised as an efficient, sustainable, and cost-effective approach to climate adaptation in urban areas, helping to cool cities during heatwaves and absorb excess water to mitigate flood risks during heavy rainfall. Given their numerous benefits for human health, environmental well-being, and urban safety, GI are often regarded as win-win and no-regret solutions.

2. Establishing the case of maladaptation

There is growing evidence, however, that under certain circumstances urban GI can contribute to green or climate-related gentrification. 'Gentrification' can be defined as 'a process in which the influx of a capital transforms a neighbourhood socially, economically, culturally, physically, and demographically,' [21] resulting in the potential displacement of low-income and socially marginalised residents. By extension, 'green gentrification' can be understood as 'new or intensified urban socio-spatial inequities produced by urban greening agendas and interventions, such as greenways, parks, community gardens, ecological corridors or green infrastructure'[22], that can contribute to rising property values, housing prices, and physical displacement of working-class residents and racialised groups and cultures. A link to maladaptive practice can be established, as the implementation of GI can lead to increased social vulnerability and diminished welfare, depending on how the adaptation measure was planned, implemented, monitored and evaluated, and especially if vulnerable and marginalised groups were involved or not. The maladaptive outcome, in this case, is caused by gaps in institutional frameworks, arising from the lack of housing laws or policies that safeguard these specific groups and cultures.

The intention of choosing and exploring the example of GI is not to ignore its proven positive effects, but to illustrate more deeply the range of possible negative effects that may lead to maladaptive outcomes in the long run. Taking these potential unintended consequences into account from the outset can harness the full exhaustion of GI's potentials and benefits as an effective and efficient adaptation measure, by ensuring that GI developments are inclusive and available to all residents. The following section illustrates two cases of maladaptive outcomes due to trade-offs with social sustainability and negative competition effects identified in recent scientific literature.

- Several cross-country studies highlight the potential negative impacts of GI on *social sustainability*. For example, a qualitative study conducted in European and American cities found that while citizens did not directly link GI to *'green gentrification'*, cities like Amsterdam, Barcelona, and several American cities are experiencing displacement due to green real estate developments and resilient greening.[23] *Increases in housing prices* associated with GI can lead to *displacement*, undermining climate equity and weakening social sustainability by *disproportionately affecting vulnerable groups*. This suggests the absence of housing laws or policies, which could act as social buffers to protect against such displacement, constituting a case of institutional maladaptation ***[criteria 4 and 7]***.

- Another study employing statistical and spatial methods across 28 cities in Europe[†] and North America tested the *'green gentrification'* hypothesis, distinguishing between cases where GI was either a primary or secondary driver. The findings revealed a strong and relevant relationship between greening efforts from the 1990s–2000s and gentrification between the 2000s–2016 in 17[‡] of the 28 cities. [24] These outcomes indicate that GI can contribute to negative competition effects, such as *rising rents and property values*, which *exacerbate social inequalities* and undermine the intended benefits of GI for climate resilience ***[criteria 4 and 7]***.

The studies show that while GI have multiple environmental, health and socio-economic advantages, greening policies can also lead to 'green gentrification' under certain circumstances, especially when potential trade-offs with social sustainability and negative market effects are ignored during the planning phase of the measure, and when no steps to evaluate the strategy were taken. In the long run, this can reinforce or create new social, health and racial inequalities undermining climate equity and justice.

3. How to prevent and limit maladaptive effects

- **Legal requirements/framework**: Implement rent control, rent stabilisation or anti-displacement policies in tandem with GI policies to ensure that the creation of green and climate responsive cities starts from an equity lens. GI strategies should focus on long-term health equity and social justice, while avoiding green cities that entrench the dynamics of unequal urban development.
- **Preparedness to deal with conflict:** Be prepared that rent control and anti-displacement policies may face political resistance, as landlords and developers may oppose these measures, arguing e.g. that they discourage investment or limit housing supply.
- **Impact and vulnerability assessments**: Robust impact and vulnerability assessments to identify potential threats, adverse side effects, and vulnerabilities associated with urban greening projects. This includes assessing factors such as socio-economic vulnerabilities to inform design and decision-making.
- **Ex-ante assessments:** Thorough ex-ante assessments prior to implementing GI projects, or any other adaptation action, to determine potential conflicts and trade-offs with social sustainability effects (e.g. physical displacement) and negative competition/market effects (e.g. rising property values).
- **Inclusive multi-stakeholder engagement:** Stakeholder involvement, including local communities, businesses, governmental agencies, and NGOs, in the planning and implementation of urban greening projects. Notably, giving special attention to adequately involving underrepresented groups and ensuring their meaningful participation in decision-making helps to understand possible side effects, incorporate diverse perspectives, build consensus, and ensure the projects meet the needs of all stakeholders.

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† The selected European cities included Amsterdam, Lyon, Nantes, Bristol, Sheffield, Valencia, Barcelona, Vienna, Copenhagen and Dublin.

‡ The results include European cities such as Nantes, Copenhagen and Edinburgh.

- **Adaptive management strategies**: Strategies must allow for flexible and iterative decision-making throughout the lifespan of urban greening measures. This involves monitoring, evaluation, and adjusting interventions based on changing conditions, emerging risks, and new information.

Annex 3: Maladaptive dimensions of insurance as an example of behavioural maladaptation to climate change

1. Introduction

Climate and disaster insurance is recognised for its clear benefits in coping with damage events and enhancing resilience. For individuals such as farmers or homeowners, insurance can significantly reduce the personal impacts of climate risks by supporting resilience and recovery. However, as outlined below, through various mechanisms, insurances can also include some maladaptive outcomes.

2. Establishing the case of maladaptation

While climate insurance offers notable benefits, growing evidence suggests it can also contribute to maladaptation by potentially:

- *inhibiting behavioural changes of insurance holders*. When having an insurance, people may be willing to take higher risks and make different choices with an often interim focus ('calculative rationality'). [25] [26] Farmers, for example, may align their management towards short-term high yields from intensive monocultures of insured crops, instead of long-term resilient production based on natural processes ***[criterion 8]***. [27]

- *sustaining risk exposure and increasing vulnerability*. Another behavioural shift is that individuals with insurance are inclined to lapse into false feelings of security and often feel less motivated to take proactive measures to mitigate climate risks or address residual impacts. By undermining the willingness to take complementary private prevention measures, procurement of insurance can thus become a stand-alone measure and have the effect of false incentive for inaction[28], hindering adaptive behaviours and systemic transitions.[26] Additionally, climate risks persist and tend to increase, having consequences for future generations ***[criteria 1, 5 and 8]***.

- *shifting vulnerability and unjust social distribution of costs and benefits*. Insurance is a strategy of risk transfer from those immediately exposed to another entity based on insurance premiums invested by many policyholders. As such, a single risk is averaged out over a broader group of people (market-based risk collectives, or society via compulsory disaster risk insurance), or sometimes even over governments (public disaster relief funds, as often done for floods). High reliance on damage compensation by risk collectives tends to decrease acceptance of additional private risk reduction measures, resulting in unnecessarily high individual vulnerabilities. Related higher damage costs are shifted to other insurance holders. [29] Through stimulating free-riding behaviour and re-distributing the costs of individual inaction to others, insurance schemes can thus undermine social justice and equity[9] ***[criteria 1 and 4]***.

- *leading to more inequity*. Not everyone can afford an insurance, resulting in unequal access to damage compensation in case of a climate-driven disaster[1] ***[criterion 4]***.

- *setting a narrow (financial) focus, while ignoring other aspects (e.g. justice) and alternative adaptation options.* Insurances generally focus on the financial compensation in case of an event, but often neglect negative effects on natural systems and thus on overall societal welfare ***[criterion 5]***.[27]

Thus, insurance can affect several criteria that establish a case of maladaptation; as pointed out above, climate insurance can reduce incentives to take adaptive action, increase and shift vulnerability (transfer in time and to others), lead to more inequitable outcomes, and thereby contribute to eroding sustainable development.

3. How to prevent and limit maladaptive effects

Various measures can be implemented to harness the benefits of insurance schemes for climate risks, while minimising their maladaptive aspects. Some of these measures pertain to the design of the schemes, while others focus rather on their implementation.

- **Ex-ante assessment:** Apply ex-ante assessments of possible maladaptive effects of insurance schemes, e.g. based on criteria as presented in this briefing, and establish a monitoring and evaluation system to reduce potential conflicts and trade-offs while fostering a learning effect.
- **Assess the need for climate insurance:** Insurance may not always be the most appropriate tool, especially in the agricultural sector. Setting up other financial schemes like stimulating certain types of adaptation measures could be more effective in reducing vulnerability.
- **Encourage diversity of solutions**: Agricultural insurance should be designed to maintain diversity (e.g. of crops, seeds, and management strategies) and should not reduce the farmer's set of choices of adaptation options.
- **Accompany insurance with information, advisory and learning programmes to limit potential risks:** For example, combining insurance with learning programs (e.g. applying diversity of crops in agriculture or more nature-based agriculture), information campaigns and pro-active personal advice can also introduce long-term climate resilience. Insurance-led climate resilience education programmes can play a role in raising awareness for the limitations of insurance and for the value of additional private risk prevention measures.
- **Integrate incentives for private risk reduction into insurance schemes:** Enhance insurance schemes by coupling the height of premiums, deductibles and/or public damage compensation payments with individual risk and protection levels. For example, by offering premium discounts for implementation of risk reduction measures, such as retrofitting measures for protection of private properties, precautionary behaviour can be rewarded and incentivised[27].
- **Limit the coverage of insurance:** Restricting the coverage of insurance, e.g. by not covering all extremes, can stimulate broader thinking on climate resilience. Clear rules on the conditions and thresholds at which damage compensation (from insurance companies or governments) can be expected can increase willingness to implement private risk prevention measures. Similar effects can be achieved by requiring personal financial contributions (deductibles).
- **Include conditionalities for social-ecological co-benefits in insurance contracts:** Tie insurance to ecological and social dimensions, e.g. by requiring certain ecological measures as part of an insurance contract or by introducing lower premiums for nature-based flood defence solutions.

Annex 4: Conflicts between EU Directives as an example of regulatory (mal)adaptation

1. Introduction

The EU Floods Directive aims to reduce the risk of flood damage, including climate-driven flood risk, in the EU and sets requirements for Member States to take adequate and coordinated measures. Planning and implementation of coordinated measures is based on member states' knowledge on flood extent and risk. Flood risk management is expected to be integrated in river basin management, by closely coordinating the Floods Directive with the Water Framework Directive, particularly in risk management plans, river basin management plans and public participation procedures. However, in practice, measures that reduce flood risk can conflict with goals set under the Water Framework Directive and Habitats Directive, and vice versa. The resulting need to prioritise between conflicting policy objectives and related regulatory frameworks in a given situation regularly causes unavoidable trade-offs, which can result in maladaptive outcomes. This is especially the case when requirements under the Floods Directive shift vulnerability to ecological systems or cause direct adverse impacts on water bodies and the conservation status of protected habitats and species, thus jeopardising goal achievement of the respective Directives. Similar conflicts may exist between other adaptation goals and environmental protection-related regulations. This example of maladaptive dimensions that may emerge from challenges in coping with conflicting policy objectives reflects on experiences made in Denmark, while being aware that other countries face similar changes.

2. Establishing the case of maladaptation

The bullet points below establish the case of maladaptation by providing examples that link the case to assessment criteria 1 ('vulnerability shift') and 3 ('trade-offs with environmental sustainability') presented in this briefing.

- Flood defences that retain water in river systems to reduce flood risk and potentially mitigate implications of drought can act as barriers for migrating fauna and flora in rivers, making them also more vulnerable to climate change impacts. Migration in river systems, including for spawning fish, is essential for maintenance of successful populations and thus for the biotic indicators of good ecological status under the Water Framework Directive ***[criteria 1 and 3]***.
- Retaining water in river systems requires the use of riverbanks and river-adjacent area, which are often high-value natural areas potentially protected under the Habitats Directive. The extent of flooding can vary spatially and temporally, but the status of the protected site can be negatively impacted, thus shifting vulnerability to ecological systems and causing implications for goals set under the Habitats Directive ***[criterion 3]***.
- Coastal habitats, highly valued and potentially protected under the Habitats Directive, are vulnerable to changes that could diminish their conservation status. Efforts to develop coastal protection measures to meet flood risk reduction requirements under the Floods Directive may inadvertently have negative impacts on the status of these protected sites, including to coastal habitats elsewhere along the coast ***[criteria 1 and 3]***.
- The examples above of flood defences can be developed as nature-based solutions, but there may be similar maladaptive implications for goals set in EU Directives. For example, re-wetting or

development of wetland areas for water retention may reduce fishes' spawning success upstream and result in changes to abiotic and biotic conditions in wet and dry habitats, with implications for goals under the Water Framework Directive and the Habitats Directive ***[criterion 1]***.

- Where trade-offs are unavoidable, the directives allow for an exemption process to overcome jurisdictional requirements. However, the maladaptive implications remain the same ***[criteria 1 and 3]***.

While shifts in vulnerability and conflicts or trade-offs with environmental sustainability are evident, the processes that result from attempts to reduce or overcome them may contribute to other maladaptive aspects. Examples of these are provided below:

- The processes required for carrying out environmental impact assessments and meeting data requirements and reporting needs of potential exemption processes under the Habitats Directive and Water Framework Directive are lengthy, time-consuming and very resource-intensive. Practitioners do not necessarily have the resources required, which may result in inefficiency and ineffectiveness in project implementation ***[criterion 6]*** and reduced incentives for adaptation ***[criterion 8]*.**
- The requirements set under the Habitats Directive and Water Framework Directive clearly provide benefits for nature protection and conservation. However, the requirement to protect nature under its current status rather than taking into account inevitable changes resulting from climate change, reduces the flexibility and potential for implementation of nature-based solutions. This can inhibit potentials for transformative adaptation ***[criterion 5]*** in that the Directives have a generally narrow focus on single risk for the respective sector.

3. How to prevent and limit maladaptive effects

Denmark, like other countries, is working to understand the dynamics of conflicts between goals set under the Directives mentioned above. These conflicts emerge in the context of climate change adaptation, but also as regards trade-offs between the need to develop renewable energy and conserve biodiversity. Denmark is comparing national implementation of these Directives in neighbouring countries and looking into how to work with the conflicts.

It is essential to assist Member States in navigating the unavoidable challenge of prioritising between climate adaptation efforts and the protection of nature and biodiversity. Generally, many synergies exist, and there is great potential to work along a spectrum of solutions that provide multiple benefits on the path towards overcoming the biodiversity and climate crises. However, beyond the theoretical ideal scenario, practitioners will regularly be faced with a need to prioritise. Therefore, the jurisdictional framework for the relevant sectors must be in line with reality. The new guidance on Natura 2000 and Climate Change presents some potential for flexibility, but it lacks in guiding Member States in cases when inevitable trade-offs must be made.

While clear and realistic EU guidelines for dealing with conflicting policy objectives may still result in continued shifts in vulnerability and ensuing conflicts or trade-offs with environmental sustainability, it still has the potential to reduce inefficiency and ineffectiveness, increase incentives for adaptation, and reduce inhibitions of transformative adaptation potentials.

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