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LOCAL KNOWLEDGE AND ADAPTATION TO CLIMATE CHANGE IN OUÉMÉ VALLEY, BENIN

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ABSTRACT

Climate change is today a major threat to sustainable development, particularly in sub-Saharan Africa, that is anticipated to be most vulnerable because of low adaptive capacity and high dependency on climate sensitive resources such as water resources and ecological systems. This paper highlights the local dimension of adaptation to climate change and the importance of local knowledge in adaptation planning. Generally, adaptation and mitigation are the main known approaches to address climate threats. Indeed, climate change is an international concern, while the benefits of adaptation are local, as opposed to mitigation. Also like climate, climate change adaptation is a dynamic and evolving process which the main determinant is the degree of vulnerability. A case study of farmers' strategies for adapting to climate vulnerability in the low valley of Ouémé showed that local people have developed a remarkable ability to adapt to climate threats, or in some cases have turned threats into opportunities. From fishing practices to agricultural techniques through agro-fishing practices, people of low valley of Ouémé managed to take advantage of their natural vulnerability through adaptation strategies mainly based on local knowledge. In fact, the trend of these local strategies confirms the dynamic nature of adaptation to climate change mainly determined by the extent of vulnerability caused by continued depletion of the environment. But given that this dynamic can sometimes lead to maladaptation, it is necessary that local people are assisted in their coping strategies, even if a synergy is needed between local institutions and national and international framework for the successful adaptation to climate change.

Key Words: Adaptation strategies, climate vulnerability, local knowledge

RÉSUMÉ

Le changement climatique constitue aujourd'hui une menace majeure pour le développement durable notamment en Afrique sub-saharienne du fait de sa faible capacité d'adaptation des populations et de leur grande dépendance des ressources à forte sensibilité climatique telles que les ressources en eau et les écosystèmes. Cet article met en exergue la dimension locale de l'adaptation au changement climatique et l'importance des connaissances locales dans la planification de l'adaptation. L'approche méthodologique adoptée a été essentiellement qualitative appuyée par la revue de littérature. Théoriquement, l'adaptation et l'atténuation sont les principales approches connues pour faire face aux menaces climatiques. Mais, même si le changement climatique est une préoccupation planétaire, les bénéfices de l'adaptation sont locaux, contrairement à l'atténuation. De plus tout comme le climat, l'adaptation au changement climatique est un processus dynamique et évolutif, avec pour déterminant principal le degré de la vulnérabilité. L'étude du cas des stratégies paysannes d'adaptation à la vulnérabilité climatique dans la basse vallée de l'Ouémé a par ailleurs montré que les populations locales ont su développer au fil du temps, une remarquable capacité pour s'adapter aux menaces climatiques, ou dans certains cas, transformer ces menaces en opportunités. Des pratiques piscicoles aux techniques exclusivement agricoles en passant par les systèmes agro-piscicoles, les populations de la basse vallée de l'Ouémé ont réussi à tirer profit de leur vulnérabilité naturelle grâce à des stratégies d'adaptation basées sur des connaissances essentiellement locales. En réalité, l'évolution

observée dans ce milieu confirme le caractère dynamique de l'adaptation au changement climatique dont le principal déterminant est l'ampleur de la vulnérabilité causée par la dégradation continue de l'environnement. Mais étant donné que ce dynamisme peut parfois conduire à une maladaptation, il donc nécessaire que les populations locales soient assistées dans leurs stratégies d'adaptation, même si une synergie est nécessaire entre les institutions locales et le cadre national et international pour réussir l'adaptation au changement climatique.

Mots Clés: vulnérabilité climatique, stratégies d'adaptation, connaissances locales

INTRODUCTION

Climate change is a major threat to sustainable development in developing countries. According to IPCC (2007), poor communities particularly in sub-Saharan Africa will be most vulnerable because of their low adaptive capacity and great dependency on high climate sensitive resources such as water resources and ecosystems. Environmental and social consequences of climate variability have already jeopardised the livelihood of many populations in developing countries. However, even though it is acknowledged that poor communities will be most affected by climate change, the magnitude of this vulnerability depends heavily on ecological and socio-economic characteristics of each community.

Indeed, a common theme in the climate change literature is the idea that countries, regions, economic sectors and social groups differ in their degree of vulnerability to climate change (Bohle et al., 1993). This is due partly to the fact that changes in temperature and precipitation will occur unevenly, and also that resources and wealth are distributed unevenly. Because of these characteristics, some communities are more exposed and more sensitive to the adverse effects of climate change than others. In many cases these communities have adapted their farming, livestock rearing, and other income generating activities to achieve successfully some degree of sustainability despite their climate vulnerability (Mortimore and Adams, 2001; Blanco, 2006; Nyong *et al.*, 2007). This is, for instance, the case of the low valley of Ouémé river in Benin, where people live in wetland ecosystems already fragile. These people mostly famers, live in precarious ecological conditions, naturally characterised by regular floods that threaten their socio-economic well-being.

But, it has been established according to climate models that the high rainfall events, devastating floods and heat waves will become more frequent in the world with great annual and seasonal variability. We should expect over the coming years, contrasted situations alternated by drought and excessive rainfall with increase in hydro-climatic disasters. In this context, developing adaptation strategies to reduce climate vulnerability and secure livelihoods is an immediate priority for local people. However, before dealing with issues related to adaptation to climate change, the threats of current vulnerability must firstly be discussed. Adaptation to current vulnerability is the most urgent task to implement in the process of adaptation to climate change (Bohle *et al*., 1993); because as emphasized by Locatilli *et al*. (2008), a community less vulnerable to the current problems could more adapt to future changes.

But, adaptation to climate stress is a local process (de Perthuis *et al*., 2010; Locatelli, 2011) that is rooted, according to Ader and Kelly (1999), in the socialisation and learning. Therefore, it is not possible to implement an adaptation policy without considering the social context in which local knowledge are developed. Unfortunately, the increasing attention to adaptation to climate change has not come with sufficient emphasis on the local nature of climate adaptation and on the role of local institutions and local governance in shaping adaptation practices (Agrawal *et al*., 2009). Indeed, while the importance of indigenous knowledge has been realised in the design and implementation of sustainable development projects, little attention has been drawn to their incorporation into formal climate change mitigation and adaptation strategies (Nyong *et al.*, 2007). Local initiatives have often suffered from a lack of visibility including in regards to climate change issues. This reduces their potential to solve the issues of climate change. It is, therefore, important to understand better the role of institutions in shaping adaptation,

especially the role of local institutions, if adaptation to climate change is to help the most vulnerable social groups (Agrawal *et al.*, 2009). Thus, this study aims at demonstrating that adaptation to climate change is primarily a local process, and therefore, draws the attention of stakeholders on the need to involve local institutions in adaptation planning, especially in farming field where local people have built tremendous knowledge to secure their livelihoods.

THEORETICAL FRAMEWORK FOR ADAPTATION

Concept of climate vulnerability. Vulnerability is the key concept of adaptation that is necessary to understand before considering the development of policies to reduce the risks associated with climate change (Locatilli *et al.*, 2008). Vulnerability assessment contributes according to Fussel and Klein (2006) to increase scientific understanding of the socio-economic and ecological climate sensitive to direct political action to the scene or the most vulnerable sectors, and to identify options for adaptation.

But vulnerability is a broad concept not specific to a particular discipline. It is complex and difficult to understand because of the diversity of definitions and expressions in the literature (Brooks, 2003). In reality, several scientific communities are gathered around the concept vulnerability and studying various issues such as livelihoods, food security, disasters, health and climate change; but setting each a specific definition of the concept (Eakin and Luers, 2006). However, Locatilli *et al.* (2008) distinguished two major interpretations of vulnerability. The first is a technical interpretation from the definition adopted by risk managers and disaster, and considering the vulnerability as the probability that a hazard exogenous (such as a cyclone or a storm) and the associated impacts on a system occur without taking into account the role of social factors in confronting the danger (Carter *et al*., 1994). The second interpretation is, on the other hand, social and embodies the approach taken by economists and policy experts in human geography. It focuses on the socioeconomic and political factors that explain why a system is or is not able to overcome an external threat (Dow, 1992; Adger and Kelly, 1999). In this case, vulnerability is described by the internal state of the system, rather than by the characteristics of threats (Brooks, 2003).

Between these two interpretations of vulnerability, the definition proposed by IPCC is less extreme and now represents a third school of thought often used in the debate on climate change (Fussel and Klein, 2006). According to IPCC (2001), vulnerability to climate change is "the degree to which a system is likely to be affected negatively by climate change or is unable to cope." Thus, for IPCC, vulnerability is determined by three main elements, namely exposure, sensitivity and adaptive capacity. According to the vulnerability's analytical framework established by the Locatilli *et al*. (2008), high exposure or sensitivity and low adaptive capacity induce high vulnerability (Fig. 1). The vulnerability is not static, but rather depends on the nature, extent and pace of climate change, changes to which the system is exposed, its sensitivity and its adaptive capacity (McCarthy *et al*., 2001).

Adaptation and mitigation. Mitigation and adaptation are two fundamental societal response options to deal with the problem of climate change (IPCC, 2001; Füssel, 2007; de Perthuis *et al*., 2010; Locatelli, 2011). These two methods have not been treated symmetrically in the context of implementation of actions to address climate change. If mitigation has traditionally received much greater attention in the climate change community, both scientifically and from a policy perspective, adaptation has been for a long time ignored in the debate on climate change (Füssel, 2007; de Perthuis, 2010). But the realisation that the climate will change anyway (Meehl and Stocker 2007), in spite of mitigation policies conducted at the international level, made the adjustment all the more urgent, especially at local level (Füssel, 2007; de Perthuis *et al*., 2010). Indeed, climate is already changing due to anthropogenic greenhouse gas and aerosol emissions, which affect average climate conditions as well as climate extremes (Hegerl and Zwiers, 2007). Also, the climate will continue to change for the foreseeable future and the rate

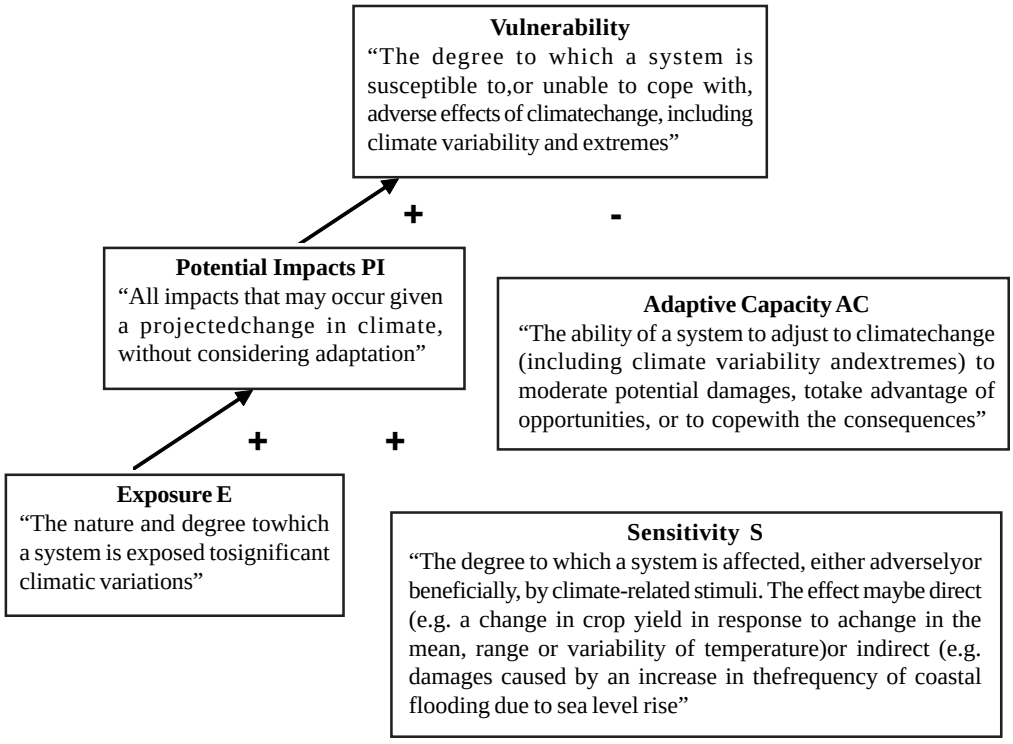

Figure 1. The components of vulnerability (McCarthy *et al.*, 2001; Locatilli *et al.*, 2008).

of global warming in the next few decades is projected to be substantially faster than in the last few decades (Füssel, 2007; Meehl and Stocker, 2007). From then on, there is needed to focus the debate on adaptation measures to climate change for preparing communities including the most vulnerable systems to cope with its impacts

But, because of the multiplicity of authors who reflect on the issue of climate change, the definitions adopted the concept of adaptation are diverse. According to IPCC (2001), adaptation is an adjustment of natural or human systems in response to actual or expected climatic stimuli or their effects, in order to mitigate the harm or exploits beneficial opportunities. De Perthuis (2009) in turn defines adaptation to climate change as the set of organisational changes, localisation techniques and operated by the communities to limit the negative impacts of these changes and maximise their beneficial effects. But just as vulnerability, adaptation is not a single action, to move from one stable situation to a new situation, different but stable as well. It is a dynamic process as its main determinant, that is, the climate is always changing and evolving. For Füssel (2007), adaptation to climate change is a continuous process. Indeed, the in coming decades or even centuries, societies will be faced with a climate increasingly fickle and unpredictable with most atrocious consequences. Thus, it is important to consider adaptation as a transitional permanent and long-term process; an adaptation plan of a few years being one step in this process (de Perthuis *et al*., 2010).

In addition to the diversity of definitions, adaptation to climate change reverts forms of action also applies in a wide variety of contexts and sectors (de Perthuis *et al*., 2010). According to him, two forms of adaptation can be distinguished: reactive adaptation and proactive adaptation. The first is to respond ex-post to the adverse impacts of climate change. The second on other hand is to act before the impacts occur to reduce vulnerability to these impacts and mitigate its adverse consequences or reap the benefits new. The anticipatory adaptation uses resources today to prevent possible crises in the

future or reap the benefits of climate change (de Perthuis *et al*., 2010). But whatever its form, adaptation can lead to undesirable results in helping to pervert the climate and increase the vulnerability of ecosystems. We are talking of maladaptation. As defined by the IPCC, maladaptation is "a change in natural or human systems leading to increased vulnerability rather than reducing it". So, it is necessary to conduct an assessment of the options used for consistency adaptation to minimise the adverse consequences of adverse events.

However, adaptation alone cannot eliminate all the negative impacts and mitigation is crucial to limit changes in the climate system (Locatelli, 2011). Mitigation strategies are procedures or activities that help prevent or minimise the process of climate change (Nyong *et al*., 2007). According to Füssel (2007), mitigation and adaptation are complementary rather than mutually exclusive. But, at beginning the debate was focused on mitigation like the main or even the only mean to cope with climate change issue. Füssel (2007) explains this focus on mitigation by the following reasons:

(i) ability of mitigation to reduce impacts on all climate-sensitive systems whereas the potential of adaptation is limited for many systems;
(ii) the benefits of mitigation are long-term and certain since mitigation reduces the root cause of the climate change problem whereas the effectiveness of proactive adaptation to climate change often depends on the accuracy of regional climate and impact projections, which are subject to considerable uncertainty;
(iii) mitigation generally applies the polluter-pays principle whereas the need for adaptation measures will be greatest in developing countries whose historical contribution to climate change has been small; and
(iv) greenhouse gas emissions are comparatively easy to monitor quantitatively whereas measuring the effectiveness of adaptation in terms of future impacts avoided is much less straightforward.

But because of the increasingly inevitable of climate change, it is required to implement adaptation policies in complementarily with mitigation. Indeed, it is increasingly realised that mitigation and adaptation can yield better results if both strategies are seen as complements. The two approaches are, therefore, necessary. Mitigation is an intervention to reduce greenhouse gas emissions or enhancing their sinks. So it is a preventive measure to stop the degradation of the environment and mitigate negative consequences. De Perthuis *et al*. (2010) consider mitigation as a form of anticipatory adaptation. There are strong linkages between the two and it is increasingly recognised that integration of both strategies may not only provide new opportunities, but may even be a prerequisite for successfully addressing both issues (Nyong *et al*., 2007). The model conducted by Locatelli (2011) indicates the linkages between the two approaches despite the differences that characterise them (Fig. 2).

Local dimension of adaptation. So far, national policies have failed to sustainably improve the living conditions of the poorest communities, including the climate threat, because once implemented, national policies are proving far from the needs of or too complex to be applied by local actors. An important step in the adaptation planning is, therefore, to consider the scales of interest for the actors involved in the adaptation (Adger *et al*., 2005). Indeed, even if both mitigation and adaptation achieve the same goal, reducing the climate risks, their characteristic time-scales and the actors concerned are largely distinct (Füssel, 2007). Although, climate change is an international concern, the benefits of adaptation are local contrary to mitigation whose benefits are felt on global scale (de Perthuis *et al*., 2010; Locatelli, 2011). Adaptation requires therefore an extensive cooperation between local agents (de Perthuis *et al*., 2010). The very nature of issues, including adaptation, requires a variation territorialised solutions (ENDA, 2010). So, actors and local communities must be at the center of the adaptation planning. In this context, it is needed to understand the functioning local institutions, because they influence the vulnerability and determine potential individual

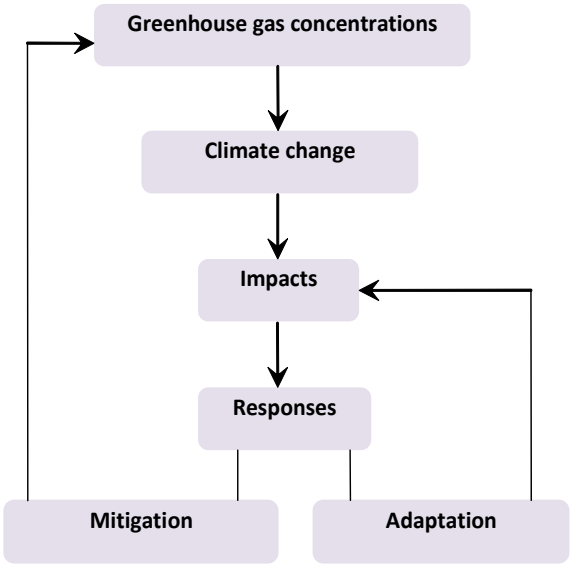

Figure 2. Synergies between adaptation and mitigation (Locatelli, 2011).

and collective adaptation measures that are required and their outputs (Locatelli et al., 2008). In reality, local communities choose and implement adaptation strategies according to their resources, their agencies, and their informal social relations and values (Pelling and High, 2005). Local knowledge is therefore a major priority in the planning of adaptation (Allen, 2006). In many cases, variously inspired communities have taken on their own initiatives to protect natural resources through local rules, showing that it is possible to govern the environment by the grassroots (Diaw, 2010).

Many aspects of adaptation to climate change are therefore not new, particularly to local communities. In fact, because climate is a key factor affecting all sectors of activities (agriculture, forestry, housing, water, energy, health, etc.) and well-being of populations, many economic agents and public institutions have a long tradition of managing climate-sensitive resources under variable climatic conditions (Füssel, 2007). According to Bohle *et al*. (1993), the fact that some African communities have survived till today with a fast population growth rate is an indication that they have developed indigenous mechanisms and strategies to cope with climate constraints. Because of this, incorporating indigenous knowledge into climate change policies can lead to the development of effective mitigation and adaptation strategies that are cost-effective, participatory, and sustainable (Hunn, 1993; Robinson and Herbert, 2001). Also, indigenous knowledge systems can facilitate understanding and effective communication and increase the rate of dissemination and utilisation of climate change mitigation and adaptation options (Nyong *et al*., 2007). Thus, if adaptation is implemented at local scale, its efficacy will be less dependent on the actions of others. So, for leading to more positive and sustainable results, planning for adaptation should take place within the traditional framework defined by local people. Adaptation planning must therefore learn from historical experience and knowledge that the local committees have developed to adapt to climate variability in the past, and their perspectives and knowledge of climate and vulnerability.

Farming practices for adaptation to climate vulnerability in Oueme Valley. The low valley of Ouémé river is located in the south of Benin. It represents the geographical area bounded by the lower delta of Ouémé river which is the most important basin in Benin. The Ouémé river, which is main watercourse of this basin, stretches from north to south over a length of 510 km (Laleye *et*

al., 2004). However, the real outline of the basin is not precise and is greatly determined by the importance of flooding. The low valley is the tank of the basin in which accumulates all the water collected from upstream of the river to its delta. Its topography is not marked with a very gentle slope facilitating the spread and propagation of flooding over a large area of floodplains potentially favourable for agricultural production when they are valued. Unfortunately, development of this agricultural potential is lacking and its exploitation is currently more determined by the hydrological regime of the river whose annual heights and flow rates undergo significant variations that influence agro-ecological conditions of the area. Year after year, the rainfall undergoes transformations which are manifested in a decrease or an increase in flooding levels (Chikou, 2006), resulting in extension or shortening of low-water durations. This climate variability which grows more and more is a serious threat to livelihoods of populations whose socio-economic welfare is closely linked to the Ouémé river pulsations.

Climate vulnerability in low valley Ouémé. Agriculture in the low valley of Ouémé is strongly related to pulsations of the Ouémé river. Depending on the movements of the river, farmers grow recession crops in the flood-plain during low-water, followed by the monoculture of corn during flood periods. The importance of farming activities, especially recession crops, is determined by the regime of the Ouémé river, namely of flood levels and duration of low-water. Indeed, when the flooding is early and important, the delta is flooded earlier, causing flooding of rainfed crops and also determines the duration of low-water and flooding. In cases the duration of flooding is very long with a delayed low-water (very wet years), the seedling of recession crops is delayed, thus reducing the duration of the season. As a result, there is a significant decline in yields of these crops namely long-cycle crops such as pepper and vegetables whose harvests are surprised by floods. On the other hand in very dry year, flooding may not occur at all (Laleye *et al*., 2004). According to Moniod (1973), in Ouémé delta during dry years, there is nearly no overflowing of the river. In these cases, the level of groundwater and water retained in the flood-plains is very low; low-water is early and flood-plains dry out quickly, affecting therefore recession crop yields, because of lack of water. Also during these dry years characterised by low rainfall and poor distribution of rain, the cultivation of rained corn is delayed and the harvests of this season are engulfed by floods. Whatever the case, the losses are significant and affect the majority of the population.

LOCAL ADAPTATION PRACTICES

Practice of whédo or fingerponds. The practice of *whédo* is one of the most indigenous and oldest innovations developed by Ouémé valley people to cope with climate vulnerability. The *whédo* are traditional *fingerponds* built since medieval times in the flood-plains of rivers and lakes to trap the wild fish during low-water periods (Plate 1). Although this practice is of very ancient times, it has been improved over time and is adopted as a major adaptation strategy to climate threats in low valley of Ouémé. The *whédo* is a traditional fishing practice that enables Ouémé valley people to take advantage from succession and regularity of flooding and recession periods in flood-plains. Indeed, the fingerponds dug mainly in flood-plains serve as refuges for wild fish migrating during the flooding. At low-water levels, these indigenous species of fish are tamed into the holes and become easy prey to farmers. This practice provides a wide range of economic and social benefits to populations who take it as a source of diversification, safety of income and food security. But for several years, there has been a serious decline in income from this activity because of continuous depletion of fishery resources in the river. At the same time, climate threats, namely flood risks, are increasingly surging with significant impact on crop yields. Thus, the farmers need for new adaptation strategies to secure crop yields and their livelihoods. The *whédo*, as traditionally constructed, is inadequate to meet this challenge. A new strategy is now needed.

Practice of *kanfli* (agro-fingerponds) and cropping dykes. Despite their vulnerability to

hydro-climate, farmers of Ouémé valley developed over time remarkable adaptation ability by practicing a diversified agriculture in flood-plains during low-water level, followed by corn cropping during the rainy season. But, due to lack of water control, crop yields are greatly affected by climate variability, which causes precocious floods or rapid drying of flood-plains. In this context, the *fingerponds* previously dug in flood-plains to trap migrating fish during the flooding, have become predilection areas for agriculture. Thus, from simple holes, the *fingerponds* became agro-fishing techniques whose pits retained their traditional use of fish ponds, but the dykes henceforth more broad and forming high strip lands are used for dry-season cropping (Plate 2). This practice is locally called *kanfli*.

Socio-economic and agronomic benefits of this practice are numerous. The *kanfli* promote the earlier emergence of lands at low-water and, therefore, the sowing in time of dry-season crops. Long-cycle crops such as pepper and leaf vegetables are then sowed earlier and crop harvests are sold in periods of best prices. Leafy vegetables are generally grown by women who are the main beneficiaries of this practice. In addition, the early emergence of the strip lands of agro-fingerponds allows spreading of dry-season length and farming activities over a longer period. This reduces labour and financial constraints, which generally characterise farming households. Besides, the water stored in the holes after flood recession, in addition to its traditional use for trapping wild fishes, enables to maintain wetness of strip lands formed by the agro-fingerponds and, therefore, fighting against water stress of dry-season crops. Indeed, water retained in the holes is used to irrigate crops grown on the dykes during the off-season.

Plate1. View of a *whédo* (fingerponds). (Imorou-Toko*et al.*(2007).

Plate 2. View of *kanfli* or agro-fingerponds.

In the other hand, there is the opposite effect in rainy season: the dykes of agro-fingerponds insure rainy crops protection against floods. However, despite the numerous benefits provided by agro-fingerponds, they now generate increasingly less interest to farmers. Thus, new farming practices are always developed in response to climate vulnerability in the low valley of Ouémé. This includes the building of dykes in the flood-plains only for crop production. In this case, the dykes have covered with mulching for holding water and reducing soil moisture loss (Plate 3).

Future perspectives for Benin. As indicated particularly by Füssel (2007) and de Perthuis *et al*. (2010), establishment of adaptation practices to climate vulnerability in the low valley of Ouémé is characterised by a dynamic determined mainly by the continued depletion of the environment. The transition from fishing technique to farming practice through agro-fishing systems is, in fact a response of farmers to their natural climate vulnerability but also especially to the continued degradation of environment (Fig. 3).

In fact, *whédo* or fingerponds were originally built in flood-plains in order to practice traditional aquaculture by trapping migrant fish during flooding periods. This traditional form of aquaculture provided to farmers important financial incomes and contributed greatly to food and nutritional security of Ouémé valley

Plate 3. View of pepper cropping on mulched dykes.

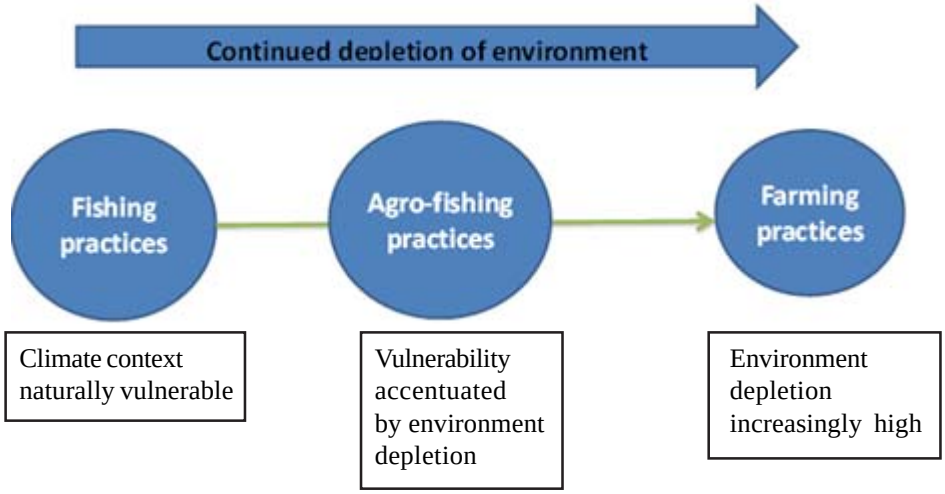

Figure 3. Dynamism of climate change adaptation in law valley of Ouémé.

people. But for several years, the *fingerponds* have lost their main functions as source of income and food security. The impoverishment of the river due to its overexploitation, coupled with the effects of climate change, have actually led to a great drop in yields of fingerponds to the extent that this practice arouse today less interest from farmers. So, as farmers have also land scarcity problems on the top of all the flooding risks, they found a new use of fingerponds. The traditional finger holes are then transformed into agro-finger holes. But this practice that should provide significant benefits to farmers is being abandoned in favor of dykes which are mainly farming practices. Actually, because the yields of fingerponds are decreasing and climate variability increasingly higher, farmers prefer building the dykes to secure crop yields than realising the agro-fingerponds whose socio-economic benefits are any more interesting.

But, with regard to the socio-economic characteristics of the populations of the Oueme valley and those of Benin in general and also to the current challenges of sustainable development, the practice of agro-fingerponds is the best strategy. Indeed, Benin is largely dependent on fish imports to satisfy the protein needs of its people; over 65% of the national demand for fishing products is ensured by importation of frozen fish. However, local production mainly based on fishing is dropping due to the impoverishment of the rivers and lakes. In this context, it is crucial to promote aquaculture in the country. Many initiatives based on classical fish farming in ponds or in pens were already underway without much success. As a result, local practices and experiences of traditional aquaculture should be encouraged, to not only improve food security but also reduce pressure on natural resources. In addition, with the challenges of sustainable development, local initiatives in the field of aquaculture should attract more interest when they are based on an approach of integrated management of natural resources such as water. According to FAO (2010) the integration of agriculture and aquaculture through integrated management of water resources can make a great contribution to the fight against poverty and food security in Africa and promote efficient management of water resources. The practice of *agro-fingerponds* developed by the people of the low valley of the Ouémé is a good example that should be promoted. External intervention is then needed to promote this practice. Improvement options to renew the interest of farmers in this practice are possible. According to Imorou-Toko *et al.* (2007), an improvement of the finger holes productivity is quite possible through artificial feeding and seeding of adapted fish species. However, an economic evaluation of various adaptation practices is necessary to better direct intervention measures.

CONCLUSION

The study highlighted the local dimension of climate change adaptation and innovation capabilities of local communities to secure their livelihood facing climate threats. There are two approaches to cope with climate change. But, by opposite to mitigation which is global, adaptation is a local process. It appears in this context that local people have important local knowledge to adapt to climatic constraints. This indigenous knowledge, far from being static, is more integrated into a dynamic process of which the main determinant is the extent of climate vulnerability. Because of this dynamism, a practice more ecologically beneficial may be abandoned in favour of another less sustainable, but enable people to secure their livelihoods. But so far, these community-based knowledge systems have been marginalised by dominant western knowledge systems in the search for sustainable solutions to climate change adaptation and mitigation. Thus, given the fact that in regards to climate vulnerability, scientific solutions carried out through top-down approach have showed their limits or in many cases are not well adapted to the socioeconomic realities of local people, a synergy between scientist and local knowledge is therefore necessary for an effective adaptation planning. But recognising the need to, and how to actually integrate indigenous knowledge into formal western science remain major obstacles to integrating local knowledge into formal climate change mitigation and adaptation strategies.

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