Decentralising Climate Funds (DCF)

Adaptation to climate change: economic value and return on investments

Near East Foundation consortium under the Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) programme

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Contents

Executive summary ---- 3
List of acronyms and abbreviations ---- 4
1. Introduction ---- 5
2. The economic value of natural resources and ecosystems ---- 7
3. The hydro-agro-pastoral systems of the West African Sahel ---- 8
4. The case of the Mopti Region in the Inner Niger Delta, Mali ---- 10
5. The case of the Kaffrine Region in the Senegalese Ferlo ---- 11
6. Investment to reinforce resilience to climate change ---- 12
7. Summary of priority gaps and recommendations ---- 14
8. Discussion ---- 15
9. Conclusion ---- 15
10. Bibliography ---- 17
Who's who? ---- 23

A brief knowledge review prepared for the BRACED DCF research programme in Mali and Senegal on the value of natural resources and the potential returns on investments in devolved systems for adaptation to climate change.

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Executive summary

To evaluate investments in adaptations to climate change, we must consider the comparative returns of the various available options. This involves understanding the immediate comparative returns on investments in various types of adaptation projects, under increasingly variable conditions and over the long term. It also requires knowledge of critical natural resources and the effects that climate change may have on them, as well as understanding their value. In arid and semi-arid environments, the availability of water resources is particularly critical. Ideally, we would like to understand these values in terms of total economic value to society.

Teams of non-governmental organisation (NGO) staff working with local decision makers in the regions of Kaffrine, Senegal and Mopti in Mali conducted a review of the available literature on these topics, in the context of the West African Sahel. The review was conducted via project meetings; fact-finding visits to relevant institutions in the capital cities of both countries; literature searches using electronic databases at the University of Southampton; and Internet searches by an intern at the International Institute for Environment and Development (IIED).

The review identified a range of cost estimates for adaptation in the Sahel, but no integrated cross-sectoral assessments of the economic benefits of adaptation at the regional level. The available studies of adaptation (economic or qualitative) tend to focus on adaptation of resource management practices by individuals over relatively short timescales. However, a full evaluation of investments in adaptation and their benefits at the regional level would require consideration not only of investments that are made by one person or project, but rather the full portfolio of investments that are made by different state and individual actors across the region and over a range of timescales (from the short to longer-term).

We believe that a full regional-scale economic assessment could be expected to demonstrate synergies between returns on decentralised investments in public goods and returns on private investments by community members themselves. It might also suggest avoided public expenditures on emergency response and social assistance. Such an assessment would illustrate the potential of a decentralised approach to climate adaptation finance. To do so, it could draw on various methods already available in the scientific literature. It would be essential to ensure that the assessment approach and findings could be informed at all stages through an effective participatory debate.

List of acronyms and abbreviations

DCF	Decentralising Climate Funds
IED-Afrique	Innovation, Environnement, Développement Afrique
IIED	International Institute for Environment and Development
IUCN	International Union for Conservation of Nature
NAPA	National Action Programme for Adaptation to Climate Change
NEF	Near East Foundation
NGO	non-governmental organisation

1. Introduction

Assessing the total economic value of an ecosystem's productivity can help to shed light on the costs and benefits of any given change in the system (Pearce, 1989; Pascual and Muradian, 2010). This approach is oriented to decision making scales in planning systems that correspond to ecological boundaries, such as watersheds. These are primarily regional and sub-national planning systems, and inevitably part of national systems as well. Such an approach has been proposed to understand the economic effects of land degradation in drylands, and the results of any given management change (ELD Initiative and UNEP, 2015; Safriel *et al.*, 2005). However, taking climatic variability into consideration in these assessments adds further complexity to the economic calculation (Chambwera *et al.*, 2014), especially in areas that are prone to droughts (Hesse *et al.*, 2013; Venton *et al.*, 2012).

IIED has explored such an economic assessment approach for the arid lands in northern Kenya (King-Okumu, 2015). This will involve, first, developing a general profile of value flows in the system (King-Okumu *et al.*, 2016), and then exploring changes due to investments by local decision makers (King-Okumu, 2016). The following aspects of the available knowledge base should be considered:

1. The economic value of natural resources as public goods.
2. The state of knowledge on critical natural resources, including the effects of climate change.
3. The nature of investments in building resilience through public goods such as ecosystems and common-pool resources.

This issue paper presents a review focusing on these themes in the context of the Mopti region in Mali and the Kaffrine region in Senegal. The review was conducted as part of the Decentralising Climate Funds (DCF) project. The review is based on reading supported by electronic library resources at the University of Southampton. This was complemented by two fact-finding visits to Bamako, Mali, on 14–18 November 2015 and to Kaffrine in Senegal, on 27–29 January 2016, as well as discussion among the BRACED project teams during a one-day workshop in Bamako on 2 June 2016, and an online search by an intern at IIED.

Context of the BRACED programme

DCF is an action-research and advocacy project supporting communities in Senegal and Mali to become more resilient to climate change through access to locally controlled adaptation funds. Resilience investments are identified and prioritised by local communities through a participatory process that includes women. Planning and finance mechanisms are embedded in local and national systems.

DCF sets out to share locally generated evidence from these experiences with local, national and international audiences, to encourage greater decentralisation of climate funds. DCF is part of the UK government-funded BRACED programme and is implemented by the Near East Foundation (NEF) with Innovation, Environnement et Développement Afrique (IED Afrique) and the International Institute for Environment and Development (IIED).

The DCF project seeks to understand the economic, social and ecological contributions of community-managed investments in public goods such as common-pool natural resources in arid and semi-arid zones. The project seeks to document the innovation process and technologies adopted by local communities with support from locally controlled climate adaptation funds.

The project team would like to understand the immediate comparative returns on investments (in terms of total economic value) among various adaptation projects in increasingly variable conditions and over the long term; while also calculating the projects' 'value for money'.

2. The economic value of natural resources and ecosystems

To understand the returns on investments in natural resource management, we must first consider the value of natural resources, and how this might increase through better management.

There are three main ways to assess the economic value of natural resources and ecosystems:

1. The most common method is to calculate the value of agricultural production (including fisheries, livestock, cereals) based on volume of production and price (CSA, 2011; INSTAT, 2013).[1]
2. Some recent initiatives have attempted to create new evaluation systems or environmental accounting to capture the stocks and flows (Cohen *et al.*, 2012a, 2012b, 2012c; UN, 2014). These enable analysis of the system as a whole, and of ecosystem services within it. The values include not only flows of services for human uses, but also stocks of natural capital such as water. Through such an approach it could be possible to identify the effects of changes in climate and rainfall patterns.
3. The cost of ***not having*** natural resources is considered in some studies of the effects of climate change (studies of loss and damage; Barry *et al.*, 2009).

All these approaches to valuation depend on the availability of knowledge on the ecosystems, including any changes that may be affecting them. They also require social decisions to agree on values that can be assigned to the resource stocks and flows – whether these are obtained from markets of one kind or another, or are derived through other means.

The majority of available studies of the returns on investments in adaptation to climate change focus on agricultural productivity (ie the first method in the list above; such as Somda *et al.*, 2013a; Somda *et al.*, 2013b), or the first and second combined (such as Shine and Dunford, 2016). Considering the effects of adaptation investments not only on agricultural productivity, but also on water resource availability, can reveal trade-offs in cases where increases in agricultural production are achieved at the cost of reduced water availability.

1 See www.fao.org/faostat/en/#home

3. The hydro-agro-pastoral systems of the West African Sahel

The West African Sahel is comprised of the transitional zone between the arid Sahara and the tropical forest that borders the maritime coast (UNEP, 2011). Desert and semi-desert gradually give way to tall grass savannah, followed by savannah woodland, a semi-humid and then a humid tropical climate with equatorial and tropical-zone rainforest. Across much of the Sahel for most of the year, life depends on the moisture stored in the major river and aquifer systems, as well as in ponds, soil and vegetation. Climate effects on human activities are therefore mediated by managing these systems on the ground.

The Sahel includes around a third of the territory of Senegal, known as the Ferlo (Hein *et al.*, 2009; Wane *et al.*, 2006). This forms part of a contiguous hydro-agro-pastoral system that stretches from the Senegal and Gambia river systems across the neighbouring state of Mali to include the Inner Niger Delta.

The populations and the regional political authorities aspire to make the region of the Senegalese Ferlo "a dynamic and sustainable agro-silvo-pastoral production hub by the year 2018" (RdS, 2013).

The value of natural resources in the Sahel

The natural resources in the region are described as 'natural capital' (Wade *et al.*, 2015: 43). They include: agricultural land, fisheries, fossil fuels, forest resources, water resources, biodiversity and minerals. Some studies have also been devoted to valuations of wild resources (Ba *et al.*, 2006).

In the Mopti region of Mali's Inner Niger Delta, the economic value of the natural resources or public goods includes the value of water resources, fisheries, rice and cereals (CSA, 2011), market gardening, forestry products and animal products such as milk (GERAD, 2012; INSTAT, 2013; Conseil Regional de Mopti, 2010a, 2010b; RdM, 2011a, 2015).

Wetlands International has studied the value of the flood plains on the river Niger in Mali (Chalmers, 2014; Wymenga *et al.*, 2012; Zwarts *et al.*, 2005a, 2005b). Their initial study focused on the value of fisheries, agricultural production, birdlife and use of the river for transport but did not consider the costs of water supplies for the human population. A study of the value of forests in Mopti has also been published by the International Union for Conservation of Nature (IUCN; Sidibé *et al.*, 2014).

A study of the value of services from the transboundary Sourou river system shared between Mopti and Burkina Faso (Somda *et al.*, 2010) has used a similar approach. However, the authors also note that, according to the populations, a canal and a series of injection wells generated considerable ecological and economic benefits in terms of saving time and expenditure on sourcing water for drinking and agricultural uses.

Various studies are available on the value of environmental degradation in Mali, including effects on agricultural production and water resources (Barry *et al.*, 2009; Pillet, 1997). One study suggested that crop yield changes and decreases in forage yields and livestock weights due to climate change could result in economic losses of US$70 to 142 million (Butt *et al.*, 2005).

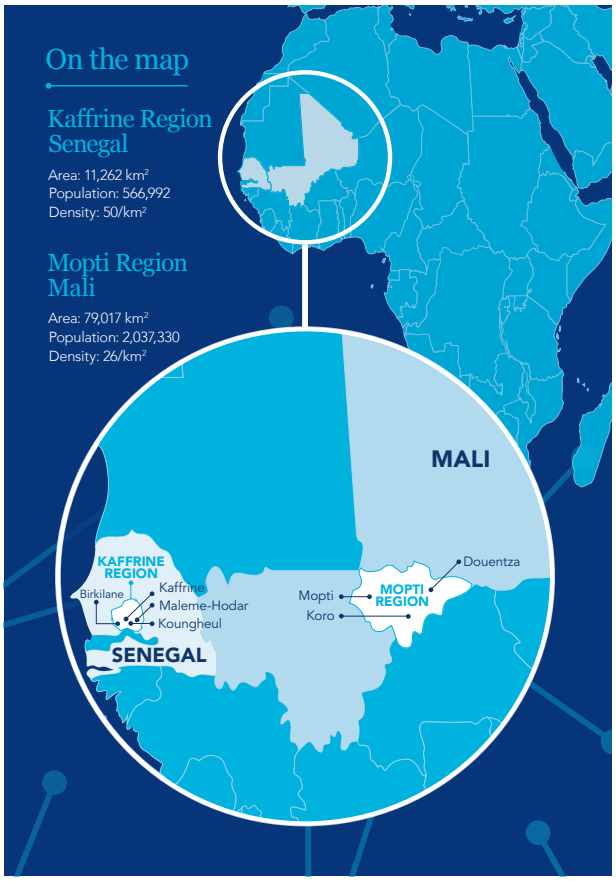
The effects of climate change in the Sahel

Researchers anticipate climate change impacts on the Malian economy, particularly in the agricultural sectors (Pedercini *et al.*, 2012). Other sectors considered include energy, health, water, wildlife, forests, transportation, education, industry and environment. These impacts are already being observed.

For the Ferlo, Hein *et al.* (2009) propose an ecological-economic model to connect climate model outputs to rangeland dynamics, grazing and livestock values.

But all these economic estimates are based on quite poor understanding of the physical changes that can be associated with climate change. This is because it is difficult to integrate local knowledge of changing resource conditions and management practices with global and regional scale climate observation systems (Mertz *et al.*, 2012). It is also difficult to incorporate changes in human behaviour into modelling the biophysical effects of climate change (Bah *et al.*, 2010).

The effects of climatic variability and those of natural resource management are closely interrelated. Across the region, a recent study observed that 80 per cent of surveyed households in Burkina Faso, Mali, Niger, Nigeria and Senegal complained of reduced rainfall. However, the meteorological services had observed a slight increase. The households had also observed soil and water resource degradation and effects on animal and plant production (Mertz *et al.*, 2012).



4. The case of the Mopti Region in the Inner Niger Delta, Mali

The Republic of Mali's (RdM) National Action Programme for Adaptation to Climate Change (NAPA) describes the state of natural resources and the effects of climate change in the target area (RdM, 2007). The available strategic documents (RdM, 2015) (RdM, 2011b, 2011c) foresee an intensifying risk of land degradation due to repeated droughts, flooding, strong winds, bushfires and destabilisation of the rainfall pattern in the climate scenarios up to 2100. They predict an average increase in temperature of 3°C and a 22 per cent reduction in rainfall across the whole country. Flooding can also cause serious problems.[2]

Some studies have developed climate change scenarios for Mali using modelling tools (Busby *et al.*, 2014; Butt *et al.*, 2005). The anticipated effects include lower water levels in the Niger River and effects on fisheries (Morand *et al.*, 2012). The region of Mopti is located at the centre of this system. The lower flows will also reduce the area of the floodplain, and therefore the extent of cultivable land (Wymenga *et al.*, 2012). Droughts affect the areas where pastoralists wait with their livestock, and the water points they use, before entering the dry season pastures. This disrupts the seasonal calendar and creates conflicts between pastoralists and crop farmers (Ajayi *et al.*, 2012; Ayantunde *et al.*, 2014). Lack of water also creates other problems for households that affect health, household expenditures and overall well-being (Becerra *et al.*, 2015; Jankowska *et al.*, 2012).

Remote sensing of vegetation cover reveals changes in the hydrological systems (Brandt *et al.*, 2014; Haas *et al.*, 2011; Kaptué *et al.*, 2015; Liebenow *et al.*, 2012). River conditions (especially water levels) are relatively well monitored, as is the extent of the floodplain area. During the dry seasons, the majority of the population is dependent on groundwater. Until recently, no national monitoring programme has focused on assessing groundwater conditions (Lutz *et al.*, 2009). However, the government hydraulic department is now installing a network of piezometers to monitor the groundwater levels and gain a better understanding of the situation.

With regard to the seasonal water points, there have not been any studies of climate change effects at the basin scale, nor have there been any studies of the effects of changing patterns of water use.

2 See www.opidin.org/en/news

5. The case of the Kaffrine Region in the Senegalese Ferlo

The damages associated with badly managed climate change and variation in the Senegalese Ferlo are characterised qualitatively (RdS, 2006; TACC, 2014). Since the 1990s, the climate in the Ferlo has had a deficit in rainfall and climate irregularities have been affecting agricultural planning (varying the dates for the start and end of the winter season) (Hein *et al.*, 2009; RdS, 2014a). The notable impacts observed and anticipated include: ''the drying of the Ferlo and the associated valleys, a general lowering of the water tables… water and wind erosion, degradation of uncovered soil and salinization of land. This situation is more noticeable in regions like Fatick, Kaolack, Ziguinchor and in the zone of the Niayes where the rainfall deficits will be most acute'' (RdS, 2015). On the other hand, flooding also causes destruction.[3]

The region of Kaffrine is located at the centre of the map of Senegal and the southeastern corner of the Ferlo. According to Kaffrine's Regional Strategy for Territorial Management (RdS, 2014b), water resources include surface and groundwater resources. The hydrographic network of the region is characterised by two main waterbodies:

- the north extension of the Saloum, a perennial saline waterbody which traverses part of the *Departement* of Birkelane, and
- le Baobolong, a branch of the Gambia River which dries up downstream in the middle of the dry season.

However, the water catchment of the Ferlo retains enormous underground water potential (RdS, 2014a). The only source of recharge to the water table other than rainfall is the Senegal River and its branches.

The region is scattered with temporary pools. These provide water for livestock to drink and fishing opportunities in certain places. However, the rainfall deficit and sand encroachment are causing premature contamination and the progressive disappearance of water points.

A map of the temporary water points is available (RdS, 2014b). But the volumes of water in the hydrographic network are not well monitored, nor is the changing water level, whether caused by climate changes or other anthropologic effects (see commentaries in Bodian *et al.*, 2016).

3 See: www.braced.org/reality-of-resilience/i/?id=9e43dee4-ddbb-4b9a-a96e-034177dc7077

6. Investment to reinforce resilience to climate change

In Senegal, the costs of the required adaptation investments have been estimated in the regional integrated development plan (RdS, 2013) and the territorial integrated plan for the *Ferlo* (RdS, 2014a), but the benefits to be anticipated from these investments have not been quantified. Similarly, in Mali, the UNFCC has assessed the amount of funds required to implement the projects proposed in the NAPA, but again, there have been no economic assessments of the benefits of adaptation.

Many studies reject economic assessments of the benefits of adaptation, underlining that the importance of adaptation is to reinforce human capacities rather than just their incomes (eg Becerra *et al.*, 2015; Brockhaus *et al.*, 2012, 2013; Djoudi and Brockhaus, 2011). This focus on strengthening capacities is re-emphasised in the BRACED programme through its focus on the '3 As': adapt, anticipate, absorb (Bahadur *et al.*, 2015). To our knowledge no economic assessments have yet been conducted using the 3 As framework.

There is plenty of literature describing the adaptation options in Mali (Samari, 2011), particularly focusing on irrigation projects (Gadelle, 1987; IRD/IER, 2002; LeGal *et al.*, 2001; Styger *et al.*, 2011), as well as village-scale schemes (Bouaré, 2012), ponds, and soil and water conservation practices (Albergel and Diop, 2012; Gigou *et al.*, undated; Sanogo, 2012). However, these descriptive studies do not attempt to quantify benefits in economic terms.

Equally, in Senegal, a long list of adaptation options has been proposed for the Ferlo (RdS, 2014a; TACC, 2014). These recommended adaptations include practices implemented directly by natural resource users, such as the use of manure, afforestation, conservation of soil and water, and protection of wildlife and plants (Mertz *et al.*, 2012).

A wealth of practical experience is available in Senegal on applying these practices, as well as interventions to support resource users' interventions through soil and water conservation (Botoni and Reij, 2009), conservation agriculture (Bayala *et al.*, 2012; Bayala *et al.*, 2009), using water harvested in ponds (Dufour, 2009), hydro-agricultural projects (Mendy, 2014), organising pastoralist systems (Wane *et al.*, 2006) and grain storage (Kent, 1998).

Other studies have been devoted to assessing the economic value of environmental management in general, without focusing specifically on adaptation to climate change (Barry *et al.*, 2009). These concern rainfed agriculture especially (Bayala *et al.*, 2012; Ebi *et al.*, 2011; World Bank, 2011) and irrigated agriculture (Dillon, 2011; Sidibé and Williams, 2015). One IUCN study has also explored the value of investing in agroforestry (Sidibé *et al.*, 2014).

One recent study compares the economic benefits of investment in adaptation versus insurance against climate risks for individual households (Delavallade *et al.*, 2015). The study finds that at the individual level, insurance to absorb climate

hazards when they occur can be as beneficial as adaptation to minimise them. However, this study did not consider the longer-term, nor the possibility of collective action, rather than coping at the individual level.

On the other hand, Senegal's nationally determined contribution (RdS, 2015) has identified more structural options to reduce vulnerability to climate change and its negative impacts on populations, such as coastal defences, retention basins, hill reservoirs, techniques to combat land degradation and water supply networks (World Bank, 2013).

Among these projects, only the coastal defences have been the subject of an economic assessment conducted by the Ministry of Environment and Sustainable Development, supported by the World Bank (IBRD, 2013).

No studies have been done to assess the value of water to households, or the costs to replace households' access to water if it is diverted for new alternative uses, (eg in adaptation projects focusing on irrigation).

Overall, there is a considerable knowledge gap on the economics of adaptation in the target region.

7. Summary of priority gaps and recommendations

Reflecting on this review, the following recommendations can be made concerning the observed gaps in the literature and issues requiring additional consideration in studying the economic returns on investments in adaptation in the Sahel:

1. We need more integration between local understanding of resource conditions, hydrology and global climate change prediction models.
2. We have to consider what trade-offs there may be at whole-system level – for example, if we increase agricultural production at the cost of reducing water availability, this is not progress.
3. It is possible to achieve win-win adaptation options that increase both public goods and private benefits, but this requires a great deal of local knowledge.
4. We need to generate plausible scenarios, taking into consideration uncertainties about both the climate and human behaviour, to help decision makers explore alternative futures with and without adaptation.

Where adaptation investments seek to catalyse changes in resource-user behaviour, the uptake of these practices should be studied to give a full evaluation of the benefits. The benefit-cost ratio should be viewed in terms of a return on investments that are made not only by the project, but also by a large number of individual actors. Such projects are intended to transform the cost-benefit ratio for individuals, and thereby to also have a catalytic effect on society.

8. Discussion

We have identified a basis for calculating the returns on investment in various public goods and production systems. One major source of uncertainty is climate change. However, another even greater source of recognised uncertainty is human behaviour and management capacity.

The DCF project is premised on the belief that the advantage of a decentralised adaptation finance system is its ability to enable greater participation by resource users, who have more knowledge of local resource management practices. We therefore anticipate that the investments they choose to enhance public goods will be better integrated with ongoing *local* public and private investments than investments that are made through a *centralised* approach without the same level of knowledge and understanding of local management investments. Were such an approach to be implemented successfully, there would be cost savings on public expenditures for emergency response and social assistance.

For adaptation initiatives focusing on investments at the local level, such as the DCF project, it could be worthwhile designing a regional scale economic assessment to illustrate how local knowledge can guide public adaptation investments to maximise synergies with ongoing private investments by resource users. This could increase the returns generated by both public and individual investors. In such an assessment, decentralised financing of investments in public goods would be shown to have a catalytic effect, securing larger returns than uncoordinated external investment strategies, and also amplifying ongoing private investments in adaptation.

9. Conclusion

There is an enormous gap in the available literature concerning the economics of adaptation in the hydro-agro-pastoral systems of the Sahel. While the damages associated with badly managed climate change and variation have been characterised qualitatively, no study has yet definitively quantified the anticipated costs of climate change in the Sahel, nor identified the economic benefits of adaptation to avoid or reduce them.

It would be useful to design a regional-scale economic assessment that could illustrate how a decentralised system for public investments in adaptation to climate changes occurring across the Sahel could create synergies with ongoing private investments by the resource users themselves. This should be done through a discursive process involving the stakeholders.

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Who's who?

Near East Foundation (NEF)

For over 30 years, NEF has developed sustainable, community-based approaches to manage forests, fisheries, rangelands and agricultural lands in Mali. Operating out of a principal office in Sévaré, the NEF team of approximately 40 development professionals works to implement programs that are consistently community-based, participatory and multi-sectoral.

NEF also coordinates a national-level working group on climate adaptation and assists Mali's government in climate policy – including participating in Mali's official delegation to international climate negotiations.

NEF's headquarters in Syracuse, United States, provides overall project management and governance oversight to the consortium.

Innovation, Environnement, Développement (IED Afrique)

IED Afrique is an independent not-for-profit organisation based in Senegal. The organisation builds on fifteen years of experience in francophone West Africa and works on issues related to sustainable development and citizenship in Africa by prioritising methodological and participatory innovations.

International Institute for Environment and Development (IIED)

IIED is a policy and action research organisation. We promote sustainable development to improve livelihoods and protect the environments on which these livelihoods are built. We specialise in linking local priorities to global challenges. IIED is based in London and works in Africa, Asia, Latin America, the Middle East and the Pacific, with some of the world's most vulnerable people. We work with them to strengthen their voice in the decision-making arenas that affect them – from village councils to international conventions.

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Decentralising Climate Funds (DCF)

Decentralising Climate Funds (DCF) supports communities in Mali and Senegal to become more resilient to climate change through locally-controlled adaptation funds.

To find out more:

The project shares lessons and experiences through a variety of publications that are available online:

www.neareast.org/braced

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Further reading:

Accessing resilience: reconciling community knowledge with government planning – Policy Brief
www.neareast.org/download/materials_center/DCF_Policy_Brief_En.pdf

Decentralisation of climate adaptation funds in Mali – Fact Sheet
www.neareast.org/download/materials_center/Decentralisation-Mali.pdf

Decentralisation of climate adaptation funds in Senegal – Fact Sheet
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