

Chapter 20

Does the Use of Local Knowledge in Complex Systems Reduce Vulnerability to Climate Change? Insights from Nexus Water Management in the Niger Basin



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Abstract In response to climate change and in an attempt to address complexity and uncertainty, management of water resources is increasingly framed as adaptive management. By definition, adaptive management includes experiential learning to improve understanding of systems and their responses to change. It is increasingly recognized that the knowledge of local communities contributes to system understanding. This is particularly important in Africa, where data is limited and vulnerability to climate change is high. This chapter focuses on the contribution of local knowledge in adaptive water resource management in Africa in a context of nexus governance. The hypothesis tested in this study is that a holistic approach to water management, which includes local knowledge and ensures local participation, contributes to a decrease in climate change vulnerability and can lead to greater capacity for adaptation, particularly for natural resource-based societies. The analysis focuses on water governance in the Niger Basin through three case studies. The first looks at the creation of National User Coordination structures for basin management. The second and third look at local participation in two major projects in the basin; the Kandadji Dam in Niger and the Fomi Dam in Guinea. These cases were selected to understand the roles of system boundaries and system understanding, stakeholders and levels of involvement, adaptation capacity and vulnerability in complex adaptive systems, and their governance. Results show that nexus governance structures generally facilitate inclusion of local knowledge in theory, but that this

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inclusion is limited in practice. Moreover, we identify a negative impact on management outcomes when involvement is limited, with indications that such limitations increase the vulnerability of communities.

Keywords Local knowledge · Participation · Complex adaptive systems · Nexus

1 Introduction

Management of water resources under climate change is highly complex. Complexity is a result of multiple uses across multiple spatial and time scales, as well as of uncertainties. Water management is a crucial element of systems management under climate change and has the potential to either mitigate or exacerbate the effects of climate change. Given the complexity and changing nature of systems under climate change, water resources' management is increasingly framed as Adaptive Management (AM). The foundation of AM is a thorough understanding of the system that is managed, through experiential learning and knowledge exchange (Fabricius and Cundill 2014). This encompasses understanding of various uses, sectors, sources, stakeholders, and their interrelations. The AM paradigm emerged in the 1970s and is predicated on managing uncertainty through management action (Johnson 1999) centered on ongoing learning about the “processes governing the system” cited by Medema et al. 2008).

AM is one of various strategies that has been developed to holistically address complexity and interdependencies in water systems. The ecosystem services approach (e.g. de Groot et al. 2002) recognizes the highly complex interactions among people and the ecosystems on which their livelihoods depend. Integrated Water Resources Management (IWRM) focuses on integration and coordination through governance and stakeholder involvement (Medema et al. 2008).

One approach that has gained traction is the Water-Energy-Food-Environment (WEFE) nexus framework, which moves away from a water-centric approach to an issue-based approach, in which natural resources are seen as instruments for achieving human water, energy, and food security and environmental sustainability (Hoff 2011). Particularly under climate change, holistic planning of natural resources should thus take account of the trade-offs and synergies of different use (Brouwer et al. 2018). However, few analyses examine practical attempts to apply the approach, and those that do focus largely on the Global North (Kurian and Ardakanian 2015; Cairns and Krzywoszynska 2016).

This chapter focuses on the role of local knowledge in adaptive water resources management in Africa to mitigate vulnerability through multisectoral nexus governance.

There is a trend toward methods and approaches in which multiple stakeholders are involved not only in the implementation of adaptation measures, but also more fundamentally in the understanding of the system that needs to adapt, as well as the design of adaptation measures. These approaches seek to improve the outcome through

better system understanding (Berkes et al. 2000; Vedwan 2006; Byg and Salick 2009; Vignola et al. 2009; Raymond et al. 2010; Alexander et al. 2011), tailoring measures, and interventions to the needs of the communities involved (Agrawal 2010; Lebel 2013), increasing ownership of implementation (Adger 2003, Chapagain et al. 2009) and strengthening sustainability, e.g., through reinforcement of local institutions (Agrawal 2010). The improvement of system understanding through integration of local knowledge might be particularly important in Africa, where data is limited and vulnerability is great, notably in natural resource-based societies (Thomas et al. 2005; Armitage 2005; Lebel 2013) where the stake of local communities is high.

This chapter describes how this premise has been tested in the Niger Basin to determine if the inclusion of local knowledge in adaptive water management promotes community empowerment and reduced vulnerability. Included is an overview of the latest research and thinking in adaptive management of vulnerable complex systems, emphasizing adaptation to climate change. The study seeks to determine how water management and governance in the Niger Basin (1) uses local knowledge and local participation; (2) uses local knowledge in a nexus approach to reduce vulnerability, and, if so, for whom, and (3) how institutional (and other) challenges are identified and addressed in inclusive nexus governance. Based on analysis of Niger Basin governance at different scales, the link between vulnerability and local knowledge integration in adaptive water management will be examined, and findings will provide elements to improve water management as a climate adaptation tool where there is great vulnerability to climate change.

2 Complex Adaptive Systems and Climate Change

A system, at its most basic, is “any group of interacting, interrelated or interdependent [elements] that form a complex and unified whole that has a specific purpose” (Kim 1999:4). All elements of a system must be present in order for its purpose to be optimized. Indeed, if elements can be removed without it affecting system performance, it can be concluded that the elements did not comprise a “system,” but were rather a collection of different parts (Kim 1999; Meadows 2008).

Similarly, the arrangement and ordering of different elements within a system also affect system performance; if the elements can be combined or ordered randomly with no effect on performance, then it also cannot be considered a “system” (Kim 1999). A key feature of system behavior is the tendency to maintain stability through feedback mechanisms, which creates a virtuous cycle of information within the system that improves performance for its systemic purpose, and enables action to correct suboptimal performance.

While systems can be delineated by boundaries, they are permeable and intersecting or overlapping with the boundaries of other systems, increasingly so in the contemporary globalized world (Midgley 2004, 2008; Brincat 2017).

Because the multitude of stakeholders interacting within and across systems (and/or issue areas) influences the system as a whole, systems, which are characterized by connectedness, complexity, uncertainty, conflict, multiple stakeholders, and, thus, multiple perspectives, grow increasingly unpredictable (de Savigny and Adam 2009 as cited in Swanson et al. 2012). Systems are characterized by boundaries, perception of system complexity, and of the stakeholders and elements composing the system, as well as of the system's vulnerability and capacity to adapt, which all contribute to system understanding. Ecosystems are also "perceived as bounded by the conceptualizations and judgments of humans" (Ison et al. 2007, p.5).

It can therefore be useful to apply analysis that accounts for the complexity of the system. The conceptualizing of systems as Complex Adaptive Systems (CAS) addresses this (Arnold and Wade 2015). Unlike "regular" systems, CAS behave unpredictably owing to external influence, to the extent that cause and effect patterns within such systems are difficult if not impossible to detect (Brincat 2017). General (linear) systems and complex adaptive systems are distinguished by the constantly evolving nature of CAS that interact with and are shaped by interactions with other systems (de Savigny and Adam 2009; Brincat 2017). CAS have emergent properties which give rise to unexpected behaviors (Brincat 2017).

Climate change can be considered the ultimate destabilizing contributor to a river basin system that excludes it from a linear realm and places it in a complex *adaptive* system. The unpredictability of climate change and its localized impact is the external dimension that requires adoption of this additional layer of complexity.

3 Vulnerability, Resilience, and Adaptation

Conceptual and analytical frameworks with roots in disciplines from economics to anthropology have integrated climate change in the analysis of complex systems of natural resource management. The vulnerability of biophysical and social systems to climate change is a specific subject of analysis (e.g., Cuevas 2010; Podschun 2017).

Vulnerability to climate change can be defined as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC 2001, quoted in Maxim and Spangenberg 2006:4). Maxim and Spangenberg (2006) provide a good overview of vulnerability, illustrating its analysis through the use of the DPSIR framework (driving forces, pressures, state, impacts, and responses) which integrates social, political, economic, and environmental factors.

For societies reliant on direct use of natural resources, which is the case in the Niger Basin, the adaptation definition by Thomas et al. (2005:7) applies: "Adaptation is seen as the adjustment of a system to moderate the impacts of climate change, to take advantage of new opportunities or to cope with the consequences. In many cases, climate does not affect people directly but indirectly, by affecting the physical and

biological systems in which they live. For societies that are reliant to a significant degree on the use of natural resources, these changes take on both direct and indirect aspects, since for such groups livelihoods do not provide a buffer against climate, but are highly reliant upon it. Adaptation can be best seen as a process that involves changes in a system to increase its coping range, rather than temporary adaptation of historically familiar measures to cope with a transient threat.”

Adaptive capacity is “the ability of countries, communities, households and individuals to adjust in order to reduce vulnerability to climate variation, moderate potential damage, cope with, and recover from the consequences, including ecosystem responses to climate forcing” (Thomas et al. 2005:7). The greater a system’s resilience, the more it adapts to maintain its critical functions (adaptation capacities): “resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks” (Walker et al. 2004:2). Points of no-return, at which the system is unable to maintain its critical functions even after adaptation, are described as tipping points.

4 Role of Governance, Participation, and Local Knowledge

From anthropology to social policy, an array of terminology and concepts has been adopted in the study of climate change adaptation and governance, as well as management of natural resources in vulnerable societies. Examples are “social learning” (Cundill 2010), “collective action” (Ratner et al. 2017), “social capital” (Adger 2003, 2013), “role of knowledge” (Lebel 2013), and “traditional ecological knowledge (TEK)” (Berkes et al. 2000).

“Adaptive governance” as it is used by Pahl-Wostl et al. (2012) describes water governance for “mastering complexity” in basins worldwide, including in sub-Saharan Africa.

Most analyses of the role of knowledge in adaptive system governance and management find that different types of knowledge improve system outcomes. Local knowledge (Vedwan 2006), indigenous knowledge and participation (Nyong et al. 2007), local perceptions and understanding (Byg and Salick 2009; Chapagain et al. 2009; Lebel 2013), and the combination of local and scientific knowledge (e.g., Van Cauwenbergh 2008; Vignola et al. 2009; Raymond et al. 2010; Alexander et al. 2011) all seem to enhance system outcomes, albeit with nuances, mostly related to the institutions and the individuals or groups managing the knowledge, as well as the role of knowledge brokers and moderators (Berkes et al. 2000; Thomas et al. 2005; Agrawal 2010).

Participatory management and governance is widely promoted not only in relationship to water, natural resources, and climate change, but also as a general approach to management of goods and services in a society. However, there is limited understanding of how to achieve the benefits of participation effectively (Van Cauwenbergh et al. 2018). Whereas methods for stakeholder analysis (e.g., Reed 2008) are routinely

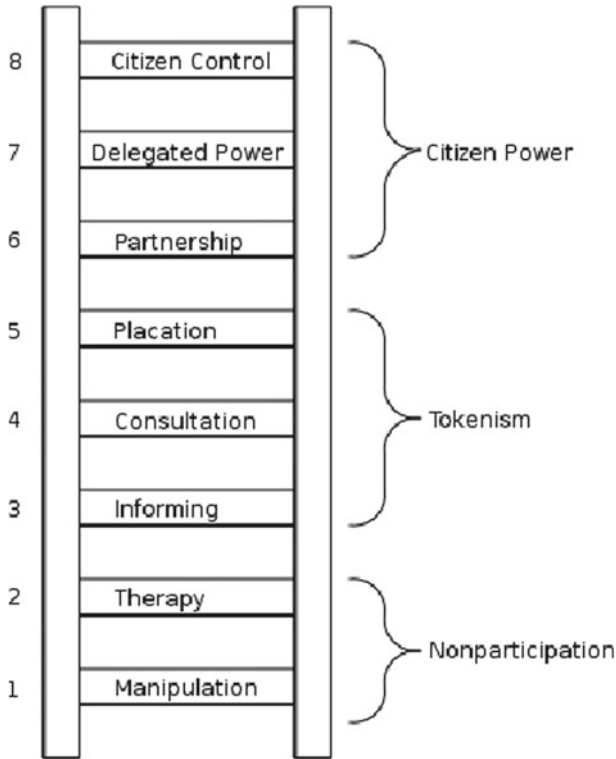


Fig. 1 The Arnstein Ladder of citizen participation (Arnstein 1969)

used, it remains a matter of debate who to involve, when, and at what level (e.g., Godinez-Madrigal et al. 2019). As early as 1969, Sherry R. Arnstein developed a ladder of citizen participation to describe the degree of citizen involvement in governance (Fig. 1). Comprised of eight rungs, the Arnstein Ladder describes increasing degrees of citizen participation, from the lowest level of *manipulation* to the highest level of *citizen control*.

The eight rungs are grouped in three types of relationships between authorities and citizens. At the lowest level is *non-participation*, where citizens are manipulated, “educated,” or “cured” by power holders (Arnstein 1969:2); the middle level is *tokenism*, where a gesture toward participation is offered to citizens who are discouraged or precluded from requesting more participation or protesting; the highest level is *citizen power*, in which citizens have an influential and equal say to that of authorities. The Arnstein Ladder is the framework used in this chapter to evaluate the degree of local participation and use of local knowledge in adaptive water management.

5 Materials and Methods

The Niger Basin is the largest in West Africa and third largest in Africa. It covers an area of 2.13 million km² and is home to over 130 million people in nine countries in West and Central Africa: Benin, Burkina Faso, Cameroon, Chad, Ivory Coast, Guinea, Mali, Niger, and Nigeria (Fig. 2).

Six of the nine basin countries are Least Developed Countries (LDCs) and seven are among the 20 poorest countries in the world, with large income disparities in the richer basin countries. The population of the basin is projected to double by 2050 while also getting richer, meaning the region could be required to increase its food production by a factor of five (Akumaga and Tarhule 2018). Over 70% of the population lives in areas where food security depends on unreliable rainfall and highly variable inter-annual and intra-annual river flows.

The basin covers six agro-climatic zones and presents a cross-section of the complex development challenges of West African societies (Ogilvie et al. 2010). Climatic zones vary from hyper-arid to sub-equatorial; annual rainfall fluctuates from over 4,000 mm in southern Nigeria/Cameroon to less than 400 mm (with no rain in some years) on the edges of the Sahara Desert in northern Mali and Niger (Ogilvie et al. 2010). Figure 3 shows the heterogenic distribution of annual precipitation and mean temperature in the basin, posing specific and diversified challenges



Fig. 2 Niger Basin and member countries of the Niger Basin Authority (NBA) (source Niger Basin Authority)

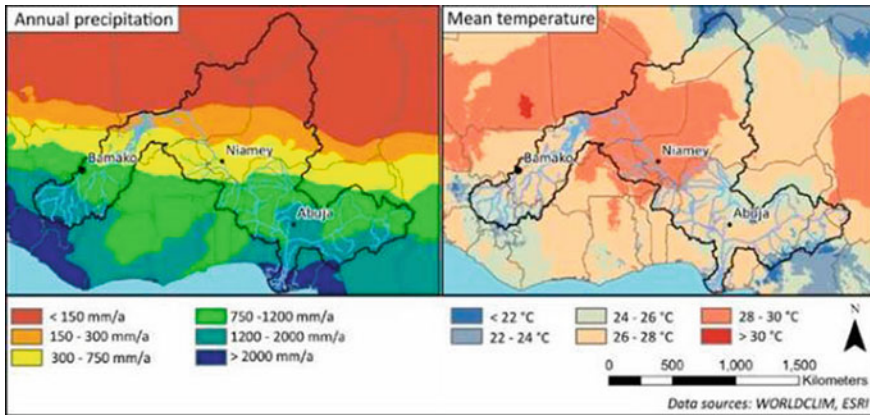


Fig. 3 Average annual precipitation and mean temperature in the Niger Basin (*source* Aich 2015)

to the sustainable management of water resources. The IPCC has declared the Niger Basin to be one of the most vulnerable regions to climate change in the world. Climate change impacts on the water resources of riparian countries are expected by some to exacerbate existing poverty and worsen inequality (Oyerinde et al. 2017).

Management and governance of water in the basin are overseen by the Niger Basin Authority (NBA), with representation of member states and civil society at regional and local levels, through National User Coordinations (NUCs). The Niger Basin is an example of a complex adaptive system. Its vulnerability to climate change ranks among the most in the world, with weak human and financial capacity and direct dependence on water resources for livelihoods. Table 1 presents an analysis of the Niger Basin as a Complex Adaptive System (CAS) (Fig. 4).

The first case study focuses on water governance at the Niger Basin scale to understand the process of inclusion of civil society, including representatives of resource users, in basin governance. It examines intended and actual levels of local participation and use of local knowledge as perceived by user organizations themselves. The next two case studies illustrate local participation in two local dam projects, the Kandadji Dam in Niger and the Fomi Dam in Guinea, both of which with regional impact. These studies reveal some of the effects of the terms of water governance as a result of varying degrees and forms of local participation (or lack thereof).

Analysis focuses on the structure of water governance in the Niger Basin, in particular, on the extent of local participation and local knowledge. Outcomes are then related to changes in vulnerability.

Analysis is based on¹ the following:

1. The history of the governance structure of the Niger Basin Authority (NBA), with a focus on the creation and functioning of the National User Coordinations (NUCs) of basin resources.

¹More details in the Annex.

Table 1 The Niger River Basin as a Complex Adaptive System (CAS) marred by vulnerability and climate change *Source* adapted from de Savigny and Adams (2009). Niger Basin inputs from the authors of the chapter

Characteristics of a CAS	Relevance in the Niger Basin
Self-organization: system dynamics arise from the internal structure of the system	The Niger Basin's multiple climatic zones, significant percentage of arid and semi-arid zones, and large ecosystems which directly provide livelihoods for millions of people (Inner Niger Delta), as well as its size and its steeply growing population make it particularly vulnerable to changes and impacts of climate change
Constant changes: systems are constantly adapting to internal and external stimuli, often in a way that is unpredictable	Increasing water withdrawals, large dam construction, intensifying agricultural practices, and population pressures on land and forests are all internal stimuli which are only partly predictable and quantifiable, particularly across national borders. Climate change, migration, armed conflict, and geopolitical dynamics (e.g., oil and food prices) are external stimuli
Governed by feedback: systems are controlled by feedback loops, moderating behavior as elements "react and back react" on one another	The Niger Basin is experiencing changes in rainfall patterns, increasing soil erosion, desertification and sedimentation, and changes in ecosystems. These affect the choice of human settlement, create conflict on hot spots of resource availability and cross-border migration to make up for changes in pressure on resources
Non-linearity: relationships within a system cannot be arranged along a simple input-output model	A choice to increase water withdrawals for irrigation as well as fertilizer use may well increase agricultural productivity, but from there to food security there is still a long way, with trade, food prices, rainfall, and energy for storage and transformation still playing an important role. Climate conditions still play an unpredictable role to determine the output of the system
Tightly linked: high levels of connectivity between and across systems: changes in one sub-system affect others (negatively or positively)	One significant example is the worsening security and instability situation in the Sahel. Itself a dimension of vulnerability, this situation affects almost all aspects of human and natural life

(continued)

Table 1 (continued)

Characteristics of a CAS	Relevance in the Niger Basin
History dependence: effects may not be evident immediately; short-term effects may be insufficient to generate continued support for an intervention	A reduction in the rate of deforestation can have a positive long-term impact on limiting soil erosion and sedimentation. But immediate pressure for biomass and firewood most often prevail, particularly for the poorest and most vulnerable
Counter-intuitive: proven or effective interventions in one setting fail to deliver when transposed into a different context	Measures addressing conflict and instability and strengthening climate-resilient development sometimes have unintended negative effects, deteriorating the security situation even further. For example, in cases such as communities in northern Mali, Niger, and Chad at the edge of the Sahara Desert, where desertification and radicalization are perceived as going hand in hand. Efforts to channel water to some of these communities, to restore land and improve its productive use, have in various cases resulted in conflict with surrounding communities and other resource users, such as herders and cattle breeders, often belonging to different ethnic groups or communities, who have attempted to benefit from the improved infrastructure for their own economic activities
Resistant to change: interventions may not generate desired outcomes if the bottlenecks and barriers are too entrenched	Attempts to change cooking practices for moving away from traditional three-stone fireplace cooking to efficient stoves for reducing firewood consumption have often failed due to resistance to change social practices

2. Reports from workshops, consultations, and negotiations among governments and mayors, village leaders, basin user representatives, elders, women's groups, and civil society organizations. The focus is on two processes of dam construction and displacement of populations in order to analyze the modalities of involvement of local populations, concerns about the use of local knowledge, and the information needs of communities. The first wave of displacement occurred in the Kandadji Dam and the concerns of local communities in the design and preparation are examined in the context of the Fomi dam.
3. Workshop debates, recommendations, and interviews with representatives of NUCs, the NBA, and representatives of national governments of riparian countries.

The question this chapter aims to answer is whether local knowledge can improve the outcome of decisions for the complex system of water resource management



Fig. 4 The Niger River Basin and the position of the Fomi Dam at the basin’s head and of the Kandadji Dam in the mid-Niger. (*source* adapted from L. Corsini 2011)

under climate change, and thus reduce vulnerability? To answer this question, analysis of vulnerability and levels of involvement of stakeholders is used. The WEF approach mobilizes theories of complex adaptive systems and their governance; referencing system boundaries and understanding; and stakeholders and their levels of involvement, adaptation capacity, and vulnerability.

We analyze the current and past degree of local participation as called for in statutes of the NBA as well as in the case of two specific major dam projects. A timeline of important events for water management in the basin since the founding of the Niger Basin Authority (NBA) provides intended levels of involvement and how these levels materialized in practice. Using the Arnstein Ladder of citizen participation (Arnstein 1969), degree of involvement is plotted against intentions.

For purposes of this study, vulnerability is defined as changes in perceived adaptation capacity by water user groups and individuals themselves as described in written assessments and reported in interviews. Finally, we identify institutional (and other) challenges for adaptive governance and management for all stakeholders. This approach enables a broad perspective of differences in system understanding, and application of system boundaries at different levels of governance in relation to participation and vulnerability.

6 Results

6.1 *Inclusion of Civil Society and User Groups in Basin Governance of the Niger Basin Authority (Case Study 1)*

Civil society involvement in water management in the Niger basin dates back to the 1980s, when the construction of large dams was increasingly met by resistance at the local level. Local communities blocked work during the construction of dams such as the Talo Dam on the Bani (a major tributary of the Niger). It took more than two decades, however, for the role of civil society to be institutionalized. In 2005, the NBA formally recognized the need to involve civil society in the governance of the basin, and in 2006 civil society was officially recognized as a stakeholder and given a formal platform in the National User Coordinations (NUCs) and, in 2007, its participation mechanisms. The functioning of NUCs was reviewed in 2009, leading to a number of adjustments and signing of new NUC Memoranda of Understanding in 2014. This section focuses on the 2005–2014 period to compare the formal provisions for stakeholder participation to its manifestation in reality in relation to capacity building and vulnerability. The section relies heavily on the analysis conducted jointly by GIZ and ABN (Edl 2017) on state of cooperation among the NBA Executive Secretariat, civil society, and national focal structures.

The NBA (2010:3) defines the objectives of civil society in the NUCs as, “the users of the natural resources of the basin [to] participate in various decision-making stages: planning, program implementation, evaluation, etc.; and contribute, through their actions as structured organizations, to the sustainable development of the basin and in particular the actions of the Development Plan and Investment Plan which may concern them.” On paper, this corresponds to a high level of participation (level 6 according to Arnstein 1969–*Partnership*). The scale of participation is defined by the geographical extent of the NBA mandate, which is the entire river basin; the type of stakeholders concentrates on main users. Users are considered to be a varied but “structured” body of stakeholders, able to make decisions and implement actions throughout the chain of water management activities. Peripheral reference is made of investments and activities at a more local level, presumably touching specific groups of users. The capacity required to participate beyond civil society participation objectives in NUCs is high, including mobilization, participation, coordination, defining interests, brokerage, planning, implementation, and evaluation. It also formalizes the definition of users.

In 2009, following a series of false starts, the NBA launched a study on capacity building and strengthening the involvement of civil society in the process of sustainable development of the Niger Basin. This study notes that the NUCs “operate timidly and are not aware of their roles and their anchoring in the process” for sustainable development of the Niger Basin. In addition, NUCs are reported to lack “an initial financial allocation to support the installation and operation” and suffer from “the absence of a formal commitment and effective involvement of Member States to provide support for the establishment and operation of the NUCs” (Tchouplaou et al.

2009:7). This reported lack of organizational, financial, and institutional capacity (Tchouplaou et al. 2009; NBA 2010; Edl 2017) indicates potential vulnerability of NUCs to decisions that reflect the interests of other, more powerful stakeholders (CRU-BN 2017; Edl 2017). This was confirmed at the NBA regional workshop on “integration of the water-energy-food Nexus in the NBA Operational Plan 2016–2024” in June 2018, where NUC representatives evaluated alongside representatives of the water, energy, agriculture, and environment ministries their respective and combined capacities to influence and implement decisions on uses of the basin’s resources in each country’s portion and the basin as a whole. The NBA study even notes ongoing debate about the identity of users, some of whom felt misrepresented by the term “civil society.” The definition ultimately agreed upon is, “rural and urban populations whose livelihoods depend on the exploitation of the natural resources of the Niger basin” (Tchouplaou et al. 2009:4).

To improve the situation, the following interventions were proposed: “The setting up of a technical assistance mission that provides technical and organizational support/advice to the NUCs; the capacity building of the members of the NUCs on accompaniment through adequate logistical means; organization of an information and awareness campaign for users and civil society organizations on NBA, Shared Vision and investment plans; support for capacity building; implementation of income-generating activities” (Tchouplaou et al. 2009:19). These interventions reflect the NBA’s drive and interest for users to support implementation of certain projects, and also serves as motivation, at least indirectly, for some state entities of the NBA member states. These interventions are however reported to have the unintended and undesirable effects of making participation more passive (KPMG 2016).

Representatives of the NUCs, particularly those who participated in the creation of the agreement following protests over the construction of dams, expressed in interviews their perception that, once users are seen as recipients of capacity building and financial support, the nature of their relationship to public authority changes. Involvement would be characterized by Arnstein’s levels 1–3, *manipulation*, to *therapy* to *informing*, which are all highly passive. In addition, the definition of “user” is limited to the identified representatives, who are allocated offices and a budget, distancing them from their stakeholder base (interviews with members of NUCs networks in Mali and Niger). Finally, the system focus remains on high-level, basin-wide processes, mainly representing the view of NBA, failing to connect effectively with lower level processes and system understanding (interviews with NUC representatives in Chad, Ivory Coast, and Nigeria).

In 2014, new protocol agreements were signed among NUCs, the ministries responsible for the NBA in each country and the NBA itself. The revised protocols refine expectations for the involvement of users in the management of the Niger Basin, to promote greater local involvement as advocated by scholars (e.g., Thomas et al. 2005; Armitage 2005; Lebel 2013); formal institutions tend to welcome voices of local interests (Agrawal 2010). But NUCs are effectively under the control of the national focal structure of the relevant ministry, and made dependent on NBA supervision and oversight. The objective of the new agreements of the NUCs are

to “Promote and organize consultation between users of the national portion of the basin; Contribute to the sustainable management of the natural resources of the Niger Basin; Mobilize users at the national and regional levels for greater participation in decision-making about the future of the basin; Promote the capacity building of users of natural resources at local, national and regional levels.”

This language suggests a top-down approach, which threatens to significantly reduce the agency of users compared to the objectives initially formulated in 2006 (interviews with NUC members in Niger and Guinea). System boundaries are limited to the national portions of the basin, and participation modalities focus more on mobilization than on planning, decision-making, and implementation (KPMG 2016; CRU-BN 2017). The role of stakeholders—users themselves—remains a mostly passive one, emphasizing the need to co-opt them to buy into schemes developed at higher levels (interviews with CNU members in Guinea and Niger). The contributions of users to actual decision-making are channeled through modalities developed and controlled by stakeholders and structures other than the local communities themselves (Eau Vive 2006, 2007; Barry 2010). Local knowledge is thus marginalized (interviews with NUCs representatives) and its impact on decision-making is diluted. On the Arnstein ladder of participation, interviewees characterize their involvement as 3 (*informing*), 4 (*consultation*), and 5 (*placation*), which make up the second of three levels of “tokenism.” There was no consensus among interviewees about the cause(s); some perceived the intention to marginalize by their NUCs (e.g., NUC Nigeria) and others blame the limited capacities of user organizations (NBA representatives).

In 2014, the NBA planned the “revitalization project of the partnership NBA-Civil Society of the Niger basin” for the period 2014–2016. The project aimed to strengthen the NBA-civil society partnership through the implementation of the NBA Investment Program. But the project was never launched due to lack of funding, with NUCs reporting “enormous difficulties due to the lack of funds as well as difficulties in the implementation of the memorandum of understanding” (CRU-BN 2017). The lack of financial resources is explained by non-payment of membership fees and dues of the NUC members, in addition to the failure to regularly finance the effort by the NBA and the member states. In addition, the NUCs report a consistent lack of regular communication with the NBA national structures that formally supervise them, as well as deficiencies in regular reporting and reaching consensus on annual work plans (KPMG 2016; Edl 2017).

At present, NUCs are not actively involved in the preparation and implementation of projects and programs. This makes them vulnerable to resource allocation decisions made at other levels and without sufficient input from users. This is in spite of policies to encourage greater stakeholder involvement and the sensitivity of technical partners to these issues, e.g., ECOWAS Directive announcement of the construction of large dams in West Africa, 2017; the Water Charter of the Niger Basin Authority, 2008); and coalitions such as the Network of Mayors on water infrastructures in West Africa. Further examples of these challenges are provided in the following case studies.

6.2 *Increased Vulnerability of Displaced Communities at the Kandadji Dam (Case Study 2)*

The Kandadji Program for Regenerating Ecosystems and Enhancing the Valley of Niger (P/KRESMIN) is a priority sectoral program of Rural Development in Niger. It is also one of the three dams of common regional interest identified in the NBA's Programme for Sustainable Development. The project is supported by multiple donors and will lead to the displacement of at least 38,000 people. This section documents the nexus impacts of displacement at the local level and uses the case to reflect on the relation between nexus governance at the project level and vulnerability of the communities involved.

A first displacement and resettlement operation to allow construction of the dam affected 5,500 people in villages in the river bed. The NUC deployed several information-gathering missions in Niger between 2013 and 2018, producing a wealth of information and lessons learned on the participation of local communities in decision-making around displacement and the project itself. These serve not only as key learning points for subsequent and future waves of displacement and planning in the Kandadji Dam Project, but also for the other major dam projects of common regional interest in the Niger Basin, Fomi in Guinea, and Taoussa in Mali.

In terms of system understanding and system boundaries, the sensitivity of the displacement operations means that the focus stays relatively local for all stakeholders. However, the project is generally perceived as a national utility initiative by the Nigerian authorities. The transboundary dimension is weak, an assessment confirmed by the little participation of the NBA in the process, despite the clear impacts beyond Niger.

The legal (inventory, compensation, land rights), cultural, and social (disruption of social networks by the displacement) boundaries of the system are subjects of misunderstanding and miscommunication and are identified by stakeholders as the main obstacles to deeper local participation in decision-making around the project. Populations underscored insufficiencies in three areas: preparation of the targeted sites before displacement, low participation of populations to be displaced, and unsatisfactory communication between project owners and impacted populations.

Whereas the project owner appears to have a very good understanding of the stakeholders involved and the different interlocutors and representatives of the local communities, serious shortcomings are noted in the level of involvement. Local community representatives think of themselves as recipients of information, and complain of the inconsistency and incompleteness of the information provided by project authorities. This self-perception as passive participants in management and communication places them, at best, at level 3 of the Arnstein Ladder (*informing*). Overall, the community structures (committees) created for the projects are perceived as dysfunctional (see reports in Annex). The capacity of local populations to participate and influence the process proactively is limited, particularly in the domains of legal rights and dealing with the unexpected. Both residential and agricultural land

rights of displaced populations are identified by interviewees as weak. Clarity among village leaders, elders, and women's groups is necessary for equitable compensation.

These shortcomings have negative impacts for the communities on the ground. Examples include the struggle by women for even minimal access to water following displacement, and a reported increase in vulnerability for new home owners and farmers. Villagers were given the choice between receiving new houses already built, and receiving the value of their existing houses in cash to enable them to build their own houses. Many villagers choose the latter, with the unintended consequence in many cases of under-investment in new homes and therefore exposure of these villagers to new risks. The capacity to plan and invest corresponds strongly to perceptions of risk, social pressures, risk aversion, and cultural influences. Village leaders and mayors are most often highly aware of the tendencies of their constituents and, in the opinion of NUC representatives in Niger, could have seen this coming. In their opinion, discussing the relocation plan with village leaders in more detail would have allowed village leaders to better explain the pros and cons of compensation options for the villagers, leading to wiser and more sustainable choices, i.e., more villagers choosing quality housing over financial compensation. Unexpected flooding of the irrigated perimeter caused by abundant rainwater during the displacement period compromised agricultural productivity for farmers.

These outcomes increase the vulnerability of local populations through damage to their livelihoods as well as a lack of sufficient involvement of local communities in the project. The reports of the NUCs also identify that the populations of certain villages “live in fear; are very perplexed and pessimistic. Even the collaborators closest to the project [management] are worried, having witnessed the experiences of the first wave of displacement” (NUC Niger 2015—translated from French by the authors of this chapter).

In the words of NUC members, “in view of the lessons of the first wave and the number of people affected by the second wave, it should be emphasized that the enormous second wave calls for a holistic and cross-sectoral participatory approach, with close communication and strong involvement of the populations to be displaced and institutional actors. The effective inventorying of goods is one of the essential keys to the success of these operations” (NUC Niger 2015—translated from French by the authors of this chapter).

6.3 Discrepancies in System Understanding Around the Fomi Dam (Case Study 3)

Located in the Guinean Highlands, the Fomi Dam on the Niandan River is 39 km from its confluence with the Niger River, and was already identified in 1940. The current presidential administration of Guinea has made the project a political priority, with knock-on political effects in Mali and the other basin countries, due to the magnitude of the project and the downstream impacts. This section considers the objectives and

potential impacts of the project at the local and regional levels and examines how its (nexus) governance leads to changes in vulnerability.

At the national level, the first priority of the Fomi Dam Project is to provide local households, markets, and the national mining industry with electricity. The significant hydroelectric potential of 100 MW was the primary motivation for Guinean authorities to conceive the project. Furthermore, the water reservoir has the potential to irrigate around 100,000 ha of agricultural land in Guinea, as well as to provide fishing and fish-farming opportunities. The initiative would require, however, the displacement of an estimated 45,000 people, which unsurprisingly is the main concern of local rural stakeholders who have long been aware of the project and associated with various activities around its preparation. Recently, a new site seems to have gained preference among the project's managers and contractors: 15 km upstream, where the population to be displaced is estimated to be only about 5,000.

The potential impact of the project is not limited to Guinea. The project regained some regional interest in 2014, notably with the call to re-evaluate the possible environmental and social impacts and discuss its shared costs and benefits among NBA countries.

The Fomi Dam Project is noted among basin-scale planning projects by the NBA for its potential to regulate the Niger's discharge beyond significant seasonal variations, along with two other dam projects (the Taoussa Dam in Mali and the Kandadji Dam in Niger). In a region that has a rainy season typically concentrated in a period of only 3 months, the need to store water to optimize its use at the economic, social, and environmental levels is significant. Regulating the discharge of Niger's main watercourse would potentially allow expansion of irrigation and agricultural production, thus improving the security and independence of food production in the region. The NBA's Sustainable Development Action Plan (in French *Plan d'Action de Développement Durable*) (Niger Basin Authority, 2008) estimates, for example, that the Fomi Dam could provide for the development of about 10,000 ha that could be developed as far away as the country of Niger. Discharge control throughout the year would also allow for improved navigation and regional commerce to be developed on the river.

The dam project has been validated by all stakeholders, including basin users. But the magnitude of the basin and of the number of communities affected mean that any proper consultation is ambitious and extremely costly. On a political and regional integration level, the project falls under the mandate of the NBA, but raises important questions for all impacted riparian countries—for example, who would determine policy for water retention and release, and the general regime functioning of the dam. There are many stakeholders associated with the project and they span a variety of geographies, including local, national, and basin/regional. In the recent consideration of social and economic impacts of the dam, certain stakeholders have felt consistently alienated, particularly when focus is on local impacts to the exclusion of regional stakeholders (interviews with stakeholders in Mali and Niger). Mali and Guinea have established a joint inter-ministerial consultation group; nonetheless, Mali has complained about not having access to the most up-to-date information about the planning of the dam (36th Ordinary Session of the NBA Council of Ministers 2018).

The position of the dam “en tête de bassin” (at the head of the basin) is particularly delicate, and raises questions about the nature of its impacts and the capacities required to adapt locally and regionally. Economically and socially, changes in the river’s regime and discharge would demand big changes in agricultural and economic practices. Artificial control of the river’s natural regime would entail a change in the relationship between the river and the ecosystems it sustains through seasonal fluctuations (Zwarts et al. 2005). It would also directly impact human activity, depending on the natural resources of each ecosystem, for example, fishing and rice farming, which depend on the seasonal flooding of certain areas of the basin. Furthermore, redirecting the main purpose of the dam from hydropower to river discharge regulation would have a significant influence on financial calculations of the economic viability of the project (NBA internal document 2018). This means, for example, that farmers, fishermen, and herders in the Inner Delta would realize impacts. While some organizations (e.g., Wetlands International and the International Union for the Conservation of Nature) regularly attempt to voice concerns, the inhabitants of the Inner Delta are only vaguely aware of the projected impacts of the dam and its implications for their economic activity. A comprehensive understanding of the project’s impacts is complex for inhabitants close to the project location as well (interviews with representatives of Wetlands International and NUC Guinea). Participants in workshops with local community stakeholder representatives in Guinea, particularly those who are likely to be affected by displacement plans, raise concerns and questions (CRU-BN 2017) that indicate insufficient understanding of the dynamics of such a project, including individual and group rights, the expected benefits of the dam as well as the risks and changes it imposes on different groups.

The NUC in Guinea is considered an honest information broker and a trustworthy moderator of relationships between the local communities and national authorities (interview with member of NUC Guinea). Mayors and village leaders participate regularly in meetings and workshops, and their point of view is integrated in discussions and group exercises. But highly varying capacities to access and use technology, communicate effectively, and advocate for strategies mean that these populations have achieved *consultation* and, at best, *placation* (levels 4 and 5 according to Arnstein 1969). An illustration of this comes from the workshop on the kick-off of the dam’s social and environmental impact updated study in 2017, at which contracted consultants had access to the full list of participants and a ranking of the issues that were most sensitive for their communities. The workshop was intended to demonstrate the complexity of the project to stakeholders, and only minimally affected the consultant’s plans for the study (AECOM workshop report, September 2017; authors’ observation at the workshop). Moreover (interview with NUC Guinea; report of the 27th Ordinary Session of the NBA Council of Ministers 2018), issues of displacement had not been communicated in detail to villagers, and many very basic questions around management and governance of the displacement processes were not addressed.

Open questions around the Fomi Dam make it difficult to predict its impact on vulnerability to climate change in the region. In view of the potential impact and the great number of stakeholders at varying levels of governance, involvement of local

populations to prepare adaptation strategies for socio-economic change as a result of the dam is important.

7 Discussion

Results show the factors influencing levels of involvement of local knowledge and its relation to nexus governance. Issues of scale, system understanding, and barriers to inclusive nexus governance are identified across the case studies.

The reported lack of organizational, financial, and institutional capacity of National User Coordinations (NUCs) signals the potential vulnerability of the NUCs to the interests of other, more powerful, stakeholders. The three case studies confirm that involving local knowledge has the potential to improve multisectoral nexus governance and reduce vulnerability. This is shown in the case of the NUC in Guinea, which established itself as a trusted knowledge broker and led to a potential new location of the Fomi Dam that would significantly reduce forced displacement. Involvement of local knowledge also accommodates sensitivities that may not be accounted for in scientific analysis: cultural considerations, relationships between and within groups, social capital, and preferred modes of communication and of social learning. Involvement of local stakeholders increases ownership of the project, as was the case, with some significant positive impacts on project implementation, in Kandadji (capacity building, involving women groups, etc.). Conversely, vulnerability can increase when local knowledge structures are not involved, as was the case in giving villagers individual choice on housing compensation.

On the Arnstein Ladder of participation, relevant rungs identified by interviewees range consistently from 3 (*informing*) to 4 (*consultation*) to 5 (*placation*), representing the second of three levels of the ladder—tokenism. This generally corresponds to a feeling of increased vulnerability, mostly caused by the lack of control of local stakeholders. This has negative implications for decision-making and trust among governing authorities.

It could be argued that the increases in vulnerability in the short term are necessary evils in order to realize the long-term benefits of the completed dam projects. Dams designed at basin level are intended to result in return at a large scale, something that is difficult if not impossible for local communities to achieve. But it is also the case that displacement occurs at a very advanced phase of dam project implementation, and co-design of resource management could start from a much earlier stage of planning to include populations in the analyses, such as alternatives to the dam. This would mean initiating a partnership with local communities early and at different scales, because resource use and allocation apply at minimum to a national scale, and often a multinational scale.

Our analysis confirms that formalization helps to mainstream local knowledge into multisectoral water management processes. Once NUCs are officially established, they participate regularly in statutory meetings and have an official mandate

to influence processes. They learn the “rules of the game” and build historical knowledge of the institutions with which they negotiate. On the downside, formalization of NUCs may result in introducing some rigidity to the system, in turn leading to a loss of depth of the stakeholder base. This is because representatives of the users in some cases lose a direct link to their base (farmers, fishermen, energy users and producers, cattle breeders), preferring to turn to other entities, particularly for financial support, which naturally influences their priorities. The establishment of official relationships between the users and public institutions, while legitimizing the NUCs and facilitating access to information and contact with project designers, owners, and implementers, also makes users more dependent on the state and other official bodies, such as the NBA.

With regard to involvement of local knowledge in water management at different levels, we note significant shortcomings in involving local communities meaningfully across the project spectrum. There are also barriers to an effective partnership among government/public institutions and users: inequality in financial capacities and leverage, different professional networks and legitimacy, and issues of perception and semantics (e.g., “civil society” and its connotations). The lack of extensive information exchange to reach a shared understanding of the boundaries of the system excludes or undervalues some stakeholders, and by extension the management outcomes for those stakeholder groups.

We also find some evidence of the value of increasing the stakeholder base in governance processes. While complexity can be daunting, our analysis confirms that polycentrism in governance reduces vulnerability and improves outcomes. The obstacles to maximizing the potential of polycentrism lie in the lack of established mechanisms and *fora* for an effective information exchange, in the overlapping and conflicting interests of different information brokers which can contradict each other, and in a loss of clarity and trust, particularly by those stakeholders which are less equipped in terms of capacities and analytical tools (often the users themselves). Effective information exchange is crucial to overcome different understandings of the system and ensure a more holistic view of project impacts.

Observations from the three case studies confirm that institutions with different mandates tend to frame the system differently, leading to a divergence of understandings (Boelens et al. 2016). The NBA predominantly looks at the basin in its entirety, while users (such as women, young people, pastoralists, fishermen, farmers) have the tendency to understand the system around boundaries and cleavages that bear on their interests. In general, stakeholder groups present a better understanding of aspects of the system that are closest to them (Van Cauwenbergh et al. 2018). This is illustrated by the deep awareness of the displaced populations of Kandadji of the rights they have lost, and the introduction of irrigated perimeters. Similarly, inhabitants of the Inner Niger Delta may well not yet grasp the potential impact of the distant upstream Fomi Dam on their livelihoods. Governance and system dynamics are directly influenced by who is interpreting the system, even within the same stakeholder group (Reed 2008). This has an impact on individual capacity to

participate; we also observed that the demographics of the spokespersons and representatives (e.g., age, gender, social capital, socio-cultural identity, and interests) also influences the type of knowledge being communicated.

At the group level, management outcomes are determined by the capacity to organize, to make decisions internally, to build partnerships, and to negotiate. This is particularly true for local groups which find themselves facing national and international institutions which are often the official owners and/or promoters of projects such as multi-purpose dams (Boelens et al. 2016). Also important is the arbiter of knowledge exchange between groups, who understands the system differently and uses different vocabularies to describe it (Berkes 2000; Thomas et al. 2005; Agrawal 2010).

Vulnerability is perceived in concrete terms by local stakeholders. Displaced populations reported difficulty in accessing drinking water after displacement, which mainly affected women. In addition, due to concurrent climatic conditions, unexpected floods and dry spells in Kandadji directly impacted food availability for the populations displaced from their farmland. In an area that increasingly experiences food insecurity, in part due to climate change, it is all the more important to put safeguards in place to ensure that food needs are met; this effects the trust of the population in the authorities managing the dam project.

The result of the overall under-inclusion of local knowledge is a potential and, in the case of Kandadji, established increase in vulnerability. This vulnerability is directly related to the underdeveloped potential of capacity across stakeholders at different levels. This dynamic can be most effectively addressed, we believe, through more autonomous organization and agency of civil society, instead of using a top-down approach driven by central governments. There is potentially a significant role for donors and technical cooperation partners in accompanying local stakeholders, while keeping in mind the risks of over-formalization and of changing the nature of the coordination-type institutions themselves. There may be a research gap here to be filled—how best to support civil society while allowing it to maintain its status as independent representatives of under-represented, and often vulnerable, groups.

The cases presented confirm the complexity involved in the multisectoral, nexus management of water resources in contexts of vulnerability, limited capacities, and highly different scales and stakeholders. Capacities remain the main obstacle to deeper proactive participation of users to higher level decision-making. Indeed, mobilizing constituencies, obtaining financing, managing transport, formulating interests, pooling resources, and organizing collective action are capacity-intensive activities. But these are exactly the activities that translate into adaptation capacities and reduce vulnerability to climate change and unsustainable management of natural resources (Walker et al. 2004; Agrawal 2010; Lebel 2013).

8 Conclusions

These case studies set out to test the claim that more holistic approaches to nexus water management, including local knowledge and ensuring local participation, lead to reduced climate change vulnerability and greater capacity for adaptation, particularly for natural resource-based societies.

Based on theories of complex adaptive systems, interventions in the West African Niger River Basin were analyzed for implications on the nexus structure across different levels, depth of participation, use of local knowledge, and the existing governance system. The recent (2006–2018) inclusion of civil society and user associations in the governance of the Niger Basin Authority was the first such intervention. The second study, in the Kandadji Dam in Niger, where several villages were displaced in the period 2013–2018, lessons learned from this experience are used to analyze the effect of local participation on (intermediate) project outcomes in the short to medium term. The third is the case of the Fomi Dam in Guinea, scheduled to start construction in the coming months; data from stakeholder meetings examines the level of local involvement and how it bears on decisions and outcomes.

Generally, these case studies indicate the importance of involving local stakeholders. This often translates into ambitious strategies and aspirational goals for a *partnership*-type involvement of local knowledge. The reality, however, is that involvement falls significantly short of goals; *consultation* and *informing* are the norm, often with complaints from local stakeholders that information is partial, inconsistent, and difficult to digest. In these cases, a lower level of involvement does appear to impact management outcomes negatively.

Polycentrism of decision-making and governance is seen as an approach that facilitates management outcomes. Formalization of polycentric governance structures appears to improve outcomes, albeit with a risk of increasing the rigidity of the system to the point of undermining continuous learning and adaptation. Given the largely unpredictable nature of climate change, designing management systems that anticipate the need to adapt and learn seems key and should be given more attention.

Institutions with different mandates tend to frame and understand the system differently, and the weakness of information exchange to reach a shared understanding of system boundaries excludes or undervalues some stakeholders, and thus damages the outcomes for those stakeholder groups. The cases analyzed indicate that inclusion of local knowledge in the management of natural resources can help reduce vulnerability to climate change. In particular, for projects such as dams, which profoundly alter the lives of entire villages in a short period of time, greater integration of local knowledge can soften the severity of vulnerability. However, assessment (both before and after governance initiatives) needs to be improved to understand the relationship among stakeholder involvement, management outcomes, and resulting vulnerability.

Future research must examine which types of local knowledge are most crucial to the management of water and land resources in vulnerable complex adaptive systems, and look into the capacities necessary and the stakeholders best placed to collect

and deliver such knowledge in governance and decision-making. This would also allow stakeholders to identify obstacles to greater involvement of local knowledge and design interventions and capacity development to support greater integration. Research must also contribute to maximizing efficiency through local knowledge, which would provide clear guidance to project developers and national governments and validate the allocation of resources required to create deeper partnerships with owners and brokers of local knowledge.

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Annex—Data for Analysis

1. Rapport De Synthèse De La Visite D'échange D'expériences Des Délégations De La Société Civile De Fomi (Guinée), De Kandadji (Niger) Et De Taoussa (Mali) A Selingue Au Mali Du 25 Au 27 Mars 2010
2. Capitalisation Des Expériences Du Processus De Déplacement Et Réinstallation Des Populations De La Zone Des Barrages De Kaleta Et Souapiti, Préfecture De Dubréka
3. Troisième Rencontre Du Cadre De Concertation Des Maires Autour Des Grands Barrages Dans Les Bassins Hydrographiques En Afrique De L'ouest Et Du Centre
4. Rapport De L'atelier De Restitution Suite A La Visite D'échange D'expériences Tenue A Selingue Entre Les Populations Riveraines Des Barrages De Fomi (Guinée) Et Selingue (Mali)
5. Atelier De Restitution Du Voyage D'étude Des Acteurs Du Projet De Barrage De Fomi (Kouroussa) Sur Le Site Du Barrage De Garafiri (Kindia)
6. Rapport De La Visite D'échange D'expériences Entre Les Futures Populations Affectées Par La Réalisation Du Projet De Barrage De Fomi En Guinée Et Les Populations Du Barrage De Selingue Au Mali.
7. Concertation Avec Les Populations Affectées Pour Le Suivi De La Mise En Oeuvre Des Aspects Sociaux Des Pges/Pr/Pdl Du P/Kresmin
8. Voyage D'étude Des Acteurs Du Projet De Barrage De Fomi (Kouroussa) Sur Le Site Du Barrage De Garafiri (Kindia)
9. Débat télévisé: <https://www.gwiwestafrica.org/fr/kandadji-reinstallation-des-populations-quelle-lecons-tirees>
10. Documentaire Kandadji: <https://www.gwiwestafrica.org/fr/kandadji-compensation-des-terres-agricoles-elles-lecons-capitaliser-debat-canal3-niger>
11. Focus Fomi à l'Assemblée Nationale de la Guinée: <http://www.crubn.org/videos/la-cru-bn-a-l-assemblee-nationale-du-mali.html>
12. Rapport de l'atelier d'information sur le Barrage de Kandadji, CNU Niger, Novembre 2018

13. Synthèse Du Premier Atelier Regional De Dialogue Nexus Eau-Energie-Sécurité Alimentaire-Environnement Dans Le Bassin Du Niger
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(ITSELF BASED ON THE FOLLOWING PRIMARY SOURCES)

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- III. Autorité du Bassin du Niger, juillet 2011 : TDRs relatifs à l'organisation des ateliers nationaux pour le renforcement des capacités des Structures Focales Nationales sur la connaissance des objectifs et résultats poursuivis par l'ABN dans les états membres (2001 à 2013).
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