Effective Implementation of Payments for Environmental Services in Lao PDR

Research Reports
ISSN 2202-7432

THE ENVIRONMENTAL, ECONOMIC AND SOCIAL CONDITION OF THE NAM NGUM RIVER BASIN

Research Report No. 2

March 2014

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The project 'Effective Implementation of Payments for Environmental Services in Lao PDR' is funded by the Australian Centre for International Agricultural Research (ACIAR). The reports produced within this project are published by the Crawford School of Public Policy, Australian National University, Canberra , 0200 Australia.

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Abstract

The main objective of this Research Report is to overview the environmental, economic and social condition of the Nam Ngum River Basin (NNRB) in Lao PDR. In addition, this Research Report identifies the impacts on the environment of current land uses. It suggests possible management actions to achieve environmental improvements. These include reducing slash and burn agriculture, reducing poaching/ hunting of forest animals, reducing legal and illegal logging by small-scale farmers, and planting trees on deforested land.

Keywords: land use changes, socio-economic, environmental services, Nam Ngum River Basin

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1. Introduction

The main goal of this Research Report (RR) is to provide a baseline for the development of a conceptual bio-physical model of the Nam Ngum River Basin (NNRB). This model will be one element of a 'virtual' Payment for Environmental Services (PES) scheme (see Research Report 3: Development of a 'virtual' PES scheme of the Nam Ngum River Basin') designed as a 'proof of concept'. The 'virtual' PES scheme will demonstrate how a PES scheme would be designed and implemented, step-by-step, in the Lao PDR context and establishes a draft set of guidelines for PES design and operation.

This RR outlines the environmental, economic and social condition of the NNRB. It outlines past and current land uses, discusses their impacts on the extent and condition of forests including the diversity of forest animal and plant species. The report goes on to suggest possible management actions to achieve environmental improvements. These include reducing slash and burn agriculture, reducing poaching/ hunting of forest animals, reducing legal and illegal logging by small-scale farmers, and planting trees on deforested land.

Furthermore, this RR provides an overview of the socio-economic condition of the NNRB. Such information on, for example, administration arrangements, population size and distribution, education levels and land tenure in the NNRB are crucial for the successful design and implementation of a PES scheme.

2. Overview

The NNRB is rich in natural resources that provide a variety of environmental services (ES) such as flood protection, recreational opportunities, landscape beauty, and soil erosion control. These ES contribute significantly to the socio-economic development of the region.

The NNRB is one of Lao PDR's largest river basins. Table 1 presents information on the major river basins with an area of over 4,500 square kilometres in Lao PDR. All rivers within these basins are tributaries of the Mekong River. The NNRB is, by area, the fifth largest river basin in Lao PDR, with a total area of 16,841 square kilometres.

Table 1: Major river basins of Lao PDR

Basin	**Total area (sq km)**	**Population (2005)**	**Mean Annual Rainfall (mm)**	**Mean Annual Discharge (sq m/s)**
Nam Ou	24,637	429,000	1,600	498
Sekong*	22,179	113,000	2,149	879
Nam Kading	14,820	103,000	2,500	546
Sebanghieng	19,223	817,000	1,500	577
Nam Ngum**	**16,841**	**502,150**	2,000	**726**
Sebangfay	10,345	231,000	2,300	523
Nam Tha	8,917	105,000	2,100	346
Nam Khan	7,490	206,000	1,300	115
Sedone	7,229	380,000	2,000	181
Nam Suang	6,578	181,000	1,282	131
Nam Ma	5,947	114,000	1,900	194
Nam Ngiep	4,577	64,000	2,736	208

Source:Water Resources and Environment Administration (2008)
Note: *Upstream of the Lao PDR – Cambodia boarder only; **Includes Nam Lik and Nam Song;

The NNRB's elevation ranges from 155 meters above sea level at the confluence of the Num Ngum River with the Mekong River to Phou Bia Mountain, the highest peak in Lao PDR with a height of 2,820 meters. The basin is mostly hilly and mountainous but contains two large plains: (1) the Vientiane plains which include the floodplain at the confluence of the Nam Ngum and Nam Lik rivers, and (2) the Plain of Jars, which is a plateau in the upper part of the NNRB.

A summary of the bio-physical features of the NNRB is presented in Table 2. The Nam Ngum River has a total length of 415.5 kilometres from its source near Ban Gnot Ngum village in the Peak District, Xieng Khouang Province, to where it merges with the Mekong River at Ban Pak Ngum, Vientiane capital. It has an average annual discharge to the Mekong River of 22 billion cubic meters. This constitutes about 5% (Water Resources and Environment Administration, 2008) of the Mekong River's total annual flow. The average flow of the Nam Ngum River is 726 cubic meters per second.

The present natural forest cover[1] of the NNRB is about 47% of the total basin area, and is concentrated mostly in the mountainous, upper catchment.

Table 2: Summery of the biophysical features of the NNRB

Biophysical features	
Area	16,841 square kilometres (7.1% of the area of Lao PDR)
River length	415.5 km
Elevation	Minimum: 155 (junction of Num Ngum River and Mekong River) Maximum: 2,820 m (Phou Bia mountain)
Annual rainfall	Minimum: 1,450 mm (Phonsavan) Maximum: 3,500 mm (Vang Vieng)
Water resources	
Average flow to the Mekong River	22 billion cubic meters per year (5%) of Mekong River flow)
Flow to the Nam Ngum 1	9.1 billion cubic meters per year (41.36% of Num Ngum

[1] Natural forest cover is defined as old growth forest and does not include use forests and reforested areas.

reservoir	River's flow into Mekong River)
Annual water extractions	0.9 billion cubic meters per year: - agriculture 99% - urban 0.48% - industry 0.08%
Land cover and use	
Natural forest cover	47.35%
Shrub land/regrowth	33.66%
Agriculture	8.04%
Grassland	7.10%
Water surface	3.82%
Urban	0.02%
Administration	
Provinces included in the NNRB	Vientiane Province, Xieng Khouang Province, Luang Prabang Province, Vientiane Capital, and Bolikhamxay Province
Number of Districts	19
Socio-Economic features	
Population	592,150 persons (8.9% of the nation's population)

Source: Water Resources and Environment Administration (2008)

The NNRB falls within the jurisdiction of five provinces (Vientiane Province, Xieng Khouang Province, Luang Prabang Province, Vientiane Capital, and Bolikhamxay Province) and contains about 10% of the Laotian population.

The Ministry of Agriculture and Forestry's (MAF) Integrated Watershed Management Unit (IWMU) has sub-divided the NNRB into 21 watersheds based on a combination of hydrological boundaries adjusted for district boundaries for the purposes of data collection and administrative management (Table 3).

Table 3: NNRB watershed areas

No.	Watershed	Area (ha)	No.	Watershed	Area (ha)

1	Nam Chat-Phae	117,710	12	Nam Chia-Hao	73,898
2	Nam Thoum-Kha-Pieng	31,500	13	Nam Lik	151,397
3	Nam Kho	78,913	14	Nam Pat	93,148
4	Hin Nam Nor	67,909	15	Nam Xan	88,987
5	Nam Ting	61,562	16	Nam Cheng	70,785
6	Yot Lik	189,009	17	Nam Xuang	37,315
7	Nam Xong	131,361	18	Nam Houm	38,236
8	Nam Phay-Kamang	62,406	19	Huay Kabang	126,572
9	Nam Muay	48,106	20	Huay Chiam	48,382
10	Nam Pha-Yen	39,633	21	Na Tong	57,441
11	Nam Mo	55,238			

Source: Water Resources and Environment Administration (2008)

3. Forest use

Land use designation in NNRB is not well understood. About 47% of NNRB area is covered by natural forests (about 8,000 square kilometres), of which 33% are declared National Protected Areas (NPAs). As shown in Table 4, the two NPAs located in the NNRB are Phou Khao Khoay and Phou Phanang, with a combined area of 2,700 square kilometres (Robichaud, et al, 2001; Kyophilavong and Tsechalicha, 2011).

Table 4: National Protected Areas (NPAs) in the NNRB

Name of NPA	**Area (ha)**	**Provinces**
Phou Khao Khouay	200,000	Vientiane Province, Vientiane Capital, Bolikhamsay Province
Phou Phanang	70,000	Vientiane Province and Vientiane Capital

Source:(Kyophilavong & Tsechalicha, 2011)

The remaining 77% are protection or production forest area at the province, district, communal and village level. However, due to limited data, it is difficult to estimate the

distribution of protection and production across the different levels. A small percentage of the forest is owned by households. Especially in the protected areas, there are also some cultural and traditional use hotspots in the NNRB.

Most of the forest, inside and outside the NPAs of the NNRB is natural forest. There are about 2,700 square kilometres of natural forests within and about 5,000 square kilometres of natural forest outside the NPAs in the NNRB in 2010. (Kyophilavong & Tsechalicha, 2011)

The NNRB is mostly mountainous and contains various types of forests. The forest areas are generally located in the mountainous parts of the NNRB. The extent of pristine forest cover has declined due to commercial logging, hydropower dams and slash and burn practices. While the natural area of forest in the NNRB is about 47% of the total basin, bamboo and shrub land/regrowth covers an area of 33%, with agriculture, grassland and water surface occupy an area of about 8%, 7% and 4%, respectively. Urban and village resettlement is less than 1% of the total NNRB area (Table 2).

The forests have been altered by human activities. Development projects, illegal logging within and outside the NPAs, and slash and burn agricultural are the major drivers of deforestation in the NNRB. Even though laws and regulations for forest protection are in place, their enforcement is weak, mostly due to a lack funding and trained staff. (Kyophilavong & Tsechalicha, 2011)

The GoL is concerned that further reduction of forest cover might have negative impacts on livelihoods and poverty reduction in term of reducing revenue from NTFP[2]. Therefore, a further reduction of forest area is a concern of the GoL. Its objective is to rehabilitate forests in order to restore the productive and protective functions provided by viable forest ecosystems. The government target is to restore forest cover to 70% by 2020.

The NNRB catchment contains many pilot projects aimed at conserving existing forest and restoring degraded ones. One example is a reforestation program for industry-oriented tree plantations employing villages backed by private Lao and international

[2] The relationship between poverty and NTFP dependence in the rural area in Laos is discussed by (Sisengnam & Kyophilavong, 2013), using data of the Lao Expenditure and Consumption Censes (2008).

investors (e.g., Chinese companies) [3]. Since 2000, forest replanting in Vientiane capital, Vientiane Province and Xienkhouang Province has amounted to 1,200 hectares, 1,600 hectares, and 130 hectares of restored forest area respectively. However, progress has been slow compared to the large areas that have been deforested.

4. Small-scale timber harvesting

The forests within the NNRB contain high value timber resources, which makes logging attractive to small-scale farmers. Logging is illegal in the protected areas NPAs, PPAs, DPAs. Logging in communal forest is allowed for household use but restricted. However, small-scale farmers still keep logging out high valued trees due to a lack of insufficient funds and equipment to provide the local government authorities to manage/patrol and empower/strengthen the laws effectively. Hence, the forest cover within the NPAs, PPAs, DPAs, and communal forests has decreased (Kyophilavong & Tsechalicha, 2011).

(Thongmanivong et al., 2005) studied the resource use dynamic in the Phou Phanang NPA. They found three main factors causing deforestation in that area[4]. Firstly, a government ban on shifting cultivation in the upland has reduced the yields of small-scale farmers and this has put harvesting pressure on forests within and outside the NPAs. Secondly, government support for irrigation and intensification of lowland agriculture and the development of regional markets have increased the incentives to households to engage in cash cropping in lowland areas. The government has supported up land communities by building/constructing irrigation systems to provide rice fields in low land areas (cash cropping). This support and a ban of deforestation in the up land areas for agricultural activities have gradually reduced the deforestation in the up land areas.

[3] The discussion of rubber plantation and land use change is discussed by Maniviong and Cramb (2008) and Thongmanivong, Fujita, and Fox (2005).

[4] Domoto (1997) and Raul and Thapa (2003) argue that degradation of forests is mainly caused by shifting cultivation.

5. Hunting and poaching of forest animals

The wildlife abundance in the NNRB has been reduced over time. However, there are some very rare large mammals including muntjac (barking deer), Eurasian wild pig, mousedeer, forest chicken, birds and reptiles (Duckworth, 2010). Due to deforestation and hunting, the populations of many species are decreasing to the point of basin-level extinction (Duckworth, 2010). The highly encroached nature of the forest in Tranninh (northern half of NNRB) reflecting the style of agriculture, the variety and intensity of hunting methods used to catch animals from large mammals to small birds, and on how rare many of the larger wildlife species had therefore become (Duckworth, 2010)

The problem of declining species diversity in the basin is not new, although it has intensified with growing human populations, expanding wildlife trade links, and shrinking habitat. In the 1990s–2000s, wildlife populations have probably decreased faster through hunting and habitat threats than ever before[5].

6. Agriculture

Agriculture continues to be a key element of the Seventh Five-Year National Socio Economic Development plan (2001 - 2015) (Government of Lao PDR, 2010). The GoL agricultural policy has encouraged and promoted a more diversified agriculture and the development of private sector involvement. Funds (about 15% of total agricultural investment) have been allocated to invest in rural infrastructure.

The NNRB is an important area for agricultural production. The main agricultural products are rice, cassava, banana, maize (and/or sweet corn), peanuts, and sugarcane. Domestic and foreign demand for agricultural products has led to an expansion of land use for agriculture[6].

[5] However, according to interviews with the district government (Mr. Khamsaveiy), the number of species and their populations are currently increasing because the government has confiscated hunting equipment and strengthened enforcement.

[6] Rice contract farming is growing in the NNRB, especially in the Vientiane Province, which has led to an expansion of land use for agriculture (Leung, 2008)

The situation in the NNRB follows the general trend of Lao PDR. More than 80 % of the population are subsistence farmers. Less than 20 of the population are able to sell their surpluses. Commercial agriculture is not yet widely practiced. The main reasons are limited financial resources of farmers and the lack of well-developed markets for their products. Additionally, the use of chemical fertilizers and pesticides is limited as farmers prefer traditional farm-made fertilizers. Therefore, crop yields remain small. This situation is likely to change in future years with the expected intensification of the agricultural sector. However, an increased use of fertilizers and pesticides may, if poorly managed, decrease the water quality in the NNRB.

Crop areas in the NNRB are shown in Table 5. Since data on agricultural land use in the NNRB were not available, data on agricultural land use in the provinces located within the NNRB were used as an approximation. The total area of agricultural land use in the province was 388,000 hectares.

The area of rice production has increased, on average, about 2% per year from 2006 to 2012. The area of other crops such as maize, soybean, sugar-cane, vegetables and beans has increased, on average, about 10% per year during the same time period. This increase might be explained by an increase in foreign demand and contract farming. Surprisingly, the area of upland rice has increased about 4% per year, despite government control on shifting cultivation. This indicates that shifting cultivation through slash and burn is continuing in upland areas. In order to promote rice production, the GoL invested intensively in irrigation development in the 1990s. However, the irrigation systems were not effective due to high costs and poor maintenance. Therefore, the area of irrigated rice production has declined, on average, by about 3% per year.

Table 5: Crop Area in the NNRB (hectares)

Province	Type of rice	2006	2007	2008	2009	2010	2011	2012
Vientiane Capital	Season rice	52,640	53,380	39,280	54335	54,039	50,311	55548
	Irrigated rice	21100	20125	21049	22176	21500	21300	20762
	Upland rice		3521	898	5540			
	Other crops	13425	13440	18060	10338	13345	16435	22985
Luangprabang	Season rice	12,115	12,570	12,578	12850	13,185	13,493	13593
	Irrigated rice	1400	1445	2176	2458	2660	2420	1313
	Upland rice	20060	16645	15779	19000	16838	13743	21625
	Other crops	34180	28370	54910	34049	28825	29945	25045
Xiengkhuang	Season rice	18,895	20,021	20,506	20617	19,820	20,123	21045
	Irrigated rice	8605	8420	8084	8525	7795	8646	8502
	Upland rice	8605	8420	8084	8525	7795	8646	8502
	Other crops	14785	20880	26590	25125	27125	28635	35870
Vientiane	Season rice	49,335	48,985	45,338	52163	52,475	47,924	52031
	Irrigated rice	6700	7820	9638	7901	8010	8600	6612
	Upland rice	1715	1200	12009	9470	8562	8247	7073
	Other crops	20645	21350	15176	26963	37645	49400	37260
Borikhamxay	Season rice	32,275	31,855	24,346	34063	33,051	25,010	33756
	Irrigated rice	3000	2720	3561	4306	4740	4770	5180
	Upland rice	3485	5939	4679	3950	5154	2844	3388
	Other crops	14915	12795	15794	16331	16590	19215	25852.47
Total	Season rice	165,260	166,811	142,048	174028	172,570	156,861	175,973
	Growth (%)	4.7	0.9	-14.8	22.5	-0.8	-9.1	12.2
	Irrigated rice	40,805	40,530	44,508	45,366	44,705	45,736	24,995
	Growth (%)	10.1	-0.7	9.8	1.9	-1.5	2.3	-45.3
	Upland rice	33865	35725	41449	46485	38349	33480	40588
	Growth (%)	6.19	5.49	16.02	12.15	-17.50	-12.70	21.23
	Other crops	97950	96835	130530	112806	123530	143630	147012.5
	Growth (%)	21.44	-1.14	34.80	-13.58	9.51	16.27	2.35
	total	337,880	339,901	358,535	378,685	379,154	379,707	388,568
	Growth (%)		0.60	5.48	5.62	0.12	0.15	2.33

Sources:Lao Statistical Bureau (2013)

The production of rice is shown in Table 6. It shows that the rice production has increased, on average, about 2% per year. However, rice production declined in 2008 and 2011 due to flood and drought.

Table 6: Rice production in the NNRB (tons/ hectare)

Province	Type of rice	2006	2007	2008	2009	2010	2011	2012
Vientiane Capital	Season rice	200075	219685	161315	225150	233935	214935	241645
	Irrigated rice	97100	96000	99825	108025	101725	103630	100945
	Upland rice	0	8425	2145	9420	0	0	0
Luangprabang	Season rice	46,080	50,290	48,205	55,050	58,990	57,710	55,790
	Irrigated rice	6000	6500	9270	11150	14110	11520	3980
	Upland rice	32,100	24,135	21,820	27,640	32,410	26,990	32,055
Xiengkhuang	Season rice	68,775	68,435	79,675	82,220	79,415	83,200	88,595
	Irrigated rice	580	570	165	550	450	465	365
	Upland rice	16,500	18,949	16,270	17,300	15,335	17,295	17,030
Vientiane	Season rice	192,410	202,580	196,160	227,000	227,220	213,880	230,430
	Irrigated rice	29430	35550	44275	35520	32920	38145	28850
	Upland rice	3,260	1,525	19,650	15,475	15,190	15,885	11,570
Borikhamxay	Season rice	119,985	119,190	81,615	132,850	125,190	91,840	124,945
	Irrigated rice	12900	13160	16310	23080	26490	24435	29405
	Upland rice	5,230	10,115	7,475	7,185	9,715	5,510	6,113
Total	Season rice	627,325	660,180	566,970	722,270	724,750	661,565	741,405
	Growth(%)	1.66	5.24	-14.12	27.39	0.34	-8.72	12.07
	Irrigated rice	146,010	151,780	169,845	178,325	175,695	178,195	163,545
	Growth(%)	7.58	3.95	11.90	4.99	-1.47	1.42	-8.22
	Upland rice	203,100	214,929	237,205	255,345	248,345	243,875	230,313
	Growth(%)	1.77	5.82	10.36	7.65	-2.74	-1.80	-5.56
	Total	976,435	1,026,889	974,020	1,155,940	1,148,790	1,083,635	1,135,263
	Growth(%)	2.52	5.17	-5.15	18.68	-0.62	-5.67	4.76

Sources: Lao Statistical Bureau (2013)

Table 7: the total sum of rice yield in Vientiane Capital, Luang Prabang, Xiengkhouang, Vientiane and Borikhamxay from 2006 to 2012 (tons/ hectare):

year	Rainy season rice	Irrigated rice (dry season rice)	Upland rice	total
2006	627,325	146,010	203,100	976,435
2007	660,180	151,780	214,929	1,026,889
2008	566,970	169,845	237,205	974,020
2009	722,270	178,325	255,345	1,155,940
2010	724,750	175,695	248,345	1,148,790
2011	661,565	178,195	243,875	1,083,635
2012	741,405	163,545	230,313	1,135,263
total	4,704,465	1,163,395	1,633,112	7,500,972

Sources: Lao Statistical Bureau (2013)

The GoL has successfully promoted Foreign Direct Investment (FDI) in the agricultural sector. The main areas of investment are rubber, coffee and rice production. As a result, the total area of agricultural activities has increased which has reduced forest cover and,

along with that, the incomes of poor household who depend on non-timber forest products (NTFP), have declined (Sisengnam & Kyophilavong, 2013).

The rice yield estimates are available for three types of rice production: rainy season rice, dry season rice (irrigated rice) and upland rice. The rainy season rice yield increased from 3.80 tons per hectare in 2006 to 4.21 tons per hectare in 2012. The dry season rice yield increased from 3.58 tons per hectare to 6.54 tons per hectare. The upland rice yield decreased from 4.07 tons per hectare to 4.70 tons per hectare in the same time period (Table 7). The increase yield of rainy and dry season rice has been achieved mainly through the introduction and extension of improved rice varieties and effective production technologies.

7. Other resources

Lao PDR is a developing country with an economy that is highly reliant on the extraction and export of natural resources, including minerals, timber and NTFPs. This sector contributes more than half of the Gross Domestic Product (GDP). Ministry of Industry and Commerce (2012) reported that the export of timber products reached USD 500 million in 2010 and is estimated to reach about USD 1000 million in 2015.

The NNRB has played an important role in the economic development and poverty reduction at the regional and national level. The Nam Ngum Dam was the first hydroelectricity power dam within the NNRB. Since the 1970s, it has generated significant revenues from foreign investors for Laos and plays an important role in securing livelihoods in the region. The NNRB is rich in natural resources. Almost half of its area is covered by natural forest. The species diversity of forest animals and plants in the NNRB has potential for bio-prospecting and ecotourism. Even though there are no data about the utilization and export of timber forest products from the NNRB, it is expected that forest products contribute significantly to the region's socioeconomic development and provide the materials for housing construction for local people. In addition to timber forest products, rural people are dependent on the utilization of non-timber forest products (NTFPs). NTFPs in the NNRB include foods, natural medicines

and herbs. These are recognized to be a source of income which improves livelihoods of local people.

The livelihoods of people living near waterways are closely related to fishing activities. National fish production in 1996 was estimated at 38,000 tons and thus increased to 143,000 tons in 2005 with fish farms accounting for 68.5 per cent of the total and capture fisheries accounting for the rest (31.5 per cent). (Mattson, Balavong, Nilsson, Phounsavanh, & Hartman, 2001) Fish and fish products in the NNRB are well known and in high demand in the domestic market. Fishers in the NNRB meet the demands of rural markets and also supply fish to the urban markets in many provinces, particularly in Vientiane capital. The yield of fisheries in the NNRB rose from 200 tons in 1990 to 280 tons in 2003. (Mattson et al., 2001)

The NNRB is rich in mineral resources, offering a significant wealth generation opportunity for the nation Kyophilavong (2009). Many different mineral resources are found in the region, including gold, copper, zinc, iron, barite, and potash. There are 21 mining companies currently operating in the NNRB. The major mines currently operating in the NNRB are shown in Table 8.

Table 8: Mines in the NNRB

Company	**Minerals**	**Province**	**Concession Area (ha)**		
			P	E	O
Phoubia Mining Co. (Australia)	Gold	Vientiane		263,700	442
Hanoi Construction (Vietnam)	Gold	Vientiane		250	
Huajin Minerals Co. LTD (China)	Gold	Luan Prabang		500	
Daolao Co. LTD (Laos-Russia)	Gold	Vientiane		504	
		Vientiane		1,121	
		Vientiane		581	
		Vientiane		1,121	
Laojiey Sinhoua Mining	Gold	Prefecture		300	

(China)					
Akkanoth Oversea (Australia)	Gold	Prefecture	30,020		
Lao-China Mineral Dev. (China)	Copper	Vientiane	1,200		
Phoujuan Mining Co. (Canada)	Iron	Xiengkhuang	2,200		
Kinghuadao Sinher (China)	Iron	Vientiane	2,000		
Phadeng Industry (Thailand)	Zinc	Vientiane		80,000	200
Sky Telecom (Thailand)	Zinc	Vientiane		80,300	
Lao Cement Co. LTD (Lao-China)	Limestone	Vientiane			4.50
	Clay	Vientiane			5.25
	Mastone	Vientiane			9
	Coal	Vientiane			175
Phialath Gold Mining (Laos)	Gold	Prefecture			16
Vientiane Trading Co. (Laos)	Gold	Prefecture		385	
Army Mining (Laos)	Gold	Vientiane	27,600		
Xaysomboun Dev. (Laos)	Gold	Vientiane		564	
First Pacific Mining (Laos)	Zinc	Vientiane			2,000
	Zinc	Vientiane	80,000		
	Coal	Vientiane		8,400	
	Coal	Vientiane		29,400	
Phetthongkham (Laos)	Barite	Vientiane			21
Oravanh Barite (Laos)	Barite	Vientiane			21
Inthovong Mining (Laos)	Barite	Vientiane			25
Lao Development Construction (Laos)	Barite	Vientiane			25

Barite Exploitation (Laos)	Barite	Vientiane			10
Agri. Ind. & Serv. Dev. (Laos)	Anthracite Coal	Vientiane			10
	Anthracite Coal	Vientiane			20
	Limestone	Vientiane			10
	Limestone	Vientiane			9
	Clay (R)	Vientiane			18
	Clay (W)	Vientiane			1.50
Sino-Lao Potash Mining (China)	Potash	Vientiane C.			7,800

Source: Department of Geology and Mines (2012)

Note: P stands for prospecting, E stands for exploration, and O stands for operation

8. Administration

The NNBR falls within the jurisdiction of five provinces: Luang Prabang Province, Xieng Khouang Province, Bolikhamxay Province, Vientiane Province, and Vientiane Capital. Most of the population and villages are concentrated on the plains areas of Xieng Khouang Province, Vientiane Province, and Vientiane Capital. The Xaysomboun Special Area was formally absorbed into Vientiane Province and Xieng Khouang Province in 2011. The size of each province and the number of associated administrative districts that are located at least partially within the NNRB are set out in Table 9.

Table 9: Provincial area in relation to the NNRB

Province name	Total provincial area (km^2)	Area inside NNRB (km^2)	Proportion of province inside NNRB (%)	Proportion of NNRB in province (% of the NNRB)	The number of districts at least partly within the NNRB

Xiengkhouang P.	17,062	2,806	16.45	16.66	3
Luang Prabang P.	16,875	669	3.96	3.97	1
Vientiane P.	21,850	11,379	52.08	67.58	11
Vientiane Capital	3,920	1,875	47.84	11.13	3
Bolikhamsay P.	1,863	112	0.75	0.67	1

Source: Estimation from Lao Statistical Bureau (2013)

9. Population

In 2005, Lao PDR had a population of 5.6 million with 50.1% female and 49.9% male, an average annual population growth of 2.3% per year, and a life expectancy of 65 years. The Lao population is highly dependent on agriculture. About 66% of hours worked were spent on activities related to subsistence farming from the Lao Expenditure and Consumption Census 2008 (LECS 4)(World Bank & DOS, 2009).

In 2005, the NNRB had an estimated population 1,976,307 (Water Resources and Environment Administration, 2008). Table 10 shows its distribution across the provinces located within the NNRB.

Table 10: Population in NNRB by provinces

Provinces	Population	Estimated Population in NNRB	Population in NNRB (%)
Xiengkhouang P.	239,812	69,559	29.01
Luang Prabang P.	405,949	5,135	1.26
Vientiane P.	409,906	270,785	60.45
Vientiane C.	695,472	155,233	22.32
Bolikhamxai P.	225,167	1,438	0.64
Total	1,976,307	502,150	

Source: Lao Statistical Bureau (2013)

The average household size in the urban and rural areas of each of the provinces in the NNRB is show in the Table 11. The average household size in the NNRB ranged between 5.4 and 6.7 persons per household, with a larger household size being characteristic of rural areas. These figures compare with the national average household size of 5.9. in 2008 (World Bank & DOS, 2009)

Table 11: Household size

Province	**Household size (person per household)**		
	Urban	Rural with road access	Rural without road access
Luang Prabang P.	5.6	5.3	5.4
Xieng Khouang P.	5.8	5.6	5.8
Vientiane P.	5.5	5.6	5.8
Vientiane M.	5.6	5.3	5.4
Bolikhamxai P.	5.7	5.3	6.3

Source: World Bank and DOS (2009)

Table 12 shows the proportion of the Lao PDR population that has attained an education and the proportion that has never attended school. The number of people who have never attended school fell from 38% to 23% between 1995 and 2005. In the same time period, provincial data suggest a clear trend towards an overall decrease in school non-attendance and this is reflected in the more remote parts of the NNRB. Studies on gender gaps indicate discrepancies between the opportunities for girls and boys to attend primary school as measured by differences between female primary enrolment rates (90%) and male primary enrolment rates (95%) (World Bank & DOS, 2009)**.** The gender gap is lowest in those provinces and urban regions that have the highest overall primary net enrolment ratios. The gender gap may reflect a cultural tradition that gives higher priority to educating boys. The chores given to girls were, traditionally, to help their mothers at home. Parents also hold concerns about girls' safety if they have to travel long distances to schools. However, notable exceptions are the urban centre of Vientiane capital and the surrounding Vientiane plain, where young girls (98%) are almost as likely as boys (99%) to be enrolled in school (World Bank & DOS, 2009)**.**

Table 12: Educational qualifications completed

Province	Educational Qualifications Completed (%)			
	School	Vocational	University	Not completed
Luang Prabang P.	22	3	1	74
Xieng Khouang P.	25	4	1	70
Vientiane P.	34	4	1	61
Vientiane C.	41	9	5	45
Bolikhamxai P.	29	6	1	74

Source: World Bank and DOS (2009)

The adult literacy rate is shown in Table 13. It shows that the literacy rate is highest in the Vientiane Capital and lowest in the Luang Prabang Province. Since the provinces that are located within NNRB are mostly rural areas it is expected that the literacy rate will be at the lower end of the spectrum in the Basin.

Table 13: Literacy rate

	Adult literacy rate (%)	
	Femel	Male
LuangPraBang P.	70.3	82.7
Bolikhamxai P.	78.7	88.4
XiengKhouang P.	77.5	87.8
Vientiane P.	84.1	90.4
Vientiane C.	92.9	95.2

Source: Lao Statistical Bureau (2013)

Lao society is highly dependent on agriculture. The results of the Population and Housing Census 2005 for the whole country revealed that 71% of all hours worked involve work on the farmer's personal land (Table 14). Differences between the provinces are relatively small, with the exception of Vientiane Capital. Employment outside their own household (i.e., being a paid employee) exists to a significant extent in Vientiane Capital (22% of total hour worked) but is between 2% and 5% at most in other areas in the NNRB (World Bank & DOS, 2009).

Table 14: Main economic activities of the population aged 10 and above

Province	% of Population 10+ working			Main activities last 7 days, % of total hour worked			
	F	M	Total	Paid employee	Non-farm activity	Owner operated farm	Total
Vientiane C.	74	76	75	22	47	31	100
Xieng Khuang P.	71	72	72	2	16	82	100
Vientiane P.	73	79	76	5	26	69	100
Bolikhamxay P.	85	82	84	3	34	63	100
Luang Prabang P.	78	82	80	5	12	84	100

Source: World Bank and DOS (2009)

The data series available on household income are limited to two variables at the provincial level: GDP per capita and net agricultural income. They were used as proxies to describe the household income within the NNRB. GDP per capita in Vientiane Capital was about 19 million kip per capita, which is about double the household income earned in any other province within the NNRB (Table 15).

About 80% of the Lao population work in the agricultural sector (Lao Statistical Bureau, 2013). Therefore, income from agriculture is the main source of income for rural households in the NNRB. Grain (rice) production accounts for about 50% of agricultural revenue at the national and provincial levels (table 15). The costs of agricultural production (such as seeds, fodder, equipment, and wages) are highest in Vientiane capital. Hence, the net profits from agriculture (income less costs) are generally lower in in Vientiane Capital compared to any other province within the NNRB (XiengKhuang, Bolikhanxay, Vientiane, and LuangPrabang).

Table 15 Gross Domestic Product (GDP) per capita

Province	GDP per capita (million kip)
XiengKhouang P.	8.00
LuangPraBang P.	9.88
Vientiane P.	8.41
Vientiane C.	18.72
Bolikhamxai P.	10.79

Sources: Lao Statistical Bureau (2013)

Table 16: Agricultural income and cost (Unit: 1000 kips/household/year)

Province	**Revenue**						**Cost**				**Net profit**
	Grain	Veg.& Fruit	Meat	Fish	Forest	Other	Seed & fodder	Equip	Wages	Other	
Lao PDR	3129	694	1234	732	40	313	183	137	189	228	5404
Urban	1696	379	543	508	37	375	222	151	308	233	2624
Rural	3598	797	1460	805	41	292	170	132	149	227	6136
Vientiane C.	2224	231	511	435	50	557	298	217	484	424	2587
XiengKhuang P.	3957	976	1867	602	21	291	644	460	277	252	6082
Vientiane P.	2673	553	1767	811	152	752	402	166	308	369	5464
Bolikhanxay P.	2471	934	917	1539	33	98	19	110	155	87	5621
LuangPrabangP.	2376	678	1615	425	87	142	143	78	151	151	4854

Source: World Bank and DOS (2009)

In order to eradicate poverty by 2020, the GoL has implemented the National Growth and Poverty Eradication Strategy (NGPES), an overall development and poverty alleviation framework (The Government of Laos, 2004). Analysis of four Lao Expenditure and Consumption Surveys (LECS) from (World Bank & DOS, 2009) showed that the incidence of poverty fell between 1992/1993 and 2077/2008 at a decreasing rate. The incidence of poverty fell from 46% in LECS 1 to 39% in LECS 2, and from 33.5% in LECS 3 to 28% in LECS 4 (Table 17). The Gini coefficient, a proxy to measure inequality, increased from 30.5 in 1992/93 to 35.6 in 2007/08 (table 18). Vientiane and northern Laos have experienced a greater increase in inequality as compared with other regions of the country. In Vientiane, the Gini coefficient increased from 29.7 in 1992/93

to 38.0 in 2007/8. In northern Laos, the Gini coefficient increased from 26.9 in 1992/93 to 35.2 in 2007/08 (Table 19). From these figures it is clear that despite a successful poverty reduction in recent years, Laos still faces a high level of poverty and inequality.

Table 17: Poverty trends in Laos

	LECS 1 1992/93	LECS 2 1997/98	LECS 3 2002/03	LECS 4 2007/8
Laos	46	39.1	33.5	28
Urban	27	22	20	17
Rural				
with road	43	32	31	30
without road	61	51	46	43
Lowland			28	20.5
Midland			36.5	29
Upland			34	33

Source: World Bank and DOS (2009).
Note: LECS (Lao Expenditure and Consumption Census).

Table 18: Inequality trends in Laos

	LECS 1 1992/93	LECS 2 1997/98	LECS 3 2002/03	LECS 4 2007/08
Laos	30.5	34.9	32.6	35.4
Urban	30.9	39.7	34.8	36.3
Rural				
with road	29.3	32.1	30.3	33.2
with road	27.5	30.9	29.4	33.3
Region				
Vientiane	29.7	36.9	36	38
North	26.9	34.5	30.7	35.2
Central	31.5	32.5	31	34
South	32.3	32.4	31.4	32.2

Source: World Bank and DOS (2009).
Note: LECS (Lao Expenditure and Consumption Census).

Data on poverty and inequality within NNRB are not available. Therefore, the head count poverty indices and the Gini coefficients measured at the provincial level within the NNRB were used as a proxy. As shown in Table 17, both poverty levels and inequality varies across the provinces within the NNRB. The XiengKhouang province had the highest, Vientiane capital the lowest head count poverty index within the NNRB.

Inequality is highest in the Vientiane Capital and the XiengKhouang Province and lowest in the LuangPrabang province in 2007/2008. Poverty and inequality are important factors to motivate change in resource use in the NNRB.

Table 19. Poverty and income inequality in provinces in NNRB

Province	Head count poverty index (%)	GINI
XiengKhouang P.	42.0	38.0
LuangPraBang P.	27.2	31.6
Vientiane P.	28.0	32.1
Vientiane C.	15.2	38.0
Bolikhamxai P.	21.5	33.9

Sources: Lao Statistical Bureau (2013)

10. Land tenure

Before the implementation of the Land and Forest Allocation Act[7] in 1996, land was occupied and sold without legal land certificates. A household could gain temporary access to forest and fallow areas. Households had the exclusive rights to the benefits of the occupied land and their labour. If a household abandoned or left the occupied land unused for a long period of time, another household could occupy the land with the consent of the former household (Ducourtieux et al., 2005; Thongmanivong et al., 2005). Since Laos introduced the New Economic Mechanism in 1986, the demand for agricultural land has increased significantly. The implementation of the Land and Forest Allocation Act in 1996 started the formalization of land allocations. To receive land certificates[8], household are required to register their land and pay taxes to the government (Fujita & Phanvilay, 2008; Thongmanivong et al., 2005). The recognition of private land

[7] There are two main objectives of this reform: The first is to increase land tenure security to increase incentives for farmers to engage in agriculture. The second is to eliminate slash-and-burn agriculture to protect natural forests (Ducourtieux, Laffort, & Sacklokham, 2005).
[8] Certificates allow private ownership of the production from the land but not ownership of the land itself.

use/ utilization rights has provided households with the opportunity to buy, sell and rent these rights to their land.

The Prime Minister Decree No. 164 on NPAs in 2007/2008 and the land law (2003) restrict access to NPAs. Despite these legal restrictions, NPAs are still accessed by households. According to (Thongmanivong et al., 2005), illegal logging through household access was a serious problem within the Phou Phanang NPA.

Due to limited data availability, the land tenure situation in the NNRB is not well-understood. However, most household have legal use rights to some land (Thongmanivong et al., 2005). In addition, the number and size of district and community forest areas are also not well documented.

11. Threats to the environment

The stock of natural resources in the NNRB has been declining significantly in recent years. The main reasons for this continuous decline are:

(1) an increasing number of development projects including hydroelectricity power plants, mining operations, and road constructions,

(2) agricultural activities of an increasing population, and

(3) an ineffective management of the natural resources since the strict laws and regulations that are in place are poorly implemented and enforced.

The main threats from a growing population of small-scale farmers include hunting/ poaching of forest animals, slash and burn agriculture [9], and logging of high value timber in natural forests (Fujita & Phanvilay, 2008; Thongmanivong et al., 2005). These actions continue to reduce the natural forest cover, reduce the species diversity of forest animal and plant, and adversely affect the water supply within the NNRB.

Despite the GoL's efforts to protect natural forests, environmental degradation has continued within and outside the NPAs in the NNRB. NTFP are important for food

[9]GoL has implemented the agricultural master plan 2011-2015, which includes a program approach for agricultural and forestry sustainable development as well as food and income security (Ministry of Agriculture and Forestry, 2010).

security and are the main source of cash income for people who live around forests. NTFP also contribute to the development of forest-based rural micro-enterprises which contribute to poverty alleviation (Foppers & Ketphanh, 2004). Species of NTFP in the NNRB includes broom grass (Thysanolaema maxima), sweet palm fruits (Arenga wsterhouttii), paper mulberry (Broussonetia papyrifera), benzoin (Styrax tonkinensis), peuak neuak (Boehmeria malabarica), eaglewood (Aquilaria sp), bitter bamboo (Indosasa chinensis), and cardamom (Amonum sp). Due to the reduction of native forest cover inside and outside of the NPAs, NTFP stocks have declined significantly. This not only has a negative impact of income generation but also on food consumption for households around the NNRB.

The NNRB used to be a biodiversity hotspot rich in wildlife and plant species. However, this species diversity has declined significantly due to increased hunting/ poaching of forest animals and a continuing loss of habitat (through deforestation).

The wildlife in the NNRB included jungle cat, leopard, tiger, Asian elephant, rhinoceros, deer, kouprey, gaur, banteng, wild cow, buffalo, monkey, rabbit, and others (Duckworth, Salter, & Khounboline, 1999).

The Nam Ngum Dam is used as a fishery for people in Vientiane province and Vientiane capital. It covers 370 square kilometres. In 200, there were more than 55 fish species present in the reservoir. They include Pa Keo (Clupeichthys aesarnensis), Pa Sagang (Puntioplites), Nile tilapia (Oreochromis niloticus), Grass carp (Clenopharyngodon idella), Rohu carp (Labeo rohita), and Common carp (Cyprinus carpio) in 2001 (Mattson et al., 2001).

In 1998, the total annual catch was estimated at 1,470 metric tons; the fisheries yield was about 185kg/ha/year (Mattson et al., 2001). There are 30 villages around the reservoir, with a total population of about 16,600 in 1998. However, it has declined significantly due to increasing population pressure and inappropriate fishing methods.

Deforestation and slash-and-burn agriculture has impacted water quantity and quality in the NNRB. The NNRB has experienced a shortage of water for consumption and agriculture purposes during the dry season (Water Resources and Environment Administration, 2008). In addition, the NNRB has also experienced poor water quality

due to reduced water flows, increased landslides and sediment loads (Water Resources and Environment Administration, 2008).

12. Possible management actions

The declining forest cover is one of the major problems in the NNRB and thus, has ripple effects on other environmental issues. Therefore, forest protection is a key option in the context of the NNRB and the rest of the rest of the Lao PDR. Improving environmental conditions as well as the livelihoods of small-scale farmers requires a change in the way the NNRB is managed. Possible management actions include:

- preventing poaching/ reducing hunting of forest animals,
- preventing/ reducing slash and burn agriculture,
- preventing/ reducing logging through small-scale farmers, and
- planting native trees on deforested land.

The prevention of poaching and reduction of hunting forest wildlife are of key importance to preserving the species diversity in the NNRB. However, currently available funds are insufficient for effective patrols. The funds received from the GoL were below the standard costs of managing a NPA in developing countries (Kyophilavong & Tsechalicha, 2011). Therefore, it is important to establish a village fund or community fund to pay people for patrolling. This approach was effective in preventing poaching/ hunting of forest animal in the Bolikhanxay province (Environmental Protection Fund, 2009). In addition, such an approach would generate income for villagers to invest in agricultural production instead of engaging in poaching/ hunting.

Slash and burn agriculture is still the dominant type of agriculture in the NNRB. Slash and burn agriculture is characterised by low productivity. The pressure on the remaining natural forests could be reduced by improving agricultural productivity of slash and burned areas. Replacing rice with more profitable crops (for example fruit trees) and introducing sustainable agricultural practices would be an option. Small-scale farmers would have to be paid to enable the transition and make the necessary investments.

Training would be necessary for this option to work. In addition, small-scale farmers could be offered compensation payments to reduce their agricultural activity, and thus reduce the area they would otherwise slash and burn.

The main reason for small-scale farmers for logging is the profit enjoyed. Preventing illegal logging through small-scale farmers would require the strengthening of law enforcement at the provincial and district levels through increased patrolling in the NPAs. Villagers could be payed to perform the patrols. Such an approach would not only improve law enforcement but would also generate income for villagers to invest in agricultural production instead of engaging in logging. In addition, small-scale farmers could be offered compensation payments to reduce legal logging activities.

Small-scale farmers could be paid to plant native trees on deforested land. Planting native trees on deforested land would reduce soil erosion (and thus the sedimentation rates in the reservoirs) and would improve the water flow regime (replenishment of the water supply in the dry season and reduction of flooding in the wet season) in the streams and reservoirs.

13. Conclusion

The protection of the natural resources and environment could improve the livelihoods of small-scale farmer in the NNRB. The objective of this RR has been to overview the biophysical condition, and the socio-economic state of the NNRB to identify the impacts on the environment of current land uses. It has been shown that current land uses have negative impacts on forest cover, water quantity and quality, and biodiversity. These impacts lead to a worsening of living conditions for the local people in the NNRB. In order to improve this situation, some recommendations are made.

First is the prevention of poaching/ reduction of hunting of forest animals. A village fund or community fund could be established to pay for people for patrolling. This approach was effective in reducing poaching and hunting levels in the Bolikhanxay province (Environmental Protection Fund, 2009). This approach also provides funding for villagers to invest in agriculture production instead of poaching/ hunting forest animals.

Second is the prevention/ reduction of slash and burn agriculture that causes negative impacts on natural resources especially soil erosion in the dam. As forest protection in NNRB could reduce soil erosion, improve water quality, and improve water regulation, this option could bring benefits to water users, especially hydroelectric-power sector, agricultural sector and households. Therefore, it is important to consider establishing the payment for environment service in the NNRB to pay households to reduce slash and burn cultivation in order to preserve the environment and natural resources.

Third is the prevention/ reduction of logging by small-scale farmers. The main reasons for logging by small-scale farmers are profits and weak law enforcement. Increased awareness and strengthening of law enforcement at the provincial and district levels and increased patrolling in the NPAs would achieve this. The implementation of payment for environmental services in NNRB to fund law enforcement patrols would protect the environment and improve livelihoods.

Fourth is planting native trees on deforested land. Conservation of the watershed in the NNRB plays an important role for maintaining hydroelectric-power dam capacity in the long run. Therefore, it is important for the hydroelectric-power companies to consider implementing a payment for environmental services scheme which allocates funds for households to plant trees.

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