

CHAPTER II

LITERATURE REVIEW

This chapter provides an overview of wetland and biodiversity, wetland functions, agriculture and biodiversity. It presents the importance of seasonally flooded forest for people and how seasonally flooded forest products have played significant roles for local livelihoods. Finally, the previous research on wetland agro-biodiversity issues is also presented.

2.1 Concept and definition of wetlands and biodiversity in the study

Wetlands are highly productive ecosystems where excess water dominates the environment. Finlayson *et al.* (2002) noted the difficulty with wetland definition, partly related to problems in delineating habitats that are often considered as ecotones between terrestrial and aquatic habitats. According to the Ramsar Convention on Wetlands (2009), wetlands are defined as transitional lands between aquatic and terrestrial systems where the water table is at or near the surface of the land. The area is usually covered by shallow water. To be classified as a wetland, an area must have one or more of the following three attributes:

- 1) The land supports plants, known as hydrophytes, which are adapted to wet soil conditions; the base land is predominantly un-drained hydric soil; and the base is

non-soil and is saturated with water or covered by shallow water at some time during the growing season of every year.

2) Water in a wetland can be static, flowing, tidal, brackish, fresh or salt.

3) Swamps, estuaries, lagoons, marshes, peat lands, lakes, sea grass beds in coastal areas, hydro-dams, seasonal flood plains in river basins are all part of the definition.

Wetlands are generally highly productive ecosystems providing many important benefits. These benefits, sometimes described as “goods and services” may be wetland functions such as ground water recharge, flood control, uses of wetlands such as water or its products like wetland values (wood collection, research site, harvesting of food crops). Wetlands also have attributes or non-use values such as aesthetic component of the landscape, religious/cultural significance like for circumcision or rituals. The term "wetlands" includes a variety of transitional areas where land based and water based ecosystems overlap. They have long been known to us by more traditional terms such as bog, marsh, fen and swamp. And while most people use these terms interchangeably, to many who study wetlands these terms have specific meanings which richly describe the various wetland environments they represent.

Wetland along the Songkhram River is one of the 61 sites categorized as internationally important in Thailand's National Wetlands Inventory (OEPP, 1999b). The Lower Songkhram River Basin encompasses a broad range of wetland habitat types associated with a functional floodplain ecosystem which is gradually becoming more widely recognized as an important site for biodiversity conservation, high aquatic productivity and the contributions that wetlands play in local livelihoods of

riparian people. Their are unique ecosystems, exceptionally rich in biodiversity and are habitats for a wide range of globally threatened species, providing water and primary productivity upon which numerous species of plants and animals depend for survival. Wetland ecosystems support high concentrations of birds, mammals, reptiles, amphibians, fish and invertebrate species. This biodiversity is fundamental to the viability of natural resource-based rural livelihoods of a population of million people living in the Lower Songkhram River Basin.

2.2 Wetland values and functions

The multiple roles of wetland ecosystems and their value to humanity have been increasingly understood and documented in recent years. This has led to massive expenditures to restore lost or degraded hydrological and biological functions of wetlands. But it's not enough; the race is on to improve practices on a significant global scale as the world's leaders try to cope with the accelerating water crisis and the effects of climate change.

The ability of wetlands to adapt to changing conditions, and to accelerating rates of change, will be crucial to communities and wildlife everywhere as the full impact of climate change on our ecosystem lifelines is felt. Wetlands are hugely diverse. But whether they are ponds, marshes, coral reefs, lakes or mangroves, they all share one fundamental feature: the complex interaction of their basic components as soil, water, animals and plants that fulfils many functions and provides many products that have sustained humans over the centuries. The recent ecosystem study

of different wetland functions (Figure2-1), as defined by the Ramsar Convention (2000) as follows:

2.2.1 Flood Control

Wetlands "hold" heavy rainfalls, preventing possible flooding downstream. By storing the water in the soil or retaining it in the surface waters of lakes, marshes, etc., wetlands reduce the need for expensive engineered structures. Wetland vegetation also plays a role in slowing down the flow of flood water. Wetlands often play a crucial role in flood control. Loss of floodplains to agriculture and human habitation has reduced this capacity. Constructions of levees and dams on rivers to improve flood control have often had the reverse effect. Floodplain restoration and removal of structures is providing a partial solution in many countries.

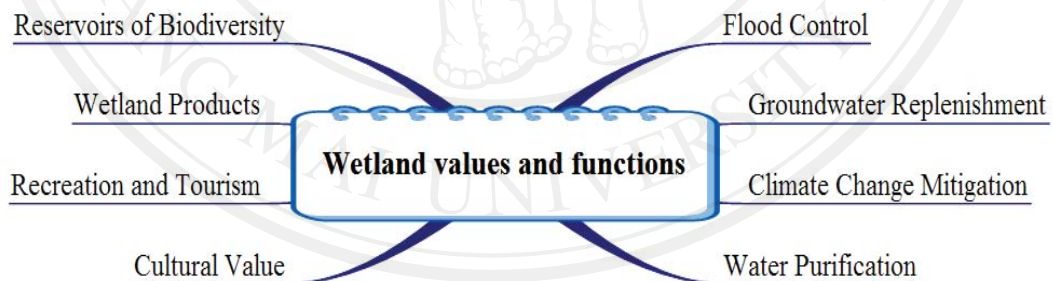


Figure 2-1: Wetland values and functions.

2.2.2 Groundwater Replenishment

Plants and soils in wetlands play a significant role in purifying water. High levels of nutrients such as phosphorous and nitrogen, commonly associated with agricultural run-off, are effectively removed by wetlands. This is important in preventing eutrophication further downstream, a process that leads to rapid plant and

algal growth followed by depleted oxygen levels that affect other species. It can also be important in preventing high concentrations of these nutrients reaching groundwater supplies or other water sources that may be used for drinking water.

2.2.3 Climate Change Mitigation

Wetlands play at least two critical but contrasting roles in mitigating the effects of climate change: one in the management of greenhouse gases (especially carbon dioxide) and the other in physically buffering climate change impacts. Wetlands act as significant carbon sinks and so the destruction of wetlands will release carbon dioxide, a greenhouse gas, while wetland restoration and creation will increase the sequestering of carbon. Wetlands will play a further role as the frontline defenders of coastal and inland areas as countries deal with the full effects of climate change: increasing frequency of storms, changing rainfall patterns, rising sea-levels and sea surface temperatures. Wetlands have been identified as significant storehouses (sinks) of carbon. Using Ramsar's broad definition of wetlands this may amount to as much as 40% of global terrestrial carbon. Peatlands and forested wetlands are particularly important as carbon sinks. Although covering only 3% of the world's land area, peatlands are estimated to store over 25% of the soil carbon pool.

2.2.4 Water Purification

Plants and soils in wetlands play a significant role in purifying water. High levels of nutrients such as phosphorous and nitrogen, commonly associated with agricultural run-off, are effectively removed by wetlands. This is important in

preventing eutrophication further downstream, a process that leads to rapid plant and algal growth followed by depleted oxygen levels that affect other species. It can also be important in preventing high concentrations of these nutrients reaching groundwater supplies or other water sources that may be used for drinking water.

2.2.5 Reservoirs of Biodiversity

Wetlands support spectacular concentrations of wetland dependent wildlife. The biodiversity in wetlands is also valuable as a reservoir of genes. Rice is a common wetland plant and the staple diet for over half the world's population. Wild rice continues to be an invaluable source of new genetic material for developing disease resistance, yet many different varieties of rice have disappeared in recent years – leaving us dependent on a shrinking genetic base. A typical "lifespan" of a commercially-bred crop variety has been estimated at 5-10 years before new genetic material is required to combat pest and disease problems. The value of such traits on a global scale is counted in the billions of dollars.

2.2.6 Wetland Products

Wetlands provide a variety of other benefits to humans in the form of products that can be exploited for human use. The range is enormous: fruit, fish, shellfish, deer, crocodile and other meats, resins, timber for building, fuel wood, reeds for thatching and weaving, fodder for animals, etc

2.2.7 Recreation and Tourism

The natural beauty as well as the diversity of animal and plant life in many wetlands makes them ideal locations for tourists. Many of the finest sites are protected as National Parks or World Heritage Sites and are able to generate considerable income from tourist and recreational uses. Wetlands offer ideal locations for involving the general public and schoolchildren in hands-on learning experiences, in an essentially recreational atmosphere, to raise awareness of environmental issues. In some countries the revenue is a significant component of the national economy.

2.2.8 Cultural Value

This is a relatively poorly documented function of wetlands, yet there are many instances where wetlands have significant religious, historical, archaeological or other cultural values for local communities, representing a part of a nation's heritage. Some wetlands support traditional activities that represent part of the history of the nation. In some cultures wetlands may have deep religious significance for local people. In Tibet, pre-Buddhist belief identified various lakes as sacred, making them objects of worship as well as ensuring their protection from pollution and other harm. As Buddhism took over, these beliefs remained, albeit in a modified form, and certain lakes in Tibet are still sacred to the people with strict regulations that determine their exploitation.

2.3 Agriculture and Biodiversity

Biodiversity is the basis of Agriculture. Its maintenance is essential for the production of food and other agricultural goods and the benefits these provide to humanity, including food security, nutrition and livelihoods. Biodiversity is the origin of all crops and domesticated livestock and the variety within them. Biodiversity in agricultural and associated landscapes provides and maintains ecosystem services essential to agriculture.

The term agro-biodiversity has evolved only in recent years in the wake of the general biodiversity discourse, which really began in the 1980s. The Food and Agricultural Organization of the United Nations (1999) defines agro-biodiversity as the variety and variability of animals, plants, and microorganisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry, and fisheries. It comprises the diversity of genetic resources (varieties and breeds) and species used for food, fodder, fiber, fuel, and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest, and aquatic) as well as the diversity of the agro-ecosystems. Analogous to the term biodiversity, agro-biodiversity encompasses different levels. It relates to the diversity of agro-ecosystems as well as that of species of crops and farm animals, and to the genetic variance within populations, varieties and races. In its broadest sense, agro-biodiversity also comprises soil organisms in cultivated areas, insects and fungi that promote good production, wild species from off-farm natural habitats as well as cultural and local knowledge of diversity and

management forms as the basis of the exploitation of diversity. In the same way Qualset *et al.* (1995) also has been defined “agro-biodiversity” as including all crops and livestock and their wild relatives, and all interaction species of pollinator, pests, parasites, predators and competitors among others. The most immediately valuable part of global biodiversity is the agro-biodiversity on which farming, in turn global food security depends (Qualset *et al.*, 1997). We consider that agro-biodiversity includes the full diversity of organisms living in agricultural landscapes, including biota for which the precise function, from the human utilitarian point of view, is still unknown (Jackson *et al.*, 2005). Agro-biodiversity has two main components. The first, planned agro-biodiversity, is the diversity of crops and livestock managed by farmers. The second, associated biodiversity refers to the biota (such as soil microbes and fauna, weeds, herbivores, and carnivores) in the agro-ecosystem that survives according to local management and environmental conditions (Vandermeer and Perfecto, 1995). Croplands and fields are also included, as well as habitats and species outside of farming systems that benefit agriculture and support ecosystem functions (Jackson *et al.*, 2007).

Agro-biodiversity for food and agriculture is constituted by various biological diversity components. Cultivated agro-biodiversity together with wild relatives provides humanity with genetic resources for food and agriculture. In fact, the global food supply rests essentially on the biological diversity developed and natured by indigenous communities, local farmers and farming communities residing in genetic resources centers of origin and diversity. Agro-biodiversity depends on people, and people must be continually and knowledgeably involved in its management. This is especially so in most developing countries where over 60% of the economically active

population is involved in utilizing and managing biodiversity in agriculture (Wood and Lenne, 1999).

2.4 Agro-biodiversity and food security

A major challenge will be to increase agricultural production over the coming decades to adequately feed the growing world population and meet the rising expectations of economically improving societies. It is essential for every human being to have adequate access, availability, and stability of food. The Food and Agricultural Organization of the United Nations (FAO) defines food security as “a situation in which all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, 1999).

Agro-biodiversity for food and agriculture is constituted by various biological diversity components that include crops, fish, livestock, pests, inter-acting species of pollinators, predators and competitors among others. Cultivated agro-biodiversity together with wild relatives provides humanity with genetic resources for food and agriculture. In fact, the global food supply rests essentially on the biological diversity developed and natured by indigenous communities, local farmers and farming communities residing in genetic resources centers of origin and diversity. There is a growing realization that agro-biodiversity is a fundamental basis of agricultural production and food security, as well as valuable ingredient of ecological stability. By ecological reasoning it is considered that under conditions of global change, complex agricultural systems, comprising key biological components, are more

dependable in production and more sustainable in terms of resource conservation than simple ones (Vandermeer *et al.*, 1998). The agro-biodiversity deserves great significance with its contribution to the household food and nutrition security, and efficient resource utilization in the rural farming systems (Tsegaye, 1997). In the same way, agro-biodiversity is vital for the livelihoods and food security of small-scale farmers. The management and use of the agro-biodiversity depends on local knowledge systems, which have guided the farmers' cultivation practices and the management of their plant genetic resources (Gari, 2001). Another dimension of agro-biodiversity to the food security is higher productivity through greater resource use efficiency and buffering in the face of biophysical and socio-economic vagaries (Trenbath, 1976; Willey, 1979). For most communities in developing countries, reliance on biological resources accounts for up to 90% of their livelihoods requirements. Agricultural biodiversity is the first link in the food chain, developed and safeguarded by indigenous peoples, and women and men farmers, forest dwellers, livestock keepers and fisher folk throughout the world. It has developed as result of the free-flow of genetic resources between food producers. Often, the diversity is itself employed in diverse ways and supports an integrated and holistic lifestyle and culture. In many developing countries, community livelihoods are provided through the combination of utilizing both forest and plant biodiversity as they all contribute to the food needs of the community. In this aspect, it is important to realize and recognize the critical value of local agro-biodiversity in the context of sustaining livelihoods and food provision at community level.

2.5 What are the causes of the losses of agro-biodiversity?

The loss of agro-biodiversity is seen as one of the most important issues to be addressed under the Convention on Biological Diversity (1992). Agro-biodiversity is a subset of biodiversity, there are many reasons why agro-biodiversity is declining at the rate it is. One reason is that the globalization of food systems and marketing has led to a competition, which forces species without market value out of farms. Another is the replacement of local varieties by exotic or improved varieties (FAO, 2004). A third view sees the long-standing enmity between environmentalists and agriculturists as a negative impact. The common view sees farmers as a threat to the environment and a detriment to natural ecosystems (Wood and Lenne, 1999). Growing economic interests are causing many environmental problems, negatively affecting ecosystem services and contributing to the loss of biodiversity (Perrings *et al.*, 1995). Major causes of agro-biodiversity loss include direct destruction, conversion or degradation of agro-ecosystems, overexploitation, habitat disturbance, pollution, introduction of exotic species, selection pressure from human activities, introduction of new technological innovation like genetic modification (Wood and Lenne, 1999; Boef, 2000). Following the UKabc (2007), there are many causes of this decline, which has been accelerating throughout the 20th century in parallel with the demands of an increasing population and greater competition for natural resources. The principal underlying causes include:

- The rapid expansion of industrial and Green Revolution agriculture, intensive livestock production, industrial fisheries and aquaculture (some production systems using genetically modified varieties and breeds) that cultivate relatively few

crop varieties in monocultures, rear a limited number of domestic animal breeds, or fish for, or cultivate, few aquatic species.

- Globalization of the food system and marketing, and the extension of industrial patenting and other intellectual property systems to living organisms, which have led to the widespread cultivation and rearing of fewer varieties and breeds for a more uniform, less diverse but more competitive global market.

2.6 The influence of river ecology on livelihoods

It is widely accepted that the goods and services provided by wetlands are very important for rural people throughout the Lower Mekong Basin (MRC, 2003; Secretariat and MRC, 2004). In the case of the Lower Songkhram Basin, it can be stated that wetlands products form the core of local-based livelihoods, providing subsistence and incomes for tens of thousands of households scattered over an area encompassing 3,000–4,000 km². The Floods in the Songkhram river basin are thought to play important roles in the maintenance of natural wetland ecosystems, remineralisation of nutrients, groundwater recharge, sediment and nutrient retention (Barbier *et al.*, 1993). During a flood, these high-energy rivers will experience big changes in their floodplain with massive erosion and deposition taking place. Mature seasonally floodplain forests are only found on the higher, less disturbed parts of these floodplains and many trees are destroyed during each flood and deposited downstream. Although these floods cause a lot of destruction, the sediments they deposit provide essential areas for new tree seedlings to grow. So floods also create many opportunities for the regeneration of new forest trees. In rivers which have less

mountainous catchments, flood patterns are often more closely related to rainfall patterns. Depending on the geology of the area, the sediments may be finer and the whole river system may be less energetic and less disturbed. Here, floodplain forests may be more extensive although there may also be fewer opportunities for forest regeneration because the channel is less mobile.

Thai Baan research (2005) studied ecology and local history of the seasonally flooded forest in the Lower Songkhram River Basin. This research illustrates that rural livelihoods are based on the combined use of a wide range of resources adapted to seasonal changes. The Thai Baan research's methodology which is based on indigenous knowledge of local communities on ecology, management of natural resources, local history, socio-economy and livelihoods was used in this study.

Most of the wetlands are concentrated in the Lower Songkhram Basin, which forms a complex mosaic of wetland types and habitats, both natural and artificial; temporary seasonal and permanent; riverine, lacustrine and palustrine (Blake and Pitakthepsombut, 2006). The river in its lower reaches meanders over a broad floodplain that contains the largest remaining area of seasonally inundated freshwater swamp forest in Thailand, interspersed with converted agricultural land and an array of ponds, reservoirs, channels, swamps and oxbow lakes. These wetlands are not only important sites in their own right for aquatic biodiversity, especially fish species, but are also vital for the livelihoods of local people who utilize them and harvest the abundant wetland products found across this region (Kunarat, 2001). So, seasonally flooded forests are likely to have numerous important functions in natural ecosystems as wetlands function. It is a colorful forest for local community in the lower Songkhram river basin. Moreover, it related with its life as routine activities such as

an area for rice fields, farm crops, vegetables and. The major roles and importances of seasonally flooded forest on local livelihoods have been divided into six parts as follows:

2.6.1 Agricultural resources

Local community has been using the area of seasonally floodplain forest for agriculture for a long time. An annual crop is rotated in a period of one year or a few years in the same area. They change kinds of plant to revive their area and keep them into the wealthy condition. There are various types of agriculture in seasonally floodplain forest such as rice field on floodplain, rice crops and farm crops like fiber plants, corns, beans and cucumber in some area.

2.6.2 Fishery resources

Seasonally floodplain forest is an area of rich mineral resource, serving as source of foods and fish breeding, which local people can catch all year round for their consumption and revenue. The river supports a remarkably productive capture fishery, which peaks each year during the flood recession period, supporting the livelihoods of numerous families locally.

2.6.3 Wildlife resources

Wildlife resources from seasonally floodplain forest include plants and animals needed by local people. There are various utilizations from this forest such as fruit products from perennial plant, fuel woods from shrubbery and forage plant. Moreover seasonally floodplain forest serves as shelter for some animal, i.e., small

frogs and various kind of insect. In other words they are major sources of protein for local people in the area.

2.6.4 Forage resources

Considering physical characteristics of seasonally floodplain forest, it is an appropriate area for domestic animals. There are various kinds of plants for cattle's nutrition. In addition, the villagers feed ducks in flooded forest due to the abundance of water, vegetables, insect and snails.

2.6.5 Forest resources

Seasonally floodplain forest is a rich biodiversity. Some areas are profitable for agriculture area. Their native species have been utilized by local people for a long time such as various edible mushrooms which serve as daily food, some wild plants are used for medicine.

2.6.6 Household utilization

Seasonally floodplain forest is a major source for household utilization such as the major source of firewood and charcoal. The plant in this area is easy lighting which proper for fuel wood accordingly.

2.7 Previous Research

2.7.1 Economic valuation

In this tripartite process of agro-biodiversity market creation, valuation plays a vital role in the initial stage of demonstration. Valuation first requires a conceptual

framework for valuing values . Agro-biodiversity as defined above has been associated with various benefits that have been conceptualized through two main frameworks. One is the well-known Total Economic Value (TEV) paradigm and the other, though similar, is the one coming from the Millennium Ecosystem Assessment (MEA, 2005) framework. The TEV framework is an aggregate concept of value that decomposes agro-biodiversity benefits into direct use (consumptive and non-consumptive), indirect use, option value and non-use values. Establishing the TEV would also assist in the design of economic incentives and institutional arrangements, and help to identify potential gainers and losers from current depletion and degradation of wetland agro-biodiversity resources. Various economic methods have been developed to capture the TEV of environmental resources. Several examples of total valuation studies of wetlands can be cited.

To the authors' knowledge, recently published studies using market price in developing countries are those by Tuan *et al.* (2009) focused on the valuing direct use values of Tam Giang-Cau Hai lagoon wetland in Vietnam. Total benefit to local people was VND35.4 billion, followed by capture fisheries was VND23.9 billion, agriculture production included rice crop and aquatic poultry farming with a total value of VND19.1 billion, and then sea-grass collection was VND3.1 billion in year 2005. Note, that this study does not include the use value of other activities in the lagoon such as tourism, transportations, and titanium mining.

Again considering Louisiana's coastal wetlands, Costanza, Farber and Maxwell (1989) attempted a total valuation which included benefit estimates for commercial fisheries, trapping, recreation and storm protection. Using a variety of techniques included market price, the authors estimate the total value of these key

benefits provided by the wetlands at \$US 2,429 per acre (using an 8% discount rate). Commercial fishing and trapping account for 19% of the total, recreation for 2% and storm protection services make up the remainder.

Then, Choosakul (2001) studied resource use values of flooded forests of 11 communities, 366 households in 3 sub-districts along the middle part of the Mun River. Resource use calendar was made for 18 activities found in flooded forests for all year round. Commercial direct use values or income from wetland products sale were analyzed and calculated. Results revealed that the total annual benefits derived from this wetland was BHT14.2 million or 38,906 baht/household/year, consisting of commercial use value from agricultural resources (including rice, kenaf, watermelon, groundnut, corn) was BHT6.5 million/year; from flora resources (fuel, charcoal, potatoes, mushrooms, bamboo shoots, vegetables, fruits, timber, reeds, rattan and other non-timber products) was BHT3.03 million/year; and from fauna resources (fish, mollusks, frogs, ant's eggs and animal dung) was BHT4.76 million/year.

Moreover, Department of Land Development (2001) monitored the socioeconomic conditions at Huai Nam Un wetlands, Amphoe Sri Songkhram, Nakhon Phanom and reported that inhabitants had an annual income of 17,250 baht from rice production, 10,606 baht from fisheries, and 3,197 baht from handicrafts. Average rice yield in waterlogged area was 123 kg/rai, compared to 217 kg/rai in non-waterlogged area.

2.7.2 Participation in resources conservation programs

Several studies have been conducted to examine the factors that affect participation in resources conservation programs. It has shown that households

within a community differ widely in their actual use of natural resources and their participation in collective management activities and decision-making processes. Most of the recent empirical studies have found that household socio-economic indicators are the main determinants of participation. Terer *et al.* (2004) pointed out that local people's socio-economic values of wetlands have forms the basis of conserving and manage wetland resources in Tana River National Primate Reserve (TRNPR). In a study on factors influencing people's participation in forest management in the Indian states of Lise (2000) found that the first consideration for people's participation in forest management is social indicators, whereas economic indicators are found to be the second most important consideration. Maskey *et al.* (2003) also reported similar findings in a study on Nepal's community forest management, suggesting that the level of participation in community forest management is based on the socio-economic profiles of individual users and the benefits obtained from the forests. And the study of Iqbal *et al.* (2006) pointed out the factors that determining the decision of smallholder farmers to adopt new farming technologies with rubber-tea intercropping in Sri Lanka by used a logistic linear regression analysis. The result found three socio-economic factors that significantly influence of the decision to intercrop tea with rubber are level of income, source of income, and availability of land considered suitable to tea cultivation.

In addition, Gavin and Gregory (2006) studied of forest use values in the Peruvian Amazon by used ordinary least square multiple regression to defined socio-economic predictor of total value of forest product in three communities. Socio-economic variables that used for predictor included: age, education, family size, resident time, land work, land owned, number of fishing nets, chickens, pigs, cows,

and/or mules owned (all proxies for productive assets), and level of ecological knowledge. In another study, Weinberger and Juetting (2001) have analyzed the determinants of participation in local development groups in Chad and Pakistan. Their results suggest that existing social networks are important determinants for people's participation.

For this study, we build on the lessons of previous research to provide an original contribution to the assessment and explanation of agro-biodiversity wetland values using livelihoods framework and statistical analysis. We substantially extended the data set of socio-economic variables to include in regression model.