Enabling and financing locally-led adaptation

White paper for the Elevating the Voices of Affected People working group of the CIFAR Alliance

Table of contents

Executive summary

The global community spends just USD 30 billion annually on climate adaptation. However, when you put this figure into perspective, it represents a mere 10% of the projected USD 387 billion required each year (UNEP, 2023). Furthermore, a limited proportion of this funding actually reaches developing countries and finances locally-led initiatives.

Locally-led adaptation is key. The most effective adaptation measures are those tailored to local needs and implemented at the grassroots level. This localized approach not only captures the immediacy of climate change impacts, but also ensures strategies resonate with the community's lived experiences. However, as with all strategies, certain barriers can impede progress, such as ecological and physical constraints, limitations in knowledge and resources, and social dynamics. Yet, despite these challenges, several standout characteristics define successful adaptation initiatives: a commitment to addressing the foundational causes of vulnerability, a drive toward community-led innovations, a strong inclination toward decentralized governance, a relentless focus on overcoming social barriers, and devolved finance.

Devolved climate finance is a mechanism designed to redirect climate finance to where it is most impactful: the local level. When local entities have resources and decision-making authority, they are empowered to spearhead climate resilience and adaptation efforts. Countries, such as Kenya, Mali, and Senegal, are testaments to this approach's efficacy, as they have incorporated decentralized finance mechanisms into their climate strategies. Central to the success of such mechanisms are principles, such as community-led planning, support to established institutions, emphasis on social inclusion, and a steady focus on public goods. Yet, several challenges persist, such as the fragmentation of funds, potential compromises in budget data quality, and issues of capacity and coordination.

The private sector is an often overlooked but critical player in adaptation financing. If enabled by international, philanthropic, and public sector funds, private finance's vast potential could usher in a new era of progress towards sustainable development goals and impactful climate adaptation. Blended finance, which combines public and private sector investments, offers a promising avenue to reduce risk and the weighted cost of capital, and to leverage capital to catalyze innovation and market transformation, at scale.

Over the past 25 years, a range of organizations, including MSC, have been instrumental in integrating local communities into the development, financing, and monitoring of projects. It is imperative to harness these accumulated insights to advance locally-led adaptation planning. A comprehensive approach should prioritize community involvement and incorporate existing regulatory, policy, climate science, and financial dimensions alongside the governance to monitor, evaluate, and learn from the implementation of locally-led adaptation plans.

We need a methodology that harmonizes national policies with local governance and future climate forecasts to provide a robust framework. A pivotal aspect of this strategy involves the diversification of financing mechanisms, which range from international climate funds to community-based organizations, and thus ensures an integrated approach to both planned and autonomous adaptation efforts. Digital technologies can potentially facilitate, accelerate, and mainstream locally-led adaptation planning and the governance functions of monitoring, evaluation, and learning, in order to refine and optimize adaptation initiatives.

We look forward to working with others and together learn ways to optimize and scale LLA planning through a range of approaches and tools.

Enabling and financing locally-led adaptation

The world spends roughly <u>USD 30 billion</u> on climate adaptation each year
However, this is just 10% of the <u>USD 387 billion needed</u> annually.

Furthermore, despite a growing realization among governments of the importance of locally-led adaptation

- No one seems to know how much of this limited funding reaches projects led by local communities,

- Private sector capital is scarcely involved, and

- Little has been done to leverage digital technologies to scale them.

Autonomous adaptation

Autonomous adaptations are initiatives by private actors rather than governments, usually triggered by market or welfare changes induced by actual or anticipated climate change (IPCC, accessed 2023).

Community dynamics play a pivotal role in autonomous adaptation. How communities perceive and respond to climate change is influenced deeply by their direct experiences, the memories associated with these events, and their inherent ability to adapt. Several determinants shape this reaction: the interplay between climatic events and non-climatic factors, community perspectives on vulnerability, the availability of resources and their adaptive capacity, the role of community organizations in mitigation, the importance given to rural livelihoods in the adaptation equation, and the proactive implementation of risk management strategies (Rahman and Hickey, 2019). See Appendix 1 for a more detailed discussion of these.

The need for local action means that it is essential to prioritize local perspectives and elevate the voices of affected people. This need has given rise to a range of participatory approaches (see, for example, Döll and Romero-Lankao, 2017; Newig and Koontz, 2013; Norström et al., 2020) – from Williams, 2020.

> **In climate-vulnerable communities, successful autonomous adaptation efforts encompass measures to maintain livelihood activities, protect shared infrastructure, and create strategies to overcome social obstacles related to climate change adaptation.**

See Appendix 2 for a discussion of the six key lessons learned from successful autonomous adaptation.

The interplay between planned and autonomous adaptation

Of course, autonomous adaptation alone is not always the most effective. For instance, coordination of efforts across an entire river basin can prevent unintended negative consequences. An example would be constructing a dam that supplies water to one community but harms those downstream. Similarly, multiple communities that dig wells in an unplanned and uncoordinated manner could lower the water table and cause widespread harm. Such actions can lead to maladaptation. (Girot et al., 2012). See Appendix 3 for a discussion of maladaptation.

At the top of the six key lessons from successful autonomous adaptation was "**Build congruence between planned and autonomous adaptation.**" In contrast to autonomous adaptation, planned adaptation results from a deliberate and typically top-down policy choice made with the awareness of changing conditions. The goal is to restore, maintain, or achieve a desired state. (See Appendix 4 for a useful range of classifications of adaptation).

Autonomous and planned adaptation strategies and activities must be coordinated and aligned to maximize the potential for success and minimize the risk of maladaptation—see table below.

		Planned adaptation creates conditions for autonomous adaptation	Planned adaptation does not create conditions for autonomous adaptation
Autonomous adaptation is incorporated into planned adaptation	Potential for sustainable adaptation[1]:	High	Low
	Potential for maladaptation	Low	Moderate
Autonomous adaptation is not incorporated into planned adaptation	Potential for sustainable adaptation	Moderate	Low
	Potential for maladaptation	High	High

Modified from Rahman et al., 2021

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[1] Eriksen et al. (2011) propose four principles of sustainable adaptation: i) recognition of the context for vulnerability, including multiple stressors; ii) acknowledgement of different values and interests that affect adaptation outcomes; iii) integration of local knowledge into adaptation responses; and iv) consideration of potential feedback between local and global processes.

Policy disconnect in northeastern Bangladesh

A noticeable gap persists between government-led adaptation initiatives and the actual practices of affected communities in northeastern Bangladesh. This discrepancy may arise from the contrasting views on vulnerability between government bodies and impacted communities. For instance, the Bangladesh government's actions lean heavily on future climate predictions and are thus technocentric and institution-centric. Conversely, affected communities base their strategies on socioeconomic realities and specific contexts (O'Brien et al., 2007). This calls for a bilateral learning approach in adaptation planning that involves both local governments and vulnerable communities, as recommended by Engle (2011)

- from Rahman and Hickey, 2019.

Optimized climate adaptation requires collaboration between the government, especially local government, and local communities to plan, implement, and monitor locally-led adaptation.
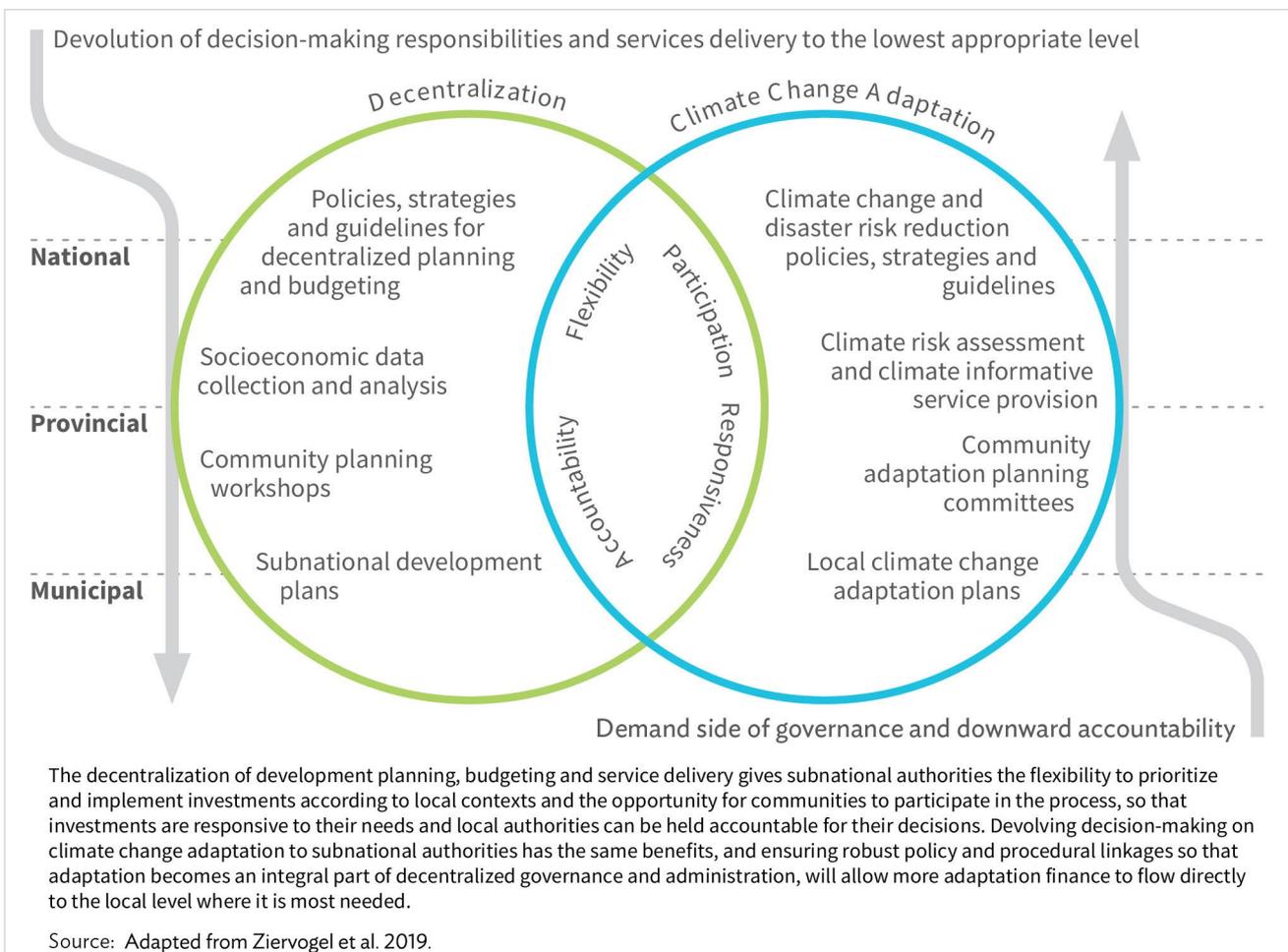
Locally-led adaptation

Synergies and benefits from locally-led adaptation

As discussed above, climate risk primarily emerges at the local level. Effective adaptation measures, tailored to local needs and priorities, have proven successful when implemented close to the affected communities through a combination of planned and autonomous adaptation (Quevedo et al. 2019). Therefore, it makes sense that subnational jurisdictions, which are directly impacted, should take responsibility for adaptation. National governments and public funds provide the regulatory and policy environment, oversight, and finance for the initiatives with participation from philanthropies and the private sector. At the same time, subnational levels design, plan, and implement adaptation measures alongside affected communities.

This approach resonates with two core principles from the general decentralization theory:

1. **Subsidiarity:** If services can be provided at multiple levels, they should be entrusted to the most local government level. This level should align with the region that benefits from those services.

2. **Correspondence:** A governing body's jurisdictional boundaries that provide a service should match the region that benefits from that service (Martinez-Vazquez 2021).

Synergies and overlapping benefits of decentralization and locally led climate change adaptation

Devolution of decision-making responsibilities and services delivery to the lowest appropriate level

Decentralization — Climate Change Adaptation

National
- Policies, strategies and guidelines for decentralized planning and budgeting
- Socioeconomic data collection and analysis

Provincial
- Community planning workshops

Municipal
- Subnational development plans

Flexibility · Participation · Accountability · Responsiveness

- Climate change and disaster risk reduction policies, strategies and guidelines
- Climate risk assessment and climate informative service provision
- Community adaptation planning committees
- Local climate change adaptation plans

Demand side of governance and downward accountability

The decentralization of development planning, budgeting and service delivery gives subnational authorities the flexibility to prioritize and implement investments according to local contexts and the opportunity for communities to participate in the process, so that investments are responsive to their needs and local authorities can be held accountable for their decisions. Devolving decision-making on climate change adaptation to subnational authorities has the same benefits, and ensuring robust policy and procedural linkages so that adaptation becomes an integral part of decentralized governance and administration, will allow more adaptation finance to flow directly to the local level where it is most needed.

Source: Adapted from Ziervogel et al. 2019.

(From Asian Development Bank, 2023)

However, these subnational jurisdictions must work with people vulnerable to climate change and most affected by it.

> **A combination of planned and autonomous adaptation strategies and activities will help secure the buy-in of affected communities and achieve the full potential of these locally-led adaptation measures.**

Barriers to locally-led adaptation

However, stakeholders must factor in three key barriers to adaptation into these locally-led adaptation plans and activities.

Conceptual grouping of limits and barriers to adaptation
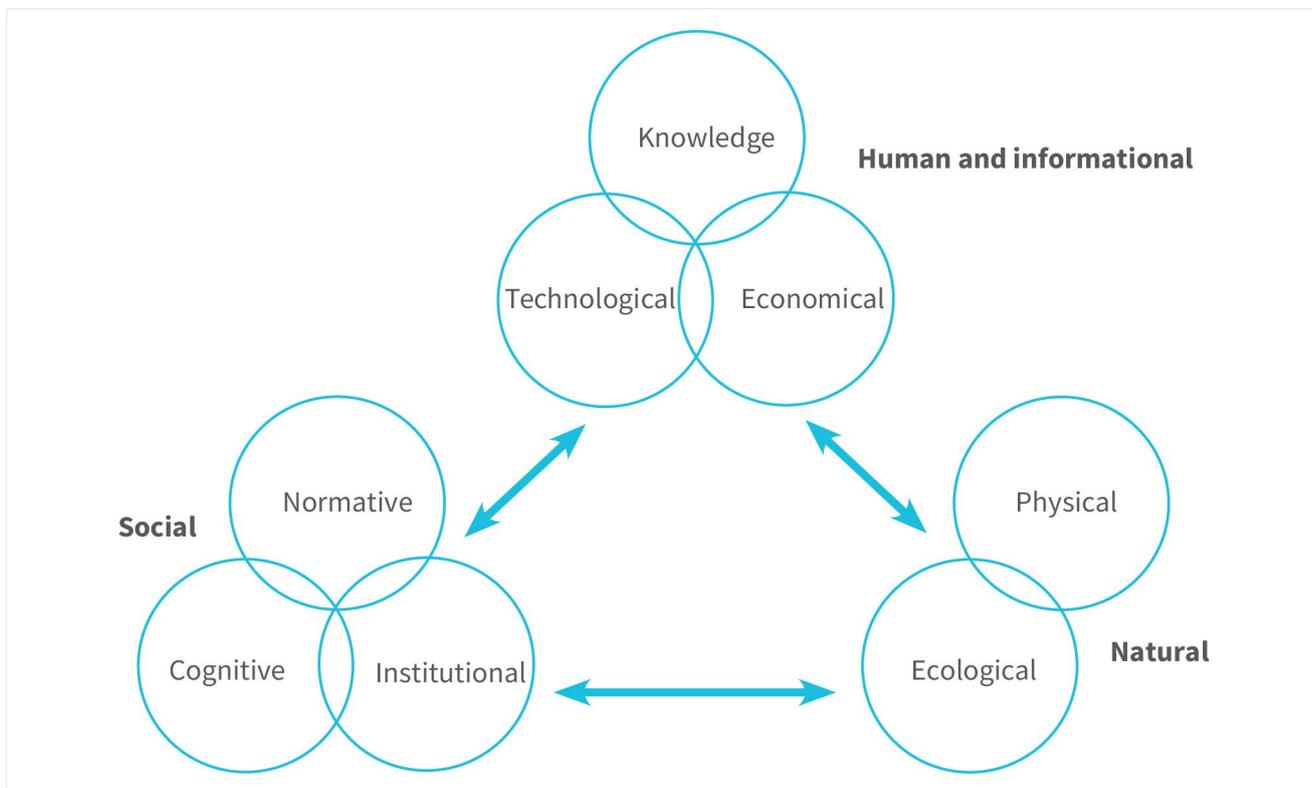
From Jones, 2010

1. **Ecological and physical limits:** These are natural barriers to adaptation deeply rooted in the environment, such as seawalls to protect from the impact of coastal erosion. These limits encompass everything from the boundaries of ecosystems to geographical and geological constraints. Furthermore, many forms of adaptation may face hard ecological and physical limits, so adaptation is no longer possible.

2. **Limits based on human and informational resources:** This category includes barriers, such as knowledge constraints, technological limitations, and financial restrictions. Challenges in this domain arise from uncertainties in forecast modeling, a lack of awareness among policymakers on the effects of climate change, and insufficient funds and support to create effective adaptation strategies. For example, drought-prone areas depend on meteorological data for water management, but forecasting uncertainties and financial limits pose challenges.

3. **Social and behavioral barriers:** These are rooted in human psychology and behavior, as well as in the structure and norms of institutions. They determine how individuals and societies respond to climate stress and change. Despite their significance, broader discussions about adaptation often overlook these barriers (see Table 1: Elements of social barriers to adaptation below for more details). Furthermore, there are very real risks of "elite capture" through which local elites benefit disproportionately from the interventions (Sovacool, 2017). Hence, the effective management of inter- and intra-community dynamics is essential to ensure that the voices of those who are most vulnerable are heard. We must be constantly aware that discrimination and social exclusion can exacerbate vulnerability to climate change.

Table 1: Elements of social barriers to adaptation

Social barriers	Examples
Cognitive	• Belief that uncertainty is too great to warrant taking adaptation action now • Lack of acceptance of risks associated with implementing adaptation action • Change not yet seen as a problem: temptation to wait for the impact then react
Normative	• Cultural norms that discourage change and innovation: an unwillingness to adopt new practices • Traditional means of reacting to climate stress and shock may no longer be appropriate given that there is no cultural memory when it comes to future climate change • Restrictive traditional and religious norms (i.e. reliance on traditional means of weather forecasting and planting, restricted role of women in the household/community, dependence on traditional means of coping with climate hazard
Institutional	• Institutional inequities and social discrimination restrict access and entitlement for certain groups • Social/cultural rigidity: lack of institutional flexibility

From Jones, 2010

Characteristics of successful locally-led adaptation initiatives in climate-vulnerable communities

A growing body of evidence has emerged on the drivers of successful locally-led adaptation and ways to overcome barriers:

1. **Addressing drivers of vulnerability:** Autonomous adaptation initiatives that address the root causes of vulnerability helped climate-exposed communities build resilience. For example, in Bangladesh, initiatives that address poverty, food insecurity, and access to healthcare enhanced the local communities' resilience to the impacts of climate change (Malik et al., 2010).

2. **Community-led innovations:** Local communities have developed successful and innovative solutions to adapt to the impacts of climate change. For example, in the Philippines, local communities have developed a range of autonomous adaptation initiatives, including the use of traditional knowledge to manage water resources and the development of community-based early warning systems (Rahman et al., 2021).

3. **Decentralized governance and administrative frameworks:** The integration of climate change adaptation with decentralized governance and administrative frameworks can effectively scale up local adaptation measures. For example, in Nepal, the government has established a decentralized governance system that empowers local communities to manage their natural resources and adapt to the impacts of climate change (Asian Development Bank, 2023). However, the World Bank, 2022 highlighted Nepal's challenges with coordination, technical capacity, and financial resources.

4. **Overcoming social and behavioral barriers:** Overcoming social barriers to climate change adaptation enhances the resilience of climate-vulnerable communities. For example, in Uganda, initiatives that address gender inequality and social exclusion empowered local communities to enhance their resilience to the impacts of climate change (Jones, 2010).

These examples show that autonomous adaptation initiatives that address the drivers of vulnerability, community-led innovations, decentralized governance, administrative frameworks, and overcoming social barriers can successfully build resilience among climate-vulnerable communities.

> **Supporting local communities and local governments with the resources and decision-making power they need to address climate change can facilitate inclusive adaptation and enable climate resilience at the local level.**

Finance is the key (often missing) ingredient in locally-led adaptation

Financial resources for effective locally-led adaptation

Effective locally-led adaptation strategies prioritize the local communities' decision-making authority in addressing climate change. They also provide the necessary resources and support for informed climate adaptation investments. However, many adaptation strategies remain top-down and are typically managed by donors, major intermediaries, and central governments. A study by WRI revealed that of 374 community-focused interventions, only around 6% incorporated local-led components, such as local decision-making. This highlights how the barriers to locally-led adaptation must be addressed urgently.

Nonetheless, despite the recognition of the need for resources, **how** to finance locally-led adaptation is largely absent from the literature—a notable exception is IIED's "The good finance guide for investing in locally-led adaptation" (IIED, 2022).

> **However, finance remains the key missing ingredient for successful adaptation.**

Insufficient financing hinders scaling localized solutions, capacity building, and technology adoption. It harms project sustainability and risks unequal distribution of adaptive capabilities across communities.

Several challenges hinder the shift toward financing locally-led adaptation. These include complex funding distribution mechanisms; unclear procedures for planning, consultation, and decision-making; inconsistent and hard-to-access data on budgets and international aid; and limited resources that prevent governments from examining if local or global financing supports local adaptation.

Seven essential principles to effectively finance locally-led adaptation

Patel et al., 2020 highlight seven principles to finance adaptation effectively. Unsurprisingly, the first two reflect the principles outlined by the Asian Development Bank, 2023 above:

1 **Subsidiarity:**	Decisions should be made as close as possible to those most impacted. This ensures designs tailored to specific areas, local relevance, and enhanced accountability toward the most vulnerable.	
2 **Convergence:**	No single action can address all climate-related risks. Coordinated efforts across different financiers and governments are essential. However, convergence is under-documented, which makes its assessment challenging.	
3 **Robust decision-making:**	Local stakeholders need to thoroughly understand climate risk and uncertainties. This ensures both current climate risks and generational insights inform their choices.	
4 **Patient and predictable:**	Long-term perspectives in climate finance are vital. They allow risks to be addressed, capacities to be enhanced, and learning to be continuous.	
5 **Flexibility:**	Adaptive programming is essential, given the unpredictability of climate change.	
6 **Risk-taking:**	Early investments in local institutions unfamiliar with managing climate finance are essential but should focus on data, technology, and capacity building from the outset.	
7 **Predictability:**	Local stakeholders should be able to rely on consistent or future financial support (Coger et al., 2021).	

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An empowerment-driven approach for locally-led adaptation

Climate financiers must adopt a hands-on, empowerment-driven approach to drive impactful change within marginalized communities. This means meticulous alignment of their procedures with the "Seven essential principles to effectively finance locally-led adaptation" outlined above. The process could be further democratized by clear, tailored policies in local languages, and acceptance of diverse forms of proposal submissions, such as videos and audio descriptions.

Instead of a top-down directives, stakeholders should commit to shared accountability and blend the wisdom of generations with cutting-edge climate science. This vision also requires a commitment to long-term financial backing, with a horizon that spans a decade or more. Early investments should flow into capacity building to foster enduring institutional evolution. A continuous, hands-on learning journey should be the default instead of the constraints of stringent resilience frameworks. Indicators should be designed to highlight and celebrate local-led initiatives, all while ensuring that budgetary strategies are nimble enough to accommodate the unpredictable nuances of our evolving climate landscape (Patel et al., 2020).

See Appendix 5: WRI's Review of LoCAL's program for an example of how some of these approaches are being implemented in practice.

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Strategies to boost funding for locally-led adaptation

Locally-led adaptation prioritizes local entities in decision-making on community investments. This approach fundamentally deviates from conventional finance practices. While tracking and reporting finance is vital, stakeholders must also bolster local leadership, promote public involvement, balance decision-making power, address societal disparities, and enhance the accessibility, quantity, and quality of adaptation finance. Coger et al., 2021 note three high-level strategies to increase funding for locally-led adaptation:
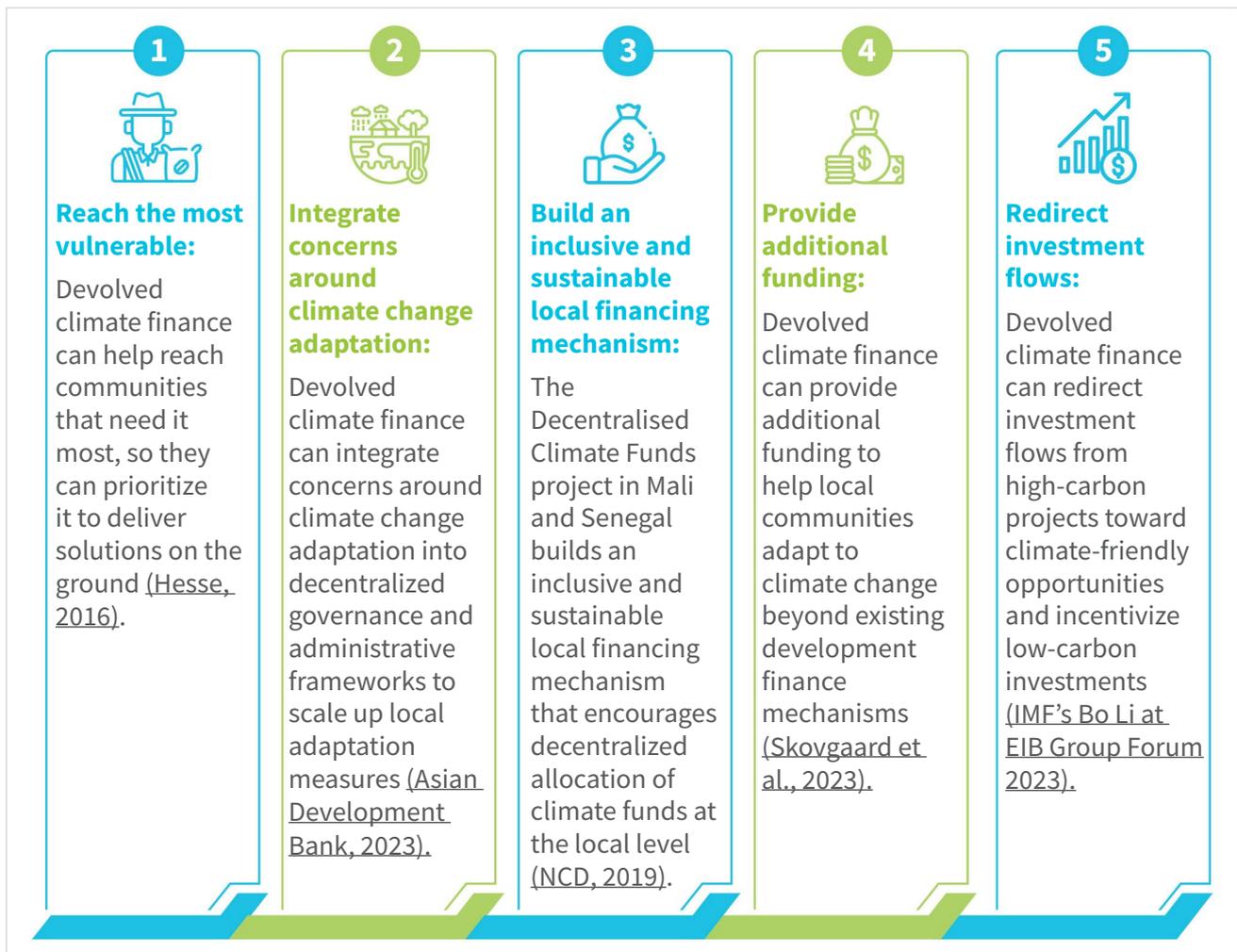
1. **Implement climate budget tagging**: This tool should be used to pinpoint investments relevant to climate concerns. Governments should enhance current budget tagging methods and integrate tracking for local adaptation finance. This can be achieved using specific codes or weights that align with carefully defined quality metrics, although significant challenges remain. These include a lack of sufficient data and expertise at local levels, which can be overcome by incorporating a strong learning component to share insights and solutions among the local governments (World Bank, 2021). For example, LoCAL directly funds local governments, and its finance management system employs unique codes to isolate climate adaptation investments. These codes simplify tracking of these finances and make them more effective. Also, LoCAL has established performance-based climate resilience grants that incorporate specific quality metrics, such as climate adaptation planning and climate-responsive budgeting.

2. **Conduct expenditure reviews**: When expenditure reviews tag budgets, they focus on current budgets and analyze past spending. As many governments already employ various public expenditure reviews to blend climate finance into their plans, a similar approach can help trace finance allocated for locally-led adaptation. Previous efforts to use this approach offer important lessons (UNDP, 2015). For example, LoCAL's program design involves public expenditure and financial accountability (PEFA) assessments to ensure financial management efficacy and examine past spending on climate adaptation. It evaluates the expenditure on resilience and adaptation actions through periodic checks for future budget allocation.

3. **Use established policy and planning measures**: Many nations already report country-level adaptation finance, which presents chances to include tracking for locally-led adaptation finance. Relevant activities might encompass surveys of regional climate actions, the National Adaptation Planning process, and the UNFCCC's biennial finance overview (UNFCCC, accessed 2023). For example, LoCAL aligns its actions

with national adaptation plans and broader climate finance reporting mechanisms. It facilitates local adaptation actions that could reflect in national surveys of regional climate actions to track locally-led adaptation finance.

The OECD notes the importance of performance metrics, localized SDG targets, and indicators that can underpin climate action as a shared roadmap to align development cooperation with national climate objectives. It also recommends policy and results-based financing modalities. It notes that the focus on climate finance's overall outcomes and lasting impacts should be strengthened to ensure climate finance access enables effective mitigation and adaptation results (OECD, 2023).

The potential of devolved climate finance

Devolved climate finance, also called decentralized finance, can help address climate change at the local level in the following ways:

1	**2**	**3**	**4**	**5**
Reach the most vulnerable:	**Integrate concerns around climate change adaptation:**	**Build an inclusive and sustainable local financing mechanism:**	**Provide additional funding:**	**Redirect investment flows:**
Devolved climate finance can help reach communities that need it most, so they can prioritize it to deliver solutions on the ground (Hesse, 2016).	Devolved climate finance can integrate concerns around climate change adaptation into decentralized governance and administrative frameworks to scale up local adaptation measures (Asian Development Bank, 2023).	The Decentralised Climate Funds project in Mali and Senegal builds an inclusive and sustainable local financing mechanism that encourages decentralized allocation of climate funds at the local level (NCD, 2019).	Devolved climate finance can provide additional funding to help local communities adapt to climate change beyond existing development finance mechanisms (Skovgaard et al., 2023).	Devolved climate finance can redirect investment flows from high-carbon projects toward climate-friendly opportunities and incentivize low-carbon investments (IMF's Bo Li at EIB Group Forum 2023).

Devolved climate finance—examples and lessons learned

> **Devolved climate finance (DCF) is designed to direct climate finance to its most impactful location: the local level.**

This approach grants decision-making authority and resources to local communities and governments, and empowers them to foster climate resilience and adaptation. Central to this strategy is the recognition that local populations have deep and intricate insights on climate strategies—to increase funding for locally-led adaptation and associated risks.

Countries, such as Kenya, Mali, and Senegal, have adopted decentralized climate finance mechanisms (IIED, 2016). These serve as practical illustrations of the power of devolved governmental structures to bolster local climate resilience (IIED, 2021). These mechanisms employ climate information services for improved planning and use monitoring and evaluation techniques to facilitate continuous learning.

Kenya has established the first national-scale model of devolved climate finance with the Financing Locally-Led Climate Action (FLLoCA) Program, which supports the government to translate its ambitious climate agenda into scaled-up action on the ground (Arnold and Soikan, 2021 and World Bank, 2021).

The Local Climate Adaptive Living Facility (LoCAL), which operates in 34 less-developed countries (LCDs), including Niger, Lesotho, and Cambodia. LoCAL underscores the importance of local governments in driving locally led adaptation. This program bridges the gap between climate finance, national climate directives, and adaptation actions at the community level using performance-based grants for local governments. However, while LoCAL supports LLA, it cannot transform entrenched power structures alone and needs broader stakeholder engagement (Dinshaw and McGinn, 2023).

Core principles of a successful devolved climate finance mechanism

The Devolved Climate Finance (DCF) Alliance presents a pioneering framework to channel investments into local public amenities and establish the right conditions for sustainable development (IIED, 2021).
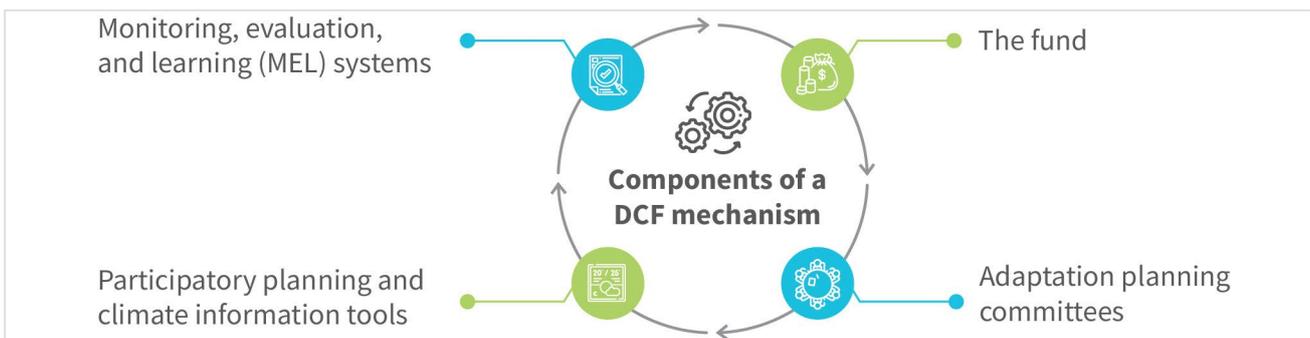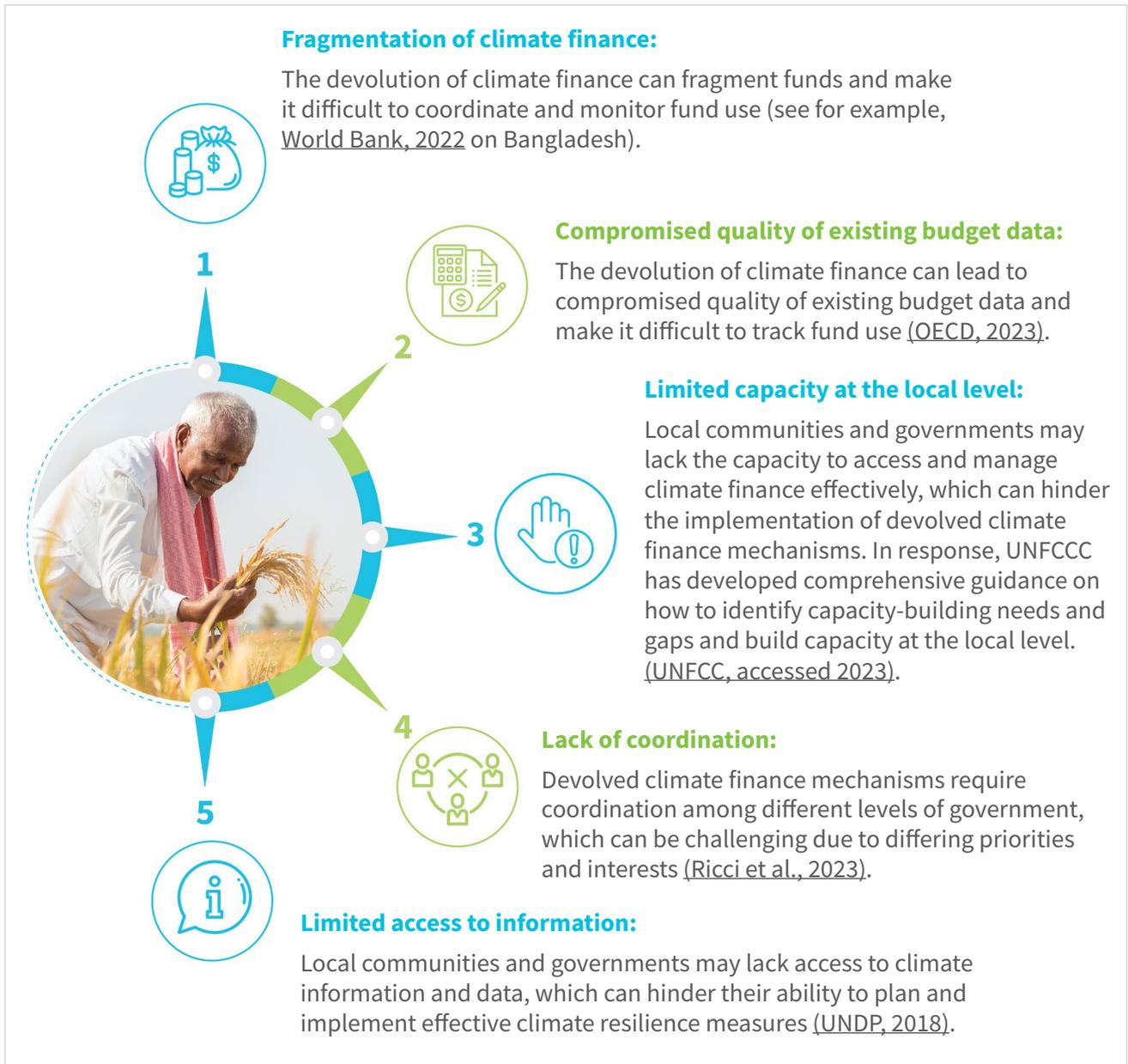

DCF operates on five foundational principles and seeks to address governance and climate challenges:

1. **Community-led planning**: It prioritizes participatory grassroots-level planning.

2. **Support for existing institutions**: The mechanism is anchored within current devolved structures and backs them.

3. **Social inclusion**: It promotes the inclusion of those most vulnerable to climate change.

4. **Adaptive management**: It employs a flexible approach to build resilience investments.

5. **Public goods focus**: The mechanism underscores public investments and emphasizes community reliance on shared resources, such as forests, water, and grazing areas.

See Appendix 6 for the DCF Alliance's insights from DCF Implementation.

Challenges to the implementation of devolved climate finance

The implementation of devolved climate finance mechanisms can be challenging for several reasons, which include:

Fragmentation of climate finance:

The devolution of climate finance can fragment funds and make it difficult to coordinate and monitor fund use (see for example, World Bank, 2022 on Bangladesh).

1

Compromised quality of existing budget data:

The devolution of climate finance can lead to compromised quality of existing budget data and make it difficult to track fund use (OECD, 2023).

2

Limited capacity at the local level:

Local communities and governments may lack the capacity to access and manage climate finance effectively, which can hinder the implementation of devolved climate finance mechanisms. In response, UNFCCC has developed comprehensive guidance on how to identify capacity-building needs and gaps and build capacity at the local level. (UNFCC, accessed 2023).

3

Lack of coordination:

Devolved climate finance mechanisms require coordination among different levels of government, which can be challenging due to differing priorities and interests (Ricci et al., 2023).

4

Limited access to information:

Local communities and governments may lack access to climate information and data, which can hinder their ability to plan and implement effective climate resilience measures (UNDP, 2018).

5

Digital technology can help address many of the challenges to the implementation of devolved climate finance mechanisms through improved access to finance, enhanced transparency and accountability, and support for climate action and resilience (IIED, 2019 and DF4CR accessed 2023).

> **Despite challenges, careful planning and coordination and the use of digital technology can ensure effectively devolved climate finance, to enable local government structures to enhance climate resilience.**

# However, the role of the private sector has been largely overlooked

> **The private sector has significant potential to meet Africa's climate finance needs, but** nationally-determined contributions from governments (NDCs) **rarely discuss its role**. Public funding alone will not be sufficient, given the magnitude of investments needed, and current and future constraints on public domestic resources in the continent. However, most current climate financing in Africa is from public actors (87%, USD 20 billion) with limited finance from private players (Guzman et al., 2022).

IIED's highly regarded primer on locally-led adaptation financing has very few examples of private-sector funding for LLA (IIED, 2022). WRI's recent paper concluded that "with supportive financial structures in place, the private sector can scale up investment in climate change adaptation—and in fact could play an essential role in closing the substantial adaptation finance gap" (WRI, 2023). Research indicates that Kenya has made significant efforts to prepare itself for climate finance, as evidenced by its climate-focused policies, laws, and institutions. However, the country has room to improve, especially in how well it acknowledges and bolsters the private sector's role in this arena (Kiremu et al., 2021). The World Bank's Climate and Country Development report for Bangladesh makes the case that LLA can help crowd in financing for MSMEs for climate resilience (World Bank, 2022).

International and national public sector funds alone will fail to provide the enormous sums of money required to support adaptation and build resilience among vulnerable communities across the globe. For example, the African Development Bank notes that "to close Africa's climate financing gap by 2030, approximately USD 213.4 billion will need to be mobilized annually from the private sector to complement constrained public resources" (AfDB, 2023).

> **Wherever possible, these public funds should be used to enable and leverage private sector financial services and capital.**

Blended finance, which combines public and private sector investments, offers a promising avenue to reduce risk and the weighted cost of capital, and to leverage capital to catalyze innovation and market transformation, at scale. The public sector, which includes national governments and multilateral development banks, such as the EIB, can offer initial risk protection through investments, equity capital, or improved credit conditions. If development partners and multilateral banks focus on equity rather than debt, they can prevent increasing the debt load of developing nations (IMF's Bo Li at EIB Group Forum 2023). See Appendix 7 for a high-level overview of financial instruments that could be used to mitigate risk for LLA and encourage private sector investment in it.
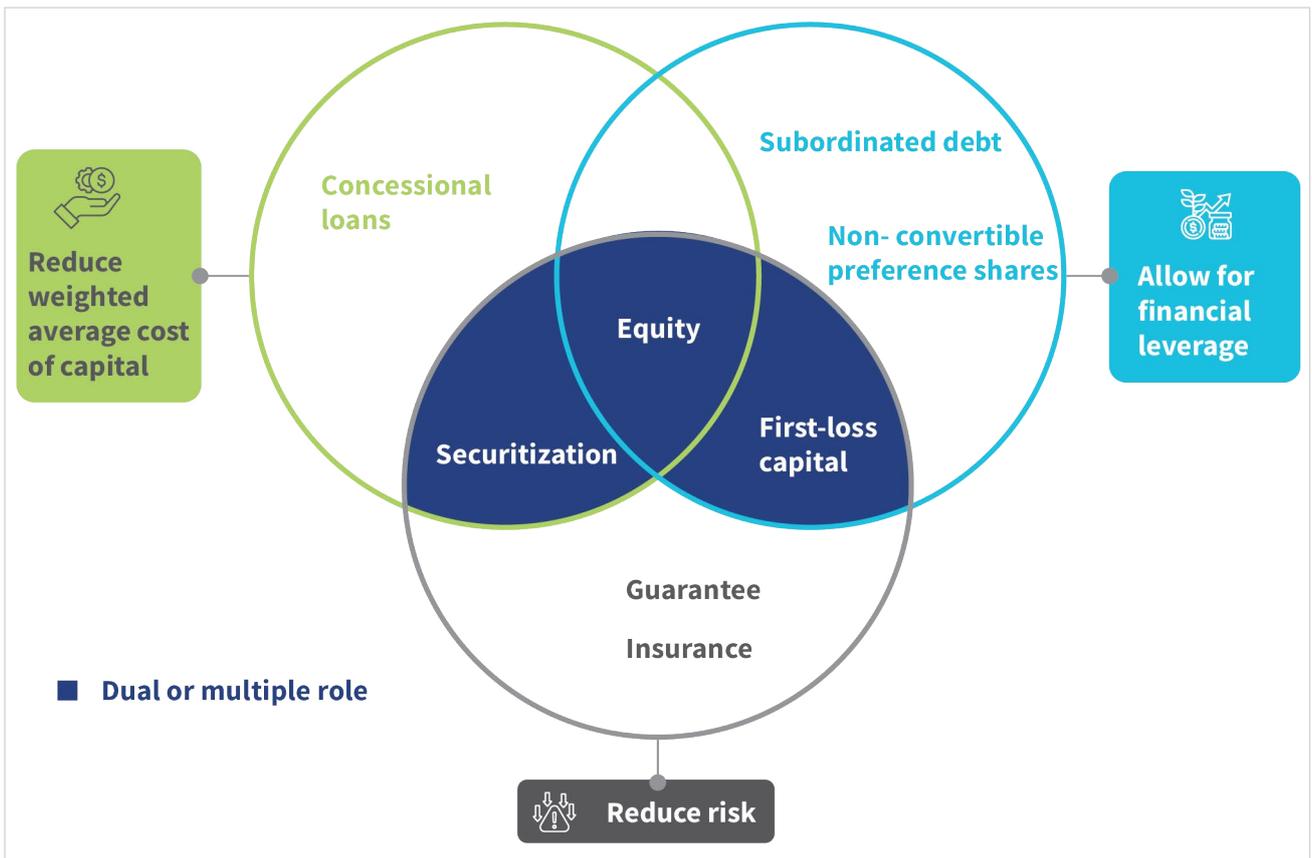
> **The private sector holds the most significant amount of capital, and it is crucial to align this capital with climate and sustainable development objectives.**

While public finance is smaller in scale, it remains vital since policymakers can directly control it, and it funds public goods and services that the private sector may not support. When used correctly, public finance can boost private investment as it can promote markets, drive innovation, and minimize risk (Amerasinghe et al. 2019).

For example, a profound disconnect often occurs between financial services and the communities most vulnerable to climate change. These communities are often poor and remote, so financial service providers cannot serve them profitably. Moreover, these communities often depend on smallholder agriculture and are thus subject to covariant risk, a problem that climate change amplifies, which makes them less attractive to institutions that offer credit or insurance services. The digital revolution and the advent of digital financial services could play an important role to address these challenges. Nonetheless, public and philanthropic funds will likely be required to manage risk through first-loss guarantees alongside other innovative approaches.

One approach to locally-led adaptation planning and financing

For 25 years, MSC has involved local communities in the planning, financing and monitoring of development initiatives. A range of other agencies[2] have also developed impressive tools that facilitate participatory planning. We will need to learn from this experience and build on it. Effective locally-led adaptation planning and financing require us to build on that experience to develop an approach that also provides inputs on the regulatory and policy environment, the future impact of weather and climate change, and the financial landscape—from the international to local level. At the same time, participatory planning must involve capacitated local government agencies even as it empowers poor and vulnerable communities to be heard. This will be essential to align and coordinate planned and autonomous adaptation.

The My Climate Risk Lighthouse seeks to develop and mainstream a "bottom-up" approach to regional climate risk, which starts with decision-makers' requirements. "Risk" encompasses the combination of hazard, vulnerability, and exposure specific to a given regional context. Climate information will be made meaningful at the local scale through a new framework to assess and explain regional climate risk using all the available sources of climate information, such as observations, re-analyses, model simulations, and better understanding. The My Climate Risk Lighthouse seeks to "empower local communities to be able to make sense of their own situation, which can be addressed by developing methodologies to produce and analyze climate information that builds trust and transparency" (Rodrigues and Shepard, 2022). See Appendix 8 for more details.

Satellite and AI-driven digital technologies could be important to help with the locally-led adaptation planning process. See, for example, Ushahidi, Amini and CropIn. This area requires more research and testing. Digital technologies can potentially facilitate, speed up, and scale locally-led adaptation planning, alongside the governance functions of monitoring, evaluation, and learning to refine and optimize adaptation initiatives (Wright, forthcoming). Similarly, carbon-offsetting initiatives, such as the Northern Kenya Carbon Program, are built on the promise of delivering benefits of offsetting initiatives to local communities through their locally-led adaptation measures. However, the mechanics of how such interventions will work to reflect the values and ambitions of locally-led adaptation are not yet clear. Carbon offsetting schemes also often struggle to deliver money to the vulnerable communities they seek to benefit. Again, digital technologies, such as CaVEx, could provide a significant opportunity to address these challenges. See Appendix 9 for more details on digitally-enabled locally-led adaptation.

In the diagram below, we outline our proposed approach, noting that it is designed specifically to address the following challenges:
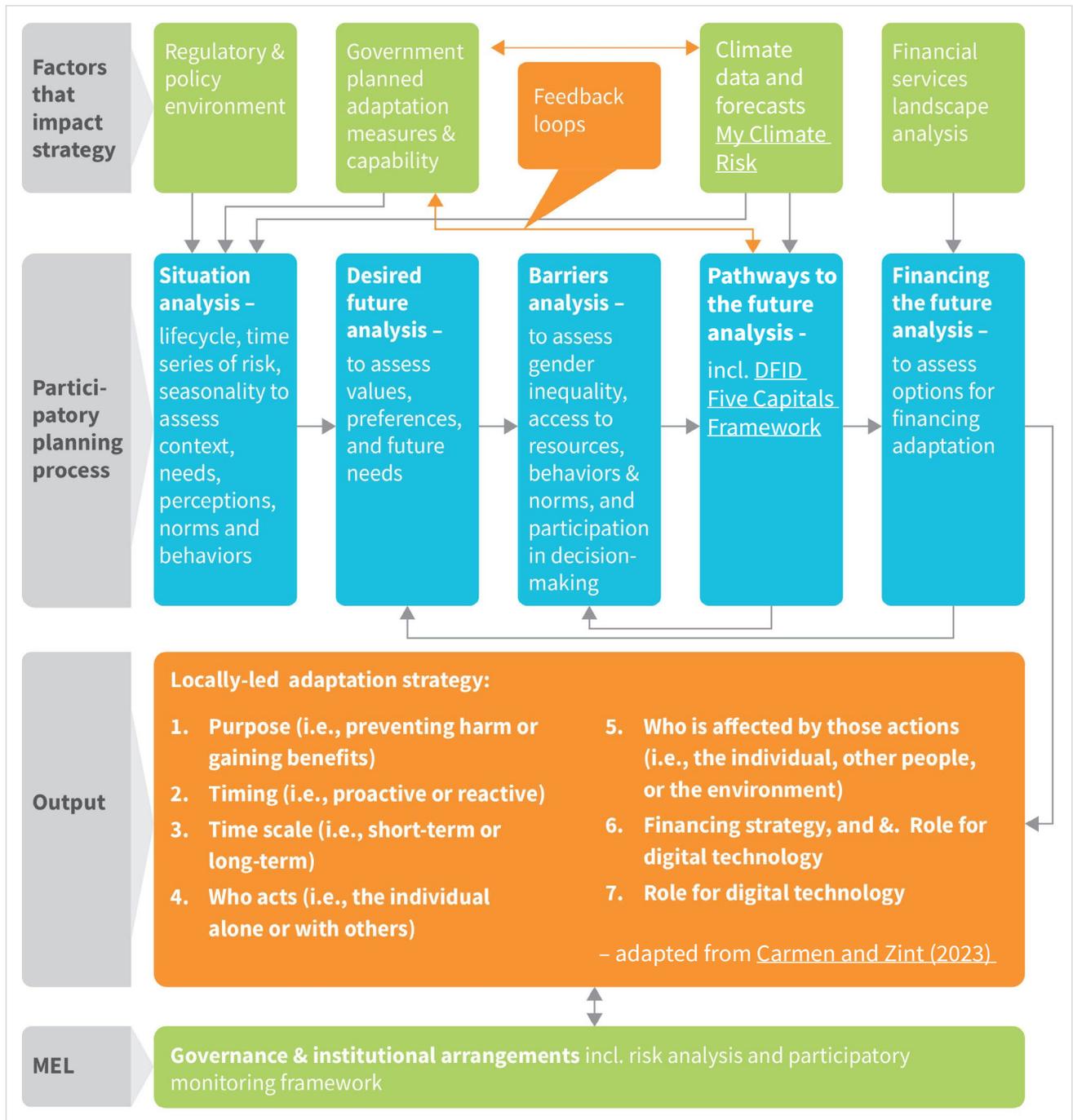
1. How to integrate national regulatory, policy, and local governments' planned adaptation measures into the participatory locally-led adaptation planning process?

2. How to establish feedback loops both to local the government and national policymaking agencies to inform and enable the scaling of locally-led adaption to improve public sector accountability?

3. How to ensure long-term climate and weather forecasts inform the participatory locally-led adaptation planning process?

4. How to identify ways to finance autonomous adaptation strategies through combinations of four types of finance: i. International or national climate finance funds; ii. Traditional financial service providers; iii. Digital financial service providers—often embedded within specific value chains; and iv. Community-based organizations and informal financial service providers?

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[2] Including CARE, The University of Reading, IISD, BAIF, WOTR, ECHO, Gorakhpur Environmental Action Group, Mercy Corps, Oxfam, WFP, MCLD, and FAO.

5. How to establish robust governance and institutional arrangements—see WRI (accessed 2023)?

6. How to scale LLA planning and execution so that all communities vulnerable to the impact of climate change are empowered and supported to adapt and achieve resilience?

> **We recognize that this is just one approach and that it will be refined over time. And we stress that it is not, by any stretch, "the" definite approach, but we hope that it will stimulate others to address all six challenges outlined above in their approaches to LLA planning.**

Factors that impact strategy	Regulatory & policy environment	Government planned adaptation measures & capability	Feedback loops	Climate data and forecasts My Climate Risk	Financial services landscape analysis
Partici-patory planning process	**Situation analysis –** lifecycle, time series of risk, seasonality to assess context, needs, perceptions, norms and behaviors	**Desired future analysis –** to assess values, preferences, and future needs	**Barriers analysis –** to assess gender inequality, access to resources, behaviors & norms, and participation in decision-making	**Pathways to the future analysis -** incl. DFID Five Capitals Framework	**Financing the future analysis –** to assess options for financing adaptation

Locally-led adaptation strategy:

1. **Purpose (i.e., preventing harm or gaining benefits)**
2. **Timing (i.e., proactive or reactive)**
3. **Time scale (i.e., short-term or long-term)**
4. **Who acts (i.e., the individual alone or with others)**
5. **Who is affected by those actions (i.e., the individual, other people, or the environment)**
6. **Financing strategy, and &. Role for digital technology**
7. **Role for digital technology**

– adapted from Carmen and Zint (2023)

MEL

Governance & institutional arrangements incl. risk analysis and participatory monitoring framework

We look forward to working with others and together learn ways to optimize and scale LLA planning through a range of approaches and tools.

Appendix 1: Six key determinants of a community's perceptions of climate change and responses to it

1. **Climatic versus non-climatic factors:** Climatic aspects often go hand-in-hand with non-climatic ones to shape community perceptions of climate change's consequences (Rahman et al., 2018). Climatic aspects include the frequency and duration of climatic stresses, while non-climatic factors include socioeconomic, cultural, and geographical factors. People who have experienced climate shocks are more likely to implement autonomous risk management measures (IPCC, 2022).

2. **Community framings of vulnerability:** Both climatic and non-climatic experiences and insights inform communities' perceptions of vulnerability. Recognizing this helps pinpoint which socioeconomic elements can bolster local livelihoods through grassroots initiatives that lean on indigenous or local knowledge bases (Rahman and Hickey, 2019 and IPCC, 2022).

3. **Capability and availability of resources:** Access to resources is a critical factor that shapes communities' ability to plan for, and respond to, the impacts of climate change. The communities that face climate-related vulnerabilities often lack the necessary expertise and resources to adapt and change. Informing and educating communities on future conditions can help mitigate disaster risk and increase preparedness (Costa et al., 2022 and Thomas et al., 2018).

4. **Community organizations:** Community members often create small-scale organizations rooted in peer-based and familial networks. These bodies facilitate collective savings and subsequently offer low-interest loans to members—and are thus often more favorable than traditional banking or microcredit institutions. They can also facilitate access to fishing rights and government-backed agricultural tools, such as tractors and irrigation systems. Nevertheless, local political challenges frequently curtail the efficacy of these organizations, primarily due to poor governance (Rahman and Hickey, 2019).

5. **Rural livelihoods and adaptation:** Rural families often merge or adjust assets and strategies to foster various livelihood avenues. While financial capital access serves as a significant adaptation driver, not all loans guarantee successful adaptation (Rahman and Hickey, 2019).

6. **Risk management strategies**: Risk management strategies can reduce trade-offs, help communities manage risks, and minimize climate change's negative impacts. Such strategies include people's participation in land-use and climate decision-making, as well as policy formation. These strategies can also advance collaboration, such as policy-based decision-making at the local community level, as well as multi-stakeholder consultations with the public sector, local leaders, and non-governmental organizations. The creation of climate-resilient infrastructure and implementation of risk management and decision-making can help reduce the risks to food systems, human and ecosystem health, livelihoods, infrastructure viability, and land value (IPCC, 2019 and OECD, 2018).

Appendix 2: Six key lessons from successful autonomous adaptation

Work over the past 15 years provides us with six key lessons on what makes autonomous adaptation effective and successful:

1. **Build congruence between planned and autonomous adaptation**: A systematic framework can help build congruence between planned and autonomous adaptation through a structured approach to guide their integration (Rahman et al., 2021).

2. **Support an enabling regulation and policy environment that encourages autonomous adaptation:** This includes a conducive legal and regulatory environment, effective institutions and governance, development and scrutiny of autonomous adaptation, consistent policy signals, and collaboration among farmers, extension agents, and researchers (IPCC, 2014 and FAO, 2017).

3. **Follow the key principles of adaptation to climate change**: These include steps that identify and prioritize adaptation actions, use a participatory approach, consider social barriers to adaptation, and ensure effective governance and institutional arrangements (UNDP, 2010 and Hallegatte et al. 2020).

4. **Ensure that autonomous adaptation sustains livelihood activities**: Climate-affected communities undertake autonomous adaptation actions to sustain their livelihood activities. These actions include diversifying income sources, changing crop varieties, and using alternative water sources (Rahman et al., 2021).

5. **Encourage proactive adaptation responses by vulnerable communities**: Local communities can respond proactively to locally experienced climate change impacts and anticipated threats. For example, smallholder farmers in Bangladesh's wetland areas cultivate short-rotation crops, such as mustard and coriander, in suitable places to replace long-rotation crops, such as rice, vulnerable to early floods. A few farmers initiated this practice, which was so successful that it found wide adoption in the region (Rahman et al., 2018).

6. **Address social barriers to climate change adaptation**: Successful adaptation initiatives require the community to overcome social barriers, such as gender inequality, poor access to resources, and limited participation in decision-making processes. For example, in Nepal, a community-based adaptation project has empowered women to participate in decision-making processes and provided them with access to resources for adaptation (Jones, 2010).

Appendix 3: Maladaptation

According to Rahman et al., 2019, adaptation policy measures may lead to **three categories of maladaptation**:

i. **Rebounding vulnerability:** This occurs when adaptation measures increase a community's exposure and sensitivity to climate issues and decrease their ability to adapt in the future.

ii. **Shifting vulnerability:** This is when the negative effects of adaptation actions are passed on unintentionally to a group that was not initially considered in the planning phase.

iii. **Eroding sustainable development:** This refers to challenges that arise from shared resources, where the actions of one user can affect the availability of resources for others.

Five outcomes of maladaptation:

i. **Emissions increase from adaptation:** Some adaptation actions might unintentionally boost greenhouse gas emissions.

ii. **Unequal adaptation:** One sector or community may benefit from adaptation measures, which could increase vulnerability for other sectors or communities.

iii. **Opportunity costs of adaptation:** The actions taken to adapt can come with significant social, economic, and environmental trade-offs.

iv. **Dependency and reduced incentives:** Certain measures may make people overly dependent on others, promote behavior that seeks undue advantages, and lessen the motivation to adapt independently.

v. **Rigid development paths:** Adaptation actions can sometimes lock in certain development trajectories and make it hard to change course in the future. (Barnett and O'Neill, 2010) and (Juhola et al. 2016).

Back to main text

Appendix 4: How we define adaptation

We can classify adaptation to climate change in various ways. The key classifications from Rahman et al., 2021 include:

- **Based on intent or purpose:**

  - **Autonomous adaptation:** It occurs without a conscious decision to address climate stimuli. It is triggered by ecological shifts in natural systems or market or welfare changes in human systems. Autonomous adaptation is also known as spontaneous adaptation (IPCC, 2001).

  - **Planned adaptation:** It results from a deliberate policy choice made with the awareness of changing conditions. The goal is to restore, maintain, or achieve a desired state.

- **Based on timing:**

  - **Anticipatory adaptation:** It is implemented before the impacts of climate change become evident. It is also known as proactive adaptation.

  - **Reactive adaptation:** It is implemented after climate change impacts have already been observed.

- **Based on agents:**

  - **Private adaptation:** It is initiated and executed by individual actors, such as households or private companies. The actor's rational self-interest typically drives this action.

  - **Public adaptation:** It is initiated and executed by governmental entities. This seeks to address collective needs.

- **Based on temporal scope:**

  - **Short-run adaptation:** Responses to climate change are limited due to a fixed capital stock. They focus mainly on variable inputs to production (Stern, 2006).

  - **Long-run adaptation:** It allows adjustments in capital stock in response to climate change.

While this part of the white paper emphasizes autonomous adaptation, we must understand its relation and interplay with other types across these classifications.

Purpose of definitions and classifications: These categorizations provide a framework to understand adaptation's nuances. In reality, distinctions, such as autonomous versus planned or private versus public adaptation, are not always clear-cut. Often, adaptation is a collaborative effort. For example, a grassroots movement may prompt the government to offer incentives, or the government could design a policy in response to public feedback. Yet, the actual adaptive action commences only when that policy is executed.

Adaptation lies on a spectrum—from entirely spontaneous actions by individuals to fully planned and orchestrated actions by the government, such as infrastructural projects or building regulation amendments.

Relationship between autonomous and planned adaptation: If autonomous actions negate the need for planned ones (and vice versa), they act as substitutes. For instance, if a government constructs large reservoirs and expects precipitation changes (a planned adaptation), farmers may not feel the need to adjust their practices (an autonomous adaptation), such as changing crops or conserving water.

The efficiency of autonomous adaptation: As per Fankhauser et al. (1999), individuals require the right incentives, knowledge, resources, and skills to adapt autonomously. The government's responsibility is to foster an environment that supports this, which includes offering the necessary legal, regulatory, and socioeconomic settings.

Types of adaptation strategies: As per Rahman et al., 2021, adaptation strategies can be grouped based on how they minimize or avert risks:

1. **Mobility:** Distributes or sidesteps risks across different regions

2. **Storage:** Accumulates or diminishes risks over time

3. **Diversification:** Disperses risks across different assets, owned either individually or collectively

4. **Communal pooling:** Emphasizes collective ownership of assets and resources; this could mean sharing wealth, labor, or incomes among households or the collective use of resources during scarcity to mitigate risks at the household level

5. **Exchange:** Traditionally seen as a way to encourage specialization and enhance revenue, it can also replace the above four strategies (Agrawal and Perrin, 2009)

Back to main text

The Local Climate Adaptive Living Facility (LoCAL) promotes locally-led adaptation (LLA) via local governments. LoCAL operates in 34 countries, provides <u>performance-based climate resilience grants (PBCRGs)</u> to local governments, and supplements them with technical and capacity-building aid for grassroots-level adaptation. LoCAL primarily targets areas with fiscal challenges, substantial poverty, and climate vulnerability.
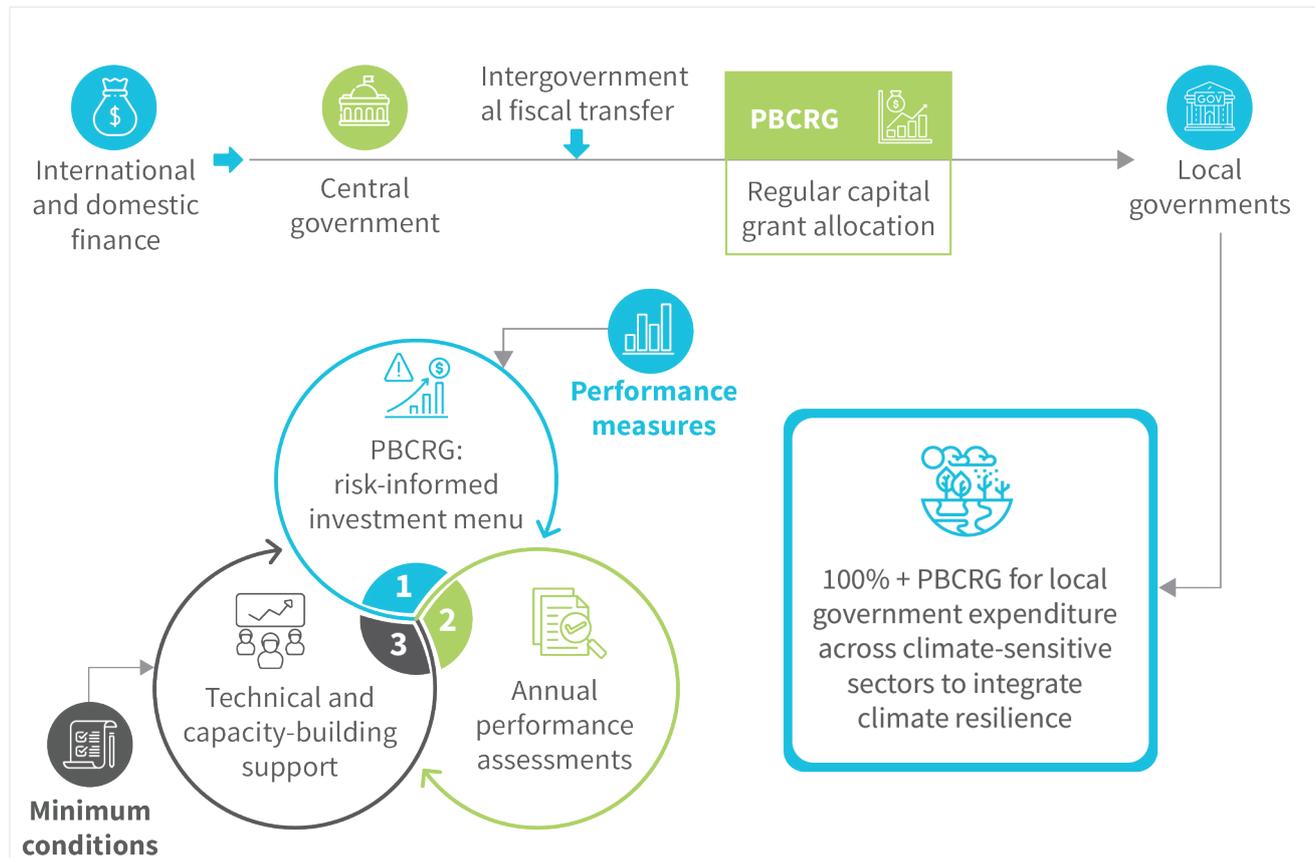
Key lessons learned:

1. **LLA enhancement**: LoCAL's resilience grants, paired with its capacity-building efforts, empower local governments to incorporate climate considerations into their plans, which spotlights their role in the LLA framework.

2. **Local governments' LLA role**: LoCAL demonstrates the essential role local governments play to bridge climate finance, national strategies, and local adaptation.

3. **Local government limitations**: Local governments can mirror top-tier power dynamics and may not represent all community factions, which highlights a need for broader stakeholder engagement. LoCAL supports LLA but cannot transform entrenched power structures alone.

4. **Boosting involvement with LoCAL**: LoCAL can amplify community and vulnerable group participation in regional endeavors. Local governments can collaborate with LoCAL to lead adaptation efforts and engage local non-governmental actors more effectively (<u>Dinshaw and McGinn, 2023</u>).

Appendix 6: Insights from devolved climate finance (DCF) implementation

1. **Bridge development deficits**: DCF investments tackle development infrastructure gaps commonly found in developing nations and enhance people's adaptive capacity. The focus on public goods is especially relevant in areas that rely on shared resources.

2. **Broadening engagement**: The DCF mechanism has widened the circle of those involved in adaptation and enhanced engagement methods. It focuses on communities to plan and advance social inclusivity. However, such processes must be assimilated into regular government operations or gender-sensitive accountability systems for sustained impact.

3. **Value to local governance**: DCF components enhance local governmental planning, lead to more efficient, accountable, and locally pertinent decision-making, and foster long-term resilience. These innovative planning methods are also cost-effective.

4. **Stakeholder consortium**: The collaboration of diverse stakeholders in the DCF mechanism showcases the potential of diverse institutional backgrounds to drive a complex program, even in fluctuating circumstances.

5. **The need for further development**: While DCF pilots have introduced several innovations, they need further refinement and deeper integration into governmental processes for lasting impact.

Given the lag in climate commitments from developed nations, the DCF mechanism can supplement prevailing top-down financing structures to bolster local governance and foster inclusive adaptation strategies for an unpredictable climate future.

DCF must be embedded deeply within domestic structures and fiscal frameworks for enduring success. This involves:

- **Policy commitment**: Strong policy backing from influential institutions is crucial to galvanize key players toward institutional reforms that facilitate the DCF mechanism.

- **Identifying the right institution**: A critical subsequent step is the identification of the most suitable "institutional home."

- **Building capacity**: Equally vital is to equip various government agencies and foster a willingness to embrace adaptive management. A recognition of climate risks is pivotal to incorporate innovations into existing budgeting and planning systems. (DCF Alliance, 2019)

Back to main text

Appendix 7: Approaches to risk-sharing mechanisms

Risk-sharing mechanisms are critical components of blended finance, especially in sectors where risks can be high due to factors, such as market volatility, climate change, and geopolitical issues. These mechanisms are designed to make investments more attractive to the private sector by mitigating or redistributing risks.

Here are several approaches to risk sharing in blended finance:

1. **First-loss capital**

   - **Description**: First-loss capital is a portion of an investment, usually provided by public or philanthropic sources, which absorbs initial losses up to a certain threshold. This arrangement gives confidence to private investors that their capital is protected against initial risks.

   - **Application**: First-loss capital is often used in funds or investment vehicles that target high-risk areas to enable more conservative investors to participate.

2. **Guarantees**

   - **Description**: Guarantees are commitments by a third party, usually a government or development bank, to cover certain losses if they occur. They reduce the risk exposure for private investors.

   - **Application**: Guarantees are commonplace in development projects, where a development finance institution (DFI) provides a guarantee to private lenders against borrower default.

3. **Insurance products**

   - **Description**: Insurance products can cover specific risks, such as crop failure, weather anomalies, or political risks. These products transfer the risk from the investor to an insurance company.

   - **Application**: Insurance products are used in agriculture to protect against risks like drought, floods, or pest infestations. They are also used for political risk insurance to protect against expropriation, war, or civil disturbance.

4. **Currency exchange risk coverage or hedging**

   - **Description**: Many investments in developing countries involve foreign currency, which can add exchange rate risk. Currency exchange risk coverage protects investors from losses due to currency fluctuations.

   - **Application**: Currency exchange risk coverage is essential for cross-border investments and ensures currency volatility does not deter foreign investors.

5. **Concessionary loans**

   - **Description**: These are loans offered with more favorable terms than market rates, such as lower interest rates or longer repayment periods. Public or philanthropic sources often provide them.

   - **Application**: Concessionary loans make projects financially viable that might otherwise be unattractive to private investors due to low returns or high risks.

6. **Equity participation**

   - **Description**: Public or philanthropic investors may take an equity stake in a project to share both the risks and rewards. This can be more attractive than debt in high-risk scenarios.

- **Application**: Equity participation is common in startups or innovative projects where the outcome is uncertain and traditional debt financing is less feasible.

7. **Subordinated debt**

- **Description**: In this structure, certain debts are given lower priority in case of default. These subordinated debts are repaid after other debts if the borrower defaults.

- **Application**: Subordinated debt can encourage senior lenders to participate since they know that their debts will be prioritized in case of default.

8. **Syndicated loans**

- **Description**: This involves multiple lenders who lend to a single borrower. This spreads the risk across several entities and makes individual lenders more comfortable with the investment.

- **Application**: Syndicated loans are useful for large-scale projects that need substantial capital, such as major infrastructure developments in the agricultural sector.

9. **Blended concessional and commercial financing**

- **Description**: This involves mixing concessional funds with commercial funds to create a financing package with an overall lower cost than standard commercial financing.

- **Application**: Blended concessional and commercial financing is often used in projects with strong development impacts but not sufficiently high returns to attract full commercial investment.

10. **Tranching**

- **Description**: Investment funds are split into different tranches with varying risk levels. Senior tranches have lower risk and lower returns, while junior tranches have higher risk and potentially higher returns.

- **Application**: Tranching attracts a wider range of investors with different risk appetites to participate in the same project.

The implementation of effective risk-sharing mechanisms requires a thorough understanding of the specific risks involved in a project and the risk appetite of potential investors. Through judicious application of these tools, blended finance arrangements can mobilize significant private capital to support locally-led adaptation at scale.

Back to main text

# Appendix 8: My Climate Risk's approach

(Adapted from <u>Rodrigues, R. and Shepard, T. 2022, "Small is beautiful: climate-change science as if people mattered", PNAS Nexus, Volume 1, Issue 1, March 2022</u>)

Climate change science echoes Schumacher's philosophy of prioritizing human concerns and requires a paradigm that emphasizes the complexities of local situations and human-centric approaches. It involves three main strategies:

1. **Conditional climate knowledge:** Climate knowledge tailored to the specifics of local contexts helps navigate the intricate realities different regions face.

2. **Embracing simplicity amid uncertainty:** Through physical "climate storylines", the inherent uncertainty of climate science can be managed through simpler, more comprehensible frameworks.

3. **Empowering communities with accessible tools:** Craft intermediate technologies that local populations can use to enhance their understanding of climate impacts and foster trust and transparency.

Methodologies must be accessible for interrogation and embody a level of simplicity that encourages broad comprehension to avoid the pitfalls of "false precision." One such methodology is Bayesian causal networks that quantify multiple causes in a logically consistent manner. These methods should be firmly rooted in physical evidence to make risk assessment more substantive than procedural.

Causal networks demystify atmospheric connections and clarify how global events translate to local climate variations, increasing the legibility of climate-change science for local adaptation (see diagram below).
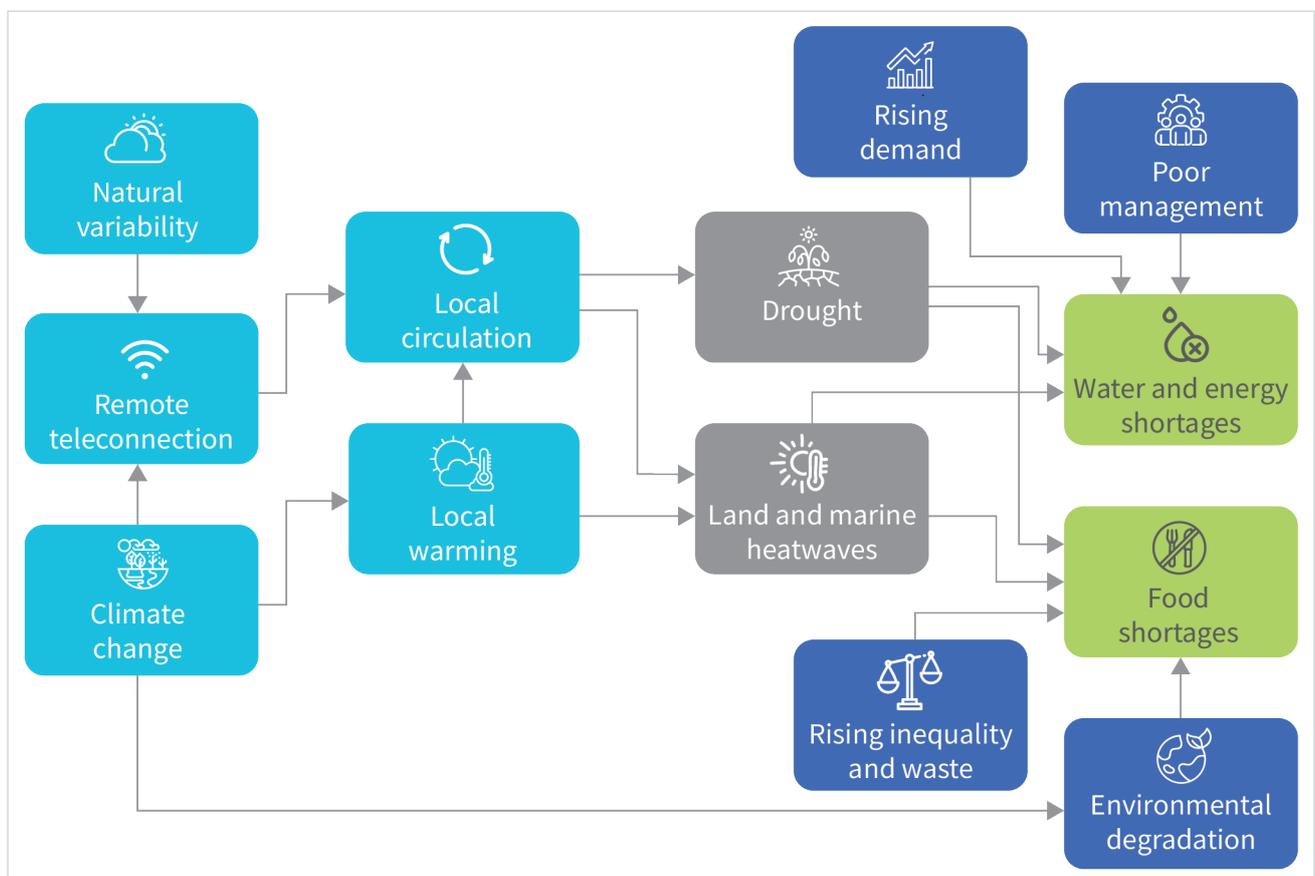
The process calls for early and active engagement of local scientific communities and stakeholders and the use of tools that resonate with the local socioeconomic fabric, such as the Household Economy Approach, which ensures decisions are relevant and bolster resilience.

The integration of indigenous knowledge from the beginning can yield more actionable climate information and empower communities to better navigate and articulate their needs in complex decision-making scenarios.

The challenge now is to bridge the gap between macro "top-down" climate information and the micro "bottom-up" needs of local decision-making contexts while recognizing climate change as one of many considerations.

In sum, climate-change science should embrace methodologies that enable local communities to discern and articulate their circumstances, built on a foundation of trust and clear communication.

We need to empower local communities through methodologies to produce and analyze climate information that builds trust and transparency so that they can make sense of their situation.
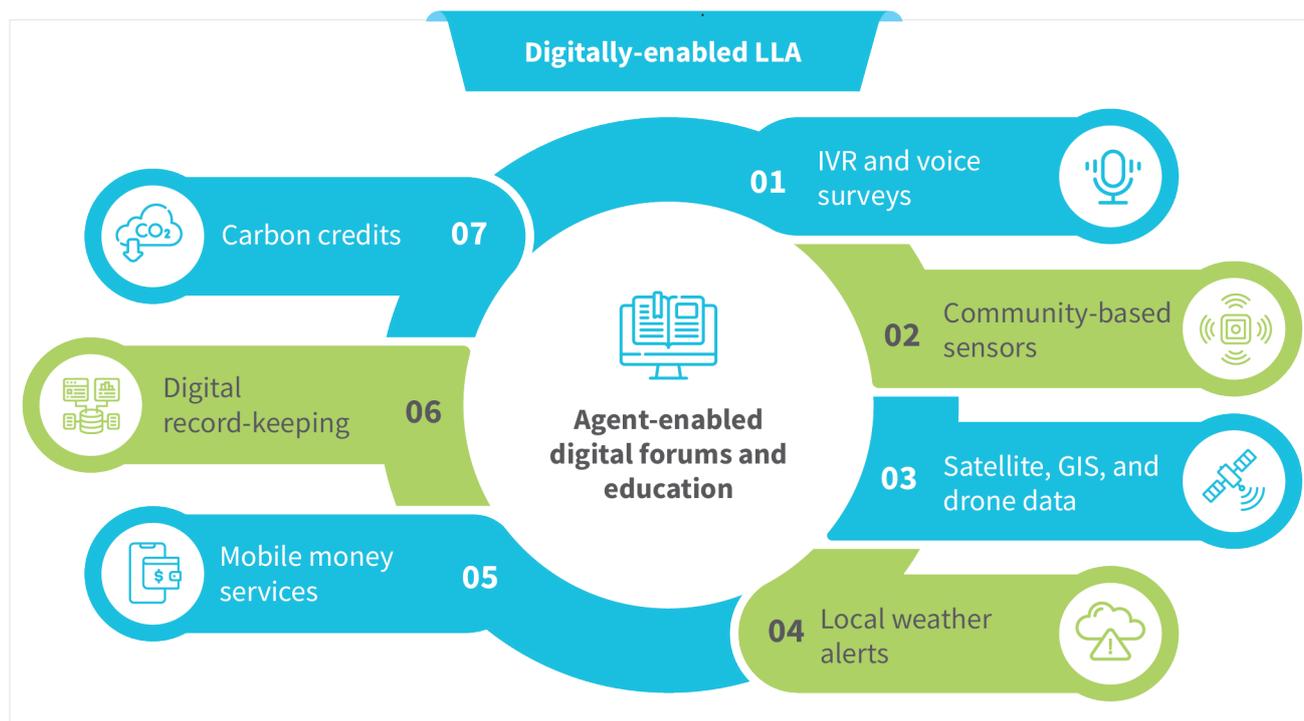
Back to main text

Appendix 9: Digitally-enabled locally-led adaptation

Cash-in cash-out mobile money or banking agents in climate change-vulnerable areas could become nodal points to help develop LLA plans. They can provide access to key data and insights for the participatory planning process, and then enable the management and governance of the implementation of those plans.

This would entail agents as "catalysts of change" who use and facilitate access to a range of digital technologies. These technologies can be deployed to support and scale LLA planning and monitor the implementation of those plans for performance-based payments. AI-enabled online forums in local languages could offer opportunities for communities to share knowledge, discuss challenges, and cocreate adaptation strategies. Mobile platforms could be used to deliver educational content on adaptation practices suitable for local conditions.

Digitally-enabled LLA

Agent-enabled digital forums and education

- 01 IVR and voice surveys
- 02 Community-based sensors
- 03 Satellite, GIS, and drone data
- 04 Local weather alerts
- 05 Mobile money services
- 06 Digital record-keeping
- 07 Carbon credits

Mobile phone surveys could complement digitally-enabled LLA to collect local climate and environmental data directly from the community, either through interactive voice response (IVR) or mobile phone (CATI). Community-based and operated sensors (see Johnson et al., 2021) could collect localized climate data for analysis and planning and complement climate change predictions from GIS and machine learning models. See, for instance, how Gharakhanlou and Perez, 2022 used machine learning models to predict current and future flood susceptibility under different climate change scenarios. These predictions could be validated and strengthened by a combination of satellite and drone service providers, such as Ushahidi, CropIn and Amini. This use of technology could allow communities to use digital mapping to collaboratively plan and visualize adaptation strategies using simple simulation tools to help them understand the potential impacts and benefits of different strategies.

As adaptation plans are implemented, local language weather apps, such as TomorrowNow, could be used to provide communities with essential alerts about imminent weather changes to enable them to prepare and respond better. Mobile money services could be used to ensure the transparent and efficient delivery of funds for adaptation projects. Furthermore, digital record keeping (see Kolande, 2021) could ensure the accountable use of resources and thus create important digital trails that facilitate lending by formal financial service providers.

In addition, digitally-enabled carbon credit tracking and trading platforms, such as CaVEx, could allow farmers to receive financial support for their adaptation. Digital technologies could then help with the monitoring and governance of the implementation of adaptation plans and enable smart contracts to reward the achievement of performance goals. Communities can use community-based and operated sensors, satellite and drone services, and feedback platforms to report progress and challenges in real time and provide insights and recommendations to improve adaptation initiatives alongside local and national climate adaptation policies.

The effectiveness of LLA strategies could significantly improve through a focus on digital technologies that are accessible and practical for rural communities and the agents that serve them. However, these digital tools must align with the local context, needs, and language to foster community participation, knowledge sharing, and sustainable adaptation practices. Particular care must be taken to ensure that the poorest and most vulnerable are encouraged and enabled to participate in the planning and monitoring exercises (Jones, 2010).

Agents' involvement in LLA planning could offer them additional revenue streams and provide real use cases for poorer, vulnerable people in remote communities, thus helping them start their journey into the digital world. These LLA-driven use cases provide us opportunities to offer real value to these hard-to-reach communities, increase their resilience, and demonstrate the benefits of digital tools to them. Many of the most vulnerable communities comprise smallholder farmers who could benefit from digitally-enabled value chains and financial services. Climate change and the LLA response to it could very well become an essential bridge across the digital divide for these farmers and others currently stranded in the analog world.

Back to main text