CLIMATE CHANGE VULNERABILITY AND ADAPTATION IN AGRICULTURE AREAS IN THE BCI PILOT SITES

Socio-economic Profile and Vulnerability Assessment in Lao PDR

Prepared by

Jiao Xi and Suppakorn Chinvanno

December 2011

Greater Mekong Subregion Environment Operations Center

Southeast Department

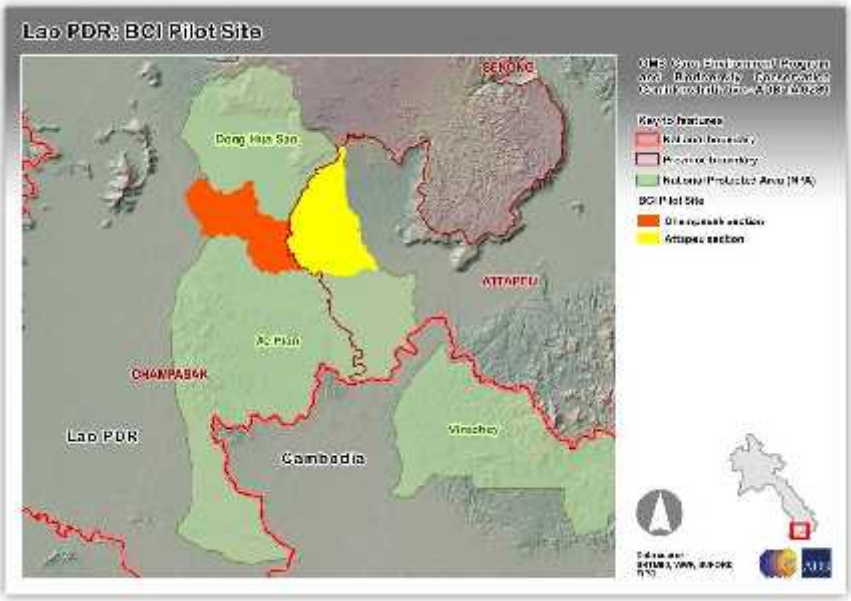
Asian Development Bank

Table of Contents

I. BACKGROUND

1. The study was undertaken in the Biodiversity Conservation Corridor pilot site in southern part of the Lao People's Democratic Republic (PDR), which is a critical area of connectivity between Dong Hua Sao in Champasak Province and Xe Pian National Protected areas in the Tri Border Forest Landscape of southern Lao PDR, two sites of biological diversity with national and international importance (Figure 1). Although the corridor area covers parts of both Champasak and Attapeu, the pilot phase of the project has focused in Patoumphone District of Champasak province.

Figure 1. Xe Pian – Dong Hua Sao Biodiversity Conservation Corridor



Source: ADB RETA 6289, BCI Pilot Site, Xe Pian – Dong Hua Sao

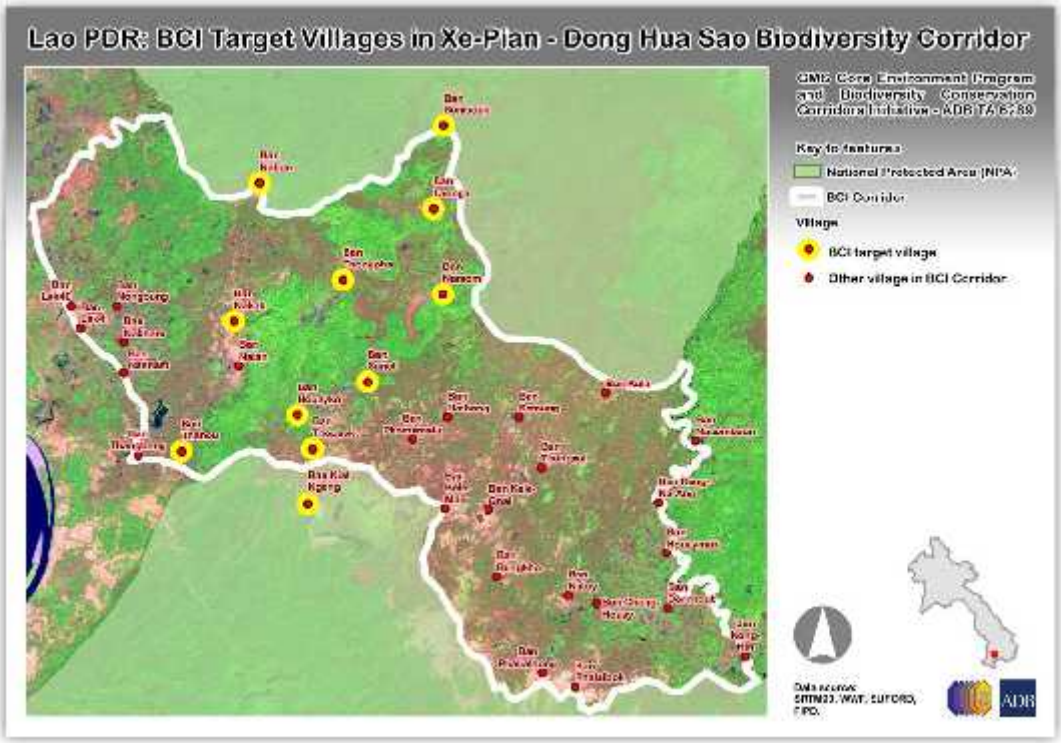
2. The BCI corridor link between Dong Hua Sao and Xe Pian is a thin strip of linear forest (total area of proposed corridor is 32,000 ha in Champasak and Attapeu provinces, however, pilot phase covers 11,000 ha in 11 villages in Champasak) connecting Ban Somsouk (Dong Hua Sao) to Ban Kiet Ngong (Xe Pian). Several connectivity links (small strips ranging between 40-100 m existing as village conservation forest areas shown as dark green) need to be linked up to have an unbroken line from Ban Somsouk and Ban Nabon in the North to Ban Thahou and Ban Kiet Ngong in the South.

3. The villages represent a wide range of geographical and socio-economic conditions (Figure 2). Several villages (Thahou, Kiet Ngong, Houayko, Sanot, Nakok, and Thopsok) are located relatively close to the road, where access is comparatively easy. Others (Thongpha, Laonga, Namom, Somsouk, and Nabon) are difficult to access, especially during the rainy season, when much of the area is flooded and tractor or elephants are required to get in and out.

4. The Xe Pian - Dong Hua Sao corridor, located in Pathoumphone district of Champasak province, has a population of 5,888 spread out in eleven villages with a total number of 1,040 households. This corridor is home to three ethnic groups: Lao Loum, Youane and Brao. Some

of these villages have been established for centuries, while others have emerged more recently as people moved into new areas due to outbreaks of diseases and in search of better agricultural land.

Figure 2. BCI target villages in Xe Pian – Dong Hua Sao Biodiversity Corridor



Source: ADB RETA 6289, BCI Pilot Site, Xe Pian – Dong Hua Sao

5. The corridor is bisected by Road 18A, the main artery of the ADB East-West Economic Corridor connecting Da Nang in Viet Nam and Mawlamyine-Myawaddy in Myanmar. The possible negative impacts on connectivity form the backbone of logic behind the BCI project. Thus the corridor has been being created in parallel to the economic corridor, in which it is hoped that livelihoods and conservation can be integrated to balance the potential environmental, social and economic impacts of the road upgrade and increased traffic. All but one of the BCI villages are located north of the road, which runs along the northern border of Xe Pian NPA.

6. The corridor has one of the highest development pressures in Champasak province. Road 14A runs across from the junction with Road 13 in the west and heads toward the Viet Nam border in the east, cutting through Attapeu province. While the long term plan is to establish a linear corridor of forest linking Xe Pian – Dong Hua Sao with Dong Ampham – Xe Kong and Xe Sap, the achievement from the current phase, as it is the corridor section with the highest pressure, will determine success or failure in the long run.

7. In this study, three villages were selected for field surveys with consultation with local implementing partners based on secondary data of climate risks characteristics, agricultural

production, socioeconomic conditions, which are: i) Ban Houayko, ii) Ban Kiet Ngong, and iii) Ban Nakok.

I. Socio-economic conditions and changes of livelihoods

8. Village livelihoods are a combination of subsistence and income-oriented activities. The livelihoods of the BCI corridor villages are composed principally of agriculture, livestock, NTFP collection, fishing and other wetland product harvesting. Other source of income, such as wage labor, small-scale business, and some ecotourism make a contribution to village economies. Recent years, remittance also becomes an important income source for some of the households.

9. Several generalized patterns in livelihood changes/development have emerged since the policy of economic opening (*chintanaakaan mai*) began in 1986. In the early 1990s, villagers produced rice in both paddy and upland fields, shifting agriculture was a widespread practice among the communities and, the Government has adopted a policy of relocation to stabilize agriculture and promote sustainable development. The policy to eradicate shifting cultivation had already begun to reduce the area of upland fields, although some households are still highly dependent on upland fields to their livelihoods (esp. ethnic minorities).

10. At that time, subsistence fishing was an important and reliable source of food, while raising of livestock provided draught power, emergency cash and meat. Villagers started to take advantage of wage-earning opportunities in logging operations and sawmills. NTFPs provided necessary building materials, supplemental food sources and materials for daily use, and the government purchased small amounts of NTFPs such as *mak jong* and cardamom. Markets had not yet penetrated the area in any significant way at this point.

11. By 2000, upland rice had been reduced significantly in line with government policy, putting increased pressure on the limited paddy land to provide grain for villagers. In fact, frequent floods and persistent draught caused a drop in paddy rice production, which was met with increased reliance on upland rice in some years. The policy of eradicating shifting cultivation has been so deeply ingrained as an indicator of poverty and backwardness, that people in the area are hesitant to use the word ‘upland field’, in fear that they will be seen as not taking government policy seriously.

12. In the early 2000s, NTFP traders had begun to visit villages to purchase NTFP products for sale in local markets, with some export to Thailand. The first market linkages sparked villager interest in income-earning activities; NTFPs came to be considered as important sources of cash and high prices in local markets raised the profile of livestock. Small village shops had begun to appear, although commercial activities were still of very small scale. Fishing remained a supplemental, but almost universal, activity for villagers.

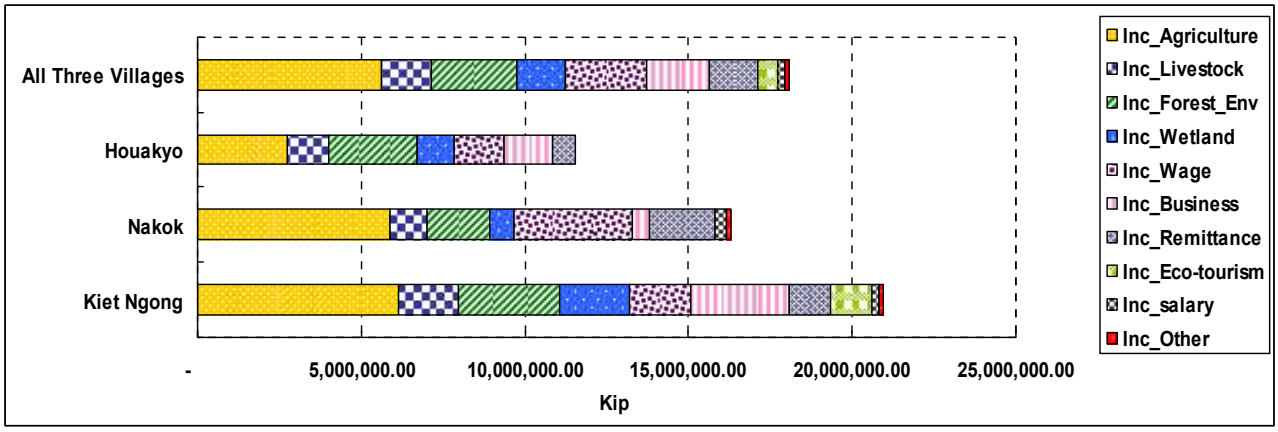
13. During last decade (2000-2010), villagers observed a decline in NTFP availability. This change is attributed to increased demand from markets, growing competition between local and external collectors and loss of forest cover. Destructive harvesting practices contributed to the overall degradation of previously stable resources such as *mak jong,* cardamom, rattans and bamboos. Improved market access, mainly through middlemen and government investments in basic infrastructure, meant an increasing orientation towards market production, including NTFPs, agricultural products, fish and handicrafts. Wetland resources experienced similar

trends in competition, resulting in over-exploitation in many places. Interest in improving paddy rice production is high, but the costs and technology require for making significant expansion of paddy fields are prohibitive.

14. Across the corridor, it is generally felt that improved market access and growing knowledge of processing opportunities are an opportunity for forest-based livelihoods. At the same time, there is wide recognition of the pressure mounting on forest and wetlands resources. It is clear that that the dual dynamics of competition within communities and with external actors will continue be a major source of instability in local livelihoods.

15. It seems that the transition to a market-reliant economy is well on its way. But the degree and nature of market integration differ across wealth groups within villages, and demonstrate some significant variation across villages. Figure 3 below shows contribution of various livelihood activities to income in 2010 for the three surveyed villages: Ban Houayko (poor village), an average village (Ban Nakok) and a well-off village (Ban Kiet Ngong) in the corridor.

Figure 3: Household income by source in three surveyed villages



16. The result shows that agriculture (31.16%) is the major income source for all three villages, and forest and wetland products (22.81%) also contribute significantly to local livelihoods. Wage labor, small-scale business and remittance become important household income sources. Poor households in Ban Houayko are highly reliant on agriculture (23.86%) and forest products (23.67%). In Ban Kiet Ngong, agricultural products (29.32%) are the most important, followed by forest products (14.87%) and small-scale business (14.27%). In Ban Nakok, agricultural products (36.01%) and wage labor (22.05%) contribute the overwhelming majority of income.

A. Agriculture and livelihood

17. Paddy production has been and remains the most important component of village livelihood strategies. Villagers place a very high importance on rice production, and consider availability of rice throughout the year to be the critical indicator of wealth status among households. The corridor area is characterized by flat lands that flood as soon as the rainy season arrives. The lack of irrigation infrastructure means that rice production in the dry season is very limited as well. Table 1 presents data on paddy land area and related indicators in the villages.

Table 1: Agricultural practice and area in 11 BCI target villages

No.	Village	No. of HH practice agriculture	Rain-fed Paddy rice area (ha)	No. of HH practice rain-fed paddy rice	Irrigated paddy rice area (ha)	No. of HH practice irrigated paddy rice
1	Kiet Ngong	143	201.60	137	1.50	4
2	Houayko	26	34.46	23	0	0
3	Nakok	197	90.40	99	28.82	48
4	Thahou	68	70.41	63	15.57	37
5	Sanode	90	91.91	76	0	0
6	Thopsok	63	118.83	64	0	0
7	Thongpha	84	83.09	77	15.69	21
8	Namom	135	87.85	120	19.18	45
9	Lao Nga	73	43.68	65	1.00	3
10	Nabon	69	68.48	68	1.40	3
11	Somsouk	77	50.09	46	4.25	8

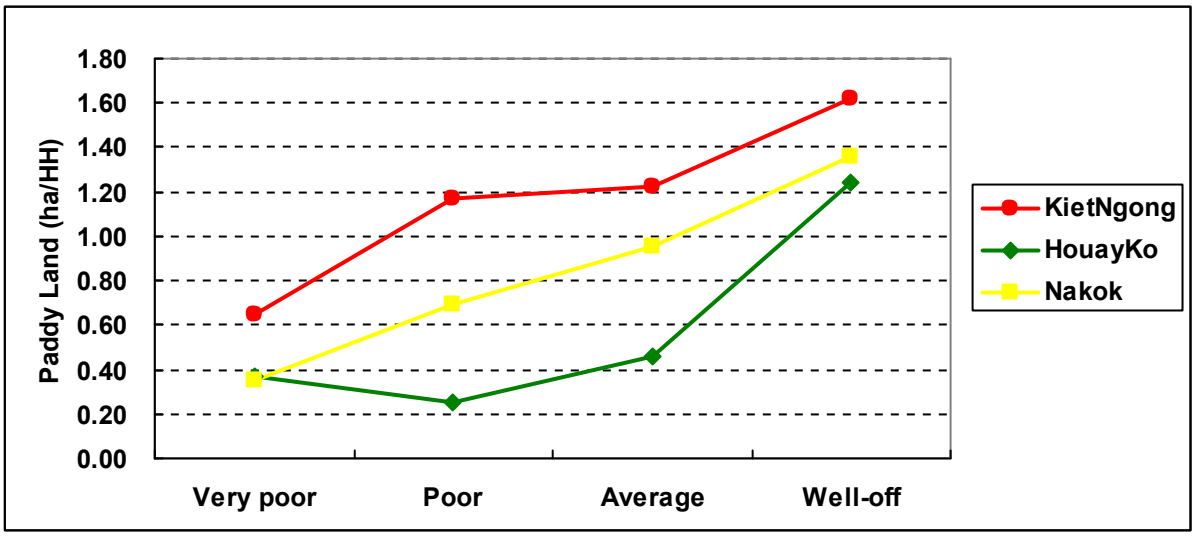
Source: Agricultural Census Survey 2011 (provided by district Agriculture office, DAFO)

18. The annual cycle of flood and drought, along with pests and the lack of labor, are the other commonly given constraints to agricultural production in BCI villages. Rice yields range between 1.5 and 3.3 ton/ha. Pests commonly cause damage to the rice harvest. In general, villagers do not apply chemicals (fertilizer and pesticide) in their farming.

19. In terms of mechanization of production, there is a general pattern across the villages in which well-off households and average households use tractors, while poor households are still use buffalo. Many poor and very poor households who do not own any paddy land, especially in poorer villages such as Ban Houayko, report that they sell their labor to paddy land owners inside and outside of the village.

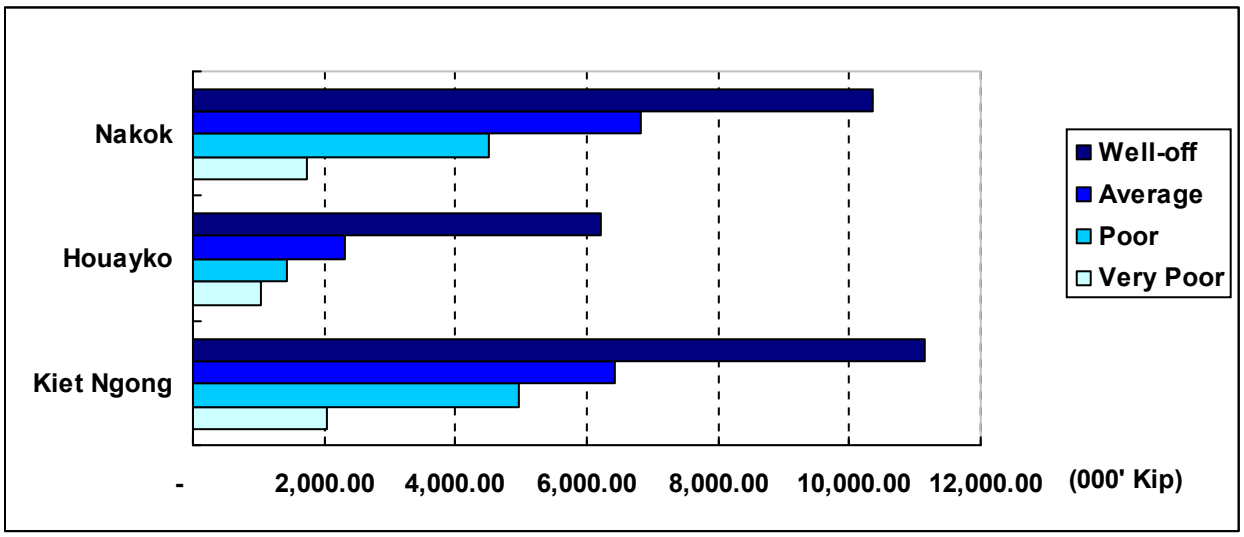
20. There is significant inequity in land holdings across wealth groups and land availability in different villages. Poor and very poor households have very little access to land for rice production in poorer villages (Figure 4).

Figure 4: Household paddy land holding in three surveyed villages



21. Sale of agricultural products is an important source of income for villagers (Figure 5). Income from agricultural products is generally higher for well-off households. However, well-off households in Ban Houayko can only reach the level (or even less) of average households in other two villages. Average and poorer households in Ban Houayko have extremely low income from agricultural products.

Figure 5: Average income from sale of agricultural products

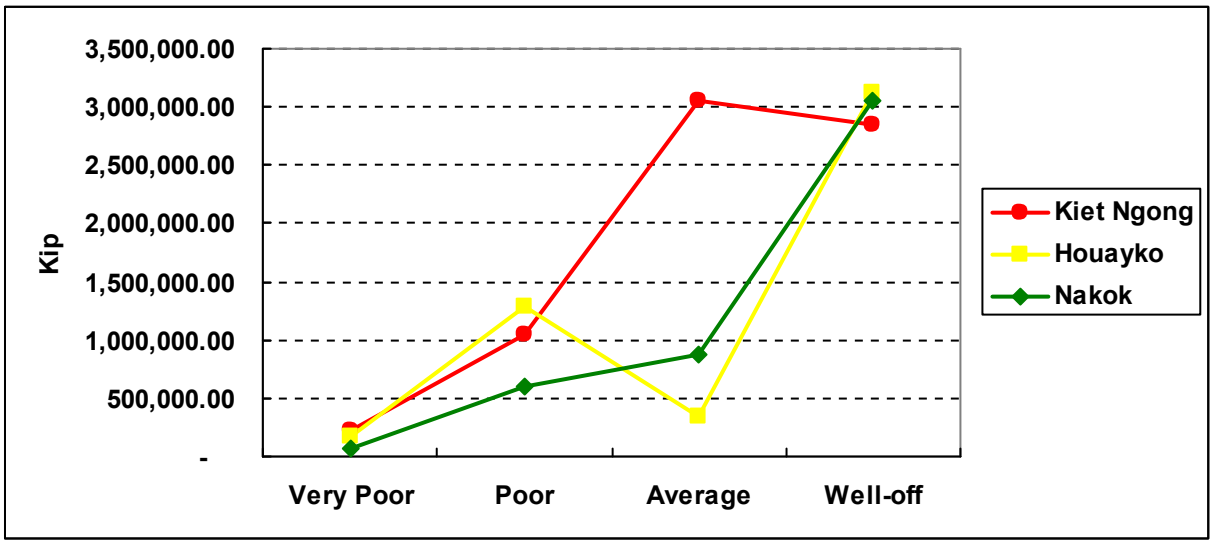


22. Villagers consider livestock to be a central element of their livelihoods, although without special efforts to maintain the level of livestock kept numbers of large bovines have declined, with negative impacts on overall livelihood security.

23. Animal husbandry is based on traditional practices, which was also raised as a problem by villagers. Vaccination of livestock against disease is another concern, signaling low levels of access to crucial veterinary services. For the most part, livestock are raised by natural feeding with no investment in any additional or improved feeding. Average prices for livestock (for an adult animal) are: buffalo 3,000,000 kip, cow 1,650,000 kip, pig 700,000, duck 50,000 and chicken 30,000. Villagers do report fluctuations in price depending upon season and market demand.

24. Livestock provides a source of cash for villagers, particularly in times of need, such as irregular weather or other shocks to the local economy. However, income from livestock sales is clearly skewed towards households of a higher economic status (Figure 6).

Figure 6: Average income from livestock



B. Ecosystem services and livelihood

1. Non-Timber Forest Products (NTFPs)

25. Collection of NTFPs is a critical element of village livelihoods. Products for both local consumption and sale provide villagers with food, daily living materials and cash income. NTFPs are especially important for poor households, who often have limited or no other cash income. These households engage in NTFP collection as a means of subsistence and cash income. Well-off households are involved in collection and trading as a wealth creation activity.

26. The major NTFPs in the corridor include malva nut (*mak jong*), cardamom (*mak naeng*), fruiting vine (*kheua haem*), rattan, and bamboo. Honey, bamboo shoots, mushrooms, wild vegetables, and orchids are important on a smaller scale for both local consumption and sale. Wildlife, such as wild pigs, squirrels, and jungle fowl are harvested by villagers, in addition to aquatic animals, which are discussed below.

27. *Mak jong* (*Scaphium macropodum*) is one of the key products harvested from the corridor forests. Most villagers in all villages are involved in *mak jong* collection. The window of opportunity for harvesting *mak jong* is quite limited, if the highest value is to be attained. Picking too early or allowing the fruits to drop naturally means that price will be low. Fluctuations in price linked to market, harvesting technique and fruit quality/quantity can be as much as 5,000-6,000 kip per kg (2002/3), 20,000 kip per kg (2003/2004), to recently 70,000 kip per kg (2011). Villagers sited several other problems with *mak jong* harvesting: premature harvesting, destructive collection (cutting trees), increased competition with outsiders, weak or no regulations on access to resources.

28. *Kheua haem* is another valuable forest product. This vine (of the *Menispermataceae* family) is widely collected by all villages in the corridor and used as a medicine. Overharvesting has become a problem, and the harvesting methods currently used can damage the plants. Villagers see this as a long-term threat that could be handled with improved management. If the

vine is cut at 20 cm above the earth, the plant can be harvested again in another 3-5 years. Enrichment planting is an option of high local interest as well. *Kheua haem* is sold in its raw form, although there is potential for local processing. Sold raw the one kilogram fetches only 500 kip, while one kilogram of medicinal grade product will get 80,000 kip.

29. *Mak naeng*, or cardamom, is harvested in some villages where it occurs naturally. Yields are extremely variable year to year, and prices are relatively low. Village middlemen buy the raw product at approximately 10,000 kip/kg. The cardamom is then sold to external middlemen for about 15,000 kip/kg, who then sells it to the processing facilities in Pakse for 20,000 kip/kg. Some cardamom is dried with traditional methods before sale. Cardamom dried in this way will get 7,000 kip/kg. A more advanced drying technique can give an extra 20,000 kip/kg of profit. Two major options for improving *mak naeng* are: 1) drying the cardamom before sale and 2) village organization to gain direct access to buyers at the processing stage. SUFORD has been working with villagers to improve *mak naeng* income for villagers.

30. Honey has been identified as a potentially important product in many villages. Villagers can sell honey in Pakse for 20,000 kip/liter. Wax is sold for 30,000 kip/kg. The GAPE project has been working to help link producers in Ban Namom with a buyer in Vientiane. In general, buyers are limited, although there is theoretically a large market for honey in Lao cities and in Thailand. Two major problems are lack of funds to purchase the product locally from individual producers. Currently, GAPE is acting as the local middleman, financing the initial purchase of honey and taking reimbursement after sale has been concluded. Some villages report competition with outsiders for honey.

31. Bamboo and rattan are traditionally an integral part of village NTFP activities. Collection of these products is linked to local handicrafts. But competition with outsiders is intense. Destructive harvesting practices also threaten the long-term viability of the resources.

32. The amount of income derived from forest and environmental products by a well-off family can be 8-10 times as much as a very poor family (Table 2), it is only one of several sources of income. However, NTFPs are more important to poor and very poor households, whose sources of income are much less diversified than richer households.

Table 2: Average household income from forest and environmental products (000'kip)

Village	Very Poor	Poor	Average	Well-off
Kiet Ngong	797.18	1,908.29	3,326.65	6,437.80
HouayKo	627.86	1,347.09	2,185.20	6,767.38
NaKok	717.38	1,296.38	2,310.16	3,358.72

33. There are two main patterns of sale for NTFPs. Many villagers sell to middlemen (external or local) in the village. This is common in most villages, and especially those where road access is poor. In Ban Somsouk and Ban Nabon, for example, virtually all NTFPs are sold initially in the village. This pattern is also the norm for Ban Thopsok and Ban Houayko, which despite being located relatively close to the main road, still have a high proportion of poor households. Middlemen are usually well-off members of the community, and one individual may enjoy a monopoly on NTFP purchase in the village. Middlemen from district or Pakse also visit the village to purchase NTFPs. In either situation, the collector has very little option for sale, and is in a very weak position vis a vis the buyer. Negotiating power is very low. This is particularly problematic when dealing with external middlemen, because in most cases villagers sell

individually to the middleman and there is no collective voice of negotiation on the villages' behalf. Prices are dictated by the buyer.

34. Alternatively, villagers can make the trip to Ban KM 40 or Pakse to link up directly with buyers. In Ban Kiet Ngong, villagers sell *mak jong*, rattan, cardamom, and resin to buyers directly in Pakse if they collect in large quantities. *Kheua haem* is sold in Ban KM 40. Fish and eels, however, are sold in the village.

2. Fishing and Wetland Products

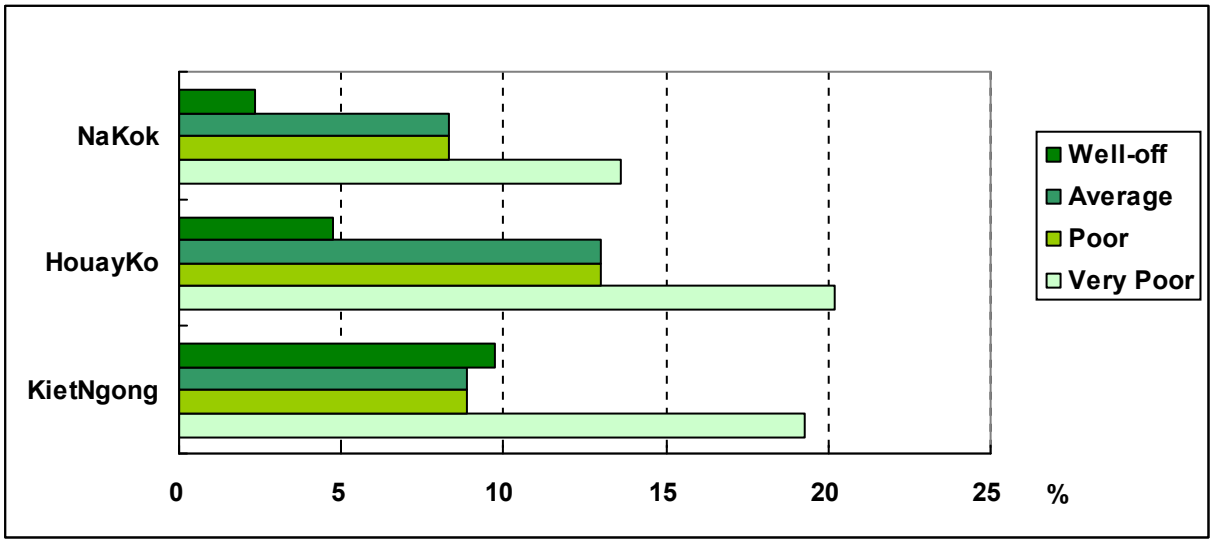
35. The World Food Program report on food security highlighted the importance of wild fish in the diets of Lao communities. Contributing the majority of animal protein, fish and other aquatic animals are the keys to nutrition and human development. In the BCI villages, aquatic resources emerged prominently as key sources of both food and cash. This is not surprising given broad expanse of wetlands in the corridor and the seasonal flooding regime.

36. In Pathoumphone district, there are 527 ponds and natural marshes, with a total area of 3,107 ha. The main wetland products gathered by villagers are snakehead fish and eels. Fishing was forms an important supplementary component of livelihoods for all villages, complementing rice production. For the poorest households, and those who do not own paddy land, fishing is critical for village well-being. All households in the villages surrounding *Bueng Kiet Ngong (Kiet Ngong Wetland)* engage in fishing activities in that wetland, many as their main source of fish, some as a supplementary source particularly for households who do not have their own fishing holes or access to riparian fishing areas.

37. Villagers have a general perception that fish catches have been declining over the past ten years. Reasons given for this decline include: increased pressure from a growth in the number of people fishing, and fish death from disease, and reduced water levels in wetlands. Lowering water levels are attributed to clearing of large trees near wetland banks to increase area under rice production.

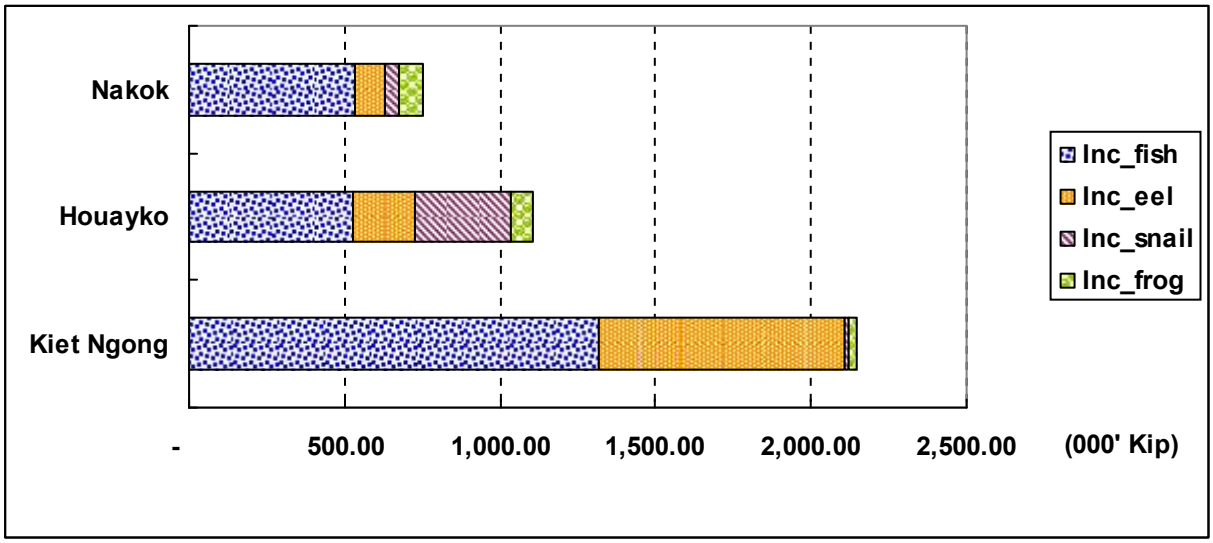
38. Dependence on fishing for subsistence and income is still high in the corridor, although there is some variation across villages according to the nature of the resources and the degree of mounting pressure from increased competition. The role of wetland products for the poorest households is striking (Figure 7).

Figure 7: Share of wetland products income in total household income (%)



39. Average incomes from fish and other wetland products vary widely across the villages and wealth groups, as shown in Figure 8. There is a clear distinction between the *Bueng Kiet Ngong* villages (Ban Kiet Ngong and Ban Houayko) and the others (e.g. Ban Nakok), which have smaller wetlands and to some extent on rivers for fishing, as well. Road access is clearly, though not surprisingly, a factor in determining income levels from fishing.

Figure 8: Average income from wetland products



II. Risks-Vulnerability Assessment

A. Key climate concerns

40. The study area enjoys a tropical climate with a cold dry season from November through February, a hot dry period from March to April. Rainy season starts in May until October with heavy and frequent rains from August to September. Winter starts in December with a shift in wind direction from North to the South/tropical. During May, the wind direction changes from the tropical (South) to North direction, bringing wet and humid weather from the ocean and rain starts.

41. In recent years, irregular climate variations were observed by the villagers: i) shifting in rainy season (starts early); ii) dry spell during rainy season (e.g. June to August in 2010); iii) warmer weather, but sudden/unexpected shifts in cold and hot weather in winter, both human and animals are easy to catch cold/get sick; iv) heat stress in March and April; and v) stronger wind during May and June, which incurred some damage of trees and roofs of houses.

42. Major climate risks in the study area are floods and droughts, which have direct impacts on rice and other crop productivity, as well as fishing, NTFP collection and livestock raising. In general, paddy land in flat area and close to the wetland is highly prone to floods, while upland fields and paddy land located at higher elevation face more risk of droughts. Figure 8 provides an overview of seasonal calendar of climate and livelihood activities. Key climate concerns for each agricultural system are briefly analyzed separately below.

43. ***Rain-fed paddy rice:*** i) floods often occurs in August and September due to intensive rainfall which cause more water availability in the wetland and streams; and ii) serious drought (dry spell during mid-June to September) happened in 2010 for the first time (according to the villagers), paddy rice area (esp. at higher location) got dried up and crops died with low rainfall during rainy season after planting.

44. ***Irrigated dry season paddy rice:*** i) low rainfall provides less water availability in river/ stream, which may cause low flow in the irrigation channel during dry season (December to April), dry season paddy rice might face water shortage with timely irrigation; and ii) high temperature in middle of crop season (March) will incur heat stress for the crop.

45. ***Upland/ shifting cultivation:*** i) dry spell during rainy season has higher impact on upland rice as the crops mainly reply on rainfall for water supply; and ii) another issue linked with drought is pest. It spread badly last year during dry period mid-mid-June to July (when rice grows up to 10 - 20 centimeter), large quantity of sand worms and Phia Fai appeared in the upland rice. Stink-bug was occurred during September to October while rice already grew up during rice heading (flowering) and ripening.

46. ***Livestock:*** i) heat stress during March to April often poses a risk of diseases on animal husbandry; ii) younger animals (esp. poultry) are more vulnerably to cold weather during winter season (December to February); and iii) during heavy rains (in August to September), it becomes very difficult to find fodder for cattle.

Appendix 2

Figure 8. Climate and livelihoods calendar

Month	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Climate												
Rainy Season				Intensive rain			End late				Shower rain	
Dry Season			Dry spell 2010									
Temperature								Winter season (colder than before)			Hot & dry months	
Wind	From the tropical (South) to North direction							From North direction to the South/tropical direction				
	Strong wind											
Climate Risks												
Flood				High risk								
Drought			Dry spell									
Storm/ strong wind	More intensive											
Livelihood activities												
Agricultural	Rain-fed paddy rice											
	Seedling, & land prep.	Trans-planting	Weeding, monitoring			Harvesting, seed selection						
								Irrigated dry season paddy rice				
								Seedling, & land prep.	Planting	Weeding etc.	Harvesting	
									Irrigation (2-3 times/month)			
	Upland rice (intercropped with other crops)									Upland rice		
	Planting	Weeding			Harvesting					Slash/cut trees		Burning/ land prep.
	Cassava											
	Planting									Harvesting		Land prep.

Appendix 2

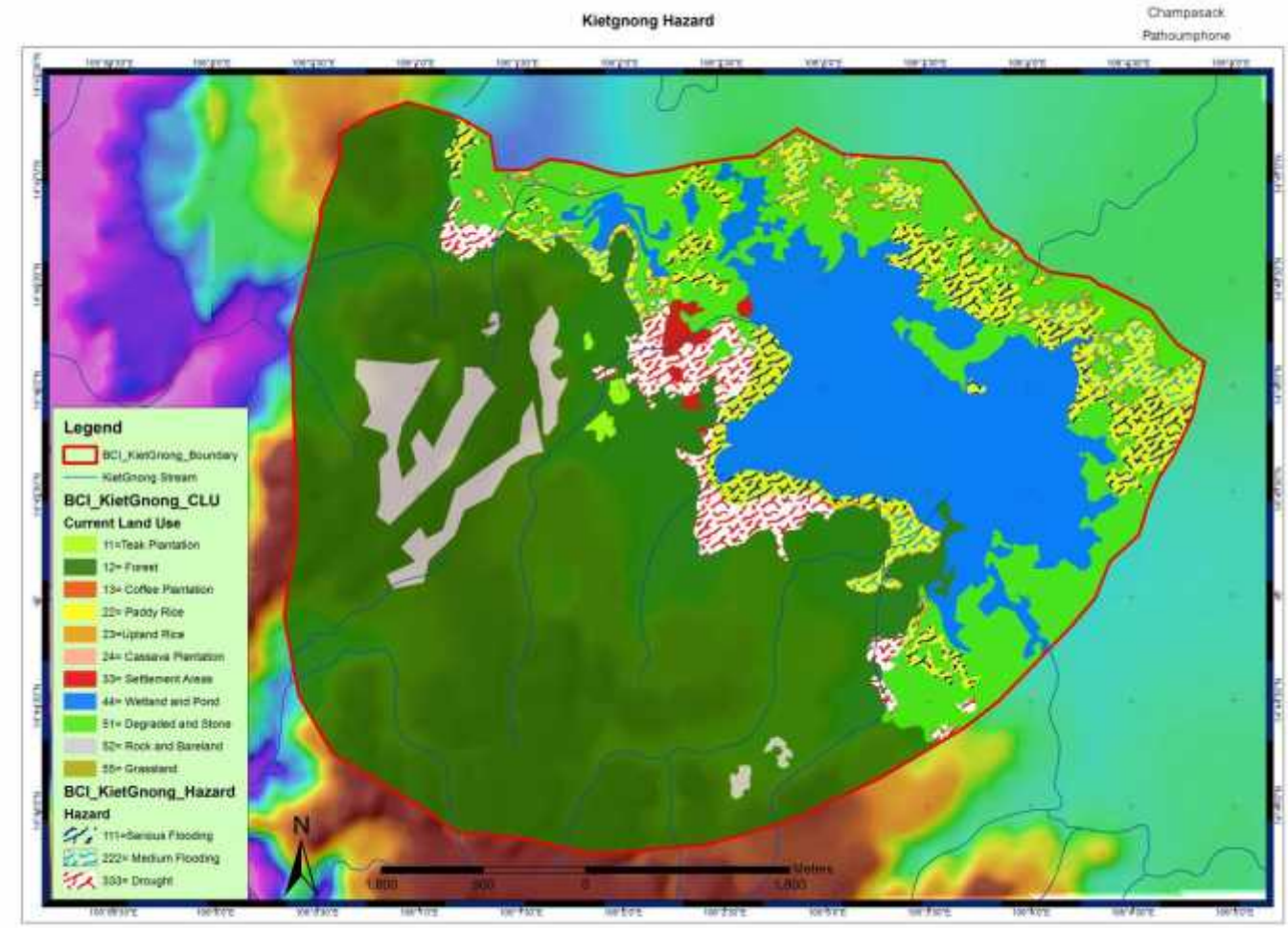
Month	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Month	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
	Vegetable garden							Vegetable garden				
								Coffee harvesting				
	Pineapple harvesting											
Livestock raising	Livestock raising											
	Folder needed, difficult to find during heavy rain						Free grazing (cattle)					
								Cold for animals, fire to keep warm			Disease prevention	
NTFP collection	- Malva Nut											Mak Jong-
			Cardamom									
									Kheua Hame (*Coscinium Fnertra Tum*)			
	Honey											Honey
							Kheua Khao Hor (*Tinospora crispa*)					
	Rattan											
	Wild vegetable											
		Mushroom										
	Handicrafts											
Wetland products	Fishing [incl. walking catfish (*Clarias spp.*), snakeheads (*Channa striata*) and swamp eels (*Monopterus albus*)]											
		Hoi Hom (type of snail)										
		Frog										
Migration for work	Long-term migration											
	Back for Mak Jong harvest					Back for rice harvesting		Seasonal Migration (after harvesting)				Back for festival
Month	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr

B. Risk Profile

1. Ban Kiet Ngong

47. Ban Kiet Ngong is one of the oldest villages in the area, located inside the Xe Pian National Protected Area, with a total population of 1,026 (181 households). The Bueng Kiet Ngong wetland, with an area of 350 hectares, is a central pillar of the local economy, including the surrounding villages of Tha Hou, Pha Pho, Thop Sok and Phommaleu. Paddy rice production and fishing are the twin major contributors of the Ban Kiet Ngong economy. Almost all households engage in these two activities. Many households collect NTFPs, which are treated as open-access resources for collectors both inside and outside of the village. Villagers have relatively good access to markets, although this is mainly through middlemen. Major sources of income for the village are rice, fish and eels, *mak jong, mak naeng,* rattan, *khi si,* and *khuea haem*. Rice is purchased by Pakse middlemen, while NTFPs are bought by middlemen in the village and sold mostly in Pakse, and to a lesser degree in Pathoumphone district. *Khuea haem* is purchased by a Vietnamese company. Due to its proximity to Road 18B and its wetland landscapes, Ban Kiet Ngong has developed a tourism business to supplement its agricultural-based economy.

Figure 9. Hazard map of Ban Kiet Ngong



48. Bueng Kiet Ngong is one component a natural network of ponds, marshes, seasonally flooded areas and rice fields that have provided a steady supply of fish and eels to the region. Agricultural production is constrained by flooding, which renders unusable approximately 30 percent of the land suitable for paddy (Figure 9). Villagers attribute livelihood insecurity to the lack of land for paddy rice production, and have proposed to control the flow of water in the wetlands, including draining ponds to expand wetlands and regulating the water of the Bueng Kiet Ngong with sluices.

49. Before 1980s, farmers faced annual flooding with over 50% productivity loss; during 1980s villagers constructed a cannel to drainage water from wetland/ponds to a nearby stream, and new areas expanded for paddy rice surrounding the wetland. Afterwards, serious flooding only happened in 1992, 1999/2000, and 2008. However, the loss of rice productivity highly depends on location of the paddy land and duration of flood remains in the paddy area (Table 3). Zone 1 (code 111 in the map) is most vulnerable to floods, and paddy rice can be totally destroyed if the flood lasts longer up to 1-2 months. While Zone 3 (code 333) nearly bears no effect from flooding, but is rather prone to drought (dry spell during rainy season), 1/3 of the rice productivity loss was reported in this area. Zone 2 (code 222) faces a moderate risk to floods and was not affected by drought so far.

Table 3. Loss of rice productivity due to floods and droughts in Ban Kiet Ngong

Location	Zone 1: Lower area, closer to wetland	Zone 2: Slope Area	Zone 3: Higher Area
1) Flooding			
< 2 weeks	< 5 %	< 5%	Not affected
2 – 4 weeks	30% loss	10% loss	Not affected
1 – 2 months	90-100% loss	40-50% loss	Not much affected
- Level of flooding			
Serious flooding year (e.g. 2008)	2-3 months	1-2 months, level of flooding reducing with time	Not much affected
Normal/less flooding year	< 2weeks	< 2 weeks	Not affected
2) Drought (2010)	High productivity	Not affected	33% loss

50. During recently years, villagers found crabs and snails start destroying their paddy crops when water gets warmer during rainy season. Pest also often occurs when the climate is dry and hot (linked to dry spell during July – September).

2. Ban Houayko

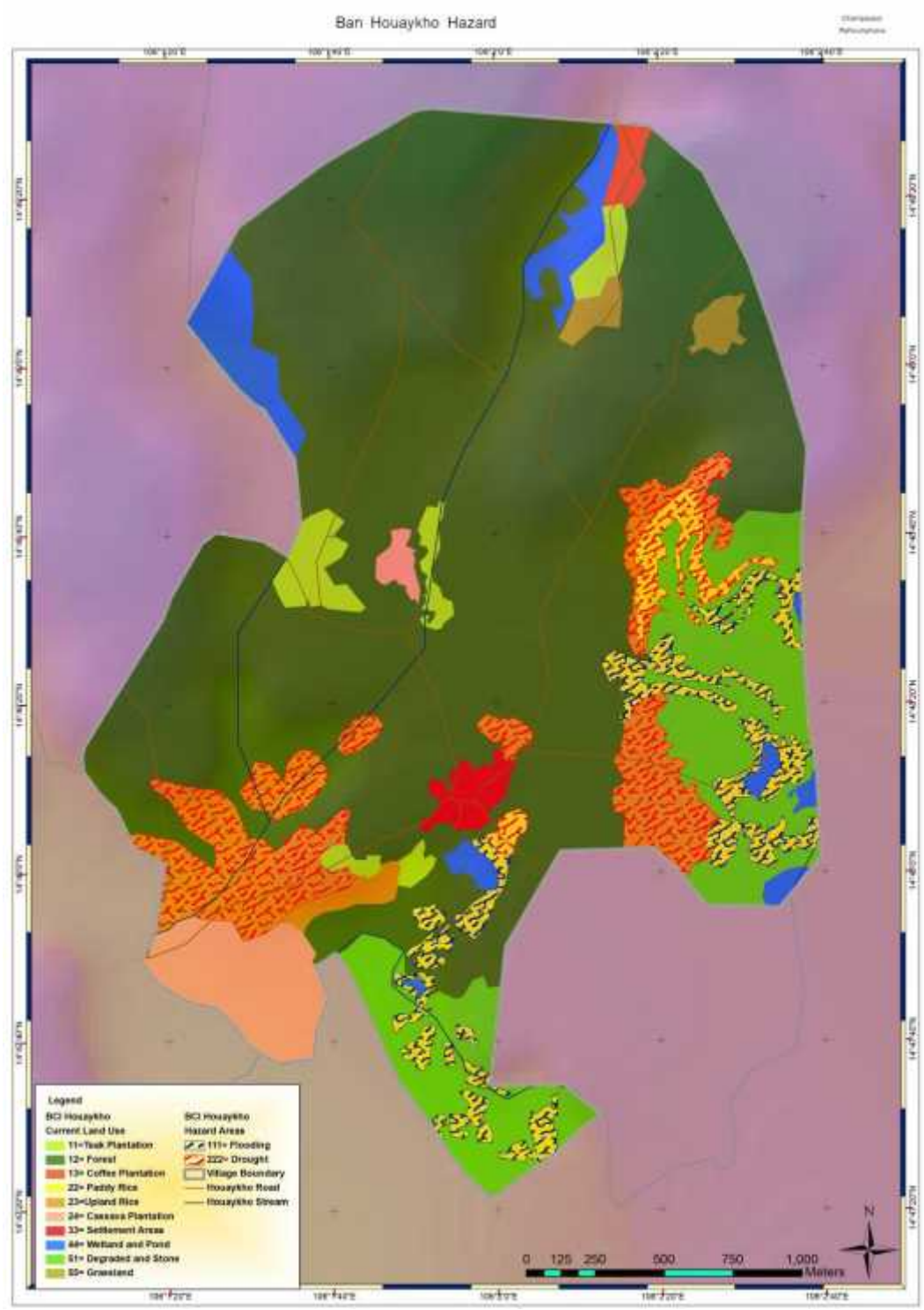
51. Established in 1973, Ban Houayko is located 20 km from the district seat. The village's 189 people are ethnic Brao, and comprise only 32 households. Ban Houayko faces economic difficulty. Majority of the households are classified as poor or very poor, and only three are considered well-off. Average paddy land holdings per household are low. A high proportion of expenditures is for medicine (approximately 33%). Indeed, health and sanitation in Houayko are major problems for the community. Economic differentiation in the village is marked, and represents a serious challenge to village development.

52. Villagers' main livelihood is derived from cultivation of paddy rice, but the relatively good environmental conditions of the village provide options such as fishing, collection of NTFPs and

animal husbandry. Forests cover 67% of the total village area. Ban Houayko is highly dependent upon its natural resources, and villagers believe that this will remain the case into the future. Currently, paddy rice production, fishing and NTFP collection form the three main pillars of the village economy. Planting of teak, coffee, cassava and off-farm income opportunities have risen.

53. Most notably, the importance of upland rice for households in Ban Houayko remains high, which partially due to paddy rice production facing continued heavy flooding damage to paddy fields nearly every year (Figure 10). Villagers explain that they lost not only paddy land, but the will to continue to battle with floods (some 11 households do not practice paddy anymore). Instead villagers turned their attention to livestock. Forest conditions reportedly improved during this period, although NTFPs started the process of commercialization with the arrival of middlemen in the village.

Figure10. Hazard map of Ban Houayko



54. Villagers believe that part of the annual flooding during rainy season is caused by a place along the stream passing through village has narrowed down by rocky area which might block the drainage of water, water overflows back to paddy land and sometimes stays 3-4 days, more seriously it can last up to 2 months. However, detail hydrological study and surveys are required to draw further conclusion and recommendations.

55. Paddy rice productivity in Ban Houayko is relatively much lower (1.5 - 2 ton/ha) than other villages (2.5 – 3 ton/ha), many factors triggered this low productivity: i) annual flooding; ii)

some paddy land area mixed with rocks which make it difficult to grow; and iii) low capability/skills of Brao people in paddy rice practice. The loss of rice productivity due to flooding is presented in the Table 4 below. Similar to Ban Kiet Ngong, paddy land located at different areas may experience different duration of flood at the same period during a particular year. Meanwhile, some households can benefit from flooding with fishing in the natural ponds (next to their paddy) created by the overflow of flooding water, which also brings back fish resources from the river/stream.

Table 4. Loss of rice productivity due to floods in Ban Houayko

Duration of flooding	**Rice productivity (ton/ha)**	**Loss of rice productivity (%)**
Normal flooding year	1.5ton/ha	-
3-4 days	1.4 ton/ha	6.7%
1 month	0.7ton/ha	53%
1 - 2 months	0 – 0.35 ton/ha	77% - 100%

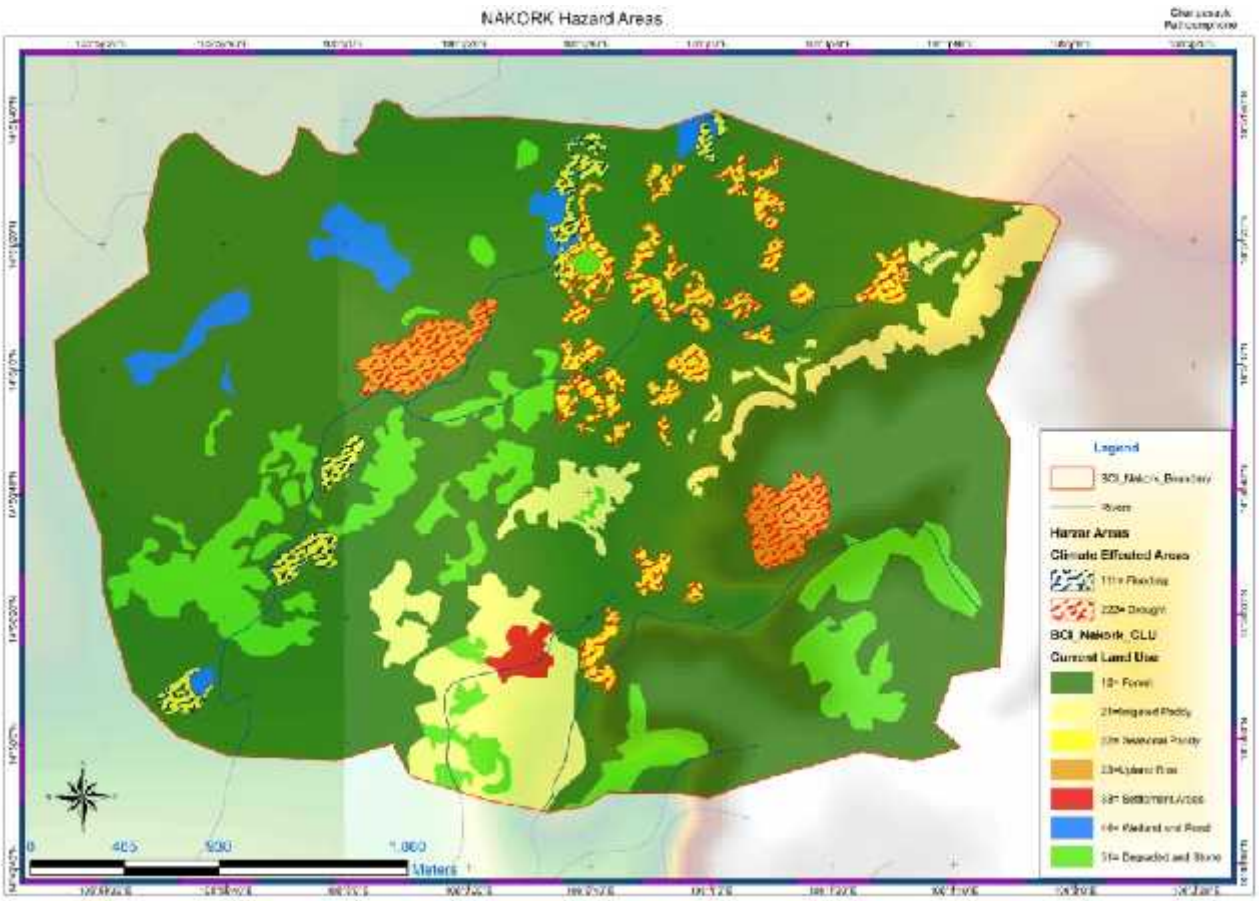
56. Drought (dry spell) only happened once (2010) till now, but shortened rainy season period were observed since 1998. Dry spell during 2010 also had a significant impact on livelihood of households in Ban Houayko: i) upland cultivation was highly affected, 11 out of 25 households got 100% loss in production, and the rest also experienced a loss high up to 80 %; ii) paddy rice production also got affected, 2-3 households were highly affected (100bags/2ha, reduced to 20bags, 80% loss); the rest faced approximately 50% loss; only one household managed to get 100% productivity (paddy land located near wetland area which normally highly affected by flood); iii) loss in fish harvesting (50kg to 20kg, 60% loss). Normally fish can be brought in to the pond created by flood, due to drought no more fish came in. Meanwhile, the ponds were less water and drying up, so villagers collected all the fish in the ponds, this year is expected no more new born fingerings. Fish resources in the nearby river/stream also reduced due to overharvesting, drought has worsen the case; iv) livestock also got sick or died, due to dryness and heat stress, and no grass grow to feed and no water to drink; v) NTFP got affected by drought too. During dry weather, the trees could not flower and bear fruits, which caused productivity/income loss, (e.g. 4,000,000 kip reduced to 600,000 kip, 75% loss, normally 40,000-50,000kip/kg), however, price of NTFP are also highly fluctuated by market demand and supply; and vi) dry and hot weather also cause human sickness.

3. Ban Nakok

57. Ban Nakok was established in 1850 with only 5 households. Currently there are 126 households with a total population of 657 people of the Laoum ethnicity. The village is located 6 km from the district seat. The total area of the village is 1,038 ha, of which 747 ha is under some type of forest land cover, which means that Ban Nakok has over 70% forest cover. With 95.5 ha of rice paddy land, the average holding is 0.8 ha per household. Average yields are 2.5 ton/ha. Additionally, there are almost 17 ha of marshes, which provide a range of fish for nutrition.

58. The economy of Ban Nakok is supported primarily by paddy rice production. Paddy rice area was expanded in the years leading up to 2007, and agricultural products became a major source of income for the well-off households. Poor households have not been able to increase their livestock. In general, there is a lack of fodder available for livestock during the dry season. The marked increase in importance of wage labor is a response to low levels of agricultural output. Fishing is mostly done by households in the average and poor categories, at only minimal levels of cash income.

Figure11. Hazard map of Ban Nakok



59. During *1983 -1985,* villagers constructed the main channel for irrigation scheme led by government, many villages participated this joint intervention. During *1986 – 1989*: villagers in Ban Nakok started collective cultivation as a while community, stopped due to conflict in benefit sharing and management. The sub-cannels were further expanded and upgraded during 1994 and 2006. Starting from 2007 up to now, irrigated dry season paddy rice were intensively practiced in 28 ha owned by 35 HH in the area closer to village area.

60. Compared with other two villages, Ban Nakok bears a relatively lower flood and drought risks. Only 7 ha (10 households) of paddy land close to the wetland area faces annual minor flooding with a loss of 10 -20 % in production. However, these ten households experienced 100% loss in productivity during the serious flooding event in 1978.

61. Majority of the paddy rice production got serious impact from dry spell during 2010, loss in productivity ranges from 30% to 85%. However, paddy land with better irrigation services could prevent from the loss from drought. Similar to Ban Houayko, natural ponds dried up and fish died.

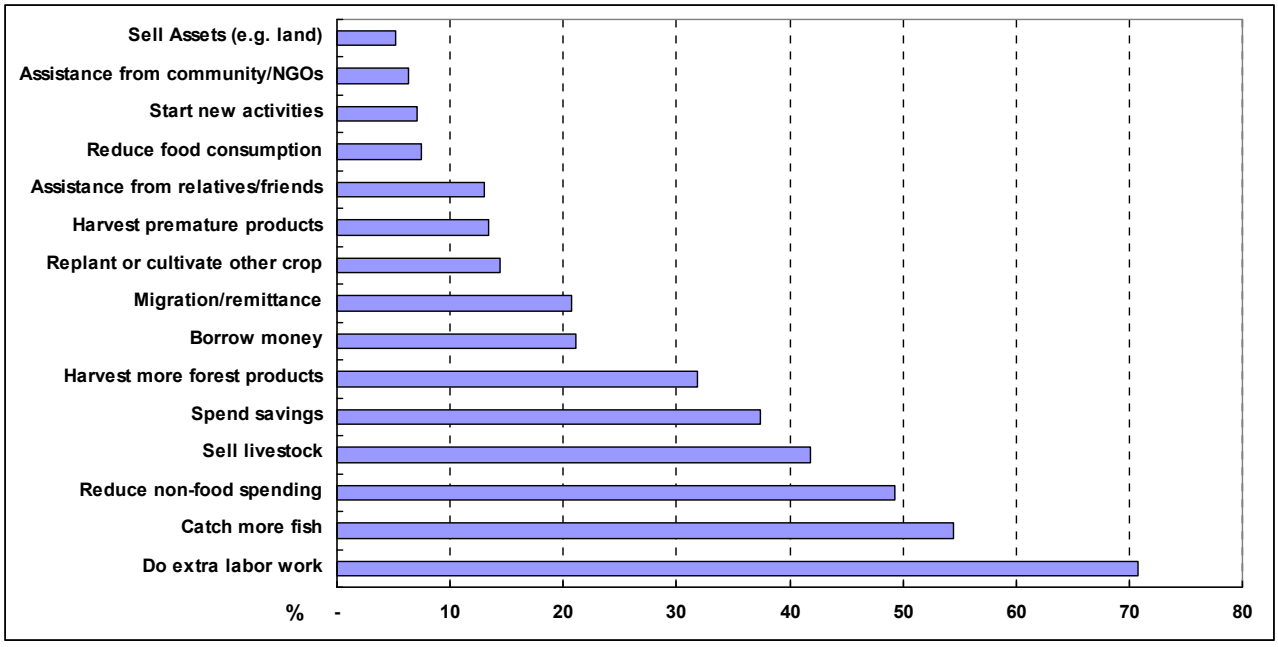
C. Coping capacity – adaptation over the past

62. Most common coping strategies for the local villagers in response to crop failure or income loss due to floods or droughts (dry spell) are:

a) do extra labor work;
b) catch more fish for eating or selling to earn money to buy rice;
c) collect more NTFP to eat and to sell;
d) sell livestock;
e) reduce non-food household spending;
f) migration – remittance;
g) buy rice early in the year (when it is cheaper) for preparation if see early signs of flooding (*Indigenous Knowledge*):
    1) local fruit ("Mak Ber") will bear many fruits;
    2) Heavy rain in the beginning month (June/July);
    3) red ants move home from up branches to lower level;
    4) home ants move from ground to higher place;
    5) color changes of tails of one kind of lizard: white shows drought/less rain, black shows heavy rain/flood;
    6) many mushrooms indicate too much rain-flood.
h) for better-off households, they are able to spend savings from previous years to cope with difficult situations;

63. Figure 12 presents the percentage of households who have taken such measures to cope with difficult situations with productivity/income loss. We can see majority of the households try to find alternative measures to support livelihoods. Nature resources and ecosystem services play an important role in hard times. They prefer to reduce unnecessary non-food spending rather than reduce food consumption. However, the low percentage of "borrow money", "assistance from relatives/friends", and "assistance from community/NGOs" indicates a weak social network/ capital/ safety net established in those local communities.

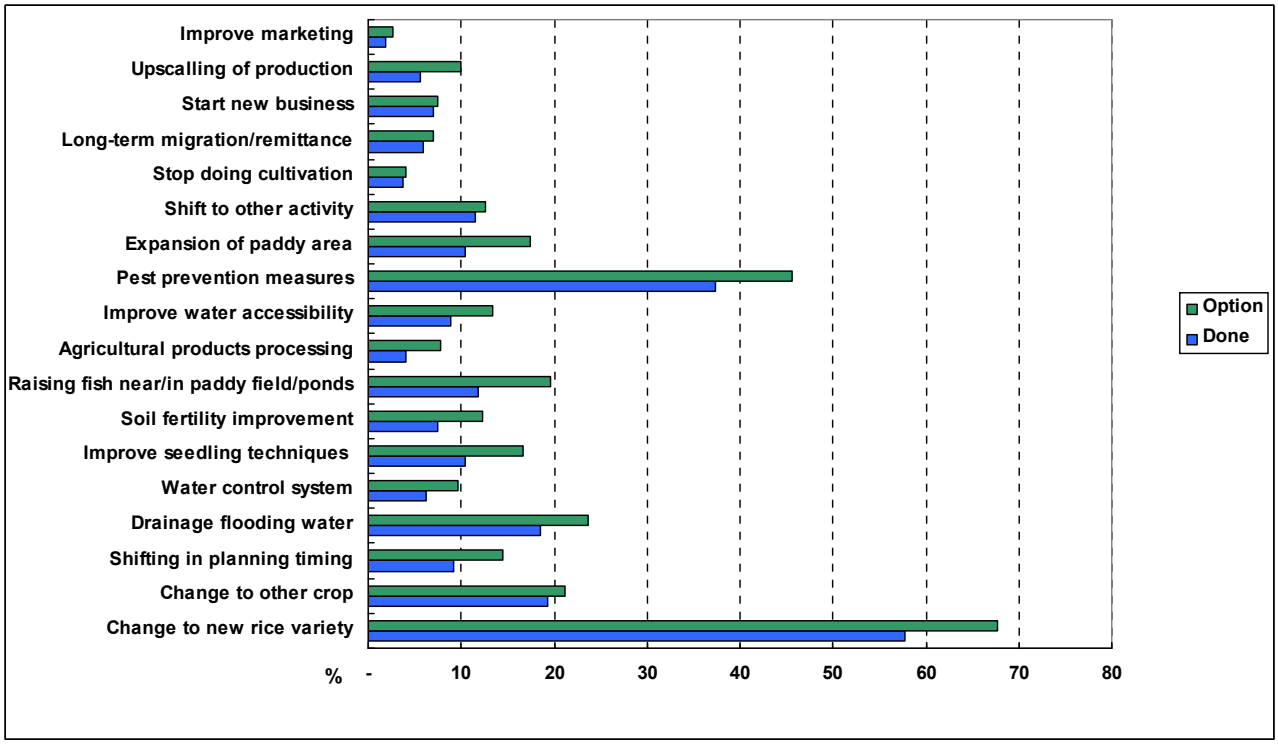
Figure 12. Household coping strategies in response to loss of productivity/income (% of households)



64. Some long-term adaptive measures were also taken place:

a) change rice variety to mid-term (4 months maturity) and long-term (5 months maturity) varieties to replace short-term variety (3 months maturity);
b) tried out flood-tolerant rice variety called “Kao Niao Loy” (swimming sticky rice), but not so successful;
c) Changes of paddy rice practice (i.e. earlier nursery preparation)
d) change livelihood strategy from paddy rice cultivation to other activities (i.e livestock raising, labor wage in the neighboring villages, long-term migration, cassava plantation, etc.);
e) in Ban Kiet Ngong, a cannel was constructed to divert water to nearby stream with collective efforts, which effectively prevented certain flood risks and benefited local communities with paddy land expansion (potential negative impacts on wetland ecosystem need to be considered);
f) in Ban Nakok, construction and upgrade of irrigation schemes provides farmers to practice irrigated dry season rice, in the meantime it also make them more resilient to flood and drought risks.

Figure 13. Household adaptive measures to hazards and livelihoods improvement (% of households)



65. More long-term household level adaptive measures were asked during the household surveys. The results (Figure 13) show that households are less active in long-term adaptive measures to hazards prevention and livelihoods improvement. “Change rice variety” is most common practiced strategy. The incremental change between measures practiced and possible future option is not so significant which also implies a low awareness in adaptation.

D. Adaptation options

A set of adaptation options to guide future development planning and investment at the Champasak BCI site has been developed. Over 35 participants (Appendix 1) drawn from key Lao PDR officials and experts worked together in an Adaptation Options workshop held in Pakse, Champasak Province from 20 – 21 October 2011. To develop the options, the workshop reviewed results of the Climate Change Vulnerability Assessment for the Champasak BCI site and discussed future livelihood options as a part of local risk management strategy. The full report is available in Appendix W1. A summary of results is provided below.

The workshop participants identified both policy and planning based options and livelihood based options.

1. Policy and Planning Options

26. Adaptation options were considered from the policy and planning perspective with a focus on options that need government intervention. The workshop first developed a long list of potential options (see Table 2 below). From this longer list, the workshop identified nine priorities:

- Introduction of integrated livestock and farming systems
- Increased research on drought and flood tolerant rice species
- Accelerated development of national education system to keep pace with economic development
- Development of community infrastructure – roads, schools, hospitals, electricity, and water systems
- Expansion of community irrigations systems
- Promotion of alternate livelihood activities - e.g. handicrafts, ecotourism
- Promotion of high technology (intensification) for agriculture – without harming the environment
- Provide information to communities on climate risks
- Support pilot projects for demonstration on new drought and flood tolerant rice species

27. The workshop also examined key policies concerns with respect to the effect that the concern might have on adaptation planning. These concerns included shifting cultivation, migration, forest and biodiversity conservation, land allocation, poverty reduction, and food security and safety. The results of the discussions are summarized in Table 3.

Table 2. Long List of Adaptation Options developed the Policy and Planning Group

Option
1. Increase afforestation and reforestation to promote biodiversity conservation
2. Planting of economic trees (e.g. mava nuts, cardamom)
3. Introduction of integrated livestock and farming systems
4. Increased research on drought and flood tolerant rice species
5. Programs for education and awareness on forest conservation and protection
6. Accelerated development of national education system to keep pace with economic development
7. Greater scrutiny of proposed development projects with national and local socio-economic development plans and priorities
8. Development of community infrastructure – roads, schools, hospitals, electricity, and water systems
9. Awareness programs for communities to help them understand the potential impacts of climate change and adaptation needs
10. Expansion of community irrigations systems
11. Promotion of alternate livelihood activities - e.g. handicrafts, ecotourism
12. Promotion of high technology (intensification) for agriculture – without harming the environment
13. Increasing productivity within the existing area of cropland
14. Forest restoration programs
15. Provide information to communities on climate risks
16. Better facilities and programs to manage domestics and agricultural waste
17. Train villagers on conservation practices
18. Develop programs for fish and release to the natural environment i. Mekong River ii. BCI site wetlands
19. Develop marketing programs to help village sell their products and better negotiate with local traders
20. Support pilot projects for demonstration of new drought and flood tolerant rice species
21. In developing livestock programs consider the constraints and opportunities related to production of feed for the livestock
22. Establish sustainable financing mechanisms
23. Need to consider the impacts on population growth on the natural resources
24. Need to ensure the benefits of forest conservation flow to the communities – government should provide incentives for forest conservation
25. Need to examine existing and potential land use conflicts

Table 3. Policy Matrix

Policy Concern	Relevant Policies or Plans	Effect on Adaptation Planning	Comment
Shifting Cultivation	Decree/ Suggestion Order on Land Allocation	• Reducing the amount of land for rice cultivation • Brainstorming in the village itself on crop rotation (soil improvement) • Integrated forest management	• Find out existing potential, find out suitable jobs • Stabilization of cultivation • Promote live production
Migration	Labor Law	• Ecotourism and other activities based on conservation • Find out suitable occupations for the area • Occupational training – skill upgrading	• Promote elephant riding
Forest and Biodiversity Conservation	Forestry Law Biodiversity Law Wildlife and Aquatic Law National Forest Strategy 2020 National Biodiversity Strategy 2020 Mining Law Environment Law Environment Strategy Climate Change Strategy	• Illegal logging due poor management and enforcement (e.g. dalbergia species) • Illegal hunting of wildlife – decrease in wildlife populations • Protection forest - restoration and planting together • Develop and promote land use • Develop and promote on environment • Prevention and restoration of environment • Promotion of participatory processes and sustainable development • Increasing on biodiversity and sustainable management • Fire prevention	• Establish patrol system through training of villagers and increasing awareness of villagers • Biodiversity (expansion of economic species) • Awareness of that people should not eat wild animals • PES – payment for ecological services

Land Allocation	Decree/ Suggestion Order on Land Allocation	• Land use rights • Prevents people obtaining land – without using it • New land concession - effects on existing land allocation • Increase land tax collection	• Development plan for land use
Poverty Reduction	Government Poverty Reduction Strategy 2020 Policy on Rural Development Poverty Reduction Fund	• Continue to improvement existing village development fund • Land management • Marketing • Technical staff training • Promotion on village handicraft • Gender • Establish crop production group • Public Health • Infrastructure development • Promotion on education	• Income generation • Promotion and skill upgrading for handicrafts • Exchange ideas between communities
Food Security and Safety	Government Policy on Food Security and Safety	• Expansion of the agricultural production area • Introduce new, more productive species and varieties that are suitable to the area • Establish rice bank • Promotion of integration livestock and farming systems • Techniques and technology for production • Integrated Pest Management • Conservation and Protection of Important Species (Plants and Animals • Organic Farming	• Establish food security fund • Information access (climate information) • Promotion of the potential for food production • Soil analysis for suitable crops

2. Livelihood Based Options

a. Summary of Current Context:

Key livelihood groups or key sectors in this area consist of upland rain-fed agriculture group, lowland rain-fed agriculture group and natural resources dependent group. There also is small area close to wetland where farmer can practice dry-season rice paddy based on small-scale irrigation, but very limited.

The upland rain-fed agriculture is primarily based on wet-season upland rice farming. Those households in the upland area are subsistence farmer and poor. They possess small farmland with low yield productivity and restricted from shifting cultivation, which used to be commonly practice in the older days. Harvesting non-forest timber products (NTFP) is common practice to provide additional income as well as food and daily living materials. Livestock also provide additional income to the household, but only to those who have sufficient fund to invest in livestock raising. Handicraft is practiced to provide additional income, but only small sum.

The lowland rain-fed agriculture is primarily wet-season rice paddy farming. This group is diverse in economic condition as land holding size widely varied. For those who own rather larger farmland, rice production provides both food as well as significant amount of income. In addition, this group also raises livestock for additional income. Those who own small farmland tend to produce rice for own consumption and rely on capture fishery from the wetland in the vicinity as additional income and also to support household food consumption.

The natural resources dependent group is typically landless farmer or own very small farmland. Their household income relies primarily on harvesting NTFP from the nearby forest and also capture fishery in the stream as well as wetland.

b. Current risk and vulnerability of key systems and sectors

These key livelihood groups are facing different climate threats and are vulnerable

Key sectors	*Exposure*	*Sensitivity*	*Coping strategy – Coping capacity*
Upland rain-fed agriculture	Dry spell during crop season, especially July – September.	Rice productivity loss by 30% in typical dry-spell event	Harvest more NTFP and handicraft.
Lowland rain-fed agriculture	Flood during farming period, especially Aug. – Sept. Flood occurs almost every year.	Rice productivity loss by 50% on average	Fishery and livestock. Eco-tourism has recently become new source of income, but still limited.
Natural resources dependent group	Prolonged drought period cause water body dry up, which affect habitat of aquatic species, and may also affect other NTFPs from the forest.	Significant reduction in fishery production and NTFPs harvesting in dry and hot year.	Seasonal migration for wages labor in town.

In general, most of these livelihood groups are vulnerably to impact of climate anomaly, of which in most cases due to insufficient coping capacity.

c. Plausible future of sector and community:

Trends of future change that may affect livelihood:

- Infrastructure development, i.e. road, leads to easy access to market and increase in tourism activity
- Increase population leads to serious situation in resources allocation
- Over exploitation of natural ecosystems, particularly over harvesting of NTFPs and over fishing as well as and fish), which is driven by needs for more household income as well as better access to market, leads to more scarcity of natural resources to support household income
- Strict conservation policy leads to restriction to do shifting cultivation and consequences in more severe soil degradation and lower yield in upland rice production.
- Migration of natural resources dependent group to seek for more secure income by becoming wages labor in the town leads to change in social structure and lack of labor force for other activities, e.g. service sector that may arise in the future.
- Key climate change trends that may affect risk of the key sectors are:
    - Higher rainfall and increase in rainfall intensity during rainy season may leads to higher flood risk during rainy season. On the contrary, this may help lower risk on dry spell for wet season farming.
    - Longer and warmer summertime may affect water body, which is habitat for fish, leads to higher risk on fishery. This may also affect other NTFPs that support livelihood of the people in the area.

d. Future risk and vulnerability of key sectors

As the context of community may change under socioeconomic dynamic and development, risks and vulnerability of key sectors will also change overtime upon change in both socioeconomic condition as well as future climate pattern.

Key livelihood group	*Current risk*	*Future risk*	*Concerns on future context of community on coping capacity & options*
Upland rain-fed agriculture	Drought / fluctuation of on-set of rainy season	Higher rainfall intensity may cause more severe soil erosion and leads to more severe soil degradation and lower yield in agricultural productivity.	• Controlled shifting cultivation • Limited farmland • Limited availability of NTFPs • Handicraft may still be viable option in the future
Lowland rain-fed agriculture	Flood	Increase rainfall and higher rainfall intensity may cause higher flood risk.	• Limited irrigation potential to support dry-season agriculture due to regulation in conservation area • Limited land holding size • Limited availability of NTFPs • Reduced availability of

			fish in natural habitat • Eco-tourism may expand in the future
Natural resources dependent group	Drought – water body dry up and heat stress may affect other NTFPs	Longer and drier summertime may induce higher risk on water body dry up and may affect habitat of aquatic species, thus leads to less fish catch as well as other amphibian and aquatic species e.g. snail and frog. Longer hot period over the year may increase risk in NTFPs productivity.	• Higher population, more competitive in capture fishery and less allocation • Limited resources to practice other livelihood support – limited land allocation (landless) • Wages labor in town may be of higher opportunity as urban economic may expand

e. Adaptation strategy for each key systems and sectors:

For upland rain-fed agriculture group, with better access to market, they may not have to primarily rely on rice production to secure household food consumption. Strategy to cope with future risk and reduce vulnerability could be to switch from rice production to other crops, of which better be perennial crop/tree.

For low-land rain-fed agriculture group, the strategy to cope with future climate risk may aim toward increasing income diversification, which base source of income from less climate sensitive production by implementing controlled and manageable agricultural production and produce NTFPs in the village. Off-farm income may be further enhanced, e.g. livestock and eco-tourism.

Natural resources dependent group may aim at practicing high intensity – on-premise aquaculture as strategy for coping with their future climate change vulnerability.

f. Options for measure to mobilize adaptation strategy

The strategy to cope with climate risk in the future may be mobilized by number of options. Each adaptation measure may require different factors to support the initial implementation of such option and also to make them success and sustain in longer term.

i. Upland rain-fed agriculture group

Options – Adaptation measure	*Benefit now & future*	*Enabling factor*	*Critical success factor*
Switch from rice to perennial crop / tree e.g. “Yang Bong” tree (persea kurzii) and Rattan or coffee (some zones only)	• Less sensitive to drought / rainfall fluctuation than rice • Help reduce soil erosion • Stable market demand	• Alternate revenue to support livelihood until tree will be ready for harvesting • Need to mix with crops which provide quick return	• Monitor progress and provide agriculture advisory • Continue agriculture promotion, which requires institution support, i.e. extension agricultural support unit in community

Switch from rice to other annual crops, e.g. sugarcane or maize	• Less sensitive to drought / rainfall fluctuation than rice • Better production income than rice (rice in highland is low productivity)	• Improve market, e.g. sugar factory or animal feed factory in Champasak • Know-how	• Continue agriculture promotion • Capacity building for local agricultural expertise in crop management • Labor force (note: this labor intensive could prevent migration)
Handicraft	• Diverse HH income	• Training	• Diverse design (requires support in more attractive design) • Quality control • Access to market

ii. Low-land rain-fed agriculture group

Options – Adaptation measure	*Benefit now & future*	*Enabling factor*	*Critical success factor*
New rice variety, which is less climate sensitive variety	• Less sensitive to climate risk – now and future	• Research on rice cultivar - PAFO	• High yield variety • High flood tolerance character
Livestock, focuses on cattle	• Substantial amount of cash • Match ecosystem	• Capital for investment	• Veterinary care support
Produce NTFB at household e.g., bee farming, etc.	• Guaranteed supply	• Capital for investment • Knowledge & know-how	• Market • Quality control – grade (certificate) • By product development
Controlled environment farming e.g., mushroom	• Guaranteed supply	• Capital • Knowledge & know-how	• Food processing facility in community • More research for diversity in variety
Implement fish sanctuary	• Increase natural supply	• Institutional arrangement to control catch quantity / method – fishing gears / season • Add more fish to natural habitat	• Fish breeding facility in community • Zoning – water control in dry season to create fish habitat
Eco-tourism	• New source of revenue	• Demand study – for proper strategic planning • Tourist promotion • Improve road and	• Tourist support facility (natural-look design) • Regulation to ensure environment protection

		access to tourist attraction spots • Capacity building e.g. English speaking, Tourist support / service • Hygiene improvement for home-stay condition – requires investment and capital	• Regulation / law enforcement to ensure public safety • Waste management • Souvenir (need support in design / quality control)

iii. Natural resources dependent group

Options – Adaptation measure	*Benefit now & future*	*Enabling factor*	*Critical success factor*
High intensity aquaculture e.g. snail, eel, frog , etc.	• Less climate sensitive than capture fishery • More stable – predictable production • Less affected from diminishing natural fish	• Capital for investment • Knowledge & know-how	• Access to market • Food processing facility in community
Produce NTFB at household e.g., bee farming, etc.	• Guaranteed supply	• Capital for investment • Knowledge & know-how	• Market • Quality control – grade (certificate) • By product development
Implement fish sanctuary	• Increase natural supply	• Institutional arrangement – control – quantity / method – fishing gears / season • Add more fish to natural habitat	• Fish breeding facility in community • Zoning – water control in dry season – create fish habitat
Handicraft	• Diverse household income	• Training	• Diverse design (requires support in more attractive design) • Quality control • Access to market

Appendix 2-1: Rapid climate change risk and adaptation assessment in Pathoumphone District, Champasak Province, Lao PDR

Sector at risk	Risk	Impact from climate change		Impact from socio-economic change		Coping mechanism - Adaptation	Other recommendations
Farmer Wet season rain-fed system Paddy Rice (Ban Houayko + Ban Kiet Ngong + Ban Nakok)	Flood (Month 8-9)	↑ ↑	High annual rainfall cause more water availability in the wetland/stream Indicator: 1. Total rainfall in month 8-9 if increas = higher risk See Figure 1. Higher rainfall during the concerned period *Note: comparison between median years of the 2 periods – however, scenario shows trend of higher precipitation throughout the whole period*		Paddy area with lava rocks/small stones not suitable for paddy – limited land area (lava from Bolaven Plateau - Champoasak) Migration – if more migration – less labor available for agriculture; require/create more wage labor (might also impact on social capital and social structure of the farmer society)	• Flood tolerance rice variety (>15 days) – "Kao Niew Loy"- swimming sticky rice, change to long term crop/variety • Start prepare seedling and planting earlier in early June • Practice more other crop (i.e. upland) • Improve flood control infrastructure (Ban Kiet Ngong) • Harvest NTFP • Handicraft – weaving • Fishing	• Need support from agronomist to identify flood tolerance crop • Need more survey / budget – flood control system (esp. Ban Houay Ko) • Need more survey on natural eco-system services (esp. wetland)
		→	2. 3 days accumulated rainfall in month 8-9 – higher peak = higher risk See Figure 2. No significant change of highest 3-day accumulate rainfall during August – Sept. (comparison between median value of the 30-year periods) The future seems to be less fluctuation, this may indicate lower risk.			•	•

Appendix 2-1

Sector at risk	Risk	Impact from climate change		Impact from socio-economic change		Coping mechanism - Adaptation	Other recommendations
Farmer Paddy Wet season rain-fed system (Ban Houay Ko + Ban Kiet Ngong +Ban Nakok)	Dry spell/ drought (little rain during Month 7-9)	 	Low rainfall during rainy season (after planting) Indicator: Number of days with daily rainfall < 3mm during month 7-9 in Pathongpone If increase = higher dry spell risk See Figure 3. Less dry-day (no rain) occurance during July and September in the future		Pest	• Fishing (also impacted by dry spell - reduced harvesting) • Harvest NTFP (also impacted by dry spell -reduced productivity) • Handicraft – weaving • Other services (i.e. eco-tourism)	Need further survey Survey and support for small –scale irrigation system
Farmer Upland/Shift cultivation Wet season rain-fed system (Ban Houay Ko + Ban Kiet Ngong +Ban Nakok)	Dry spell/ drought (little rain during Month 7-9)	 	Low rainfall during rainy season (after planting) Indicator: 7-days total rainfall (summarize every 1-day step) during month 7-9 – less rain = higher risk See Figure 5. Rainy season seems to start slightly earlier with evenly distribution of rainfall in the early part of the season, but higher precipitation in the late season. Rainy season seems to end earlier than present. Total 7-day rainfall seems to be higher than threshold of 100mm. throughout the critical part of the crop season (July – Aug. – Sept.)		Pest	• Fishing (also impacted by dry spell - reduced harvesting) • Harvest NTFP (also impacted by dry spell -reduced productivity) • Handicraft – weaving • Other services (i.e. eco-tourism)	Need further survey Survey and support for small –scale irrigation system Survey and support for water harvesting measures

Sector at risk	Risk	Impact from climate change		Impact from socio-economic change		Coping mechanism - Adaptation	Other recommendations
Farmer Dry season irrigated system Nakok)	Low flow in dry season (Month 12 – 4) *Note: since we do not run hydrological analysis, we take rainfall in the study site as indicator of water that will be stored in the wetland area where water is drawn for irrigation to support dry season rice.*	↓	Low annual rainfall cause less water availability in Houay Tomo (river/ stream) Indicator: Cumulative monthly rainfall from January to December See Figure 4. Slightly higher average annual total rainfall, which indicates no change or slightly more water availability in wetland for dry season rice farming.		Irrigation Cannel not in so good condition – water leakage along the way; Upstream irrigation supply to Ban Thongpha Deforestation	• Improve part of the cannel system – constructed some concrete gates • Expand water distribution canal	• Need more survey / budget to expand and upgrade the cannel to concrete • Need support from agronomist to identify drought tolerance crop
Farmer Dry season irrigated system (Ban Nakok)	Heat stress in dry season crop (Month 3) Need to be confirmed	↑ ↑	High temperature in middle of crop season Indicator: Number of days with daily maximum temperature > 37ºC in March in Pathongpone - If increase = higher heat stress in dry season crop See Figure 6. Longer hot period during March (day with max. temp. is above 37ºC)		Pest	• Change crop • Livestock	• Need support from agronomist- Heat tolerance rice variety

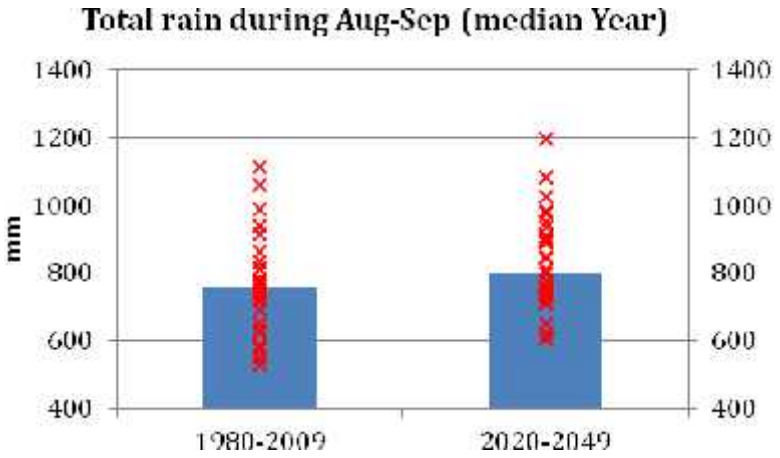


Figure 1. Total rain during August and September (Remark: x indicate value of individual year)

Note: comparison between median years of the 2 periods – however, scenario shows trend of higher precipitation throughout the whole period

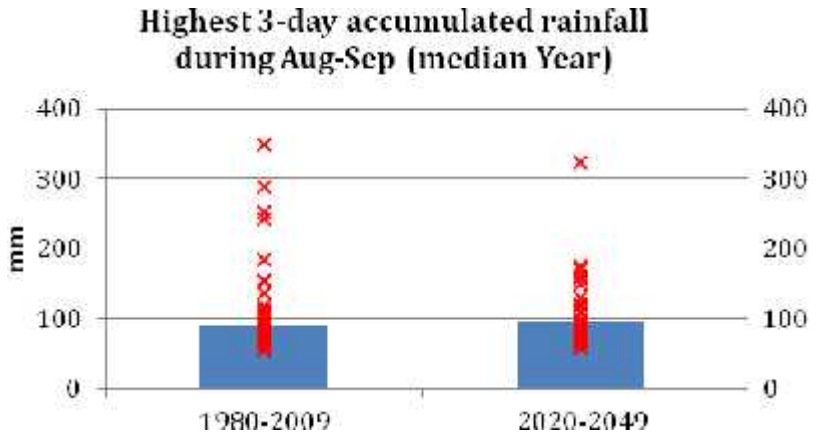


Figure 2. Highest 3-day accumulated rainfall during August and September (Remark: x indicate value of individual year)

Note: seems no change, but the future seems to have less fluctuation from year to year

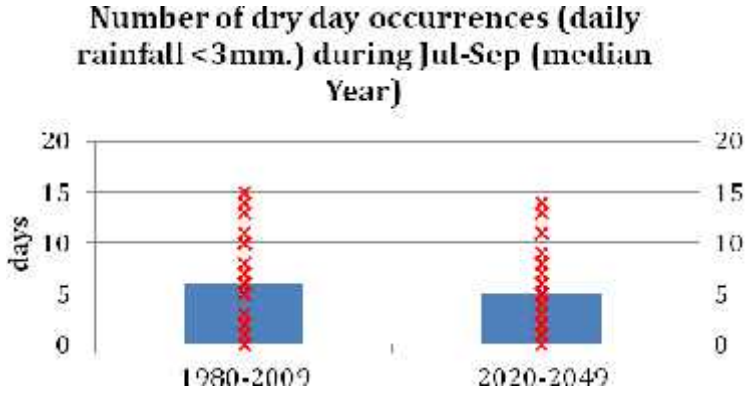


Figure 3. Number of days with daily rain less than 3 mm. (Remark: x indicate value of individual year)

Note: consider <3mm as no-rain day

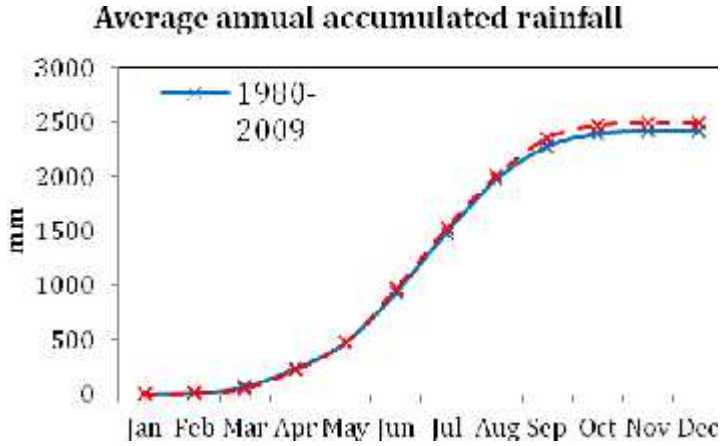


Figure 4. Mean annual accumulated rainfall

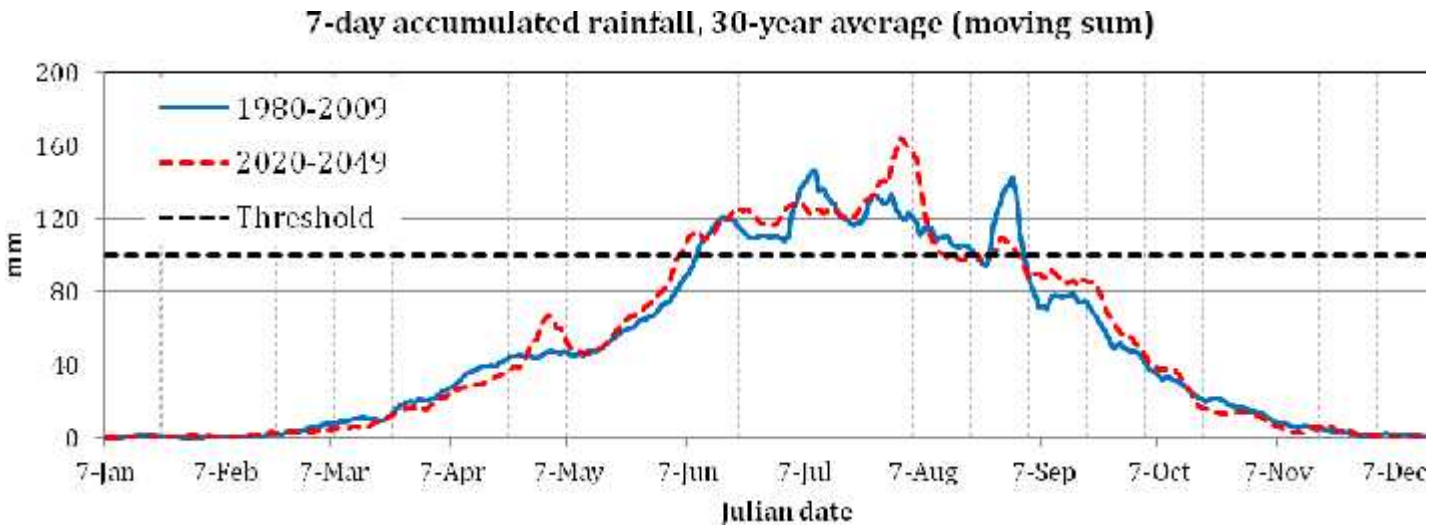


Figure 5. 7-days total rainfall (Remark: moving sum with 1 day time-step)

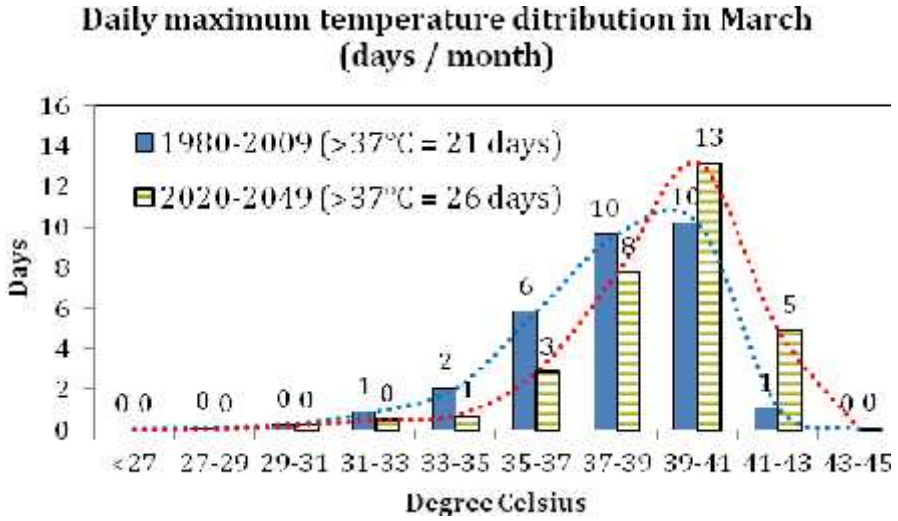


Figure 6. Daily maximum temperature distribution

Additional climate data analysis - options

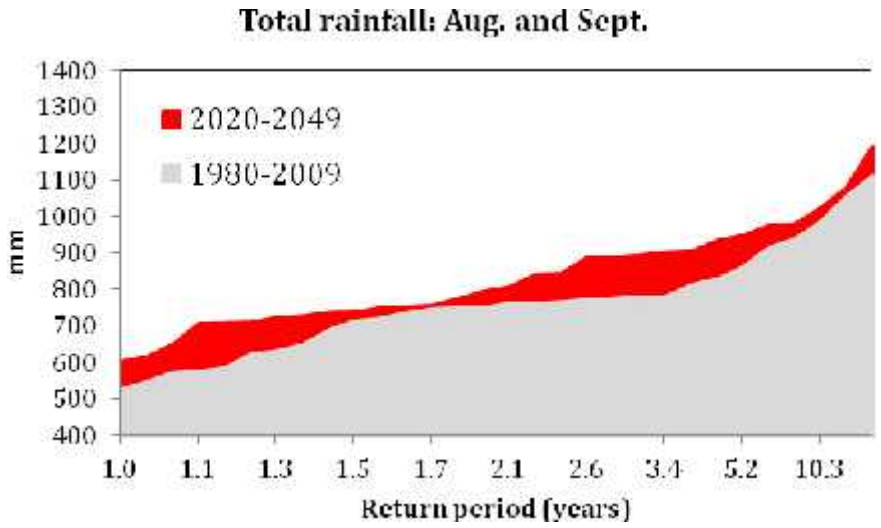


Figure 7: Higher total rainfall in Aug.-Sep. throughout the 30-year period in the future. The return period of heavy rainfall event will become shorter.

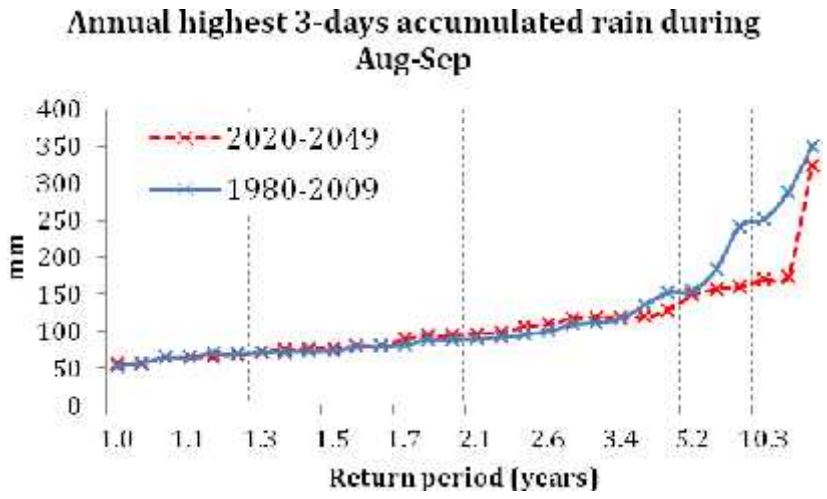


Figure 8: Extreme rainfall event in Aug. – Sept. will be lesser in magnitude and frequency.

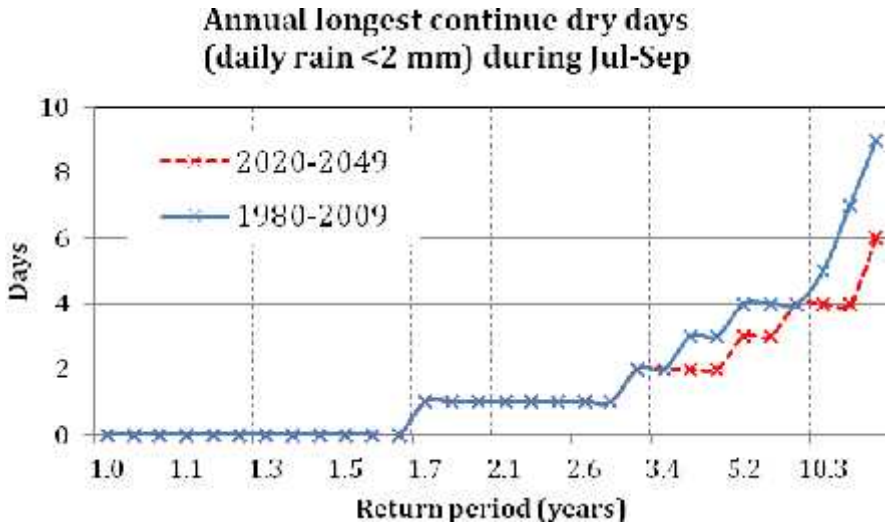


Figure 9: Dry-spell period in future will be shorter with longer return period.ter

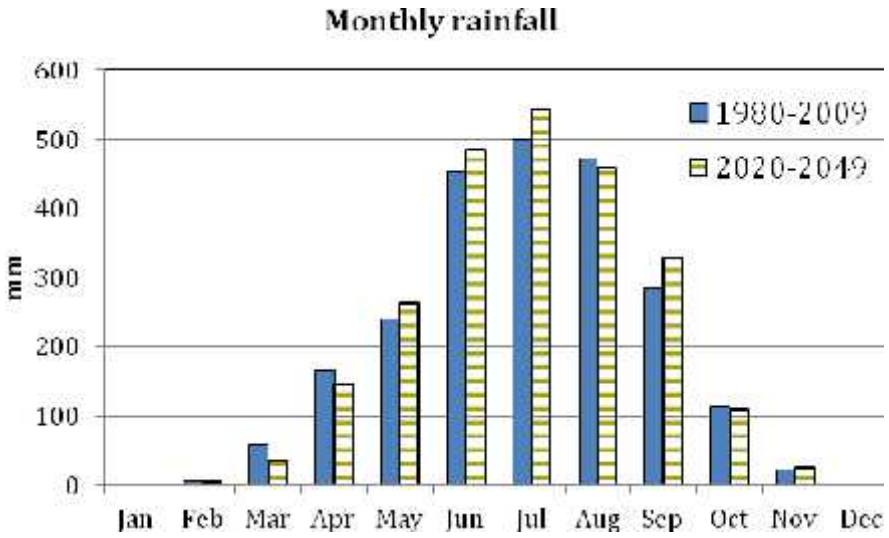


Figure 10: Higher rainfall in rainy season (Jun.-Sept.) and less rainfall in dry season (Mar.-Apr.)

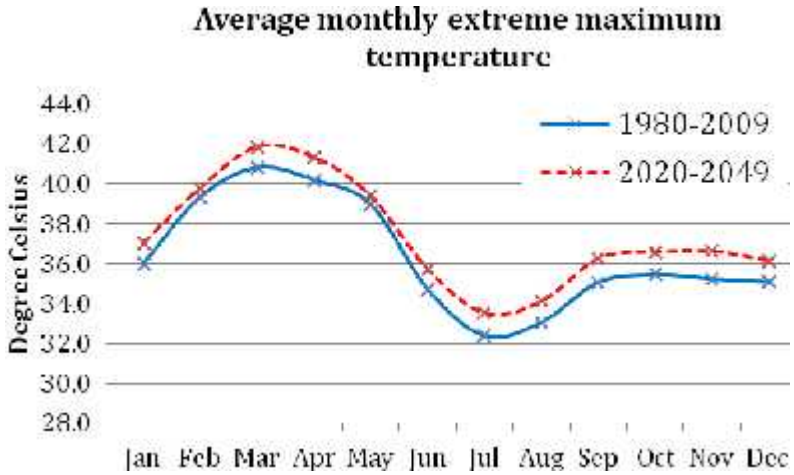


Figure 11: Average maximum temperature of hottest day of the month over 30-year period – extreme maximum temperature will be warmer throughout the year

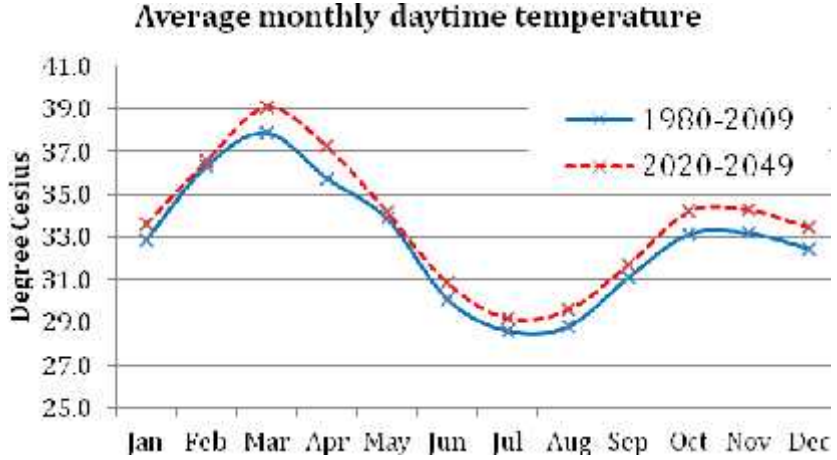


Figure 12: Average monthly maximum temperature – daytime temperature will be warmer throughout the year

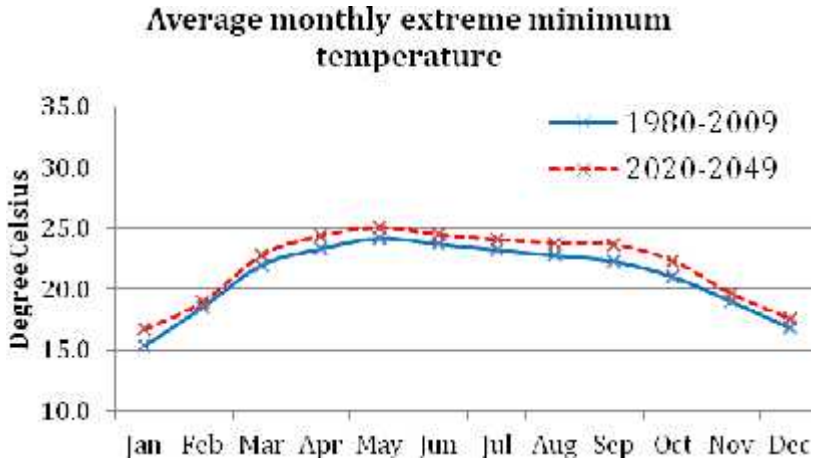


Figure 13: Average minimum temperature of coolest day of the month over 30-year period – extreme minimum temperature will be warmer throughout the year

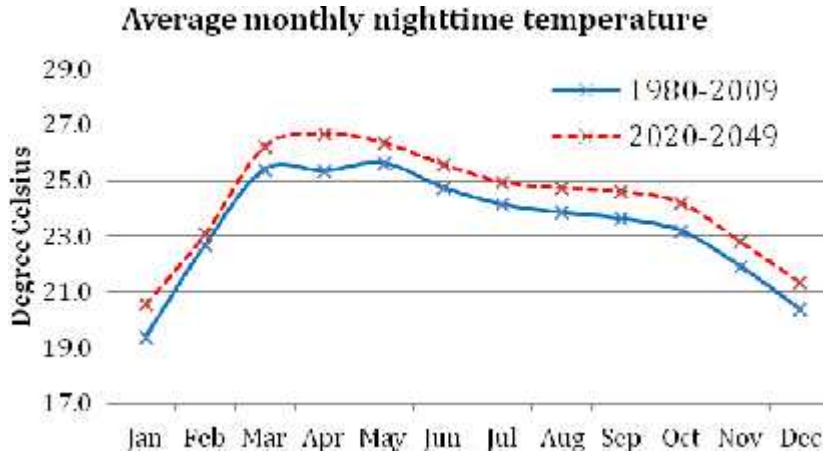


Figure 14: Average monthly minimum temperature – nighttime temperature will be warmer throughout the year

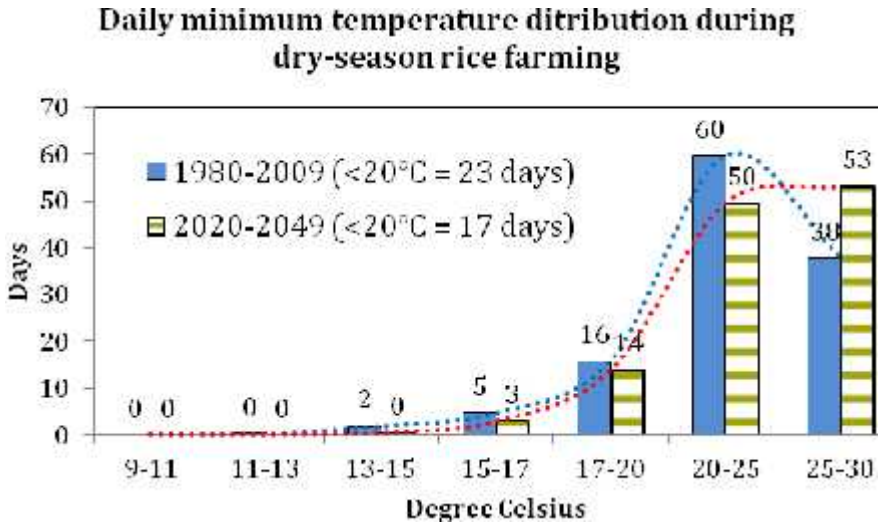


Figure 15: Cool period in Jan-Apr will be shorter and warmer (no. of days / 4 months)

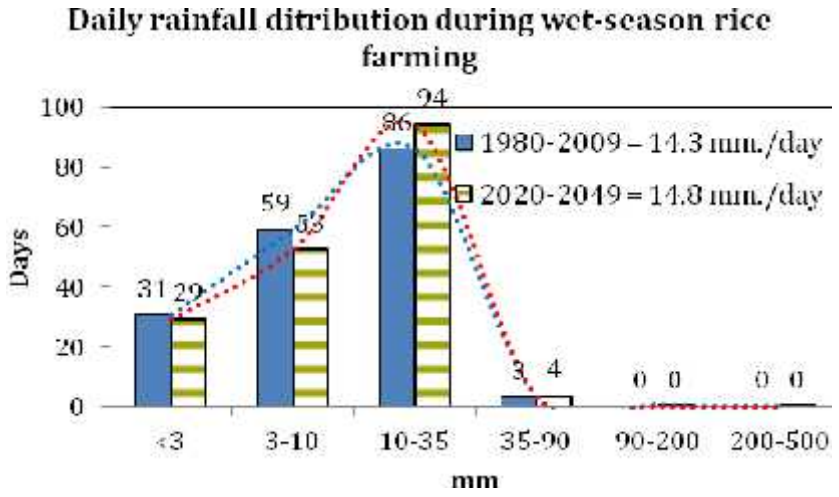


Figure 16: More moderate (10-35mm/day) and heavy rain (35-90 mm/day) day in the future. (no. of days / 6 months)
Note: consider <3mm as no-rain day

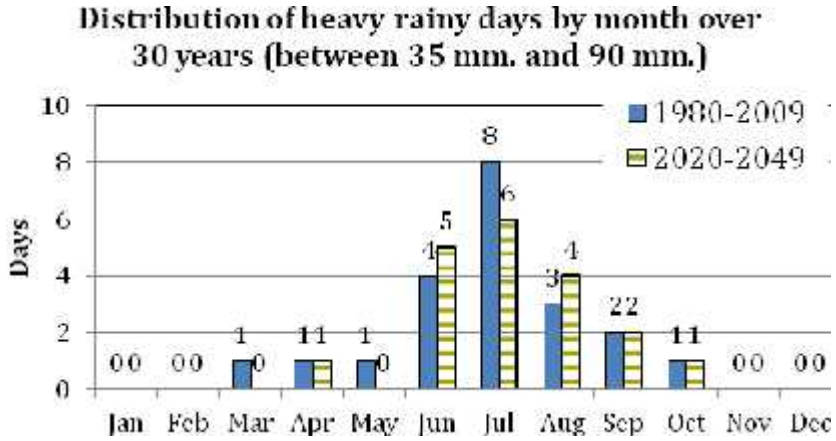


Figure 17: Wider spread of heavy rainy day over the year
(21 days / year VS 19 days / year – note: use highest value of the months in each period)

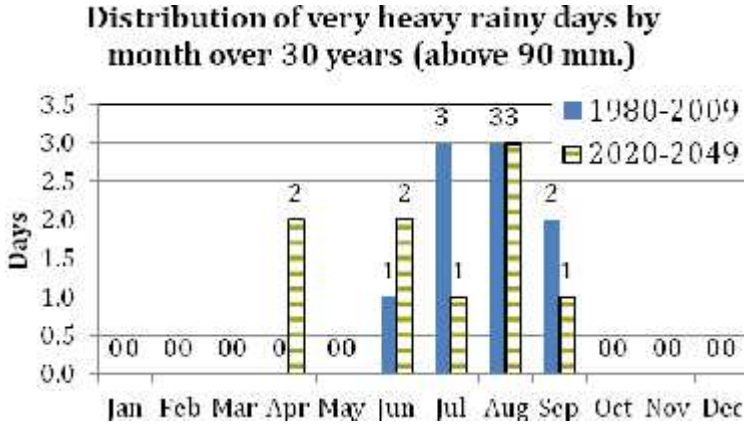


Figure 18: Wider spread of very heavy rainy day over the year
(9 days / year VS 9 days / year)

General Information from climate change scenario data

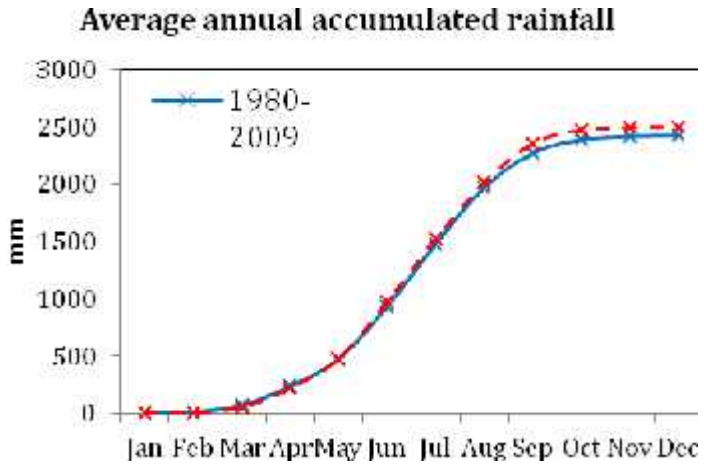


Figure 19: Average annual rainfall – monthly accumulate

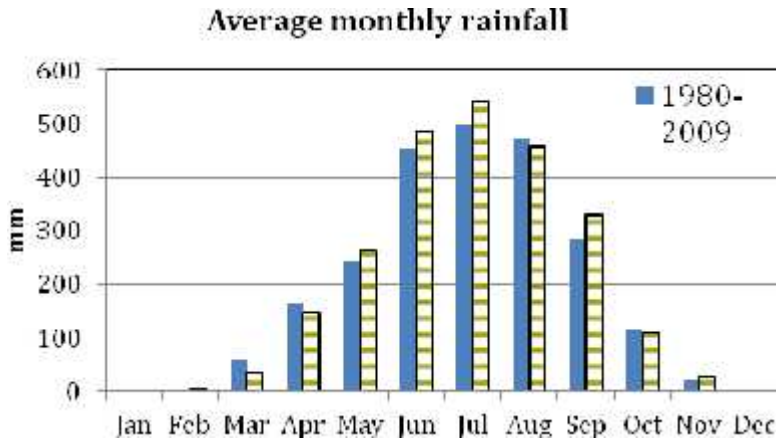


Figure 20: Average annual rainfall

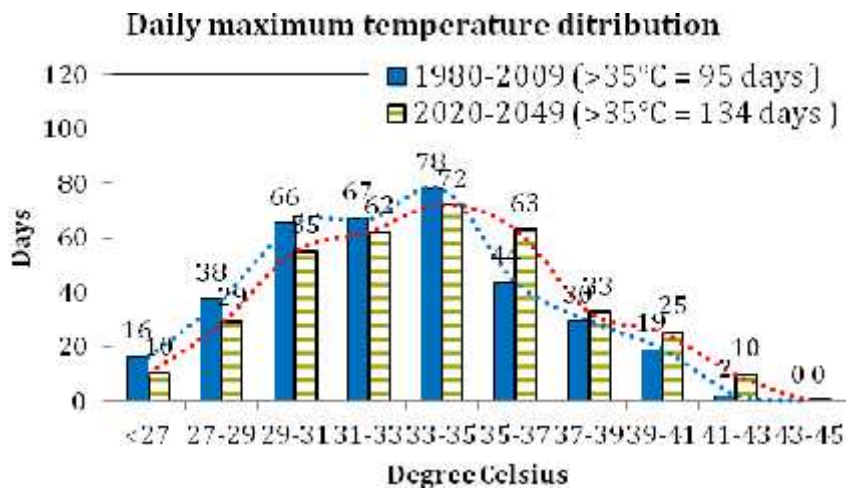


Figure 21: Distribution of maximum temperature by number of days.
Note: Number of days at high temperature tends to increase.

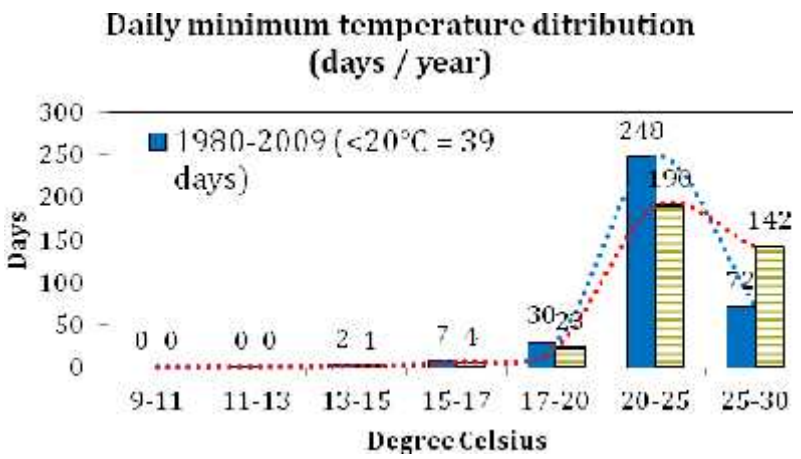


Figure 22: Distribution of minimum temperature by number of days.
Note: Number of days at low temperature tends to decrease.

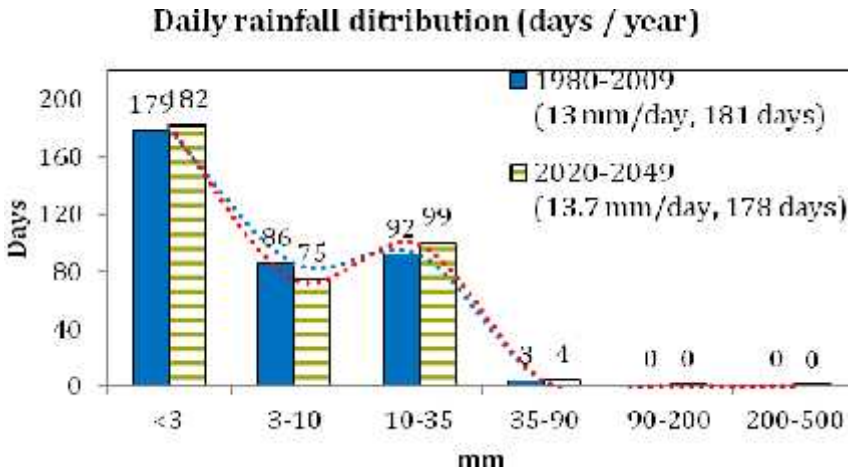


Figure 23: Distribution of rainy day by daily rainfall. *Note: Consider <3mm as no-rain day, trend of change shows slightly higher rainfall intensity.*