BDP

The MRC Basin Development Plan

Sub-area Report

Northern Lao Sub-area (SA1L)

BDP Library Volume 3-1L

October 2005

Mekong River Commission

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Acronyms and Abbreviations

ADB	:	Asian Development Bank
AIT	:	Asian Institute of Technology
ASEAN	:	Association of South East Asian Nations
BDP	:	Basin Development Plan (MRC)
CH4	:	Methane
CO2	:	Carbon Dioxide
DANIDA	:	Danish International Development Agency
EU	:	European Union
FAO	:	Food and Agriculture Organization
FDI	:	Foreign Direct Investment
GDP	:	Gross Domestic Product
GEF	:	Global Environmental Facility
GMS	:	The Greater Mekong Sub-region
GTZ	:	German Agency for International Development
Ha	:	Hectare
HIV/AIDS	:	Human Immunodeficiency Virus/Auto Immunodeficiency Syndrome
HRD	:	Human Resource Development
HRM	:	Human Resource Management
ID	:	Irrigation Department
ILO	:	International Labour Organization
IOs	:	International Organizations
IUCN	:	International Union for the Conservation of Nature
IWR	:	Integrated Water Resources
JICA	:	Japan International Cooperation Agency
LA/LUP	:	Land Allocation/Land Use Planning
Lao PDR	:	Lao People's Democratic Republic
LMB	:	Lower Mekong Basin
LNMC	:	Lao National Mekong Committee
Lpcd	:	Litres per capita per day
MAF	:	Ministry of Agriculture and Forestry

MAF	:	Ministry of Agriculture and Forestry
MIH	:	Ministry of Industry and Handicrafts
MRC	:	Mekong River Commission
MRCS	:	Mekong River Commission Secretariat
MW	:	Megawatts
N, E, S, W	:	North, East, South, West
NBCA	:	National Biodiversity Conservation Area
NFI	:	National Forest Inventory Agency
NGOs	:	Non-Governmental Organizations
NPEP	:	National Poverty Eradication Programme
NRDS	:	Northern Regional Development Strategy
NRM	:	Natural Resources Management
NSC	:	National Statistic Centre
NTFP	:	Non Timber Forest Products
OPEC	:	Organization of Petroleum Export Countries
PIPs	:	Public Investment Programs
PR China	:	People's Republic of China
RWS	:	Rural Water Supply
SA-1L	:	Northern Lao Sub-area
SAWG	:	Sub-area Working Group
SIDA	:	Swedish International Development Agency
SMEs	:	Small and Medium Enterprises
TOC	:	Table of Contents
UN	:	United Nations
UNDP	:	United Nations Development Programme
UNICEF	:	United Nations Children's Fund
USAID	:	The United States Agency for International Development
USD	:	United States Dollars
UXO	:	Unexploded Ordance
WB	:	World Bank
WHO	:	World Health Organization
WM	:	Watershed Management
WRM	:	Water Resources Management
WSM	:	Watershed Management

WUG	:	Water User Groups
WUP	:	Water Utilization Programme
WWF	:	World Wide Fund for Nature

EXECUTIVE SUMMARY

BACKGROUND

The Basin Development Plan (BDP) formulation started on 1st October 2001, as one of the three core programmes of the Mekong River Commission (MRC). The formulation involves the National Mekong Committees (NMCs) in each country, national planning and line agencies, and a wide range of other government, private sector and civil society actors. The work is supervised by the MRC Joint Committee and by National Sub-Committees.

The BDP seeks to develop both an *initial plan* as a framework for the basin-wide water and water-related resources development and a sustainable *planning process* in the four member states of the MRC, including Cambodia, Lao PDR, Thailand and Vietnam.

The BDP team in each country has been initiating studies and analysis in a number of Sub-areas making up the Lower Mekong Basin (LMB). This is the first stage of the BDP development process. Five Sub-areas have been delineated in the Cambodian part of the Mekong Basin (MB).

In Laos, the Lao National Mekong Committee (LNMC) is leading the efforts on the BDP. The overall process involves reviewing, collecting, analyzing relevant data and information and conducting forums at regional, national and provincial levels. Background study is being finalized at national level through sub/sectoral reviews by Technical Officials from line agencies involved.

The work in the Sub-areas is being divided into two components as following:

- **Component A: Review and Analysis**
  - Review of provincial and sector plans/data and insight collection; and
  - Analysis.
- **Component B: Scenario and Strategy Development**
  - Scenario development; and
  - Strategy development.

The Sub-area review and analysis will provide the basis for formulating the scenarios and strategies for water use in the Sub-areas and subsequently in the region. It will therefore be essential that *the level of detail be tailored and targeted to facilitate macro thinking and analysis and the promotion of suitable oversight and vision in the subsequent stages*. The outcomes for each Sub-area analysis will therefore be:

- Summary of present conditions and context for development;
- Summary of water availability, ecological demands and present water uses;

- Identification of opportunities, concerns and risks; and
- Formulation of development objectives.

PROCESS OF SUB-AREA STUDY AND ANALYSIS

Sub-area studies involve:

- ***Preliminary review:*** Review of available information at regional, national and Sub-area levels to provide overviews of keys issues, review of development plans/programmes (either already prepared or under preparation) and preparation of GIS and related information from MRC data sets;
- ***Identification of key issues and sectors;***
- ***Information collection****:* Identify information gaps, collate or collect required information (particularly from national and provincial agencies);
- ***Analysis:*** Identify Sub-area development objectives, formulate scenarios and strategies and identify potential projects/programmes; and
- ***Public consultation:*** Include local knowledge and opinions.

It is proposed that the process of Sub-area study and analysis should be orientated around two forums. The process can then be broken down into a number of steps as follows:

- ***Review:*** Mainly through activities coordinated at MRC Secretariat;
- ***Forum 1:*** A multi-stakeholder forum within the Sub-area to consider Sub-area information, identify key issues and information gaps, and prepare a work plan for further study and analysis;
- ***Implementation of work plan:*** Mainly collection of further information as defined at Forum 1; and
- ***Forum 2:*** A second multi-stakeholder forum to agree on Sub-area development objectives, scenarios and strategies and to identify potential projects/programmes.

DEVELOPMENT OF SCENARIOS AND STRATEGIES

According to the BDP, scenarios are not about predicting the future; rather they are about perceiving the future in the present. A scenario is a hypothetical combination of events and physical conditions, describing a possible future situation. Development scenarios will be formulated in order to illustrate anticipated limits to the long-term basin development, as well as the significance of external driving forces and uncertainties about applied key assumptions.

Development strategies will be drafted as a tool for identification and assessment of development projects and programmes. Development and management strategies will be

formulated for each Sub-area and each relevant water related sector. This will be done in a close dialogue with the stakeholders, and drawing on related MRC programmes.

The strategies need to be justified in terms of: (i) socio-economic implications; (ii) environmental implications; (iii) human resources development implications; and (iv) national priorities, strategies and plans.

IMPORTANCE OF THE REPORT

The report might also be useful for governmental institutions, external support agencies, project evaluation teams, investors and technical specialists in helping them understand:

- The current condition of various development sectors at provincial levels around Northern Lao Sub-area;
- The trends within and future plans of the sectors within Northern Lao;
- The linkages between one sector and another;
- The cross-cutting themes: socio-economic, environment, public participation and human resources aspects; and
- The Trans-boundary issues within Northern Lao Sub-area.

OVERVIEW OF THE SUB-AREA 1L

Baseline Description

Six provinces of the Lao PDR wholly within Sub-Area 1L (SA-1L) Bokeo, Luang Namtha, Phongsali, Oudomxay, Luang Phabang and Xayabouli are to be fully considered in this study. Where data is easily available for the parts of three other provinces, Huaphan, Xieng Khuang and Vientiane, in SA 1L it will also be considered.

Within SA-1L Luang Phabang, Bokeo and Xayabouli have the densest. Luang Phabang has the largest population and density presumably due to it having the ancient regional centre despite an unfavourable topography. The population of Northern Laos, that includes not only the six provinces of SA-1L but also Huaphan, Xieng Khuang and Xaysomboon Special Zone, has been growing at the moderately fast rate of about 2.4 percent per year.

The area contains four larger tributary catchments, Namtha, Ou, Seuang, Khan, and many smaller areas. Mountainous and hilly steep sloping topography cover nearly of Sub-area 1L. Plain areas are found mainly in Xayabouli, with smaller areas in southern Bokeo, southern Oudomxay, and Northern Luang Namtha. Elsewhere stream flats are narrow.

Lao PDR constitutes 25 percent of the area of the whole Mekong Basin but contributes about 35 percent of the mainstream flow rate estimated at 5270 m^3/sec. The contribution of Sub-area 1L can be roughly estimated at about 1500 m^3/sec or 47,000 Mm^3/year that is 28% of the Lao total. Notice that this stream flow is the whole of SA-1L not just six provinces. It will be compared with water consumption by riverfed irrigation and town piped supply.

To a mainstream input from PR China estimated at 2,688 m^3/sec (84,770 Mm^3/year). Runoff from all tributaries in SA-1L is about 1500 m^3/sec or 47,000 Mm^3 {mega cubic meters}. Compared with that used by vegetation which is more or less half of rainfall, irrigation is a minor user, consuming a mere 200 Mm^3 and town and village water supply, including minor industrial uses consuming a much smaller amount still.

The Agenda for Development

This study of Sub-Area 1L acknowledges the Northern Region Development Strategy (NRDS) developed by the Committee for Planning and Cooperation with ADB support, which itself builds on the government's long-term plans and especially the National Poverty Eradication Program (NPEP).

The NPEP has three key goals: eradication of mass poverty by 2010, elimination of opium production by 2005 and phasing out of shifting cultivation by 2010. It also has three pillars or objectives:

- Rapid growth with equity;
- Socio-cultural development; and
- Conservation of the environment.

The Local Challenge:

The development challenge in Northern Lao PDR seems enormous. Some important conditions in SA-1L are:

- Land that is about 95 percent steeply sloping, excluding Xayabouli;
- Most of the forest has gone in the central zone of SA-1L;
- The people are 'materially poor' by modern standards, but not necessarily by their own standards;
- Many have poor health. In some hill and mountain villages about one in three children dies in its first year; and
- But the people are culturally rich.

METHODOLOGY

The analysis is conducted through the following tasks:

- Document review and analysis
- Stakeholders consultation; and
- Analysis of the outcomes of the informal Working Group session and the outcomes of Forum 1 and Forum 2.

1. Overview of National Sector Development

1.1. Irrigated Agriculture

As the agriculture and forestry sector provide the economic livelihood, the social and cultural base for more than 80% of the population and accounts for about 53% of GDP, the Government is earnestly striving to modernize these sectors to fully meet sustainable practice and achieve food security and better life for all Lao people. The goal of poverty eradication and graduation from Less Developed Country status depends on a more productive agriculture and forestry sector.

As most of the irrigation schemes located in the upland and mountainous area are of small size (less than 100 ha) and made with natural materials which are temporary. The role assigned to irrigation in this respect is crucial and planned to develop along the following directions:

- To expand the development of irrigation to the rural areas and contributing to change natural economy and semi-natural economy into commodity production;
- To protect the environment by stabilizing the areas of production and create new settlements for people previously practicing slash and burn cultivation as well as avert all setbacks linked to the irrigation works;
- To build new irrigation schemes, rehabilitate and improve existing irrigation projects and strengthen facilities for the implementation of the development of irrigation; and
- To develop human resources, particularly at managerial level.

Since 1996, the Government has given a great importance to the irrigation sector translated by the leap forward of the irrigated area during the dry season from 24,000 hectares in 1996 to 214,832 ha in 2003. As a result, about 65% of agricultural production of the country and 20% of rural population benefit from irrigation.

The Government will support small-scale irrigation projects initiated or practiced by families or communities to foster the participation of farmers and private sector in the irrigation development and secure the socio-economic development as well as the protection of the environment.

1.2. Integrated Watershed Management

Laos is a resource-rich country in terms of natural resources in proportion to the population, with high potential for future economic growth. However, unsustainable resource management practices are beginning to reverse this favourable situation. The fragile mountain ecosystems are severely at risk. For instance, forest cover has declined from 70% to 47% over the last 50 years.

In order to preserve the natural resources as a basis for Lao People's Democratic Republic's sustainable development and maintenance of the overall system of the natural resources, the integrated watershed management approach was fully endorsed in 2002 by the National Agriculture and Forestry Conference.

The country is divided into 64 watersheds, of which 53 watersheds or 91% of the land area drained into the Mekong River and the remaining into Vietnam from Xieng Khuang and Huaphan provinces.

Eight of case studies or model development representing district and provincial level integrated watershed management plans have been developed nationwide.

By 2010, integrated water management would have been developed for the whole country at district and provincial levels.

1.3. Fisheries

Fish is one of the main foods for the population who live along the rivers, which accounts for about 42% of animal protein consumed.

In 2001, fish production amounts 73,100 tones and contributes as 7 to 8% of GDP. The trend is progressing over the years as from 1996 to 2001 capture fisheries as well as aquaculture increased 152% with the production of fish from aquaculture totalling 18,000 tones in 1996 up to 43,100 in 2001.

With the increasing population of 4.7 million in 1996, it is estimated that the population would be approximately 8.2 million in 2020; thus the total fish demand of about 48,000 tones in 1996 would be about 188,600 tones in 2020.

To meet this demand, increase in production from capture fisheries may not be possible in the spirit of sustainable use, appropriate management and protection of natural resources including aquatic biodiversity. The only way is the increase in fish production from aquaculture or enhanced fisheries that are still in infancy.

Since 1989, the Lao Government has attached priority to develop its fishery resources by seeking funds and know-how to develop technical manpower, fishery infrastructure, credit schemes, processing and cold chain including marketing avenues and by cooperation with regional and international ventures for the sound exploitation and management of its resources in accordance to the "FAO Code of Conduct for Responsible Fisheries.".

The Government's policy regarding fisheries products is as following:

- The contribution to food security with more emphasis on supplying more animal protein to the rural area, particularly the rural farming communities.
- The contribution to poverty reduction in the sense of getting a complementary source of income.
- Gradual integration of sustainable aquaculture farming into agricultural mixed farming and generating new employment in the sub-sector.
- Supplementary food supplies to the growing urban population by promoting peri-urban semi-intensive aquaculture (pond, cage, pen…) with attention to animal health and good management practices.

1.4. Hydropower

With 87% of its land area considered as hilly and mountainous, Lao People's Democratic Republic is endowed with more than 60 "promising" sites for hydropower generation that have been identified on the tributaries of the Mekong River. It has been estimated that the country has a generating potential of 12,000 MW, of which only 930 MW has been developed so far.

Steady progression of electricity supplied to the population is noticeable. From 33 MW produced in 1975, the figure reaches 627 MW in 2000. Families benefiting of the use of electricity expand from 5,000 to 293,495 during the same period, which means that 35.8% of the population have access to electricity.

While projection for future use of energy is expected to expand, it is obvious that the use of energy per capita per year, which is around 124.23 KWh/capita/year remaining the lowest one among ASEAN countries.

The bulk of energy originates from hydropower (98%), while the rest is from other sources such as petrol or solar energy. The State is however not the main producer.

Regarding the hydropower sector, the Government's aims are as follows:

- Focusing on the production of electricity for internal use and reducing imported fuel;
- Supporting rural development and reducing regional power imbalance within the country;
- Encouraging private investment in hydropower investment;
- Earning foreign currencies for socio-economic development;
- Minimizing environmental impacts result from hydropower development activities; and
- Developing watershed management.

1.5. Navigation, Transportation and River Works

The Mekong River forms the natural artery of Laos, flowing through more Lao territory than other countries in the region. It was a convenient communication facility for people living on its shores using traditional means characterized by small volume of merchandises and limited passenger numbers.

However, the Mekong River in its Lao section is plagued with dangerous rocks and obstructed with shoals in some parts. The solution requires trans-boundary cooperation to pool efforts to harness and exploit the potentialities of the Mekong River for the socio-economic development of the region.

With the achievement of the Phase 1 in the improvement of the navigational channel and in the setting-up of navigation aids from China's border to the Golden Triangle, the northern reach is increasingly busy. Environmental problems are

expanding with the rapid increase of the traffic on the Mekong River, but they are still under control. The northern section will be increasingly used as Road no. 13 is far from the Mekong River, thus the competition between land transport and river transport will not be detrimental to the navigation as it is for the southern reach between Vientiane and Savannakhet.

While contributing in the past to the economic development of the country, river transport reveals to be a relatively low-cost infrastructure investment and energy saving with minor pollution. To decrease heavy land traffic, the Government's strategy is mainly focusing on:

- Maintaining current transport capability by river;
- Improving navigational aids and information for travel safety;
- Encouraging use of river transportation in the wet season instead of poor road conditions; and
- Protecting the riverbanks from erosion.

Efforts have been concentrated for the period of 2002 to 2005 on creating new facilities or improving existing ports along the Mekong River. Aids to navigation had been installed from Vientiane to Paklay.

Particular trans-boundary setbacks regarding river works are to be noticed. The river's bank protection developed on the Thai side along the Mekong River creates severe erosion on the Lao shore, particularly in the provinces of Bokeo, Vientiane, Bolikhamsay, Khammouan, and Vientiane Capital. Construction of ports on Thai shore and road to exploit sand has deep effects, resulting in changing the flow direction.

For the next twenty years, efforts will be focused on:

- Using local materials in the protection of the river's banks;
- Constructing or improving ports and services according to international standards; and
- Using navigational aids agreed upon by all parties.

1.6. Tourism and Recreation

Since 1990, there has been a very strong growth in the Lao tourism sector from only 14,400 international arrivals in 1990 to 735,662 arrivals in 2002. Tourism is now a major contributor to national income (7 to 9% of GDP) and employment.

The Lao People's Democratic Republic's tourism strategy favours pro-poor, community-based tourism development, the enhancement of specific tourism-related infrastructure improvements and sub-regional tourism cooperation. Current activities include: awareness initiatives focusing on tourism benefits and environmental and cultural conservation and enhancement; awareness programmes

on prevention of HIV/AIDS; sexual exploitation and trafficking of women and information on successful regional experiences.

Sub-regional co-operation for sustainable tourism is an important aspect of the Government's tourism strategy.

1.7. Domestic Water Supply and Sanitation

Domestic water and sanitation are essentials for the life, health and productivity of the population.

The national production of the existing 36 water treatment plants is 188,380m^3/day. But the average production is only 157,340 m^3/day supplying water to 525,395 people or 37.67% of the urban population. This means that only 300 litre/day/person is provided by these plants. Water supplying people in urban towns and cities (about 85%) originates mostly from the Mekong River and its tributaries, which represents about 0.04% of the annual discharge of the Mekong River.

The thrust of the Government's development policy is to increase amenity of life in urban areas by providing affordable and reliable and quality services in commercial water supply and in sanitation.

With regard to water supply in rural areas, it was estimated that about 60% of the population in rural areas could access to drinkable water from a public tap or hand pump or spring in 2002. The goal is to reach the figure of 90% by the year 2020, as the Government's development policy is:

- To improve water supply and environmental health in rural areas;
- To focus on inaccessible, poverty-ridden areas; and
- To encourage private supply and sanitation ventures in easy-to-reach areas.

The percentage of people (41%) having access to sanitation is relatively low in 2002. The goal set for 2020 will be to significantly improve the situation and raise the figure up to 80%.

Wastewater is mainly from domestic usage, as only 2.5% of the piped water is used in industrial activities. The average of the dilution of rain and wastewater into the Mekong, in Vientiane, is estimated to be 1000:1. The figure of dilution would be 800:1 during the dry season.

1.8. Flood Control and Management

Most of cities and towns of the Lao People's Democratic Republic located along the Mekong River and its tributaries are prone to flooding during the rainy season.

About 80% of the rural flooding and 20% of the urban flooding are caused by water from tributaries. The four major flood prone areas are situated along the

mainstream near large tributaries: Vientiane Plain, Thakhek and Savannakhet in the Sub-area 4L and Pakse in the Sub-area 6L.

Since 1990, the Government has provided data to the Mekong River Commission, and cooperated about flood warning.

The network to monitor the hydrological situation was strengthened in two phases, in 1998 and in 1998-2000, with the repairing and establishment of staff gauges.

Dykes to protect against floods, water gates, and diversion canals had been built by the Government's budget, loans and foreign assistances in major cities and towns (Vientiane Capital, Bolikhamsay, Khammouan, Savannakhet, and Champassak) located along the Mekong River.

Development plans for the next twenty years comprise the following components: (i) Complete the construction and the restructure of hydro-meteorological stations along the Mekong River and its tributaries; (ii) Achieve the automatic collecting and dispatching of data at the 13 existing station; (iii) Complete the forecast of flooding through GSM mobile phone at Luang Prabang and Pakse; (iv) Ensure a nation-wide system of flood warning; (v) Compile the hydrological and meteorological databases; and (vi) Water drainage construction plan in Vientiane Capital (2003-2005).

2. Baseline Description of the Sub-area

2.1. Geographical Features

2.1.1. Coverage

Six provinces of the Lao PDR wholly within Sub-Area 1L (SA-1L) Bokeo, Luang Namtha, Phongsali, Oudomxay, Luang Phabang and Xayabouli, are to be fully considered in this study. Where data is easily available for the parts of three other provinces, Huaphan, Xieng Khuang and Vientiane, in SA 1L it will also be considered.

2.1.2. Land Use and Forests

The range of forest types and areas given for Northern Lao PDR varies according to the source. Data comes from two sources of remote sensing (Landsat and SPOT) and village survey. The numbers are hard to reconcile. Some maps show large areas of shifting cultivation while others show very small areas although the studies are only a few years apart. A proportion of the differences can be explained by changes over time, but most seems to be due to varying interpretation of the data and different data. The table below summarizes the various figures.

Table 1: Agricultural Land Use (and 'forest') and Population in the Northern Region of Lao PDR (Unit '000 hectares)

	1982	1989	2000
Forest, potential forest and other wooded areas	8,995	8,980	8,871
Shifting cultivation	353	365	380
Permanent agriculture	51	57	125
Grassland	368	365	380
Other areas	54	54	65
Population (thousands)	1113	1296	1708
Crop land per capita (hectares)	0.36	0.33	0.3
Total Area ('000 Hectares)	9821	9821	9821
Percentage Area of Shifting Cultivation	3.6%		3.87%

Source: JICA/MAF.

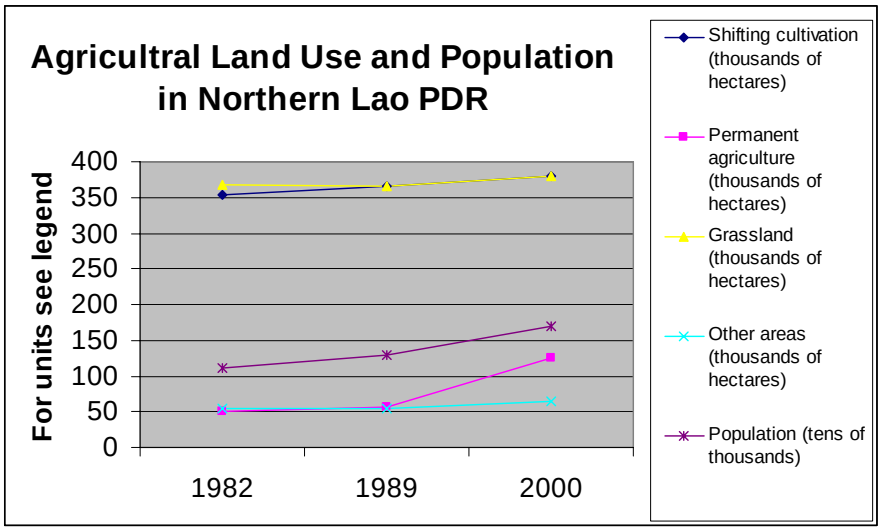
Table 2: Percent Area of Shifting Cultivation from Three Sources

	1982	1989	1993	1995	1997	2000	2005	2010
MAF Study/JICA	3.6%					3.87%	3.9%?	
MRC Landsat			approx 25%		approx 5%		0%?	
Survey of Villages				2%		1.2%	0.5%?	0%?

The following table shows land uses/covers and population for Northern Laos. The figure below it shows all the other land covers but does not show the area of forest etc. The large area of grassland is significant, probably largely created by

highland 'pioneer' shifting cultivation. According to this data the percentage of total area covered by shifting cultivation ranged from 3.6% to 3.87% over 18 years.

Figure 1: Land use and Population in Northern Laos



Source: JICA/MAF.

According to this study the percentage of total area covered by shifting cultivation ranged from 3.6% to 3.87% over 18 years, 1982 – 2000. The map below from the MRC based on Landsat satellite imagery shows a large area of shifting cultivation in 1993 that is much greater than 3.8 percent of the area of Northern Laos noted above.

To what extent is the 1997 shrub land really re-growth in the cultivation cycle? Such maps should be accompanied by the criteria for categorization. To whatever extent shifting cultivation has been abandoned to low or non-productive ecosystems, the paucity of forest is serious. But interestingly on these two maps the area of forest has hardly changed.

The 'shrub' area undoubtedly includes the fallow lands of the shifting cultivators and thus gives a misleading picture. Fallow should be mapped separately. Adding fallow to the actual cropped fields of the year of investigation would mean a multiplying the agricultural area by a factor equal to the cycle length in years. This would range up from about 8 years.

It would be useful if future mapping whether using remote sensing or village data collation and surveys distinguish between the cropped area, the low re-growth in the cycle and that outside the cycle that is either degraded and stable or recovering to forest.

Below is a map that shows the land use/land cover for SA-1L for 1997. This is closer to the 3.8 percent of the area of Northern Laos. Note that if shifting cultivation area decreased at this rate between 1993 and 1997 it should have been eliminated by now.

Figure 2: The Provinces of Sub-area 1L

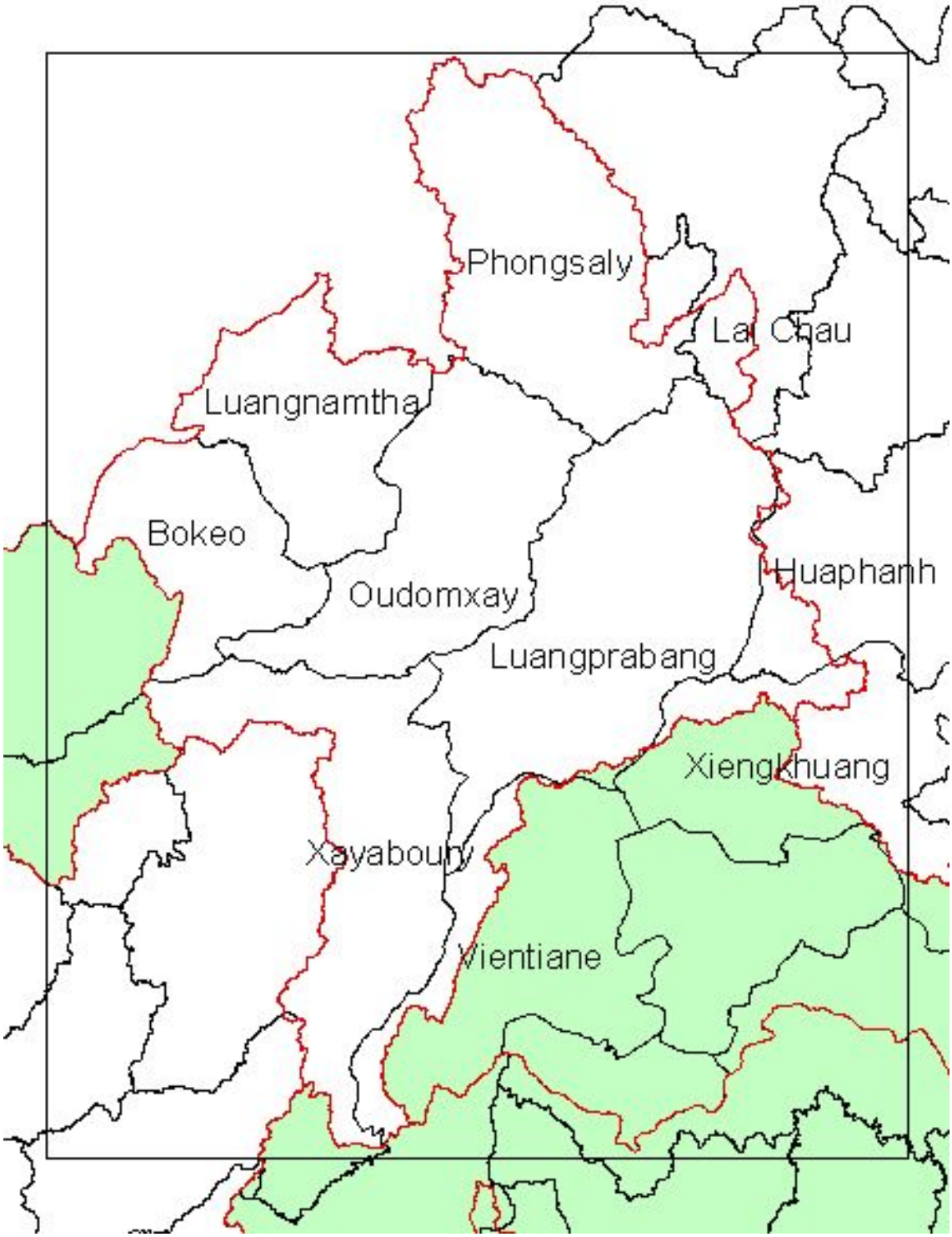


Figure 3: 1993 Land Cover-Land Use Map SA-1L

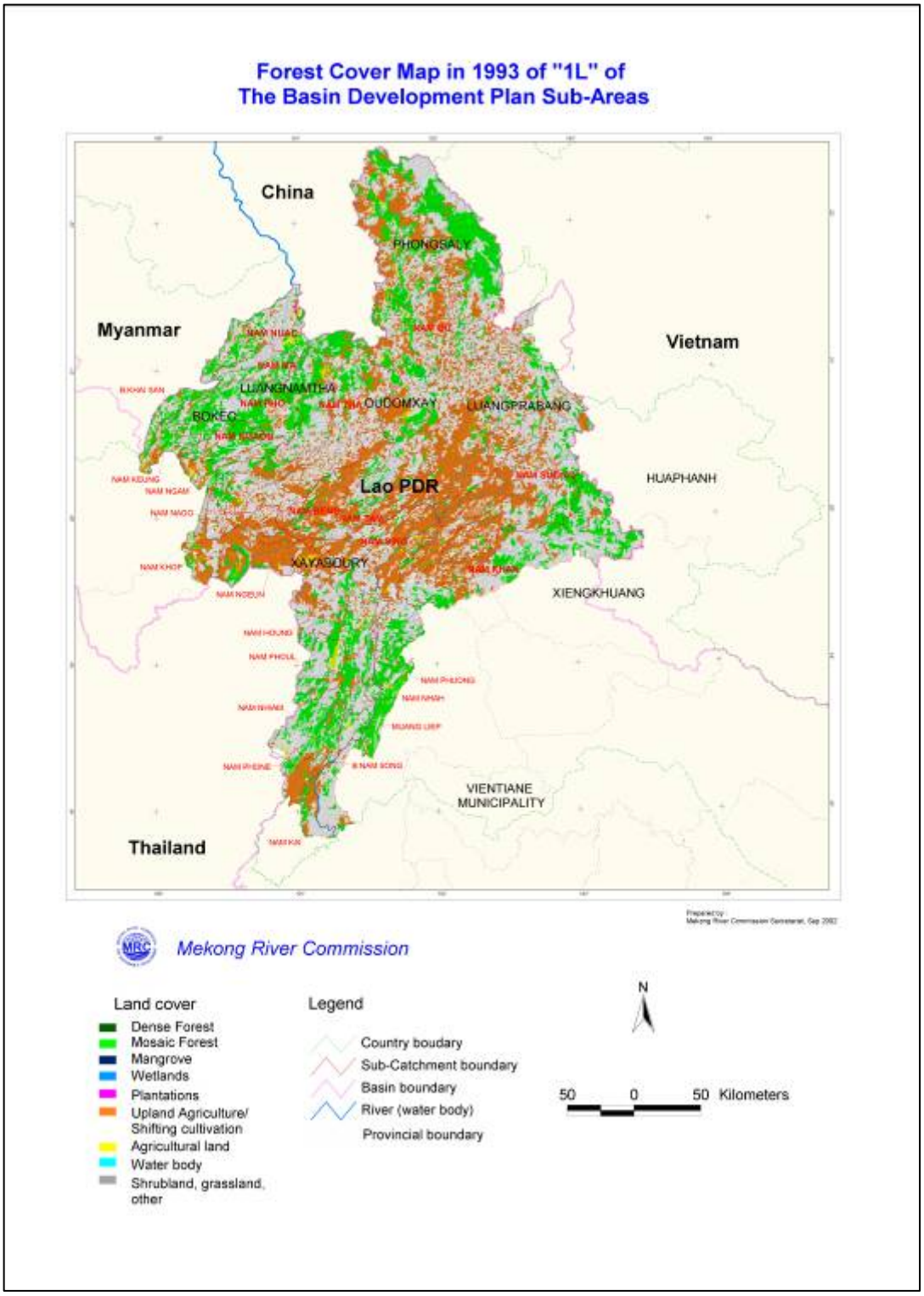
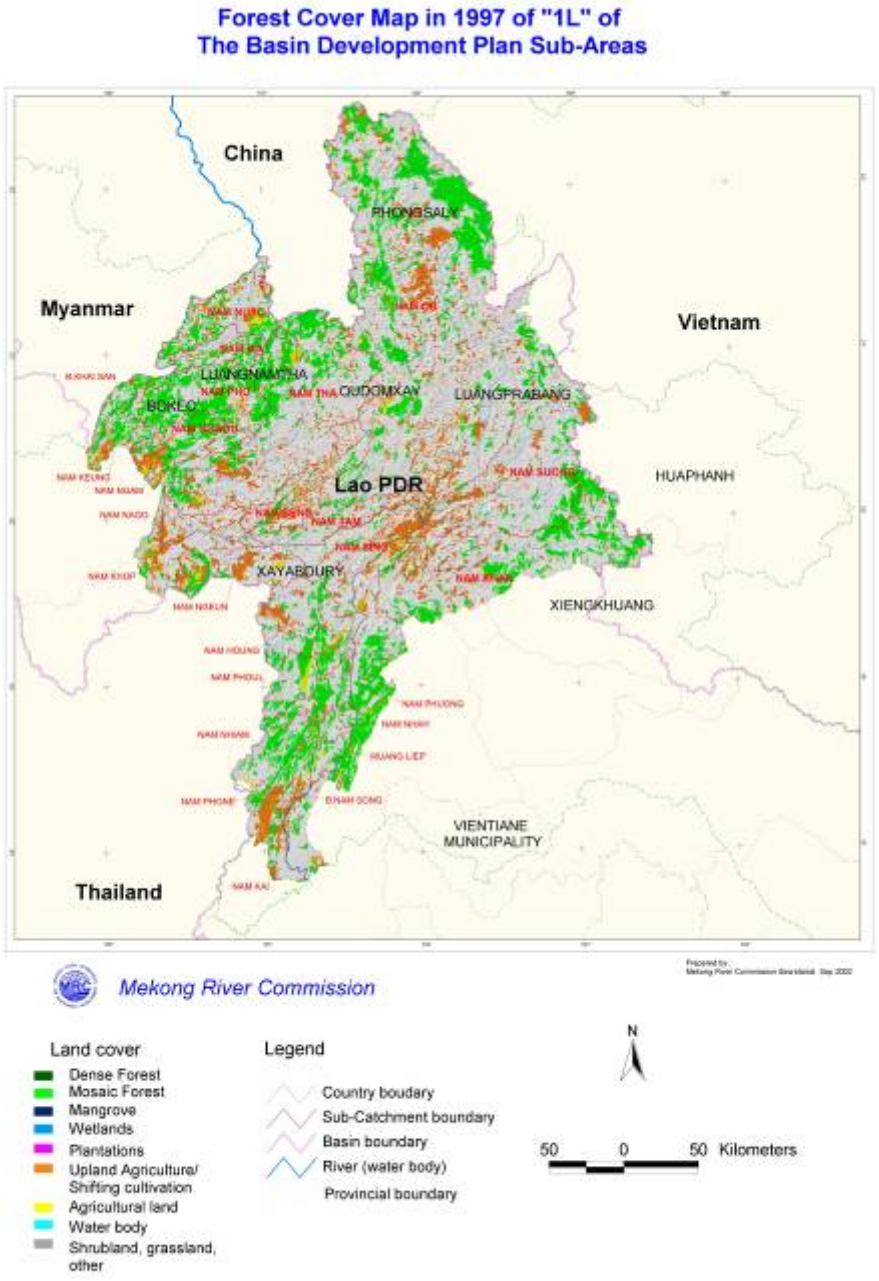


Figure 4: 1997 Land Cover and Land Use Map SA-1L



Inistrative Forest:

The chart below is another interpretation of land cover –land use. This shows very large areas of forest of various types that are inconsistent with all other data. They probably have administrative significance.

Agricultural, Forest and Other Land	
Wet Rice	205,937
Short-term crops	375,585
Orchard crops	18,147
Communal Grazing	1,445
Household grazing	11,268
Government station grassland	630
Other agricultural Land	29,934
Industrial trees	15,779
Conservation Forest	1,952,518
Protection Forest	1,183,926
Production Forest	640,091
Rehabilitation Forest	619,764
Degraded Forest	101,272

Source: JICA/MAF.

Trends in harvested area of rice shown below indicate jumps in the area of rainfed wet rice and irrigated rice, but a decline in area of sloping land rainfed rice which means a reduction in the area of shifting cultivation systems. The question is whether this is due to out-migration or smaller area of shifting cultivation through the mechanism of land allocation.

Figure 5: Northern Land Use Pie Chart

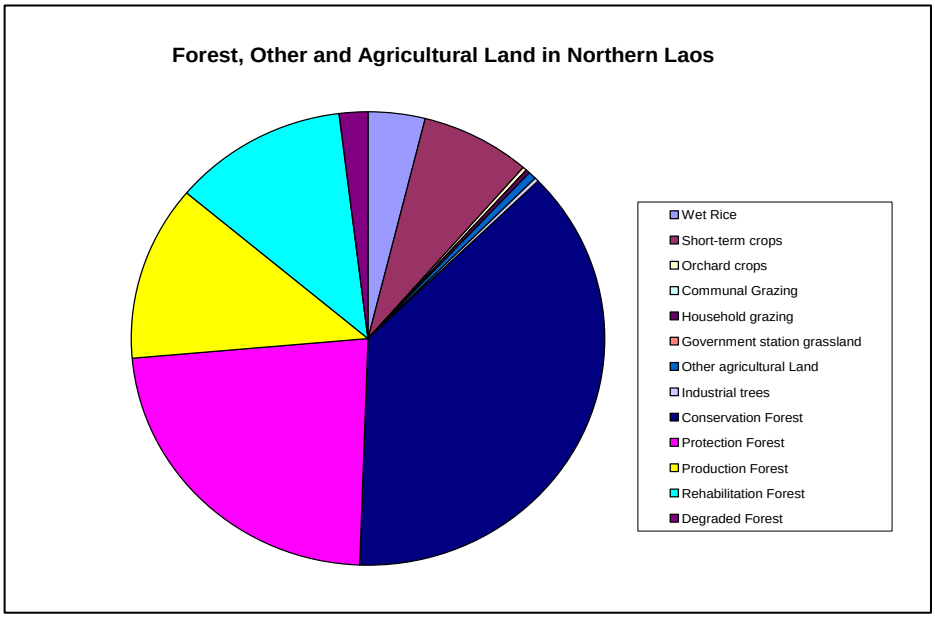
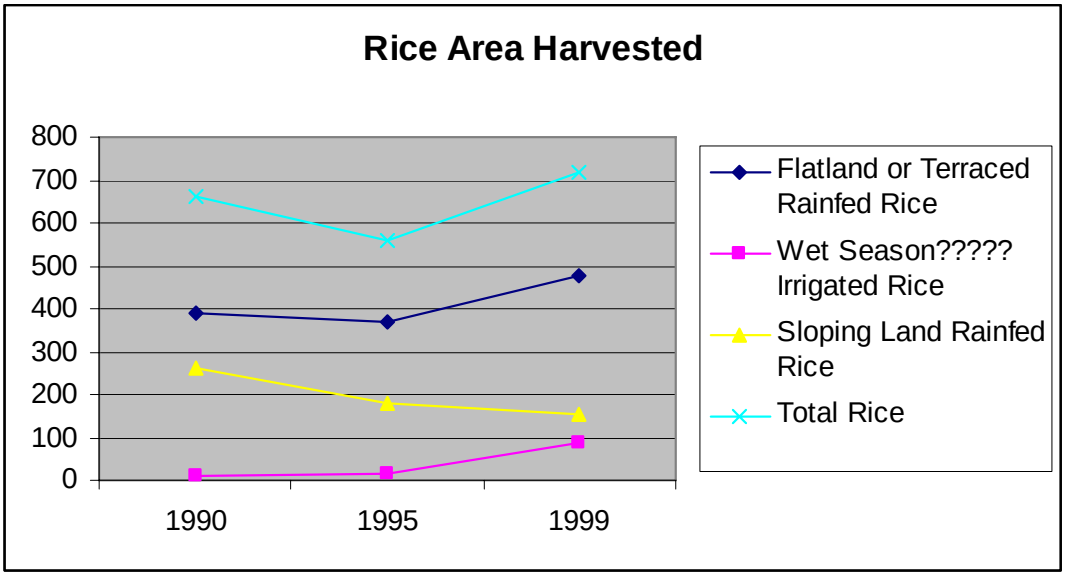


Figure 6: Rice Areas



Source: MRC State of the Basin Report, 2003.

Not only is shifting cultivation in densely populated areas causing high runoff and erosion but it contributes to air pollution through burning in the hot season. A much greater amount of biomass is burned than in the flatland or terraced rice areas where stalks are also burned. This air pollution is locally visible and probably temporary reducing solar radiation and thus plant growth. It has a detrimental effect on human and animal respiratory systems. Moreover it is believed to contribute 'climate change' by inhibition of solar radiation thus counteracting global warming a little.

Village Survey of Shifting Cultivation:

According to JICA/MAF a separate government survey by interview of villagers showed that for Northern Laos:

- The area of shifting cultivation was much smaller than that shown above, particularly for the 1993 map.
- It shows the area to be falling markedly from 2% to 1% of the total area.
- The number of families is shown to be falling in parallel.

This said reduction from 1990 or 1995 to 2000 is conceivably due to:

- Out-migration of shifting cultivators individually or as a village.
- Cultivators taking up permanent farming or other occupations in the village

Table 3: Areas of Shifting Cultivation and Families

	1995	1998	Fall 95-98	2000
Families	198,868	156,720	21%	
Shifting Cropped area (hectares)	192,258	148,000	23%	118,999
Total Area	9,821,000	9,821,000		9,821,000
Percentage Area of Shifting Cultivation	2.0%			1.2%

As the number of families is also dropping (by 21%) the fall in area (23%) does not seem to be due to farmers lying about the area they farm in order to avoid taxes. Some farmers may have had their shifting cultivation area reduced by land allocation but according to the survey this must be a minor effect. Is it possible that some families denied they were doing any shifting cultivation in order to avoid taxes or other penalty? Where actually do the out-migrating families go and what other occupations do they take up? Anecdotal evidence suggests some return to old locations, and others migrate to other provinces and to local towns.

Can we explain the difference between the remote sensing in close-by years, and survey and remote sensing results?

Land Reform:

Land reform being carried out in the Lao PDR is called Land Use Planning and Land and Forest Allocation (LUP/LA). This is said to be tending to result in reduced access to land and some increased poverty. The process needs ongoing improvement but is undoubtedly an important step in the process of 'stabilizing of shifting cultivation'. A form of general land use planning is usually integrated with land and forest allocation. One consideration is the possibility of greater integration with agricultural extension. Other issues are population growth, document and data storage, the value of land certificates for loans, the appropriateness of the tax level, and gender equity.

Table 4: Land Allocation

Province	Total Number of Rural Villages in Province	Number of Villages with LA/LUP in 99-2000
Phongsali	562	214
Louang Namtha	382	230
Oudomxay	677	305
Bokeo	346	449 *
Luang Phabang	895	1296 *
Xaignabouli	480	1374 *

Note: * Probably double or triple counting of LA/LUP at least in these provinces. Many villages that were counted as complete have not completed all steps of LA/LUP.

Land and forest allocation to families and villages respectively is a critical step in the mitigation of rapid runoff and erosion on sloping land. Land Use Planning is a

process that at the general level is useful but at the detailed level can limit farmer options that will be presented by new extension and other ideas and market opportunities.

A little more than one third of the total land area of Sub-Area 1L has been allocated. A temporary land use certificate is provided by the government. Farming land has been allocated to households {really male head of household} and local forest land to villages to look after collectively.

Table 5: Land use for Allocated Land in Six Provinces in SA-1L

Category	Phong Saly	Luang Namtha	Oudomxay	Bokeo	Xayaboury	Luang Prabang
Villages Allocated Land & Forest	243	397	466	515	1,346	1,281
Land Use						
Paddy	547	5,886	2,669	5,713	13,613	8,288
Short-term Crops	688	626	398	28,569	236,963	56,161
Orchard Crops	300	770	2,539	1,404	2,899	8,194
Communal Grazing	93	825	103	0	0	62
Household Grazing	5,030	738	538	0	0	1,305
Improved Grassland	0	0	0	0	0	0
Government Station Grassland	618	0	0	0	0	0
Agro-Pastoral	0	0	0	0	0	0
Other	23,089	1,240	62	0	0	269
Total Agricultural Land Allocated	30,365	10,085	6,309	35,687	253,475	74,279
Forest Land						
Industrial Trees	148	17	1,719	526	4,538	8,750
Conservation	37,593	127,996	130,422	199,226	179,050	144,986
Protection	32,404	100,001	159,797	183,376	156,323	215,810
Production	24,415	96,495	28,877	135,733	197,203	115,297
Rehabilitation	10,714	46,231	91,679	104,126	227,770	99,322
Degraded	307	3,207	11,101	0	3,908	78,455
Total Forest Land Allocated	**105,581**	**373,947**	**423,595**	**622,986**	**768,827**	**662,621**
Total Land and Forest Allocated	**135,945**	**384,032**	**429,904**	**658,673**	**1,022,302**	**736,900**

Shifting Cultivation and Land Reform:

For several years the government has been aiming to reduce shifting cultivation by resettlement of the practitioners to other areas. Now the government is planning to reduce shifting cultivation (graph below) by training the farmers in new techniques of permanent sedentary farming including contour cultivation and diverse tree culture tested by the Lao-Swedish Forestry Programme and continued by NAFRI with the LSUAFRP. It might be noted however that if sedentary farming is to sustain viable livelihoods each family may need a largish area as land productivity may fall in the short term while new systems are being established.

Other Aspects of Rainfed Agriculture:

Several agricultural border areas are doing well commercially such as cotton growing areas in Southern Xayabouli and Sugar cane areas in western Phongsali (NRDS).

Wet rice is prominent in flatlands in NW Phongsali, southern Bokeo, north Luang Namtha but is grown right across SA 1L in small stream flats and large areas of sloping land.

Forest Cover/Forest Loss:

Different elements of the population have been practicing:

- Shifting cultivation in the hills for many hundreds, perhaps more than a thousand years.
- Logging by clear felling for many decades.

As a result the forest cover in SA-1L has been severely depleted, especially in central Luang Phabang province and directly to its west in Oudomxay and northern Xayabouli.

- Forest is now thought to cover about 41 - 47 percent of Laos depending on the source of data. But the latest data from the Department of Forestry suggests the 41 percent figure is fairly accurate. However we do not know their criteria for separating re-growth and forest.
- Deforestation seems to have increased in the 1990s due to the growth in roads and some other infrastructure.
- But according to the MRC satellite image interpretation it only covers about 20 percent of Sub-area 1L and by eye only less than 10 percent in most of the central part of SA-1L. This is where most of the population live.
- This deforested area and much of the rest of the north is covered by low forest re-growth, scrub, bamboo, and shifting cultivation fields.
- Forest is now especially concentrated in the extremities of the sub-area in Phongsali, Luang Namtha, Bokeo, southern Xayabouli and the edge of Huaphan and Xieng Khuang

Wild harvesting by villagers (NTFP) in the forests is severely threatened by forest loss especially in the central east-west zone. It is here that efforts on forest conservation and supporting re-growth around the remaining stands should be most intense.

Two Methods Compared for Six Provinces:

But according to the Department of Forestry' NFI analysis of 1999 (using SPOT?) shown below it covers 39 percent of SA-1L and GTZ/MRC analysis for 1997 (Landsat) it covers 18 percent.

Table 6: A Comparison of MRC/GTZ and NFI Interpretations of Forest Cover of Six Provinces.

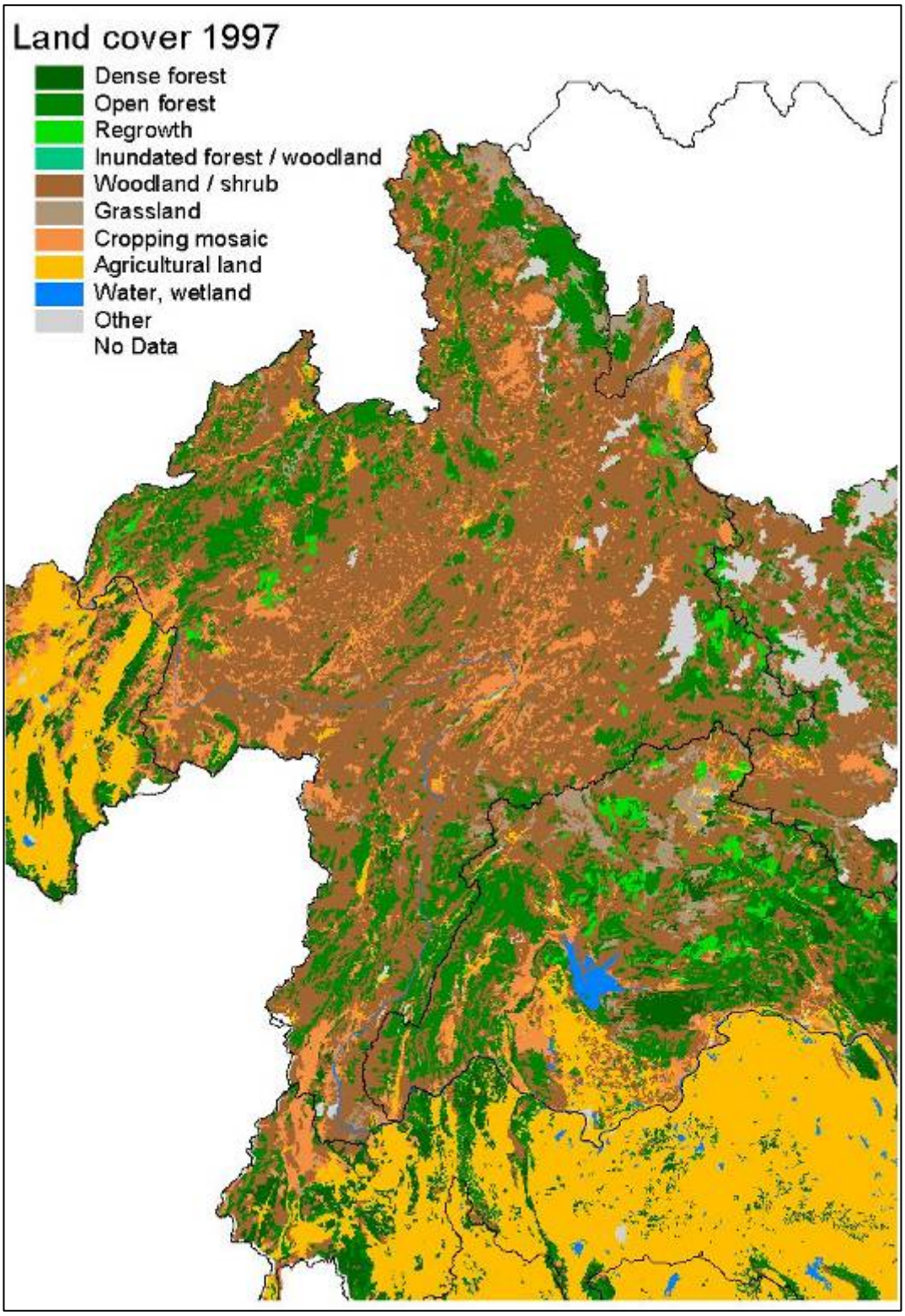
	Land Area	Forest Cover NFI 1999	Percent Cover NFI	Forest Cover MRC/GTZ 1997	Percent Cover MRC/ GTZ	Ratio of MRC/ GTZ % to NFI%	Pop (2000)	Pop Density (persons / km²)
Phongsaly	1595100	718000	45	382800	24	0.53	174000	10
Luang Namtha	841000	464400	55	269120	32	0.58	131000	14
Oudomxay	1550900	488000	31.5	170500	11	0.35	240000	15
Bokeo	490500	272600	55.5	142100	29	0.52	130000	20
Luang Phabang	2001200	364300	18	180090	9	0.5	416000	24
Xayabouli	1638500	862300	52.5	343980	21	0.4	333000	20
Total	**8117200**	**3169600**	**39**	**1488590**	**18**	**0.46**	**1424000**	**17**

The ratio of MRC/GTZ percentages to NFI percentages is usually about 0.5 – 0.6, but for Xayabouli and Oudomxay provinces. It seems that the MRC/GTZ team may have more or less consistently interpreted large areas of re-growth forest as non-forest while the NFI team has more or less consistently interpreted re-growth as forest. The two teams might meet and compare methodologies. This shows how important it is to explain the methodologies rather than just put out a map. Unfortunately this is all too common.

But since that time what is now the Forest Inventory Planning Division of the Department of Forestry has assessed the 2002 SPOT images. But the only statistics we have is the national forest area of 41 percent.

Wild harvesting by villagers (NTFP) in the forests is threatened by forest loss especially in the central east-west zone whatever the exact forest area. It is here that efforts on forest conservation and supporting re-growth around the remaining stands in the most degraded areas should be most intense. Wildlife conservation would be supported by joining forest areas, large and small, into continuous zones with only small tracks across them. This would give wildlife a larger resource area in which to seek to survive.

Figure 7: Land Cover, 1997, SA-1L



Where vegetation is not diverse and/or dense and disturbed by cultivation, rainfall and runoff is erosive:

- Depleting erodable soil;
- Causing small streams to fill rapidly with muddy water;
- That may be deposited behind weirs and in reservoirs and canals; and
- Degrade fish habitats.

Land slides and mud flows may also occur, especially where clear felling of forests is still occurring.

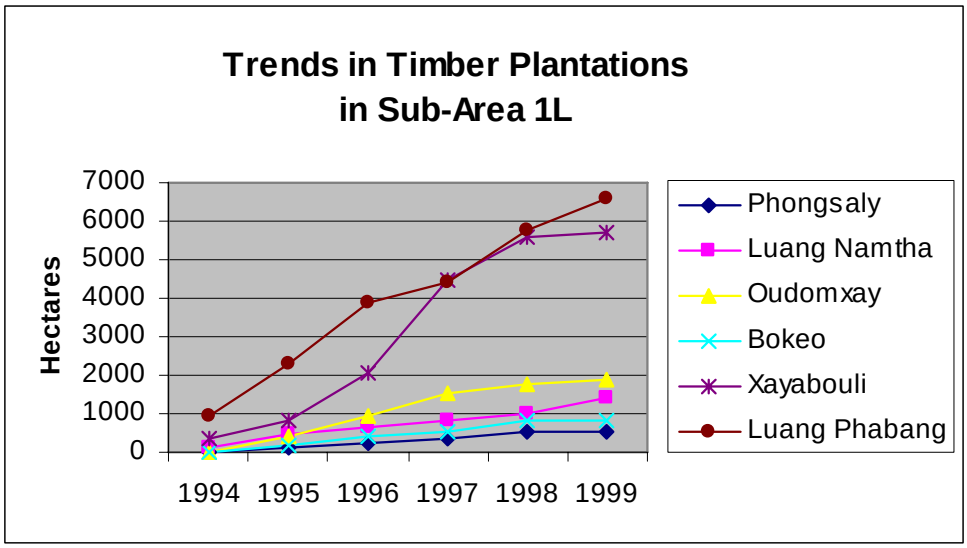
Timber Tree Plantations and Logging:

Timber tree plantations must be distinguished from forest re-growth or what is misleadingly called reafforestation. Reafforestation is actually impossible, as it implies that humans can recreate a forest. Humans can either let the natural re-growth process occur or they can interfere with it in one way or another, by either planting chosen species in the re-growth (under planting) that creates various degrees of hybrid plantation–forest, or eliminating the re-growth entirely and planting timber or other trees (a plantation).

Planting and maintenance of timber tree plantations in areas of degenerate ecosystems and low re-growth, is appropriate where it is too steep for sedentary farming systems, but well away from tall or re-establishing forest.

The graph shows progress in plantation area for six northern Lao PDR provinces. Luang Phabang and Xayabouli are well out in front in timber plantations. Oudomxay could well be given further support as it has very little forest.

Figure 8: Timber Plantations in Six Provinces

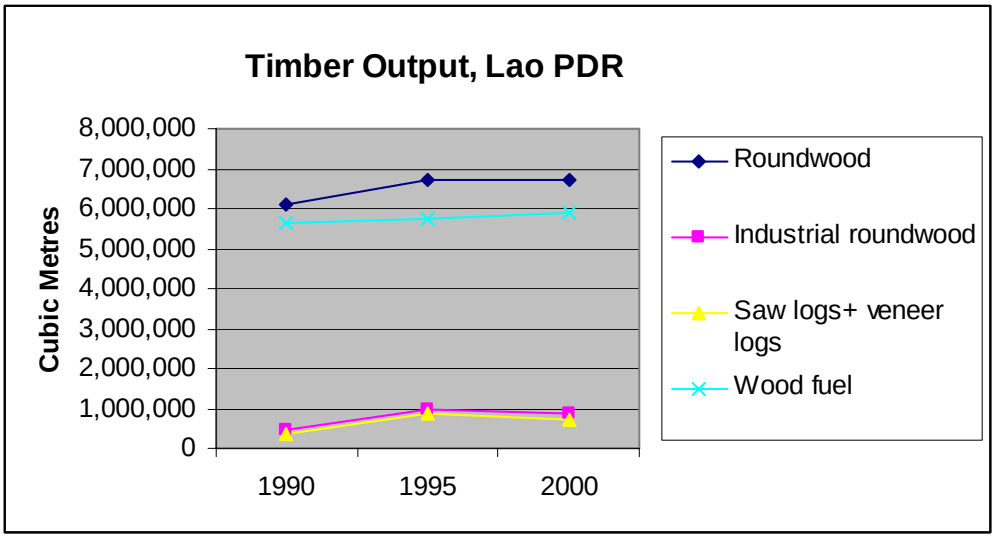


Timber Output:

The graph below shows:

- The predominance of round wood in timber output
- A promising plateau out of round wood output from 1995 to 2000.
- Round wood exports are said to have declined 20% in recent years.

Figure 9: A Decade of Timber Output

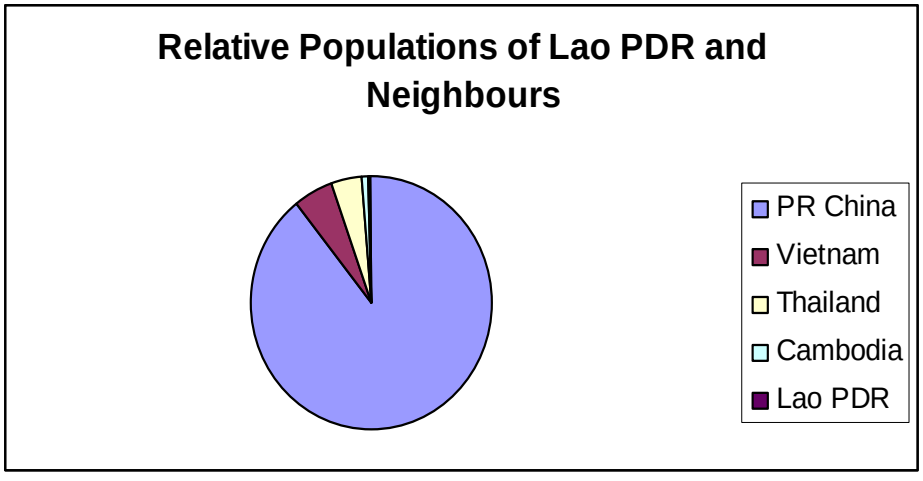


2.2. Population and Livelihoods

2.2.1. Population

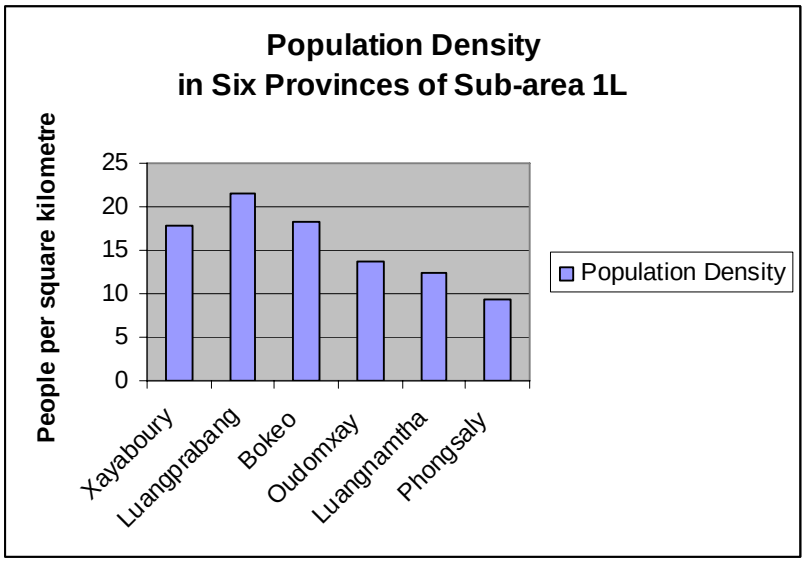
As is shown in the figure below the Lao PDR is a tiny nation mainly among giants that have either grown rapidly or are growing rapidly. This provides not only opportunities but also actual and potential threats.

Figure 10: Relative Populations of Neighbouring Nations



Within SA-1L Luang Phabang, Bokeo and Xayabouli have the densest, if not still sparse populations. Luang Phabang because of its ancient status, Bokeo due to its similarity and closeness to Chiang Rai and Xayabouli because of its flat to undulating land.

Figure 11: Provincial Population Density



The population is also shown in the map below mainly as dots and patches for scattered villages. The density is given in 'head' per square kilometre.

Looking at the 'population map' prepared by MRC (below) the population is certainly densest and seems to be concentrated in the flat lowlands but this area is so small that really most of the population is probably scattered at low density in villages in the hills and mountains.

Luang Phabang has the largest population and density presumably due to it having the ancient regional centre despite an unfavourable topography. Nevertheless it is the topographic-related density that is important.

Table 7: Provincial Populations and Densities, SA-1L

Province	Rural Villages	Population 2000 (mid-year)	Area* km²	Density head/km²
Phongsali	562	174,000	16270	11
Louang Namtha	382	131,000	9325	14
Oudomxay	677	240,000	15370	16
Bokeo	346	130,000	6196	21
Luang Phabang	895	416,000	16875	25
Xayabouli	480	333,000	16389	21

* Exact areas are in dispute.

Figure 12: Population Dot and Shading Map for Sub-Area 1L

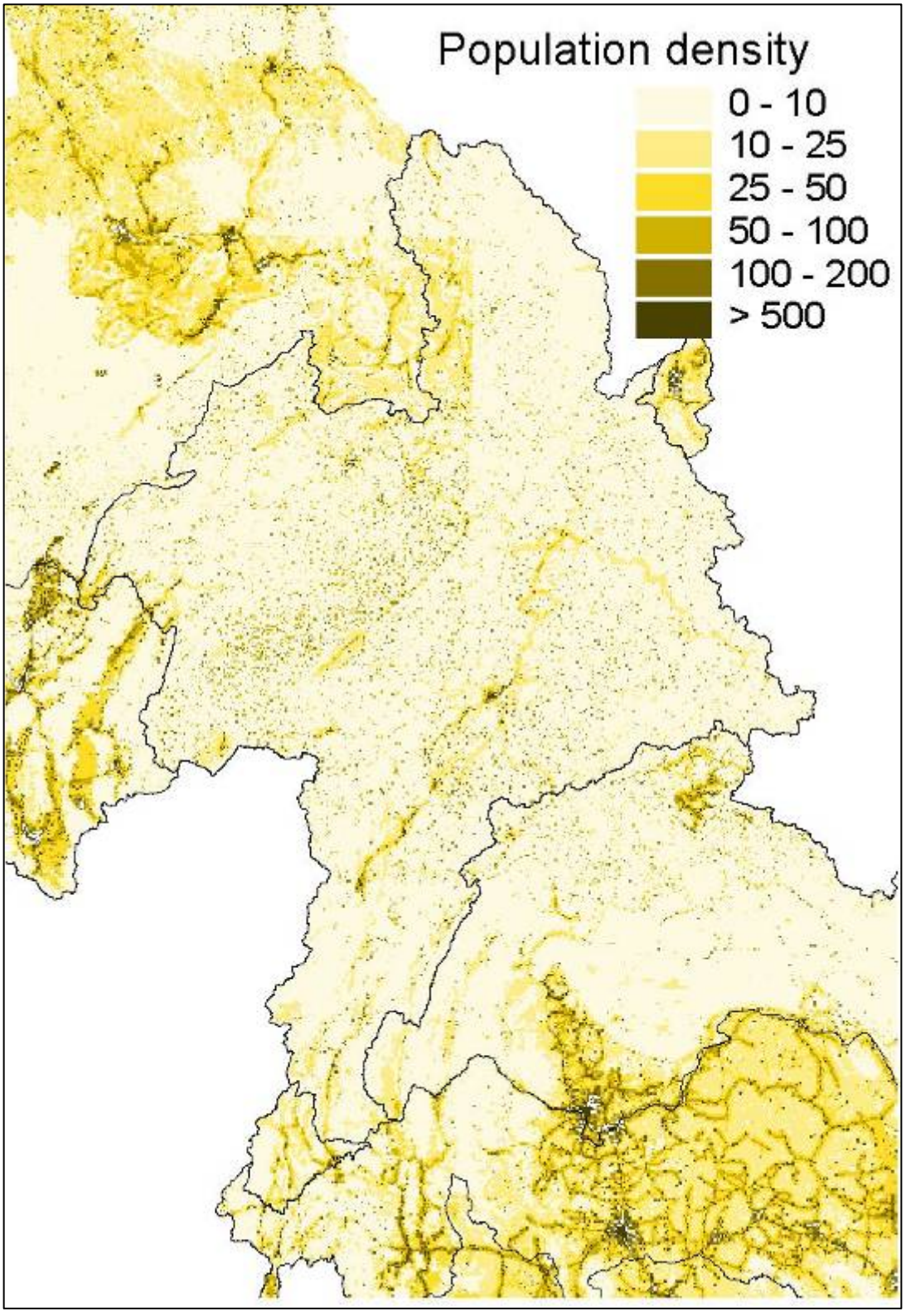
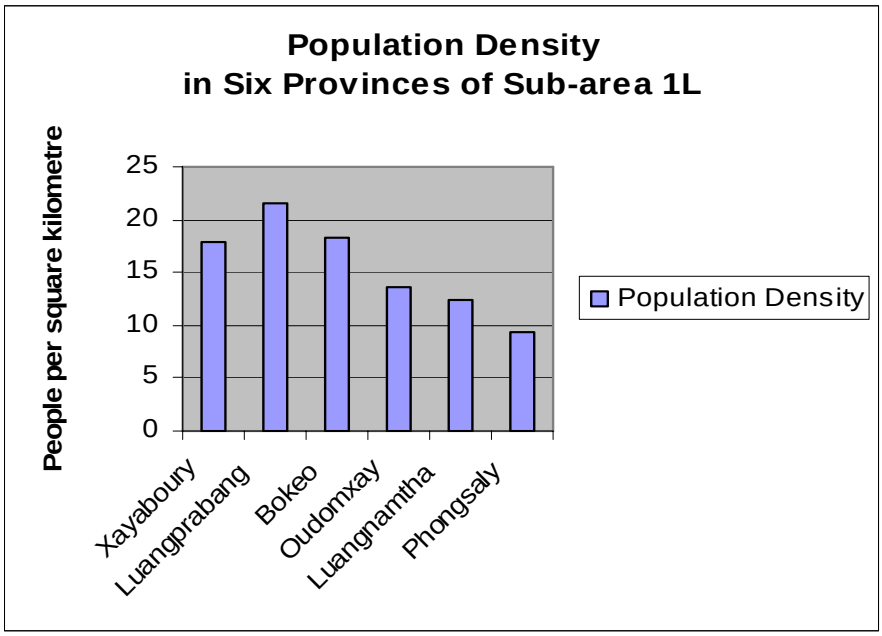


Figure 13: SA-1L Population Densities



Luang Phabang also has the greatest number of villages and households. Xayabouli has the best sex (not gender!) balance.

Table 8: Settlements, Households and Sex in the Provinces of Sub-Area 1L, 2001

Feature	Phong-saly	Luang-namtha	Oudomxay	Bokeo	LPB	Xayaboury	Total
Area Km²	16,270	9,325	15,370	6,196	16,875	16,389	80,425
District	7	5	7	6	11	10	46
Village	598	403	695	373	950	533	3,552
Household	26,800	23,034	35,886	22,121	65,620	56,406	229,867
Population	179,600	134,900	241,100	133,500	428.800	342,900	1,460,800
Males	90,400	69,000	124,500	67,500	216,400	171,500	739,300
Females	89,200	65,900	122,600	66,000	212,400	171,400	727,500
Density Per./km²	11	14	16	21	25	21	

Source: National Statistics Centre, 2001.

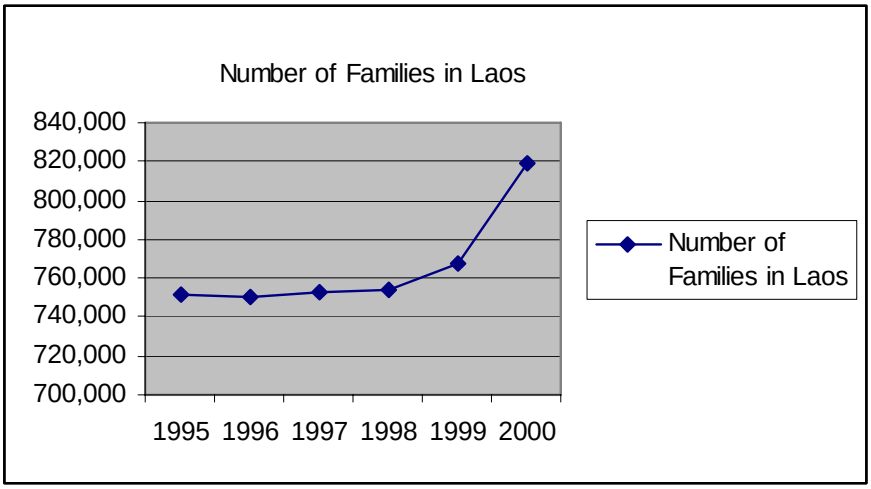
The population of Northern Laos, that includes not only the six provinces of SA-1L but also Huaphan, Xieng Khuang and Xaysomboon Special Zone, has been growing at the moderately fast rate of about 2.4 percent per year.

Table 9: Population Growth in Northern Lao PDR

	1982	1989	2000
Population of (millions)	1.1	1.3	1.7
Annual growth rate	2.38	2.42	

The figure below shows the population spurt from 1998/99 as the number of families (really households).

Figure 14: Household Growth in Lao PDR



Six provinces of SA-1L have populations growing at similar rates annually between the rates of 2.621 and 2.631.

Table 10: Provincial Population Growth in SA-1L

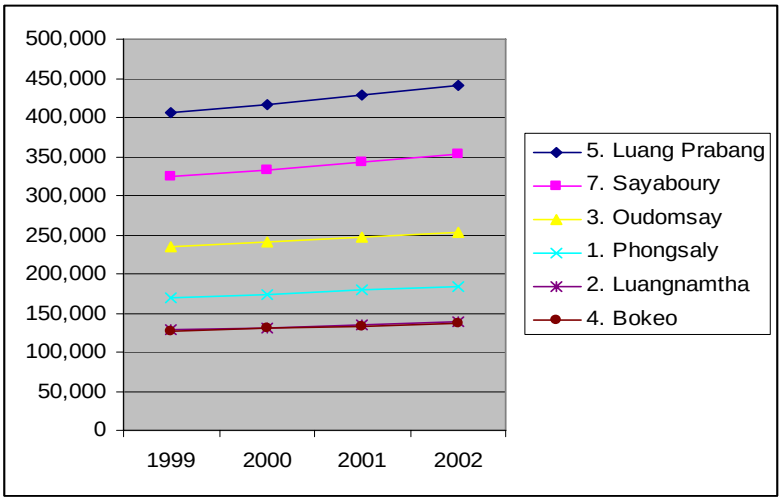
	1999	2000	2001	2002	Annual Growth Rate (Percent)
Luang Prabang	406,000	416,000	428,800	440,693	2.624
Sayaboury	324,700	333,000	342,900	352,424	2.622
Oudomsay	233,900	240,000	247,100	253,910	2.627
Phongsaly	170,100	174,000	179,600	184,626	2.623
Luangnamtha	127,700	131,000	134,900	138,596	2.621
Bokeo	126,400	130,000	133,500	137,233	2.631
Total	**1,388,800**	**1,424,000**	**1,466,800**	**1,507,482**	**2.624**

(Data from Sub-Area Sector Review)

(Note that the population for Oudomxay here is different from that of the NSC). The growth rate of the hill and mountain peoples is higher than that of the lowland Lao so that of North is likely to be higher than the national average.

The birth rate is highest in Xayabouli, followed by Luang Phabang. Significantly these are also the provinces with highest death rate along with Bokeo. Life expectancy for women is highest in Phongsali and Oudomxay. Bokeo has a high birth rate and high mortality rate but low infant mortality rate.

Figure 15: Population Growth in Six Provinces



Significant migration is occurring between and within provinces. Northern Luang Namtha and Western Bokeo are experiencing the highest inflow of people, while scattered districts further east are experiencing significant outflows. Phongsali is experiencing major migration between districts while provincial capitals of Luang Namtha, Oudomxay and Luang Phabang are experiencing the most significant inflows. Notably Xayabouli residents tend to be moving out. Southern Luang Phabang people are moving out to Xayabouli and eastern Luang Namtha people are moving to Bokeo while western Luang Phabang people are moving to Oudomxay.

The people of Phongsali and Luang Namtha notably spend a higher proportion of income on food than others of SA-1L

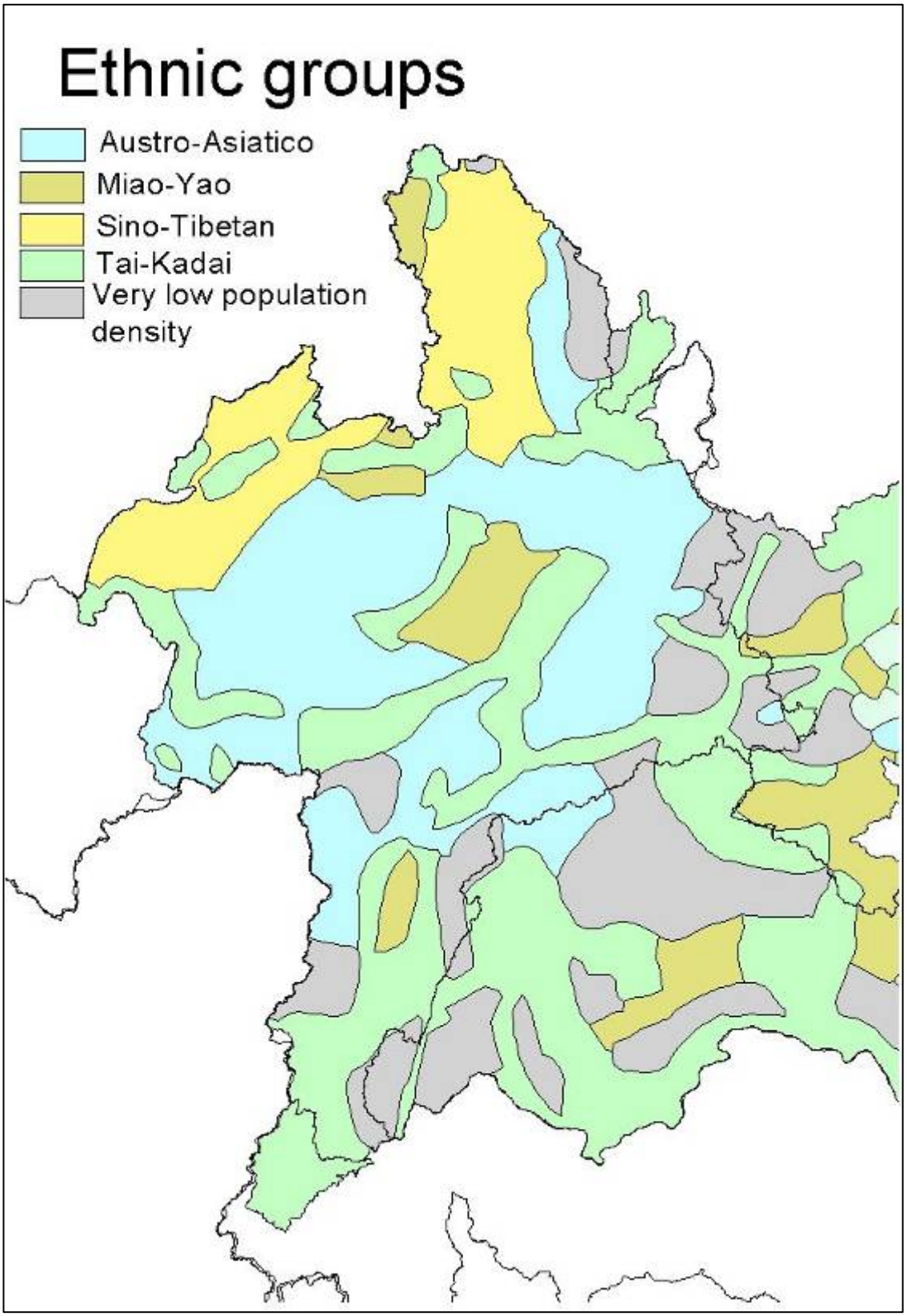
The structure of population needs to be known in order to predict the significance of these scenarios for development. It is assumed that the present young age structure will age slightly as the large numbers children enter the work force, with if a moderate decline in fertility due to the spread of girls schooling and urbanization.

2.2.2. Population Scenarios

Table 11: National Population Scenarios (000')

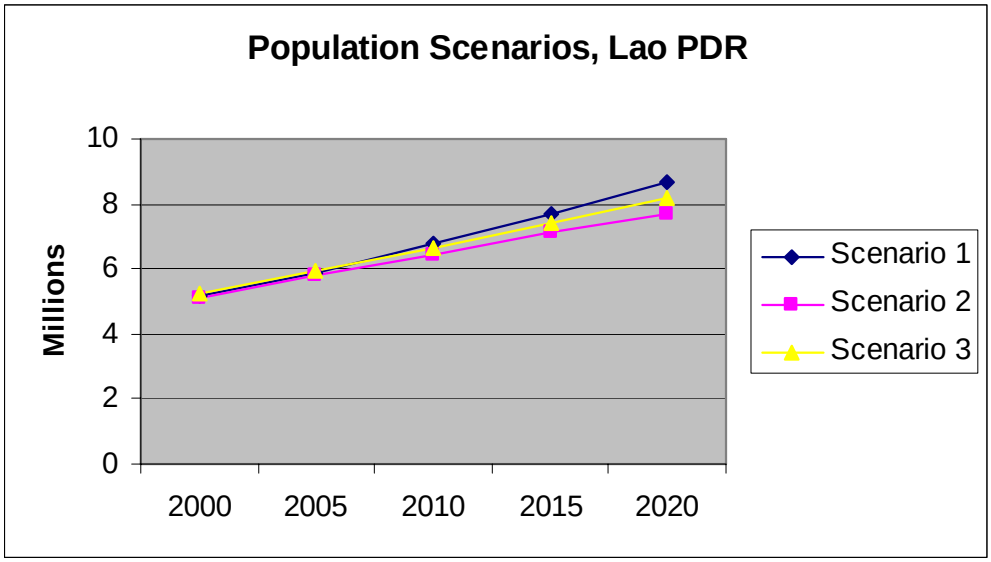
	2000	2005	2010	2015	2020
Scenario 1	5,200	5,900	6,800	7,700	8,700
Scenario 2	5,100	5,800	6,400	7,100	7,700
Scenario 3	5,234	5,921	6,651	7,415	8,207

Figure 16: Ethnic Groups of Sub-Area 1L



Given Laos's low population and low population/resource ratio, population growth is not a concern, but the young age structure is, because this requires major investment in schooling and health. The national population scenarios are given above.

Figure 17: Population Scenarios



2.2.3. The Ethnic Populations

The Khamu people and others of the Mon-Khmer family of the Austro-Asiatic Linguistic group is the earliest recognized ethnic group in Sub-area 1L, dating back more than 2000 years. They are thought to have evolved from the Hoabinian cultural population that is recognized from 10,000 years ago. It is probable that the Mon-Khmer initially lived mainly in the lower flatlands. Into this northern region of Laos various other ethnic groups have been migrating from the north and possibly other directions, starting with the Lao and possibly other Tai-Kadai groups more than a thousand years ago. More recently various Hmong-Mien and Tibeto-Burman groups have migrated in, mainly occupying hilly and mountainous land.

The people of SA-1L are:

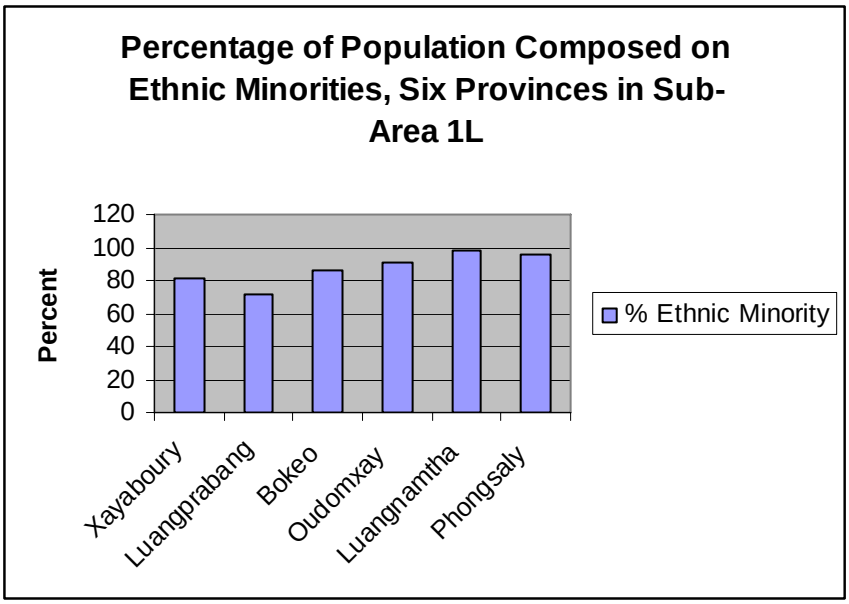
- Mainly Austro-Asiatic (Mon-Khmer) (mainly Khmu) living predominantly in hilly country in the central zone;
- Lao living mainly in lowlands (mainly Lue and Luang Phabang Lao);
- Hmong-Mien (Miao-Yao) living in mountains, mainly right in the centre; and
- Sino-Tibetan (Tibeto-Burman) living in hills and mountains in the far north and west.

The Mon-Khmer are the predominant group in Oudomxay and Luang Phabang but are also numerous in southern Luang Namtha, eastern Bokeo and southern

Phongsali. Tibeto-Burman people are concentrated in Phongsali, Luang Namtha and Bokeo. The Hmong-Mien groups, more scattered across SA-1L, are common in south-eastern Luang Phabang, northern Xayabouli and southern Bokeo. Tai-Kadai group to which the Lao belong, are found mainly in Xayabouli and other small plains and river flat areas but in higher density than those on steep sloping land. Nevertheless the Lao people are increasingly farming (including growing and owning trees) on the slopes (Bounthavy and Taillard, 2000).

Ethnic minorities form between 71 and 98 percent of the population of the six provinces.

Figure 18: Ethnic Minorities



We should carefully consider the HRD implications for this language diversity.

2.3. Sector Summaries

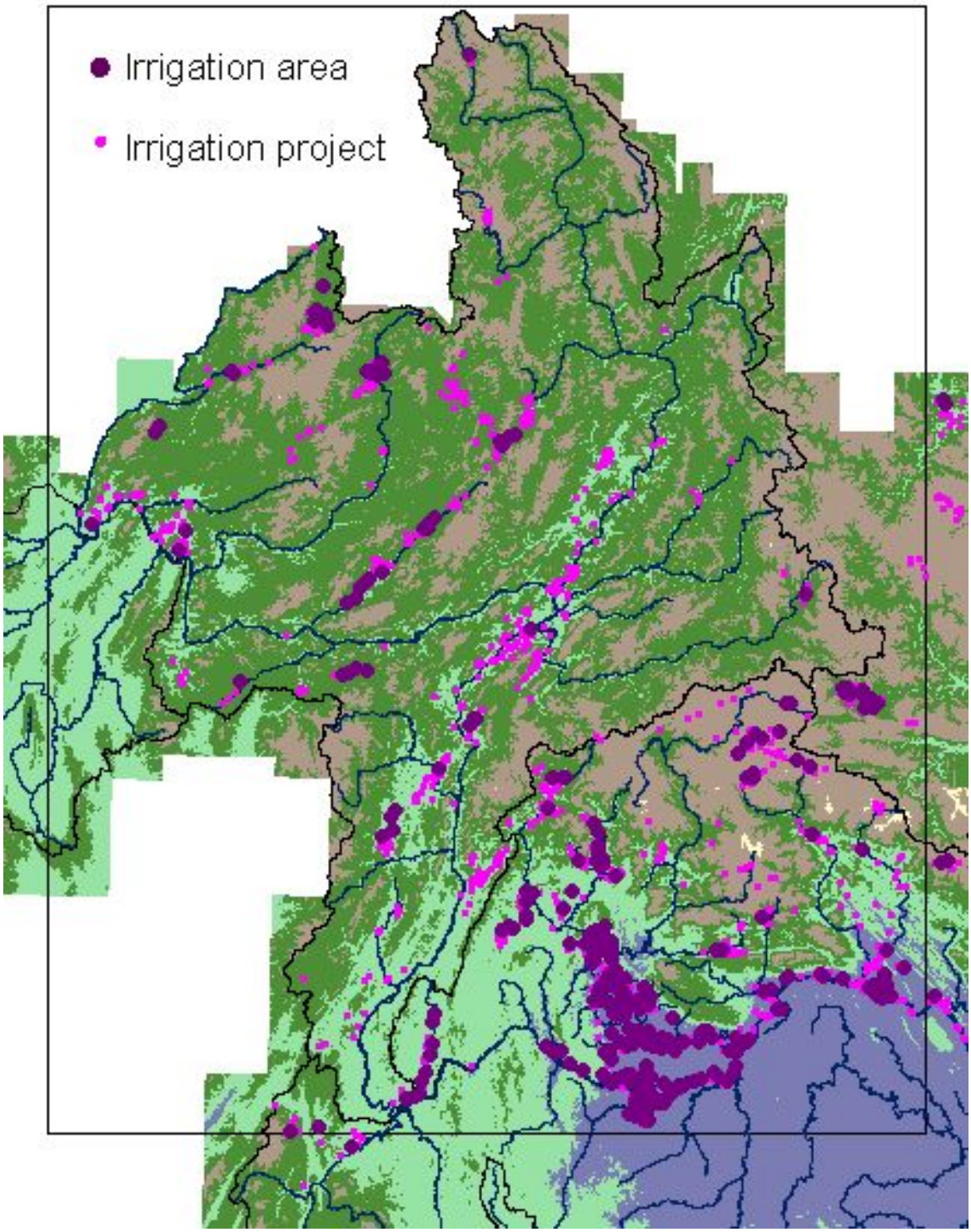
2.3.1. Irrigated Agriculture

Irrigation is almost always the largest consumer of water in a nation.

Irrigation construction by the government of Lao PDR has been expanding rapidly, but only 4 percent of the total rice production in SA-1L is produced under irrigation, compared with 20 percent nationwide, because of the hilly and mountainous topography.

Riverfed irrigation covers small areas in northern Lao PDR in NE-SW zones following the topographic pattern of flat lowlands.

Figure 19: Spatial Trends in Irrigation in SA-1L



Irrigation increases household and sub-regional food security and nutrition and reduces migration to towns, but can have a detrimental affect on fisheries and perhaps hinders malaria reduction.

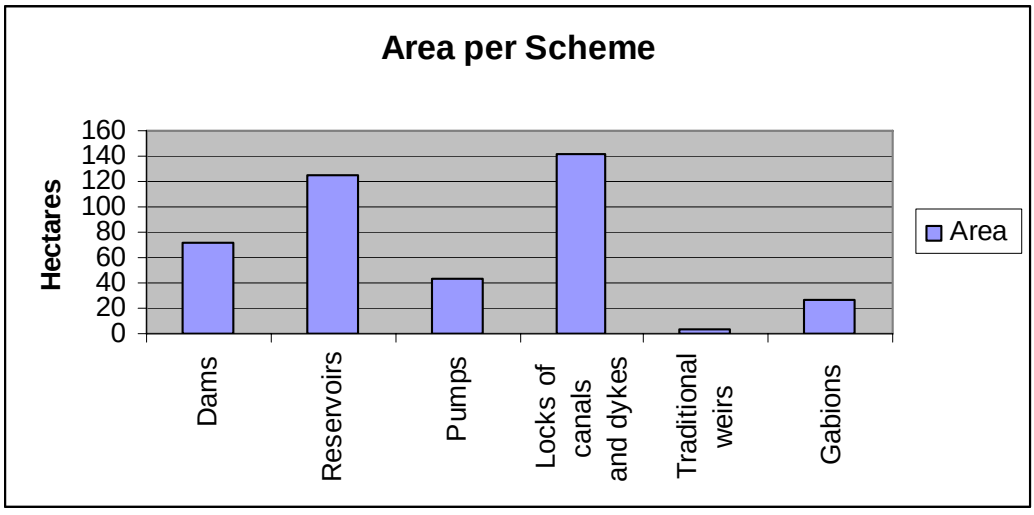
Irrigation is estimated to use very roughly 90% of total water withdrawals from streams, springs and groundwater nationwide. For Northern Lao PDR the percentage may be lower because of the small area of flatland.

The village people living on small streams have long had their own small scale irrigation schemes, gravity fed from weirs. They can be seen to vastly out number those built with outside assistance, but provide irrigation to only relatively small areas. This may be having an evening out effect on these small streams and trapping sediment.

Table 12: Irrigated Area by various Techniques, Nationwide 2002

Techniques	Number	Irrigated Area in the Wet Season	Irrigated Area in the Dry Season
Dams	786	56,882	25,873
Reservoirs	184	22,896	11,131
Pumps	3,828	166,459	144,630
Locks of canals and dykes	69	9,749	2,614
Traditional weirs	17,604	47,945	29,261
Gabions	116	3.168	1,117
Total	22,857	307,097	214,625

Figure 20: Average Wet Season Irrigated Area per Scheme



Note that although traditional irrigation weirs let the fish through either between perennial gaps, or when floods periodically destroy them, these very small schemes are set up on very small streams and thus may deplete the stream below the weir. This means that even if fish can pass the weir in wet season floods, in lower flow periods the stream may be inadequate for fish. The fish may however live for some

months in the irrigation system including the rice fields. The villagers, interested in irrigation and fish, understand the trade off, but the irrigation and the associated fish catch may be controlled by a fairly small number of people who have use rights to narrow stream flats, whereas the fish in the stream or former stream could be caught by all. This issue requires study. Conflicting reports have been heard of the effect of small irrigation schemes on fish. Presumably the conditions are spatially variable, depending on topography and ethnic culture among other things.

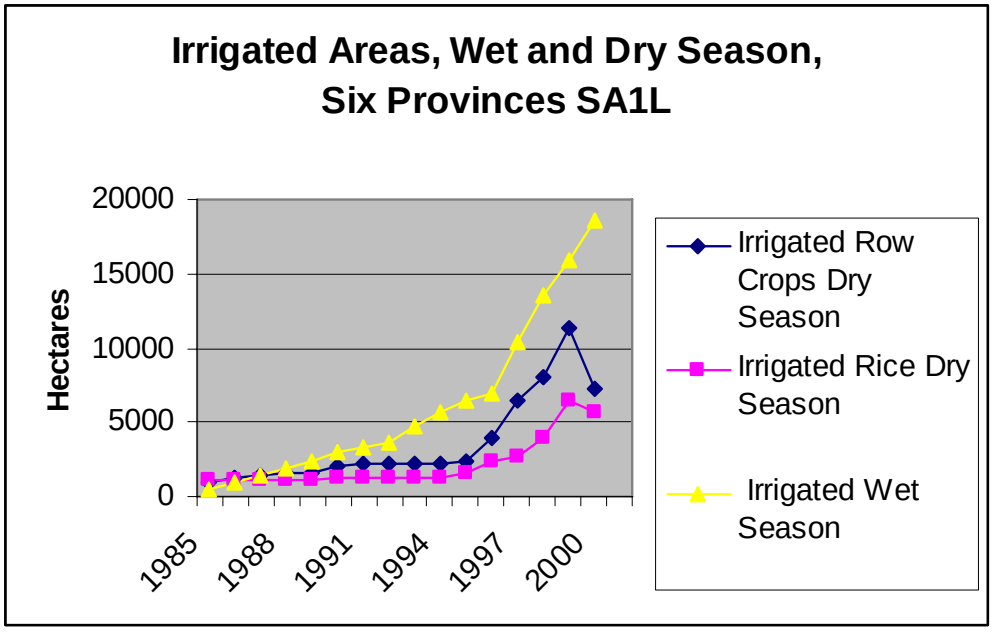
Government irrigation construction expanded rapidly from 1998 to 2000. The wet season irrigated area is an indication of the maximum command area. Notice that not only was there a rapid increase in the wet and dry season area, but also the proportion of the wet season area covered in the dry season. Was this due to better management of old schemes or the better design of new schemes or both?

The massive increase in irrigation in 1998 – 2000 drew on finance from the Bank of Lao PDR. There is evidence that this contributed to the depreciation in the kip at this time.

Time-series data is available for irrigation in six provinces of SA-1L from 1985.

The irrigated wet season rice area for six provinces has been rising steadily over 15 years from very little to about 18,000 hectares. But this is still only about 6% of the national figure of more than 300,000 hectares. Total irrigated areas in the dry season are about the same.

Figure 21: Wet and Dry Season Irrigation Areas in Six Provinces of SA-1L

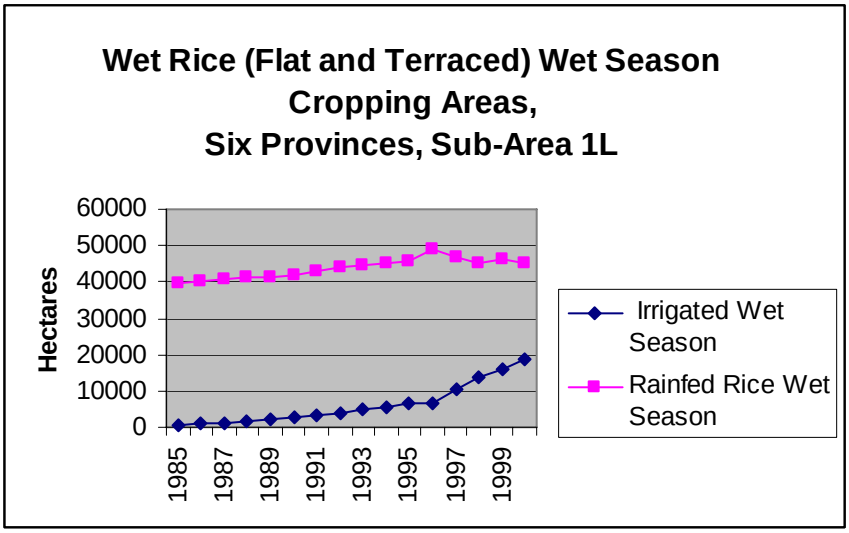


If we assume that irrigated area in the wet season in SA-1L is supplied with about 0.4 meters of water, the total volume 'consumed' is about 72Mm3. If we assume that a dry season irrigation is about 0.7m the volume consumed is about 126Mm3. Irrigation in SA-1L thus uses about 200Mm3 per year. But this is less than half a

percent of the contribution of SA-1L's stream flow (1480 m3/sec or 46,620 Mm3/year) to the Mekong).

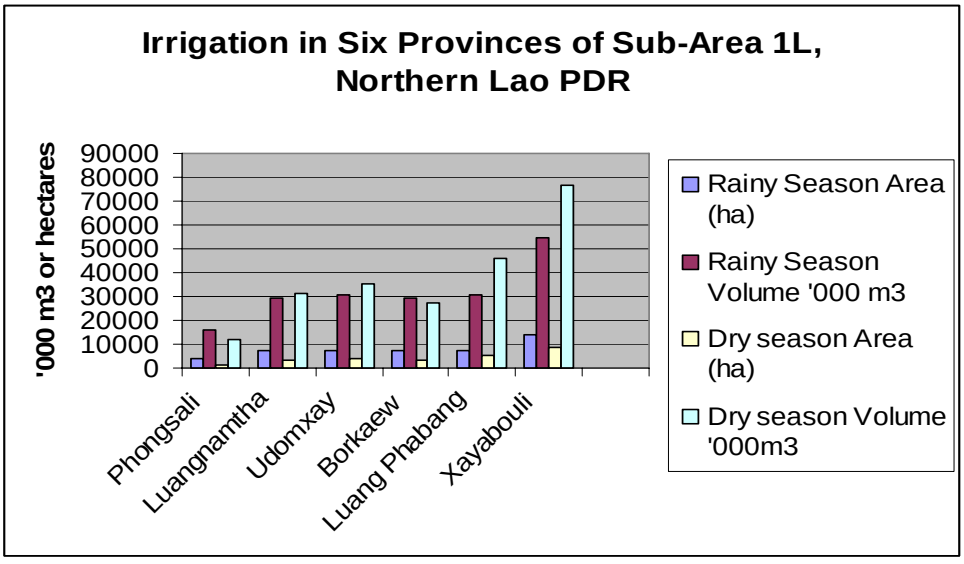
The area of rainfed (non-irrigated) wet rice {flat land and terraced} in the wet season in six provinces of SA-1L is more or less stable and is now about twice that of the irrigated area. Wet season wet rice area in six provinces now totals about 64,000 hectares.

Figure 22: Wet Season Wet Rice Areas



As would be expected given the relatively large area of flat to undulating topography in Xayabouli the largest areas of irrigation is found there.

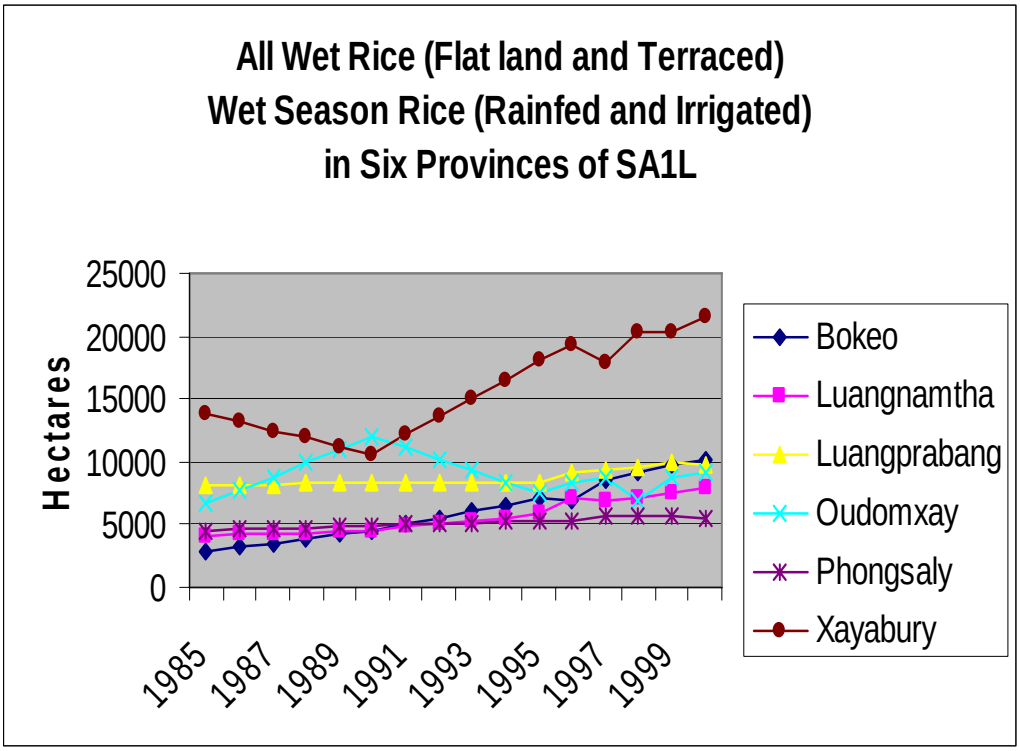
Figure 23: Wet and Dry Season Irrigation Area and Harvested Volume, SA-1L



The decline in the area of all wet season wet rice grown on flatland and terraced areas whether irrigated or rainfed in Oudomxay after 1990 is interesting if not a

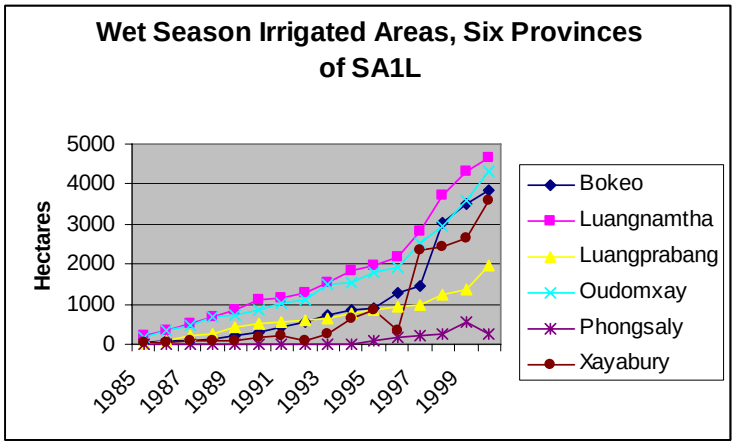
concern. It was from the same date that Xayabouli recovered and took off again. The area in Bokeo and Luang Namtha to a lesser extent, have been rising steadily. Areas in other provinces are fairly stable.

Figure 24: Wet Season Wet Rice Areas



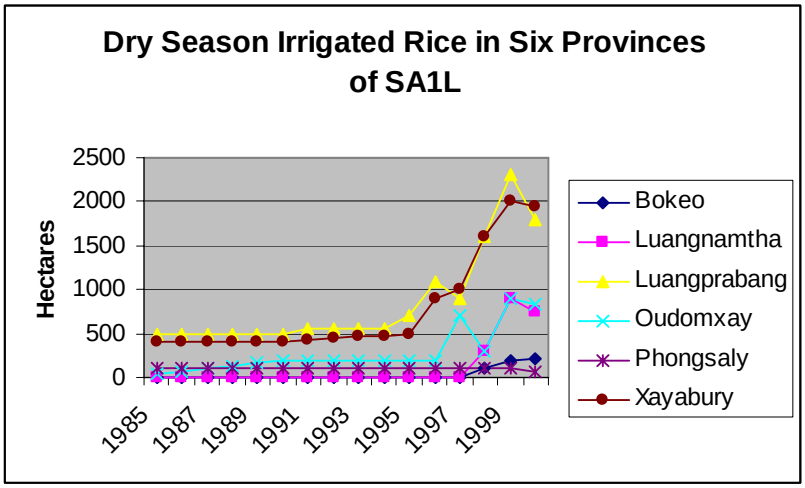
Luang Namtha is leading in wet season irrigated area followed close behind by Oudomxay, Bokeo and Xayabouli. Phongsali is well behind having extremely little any flat land.

Figure 25: Irrigation Areas in the Wet Season



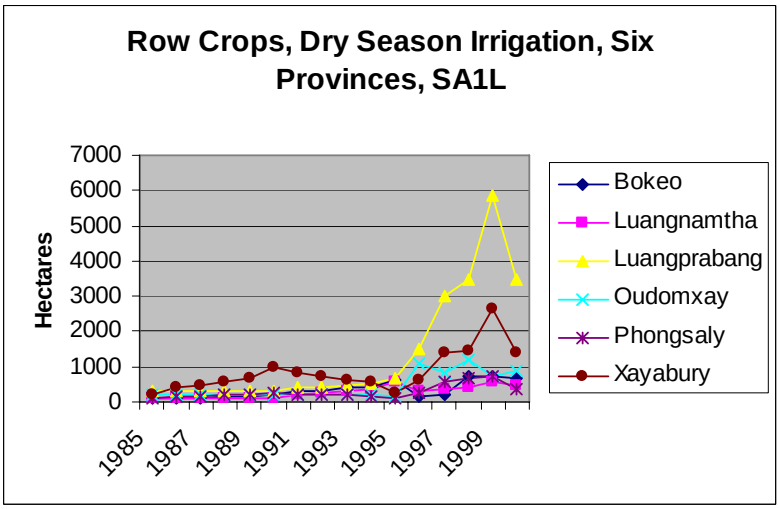
Note that Luang Phabang is as prominent as Xayabouli in dry season rice irrigation, both provinces booming notably from 1995. Luang Namtha and Oudomxay both experienced a small rise in area in 1996 -2000.

Figure 26: Irrigated Dry Season Rice Areas



Row crops (or 'upland' crops) (i.e. non-rice) under irrigation (or what the data refers to as 'vegetables') have particularly taken off in Luang Phabang. This no doubt reflects the tourist market and the better access to Vientiane.

Figure 27: Dry Season Irrigated Row Crop Areas

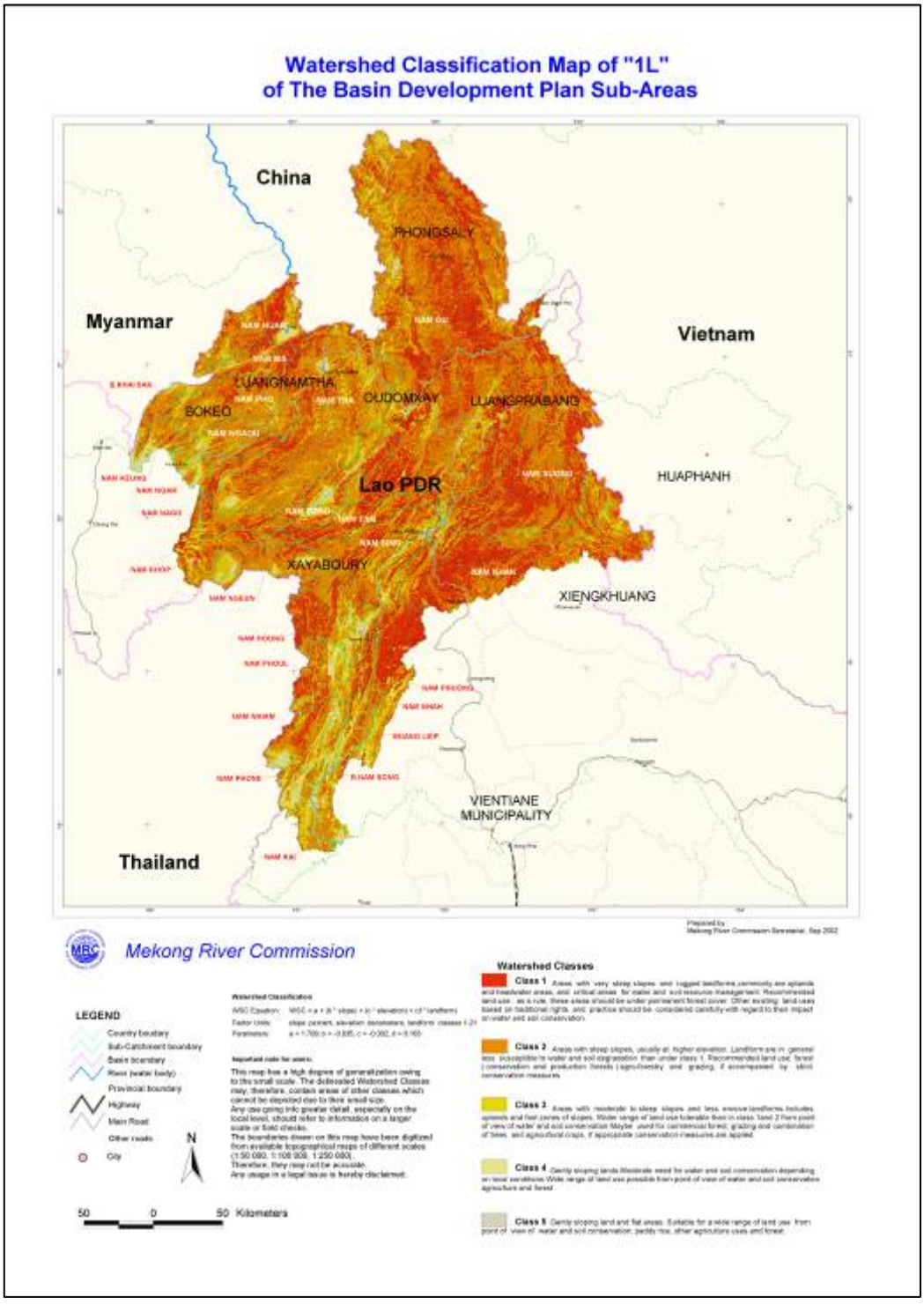


2.3.2. Watershed Management

Because Sub-Area 1L is 90-95% hilly and mountainous, watershed management looms large in any analysis of the area. The 'sector' is one that not only includes the specific watershed area planning but the roles of agriculture, plantations and forestry in all its forms.

The government is planning to prepare watershed development plans for the whole nation. Districts are responsible for developing watershed plans by themselves or with neighbours, depending on the topography. Provinces are responsible for integrating these plans and developing strategies for watershed management and priorities. (National Sector Review)

Figure 28: Physical Watershed Classification in SA-1L



Watershed management is of course an inaccurate term for this sector as most of the activities in the 'watershed' are in effect 'non-management' really oblivious to the issues and often degrading. It would be better to call this sector simply *Watersheds* just as say *Fisheries* is called just that.

A watershed classification map is available from MRC. This should be used flexibly as it is based on slope and soil, and takes no account of villager preferences.

Table 13: Watershed Management or IWRS Projects in SA-1L

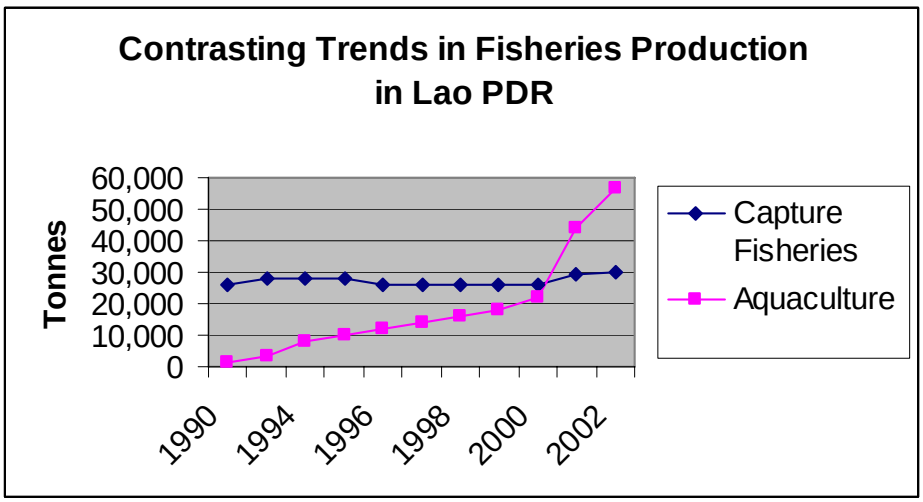
Watershed	Province	Area (km²)	No. of Villages
Nam Tin	Bokeo	220	23
Nam Et Phou Loei NBCA	LPB and Huaphan	4200	110 villages in buffer zone and 35 in conservation area
Nam Neun	Xieng Khuang and Huaphan	6881	~400

2.3.3. Fisheries

At least 70 percent if not all of the people of the Lao PDR depend on fisheries, including aquatic invertebrates, for their protein input to some extent.

Aquaculture is taking off and from 2000 has overtaken wild/capture fisheries production. Most aquaculture is practiced commercially, not for subsistence.

Figure 29: National Fisheries Trends



71 percent of the people of the Lao PDR depend on fisheries for their protein input to some extent. Fish accounts for about 42% of animal protein consumed. Total fisheries production in 2001 was about 72,000 tones and contributes about 7-8 percent of GDP. Average fish intake is 14 kilograms per person. (National Sector Review).Wild fisheries are particularly important for the mass of subsistence farmers. The species caught include molluscs, crustaceans, insects, amphibians and reptiles. Extremely little of the catch is wasted.

Rural people living near wetlands fish following traditional rules that avoid over-exploitation of the fisheries. When however traditional irrigation has a negative impact on fisheries those that control the irrigation scheme may overlook the impact. The impact may include reduction in flow below the weir and blockage of migration. This topic is covered further below under irrigation.

River fisheries are thought be being negatively affected by soil erosion, transport and deposition, and the degradation of wetlands on flood plains for 'development'. There is also the risk that they will be affected by larger dams built for hydro-power and by changes in the stream flow and erosion and sedimentation of soil and litter downstream and upstream. Chemical pollution is not a major problem as chemical inputs to agriculture are limited and especially pesticide use has markedly decreased over the last decade. Modern technology and regulations are more likely to result in over-exploitation, but this is as yet not common in Lao PDR.

An important law on the management and protection of fisheries was passed in 1989. Although its main practical consequences have mainly been found in the Nam Ngum reservoir, the setting up of LARReC has resulted in nationwide programmes, especially in fingerling production which reached 185 million in 2001 (National Sector Review). The following table shows progress in fingerling production at this time.

The Importance of Conservation:

- Wild (capture) fisheries are particularly important for the mass of subsistence farmers, but especially those living close to streams in flatland or hill land. This traditional production is stable.
- Native fish from the wild rivers are also more popular with the urban consumers.
- The upper hill people and mountain dwellers have less opportunity to fish, and are thus more dependent on wild forest food.
- It is thus especially important that the stream fisheries are conserved for the riverine and urban people and that forest is preserved near upper hill and mountain villages.

Community Fisheries in Luang Phabang and the Sub-Area Fish Value:

In Luang Phabang most villages have 'community-based management systems for living aquatic resources. These include conservation zones, and restrictions on seasons, gears and fishing certain species. They often apply to migratory species and relate to specific spawning sites. Aquatic animals account for about half of the animal protein intake in these communities.

- The province is estimated to produce between 10,000 -15,000 tons per year. At the town market fish fetches about 2,800 kip per kilogram (LARReC).
- Thus the imputed value of the annual catch is about 3.5 million US dollars.

- Luang Phabang area is about 15 percent of SA-1L so the sub-area total can be assumed to be about 23 million US dollars.

Aquaculture:

The 30 government hatcheries nationwide produce about 250 million fingerlings for sale annually. But another 250 million are imported to satisfy national demand. In Northern Laos all provinces are involved in fingerling production indicating a potential for growth in aquaculture. Only 22 million fingerlings are produced in SA-1L but each province has a hatchery operating or under construction.

Table 14: Fingerling Production in Six Provinces of Sub-Area 1L, 2001

Provinces	Stations for Fingerling Production		Fingerling Production (million)	Remarks
	State	Private		
1.Phongsaly	Muang Boun Neua			Under construction
2.Luangnamtha	Muang Luang Namtha		0.52	Operating
3. Oudomsay	Done Keo	1	4.15	Operating
4. Bokeo	Muang Tonpheung			Under construction
	2. Nam Tin	1	3.05	On proposal
5. Luangprabang	Na Luang	1	9.5	Operating
		1	3.8	
6. Sayabouri	Nam Tan Dam		4.2	Operating
			22.17	

Water consumption by the wild fisheries sector is non-consumptive. Aquaculture relies directly on rainfall and pumping. Some pond water is pumped from streams but we have no data on pond area or volume or pumping rates and times. However they are likely to be small.

2.3.4. Hydropower

Lao PDR landscape has the physical potential to generate about 18,000 MW of hydropower from more than 60 promising sites. This physical potential and the possible benefits for navigation and irrigation must be considered carefully given the economic, social, ecological and other environmental constraints. Although the present and especially the future four nation regional demand is greater than this physical potential, gas has become an effective competitor that has rendered many potential sites unviable at the present time on simply technical economic grounds. If the socio-economic and environmental costs are included the potential sites are even fewer.

Electricity is the form of power generated by water flow through turbines. It is more explicit to refer to hydro-electricity rather than hydropower. You can find such water driven wheels used to mill rice in northern Laos in shallow fast flowing

rivers. On the other hand power and energy have distinct meanings in physics that makes their careful use in that sense important. Power is a physical capacity unrelated to time. Is units are watts (W) or Megawatts (MW). Energy is the expenditure of power over time so is measured in watt hours or to be more practical for generating stations Gigawatt hours per annum (GWh).

We use large amounts of water to generate hydro-electricity but once used it seems to flow on down the river. However evaporation takes place from the reservoir of nearly two meters per year an amount equal to an equivalent area of triple cropping of wet rice. Moreover the reservoir is subject to gradual filling by eroded soil. The coarse material accumulates as a fan at the upper end and the fine material is distributed across the reservoir area. Dams can be designed with sluice gates to move water and some of the sediment through, that benefits downstream environments, but the loss of water through low gates reduces the power potential for which the dam was built.

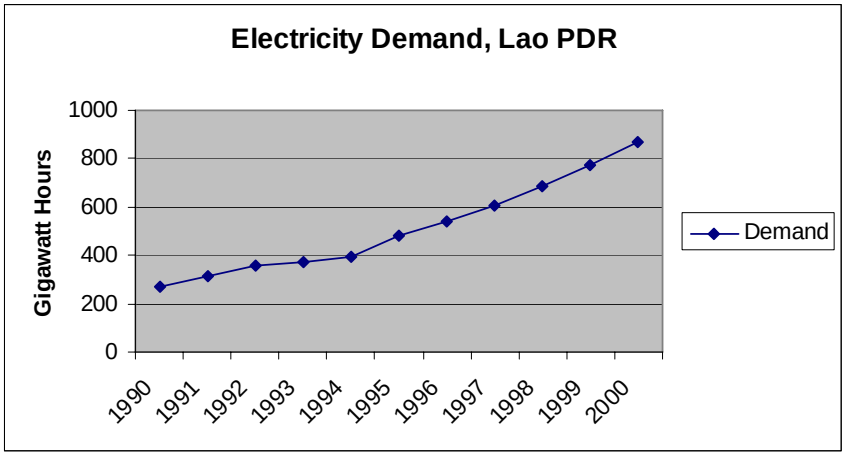
The sediment accumulated is lost to the river below the dam and thus the natural sedimentation and erosion processes, and the habitats on which ecosystems depend. The timing of the flow through sluice gates and past the generators, and thus the change made to the wet and dry season flow rates and levels is an important issue for many stakeholders. Electricity peak demand is in the hot dry season but downstream users and environments may prefer a higher river flow at other times.

The risk of earthquakes exacerbated by the reservoir is another problem.

Electricity Supply/Use/Demand:

The general aims and methods (policy and strategy) of the government in promoting hydropower is to reduce the regional power imbalance and thus reduce fuel imports, support rural livelihoods/ development, and earn foreign currency while minimizing the environmental impacts by developing watershed management. It can do this mainly by encouraging private investment.

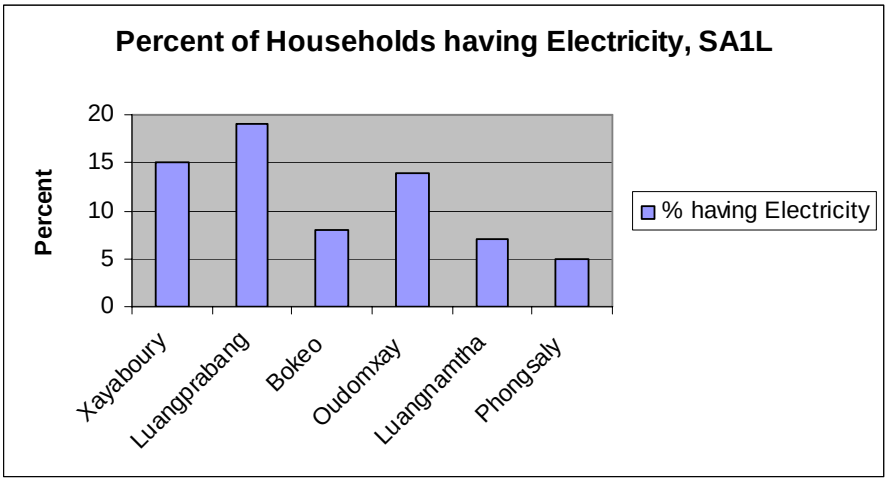
Figure 30: Trends in Nationwide Electricity Demand



The graph below shows the use (partial 'demand') rise over 11 years. Electricity demand for Laos from all sectors that is shown below is of course only a small part of the potential market for Lao power generation. But this depends on price/cost ratios. 1994 was a key year in which the rate of increase of foreign direct investment (FDI) rose markedly raising the rate of increase in electricity demand to about 80GWh per year.

In SA-1L large differences in household electrification are apparent between provinces.

Figure 31: Sub-Area 1L Electrification



Demand Projections:

The annual rate of domestic use/expansion is projected to fall from its present 4% to 2% from 2000 to 2010 (due to revenue problems) then grow again to 4.5 % between 2010 and 2020.

The peak load in 2000 in the Lao PDR was 167 MW. For the four nation region it was 20,089 MW. This broadly illustrates the export potential.

Peak demand for four nations is estimated to rise:

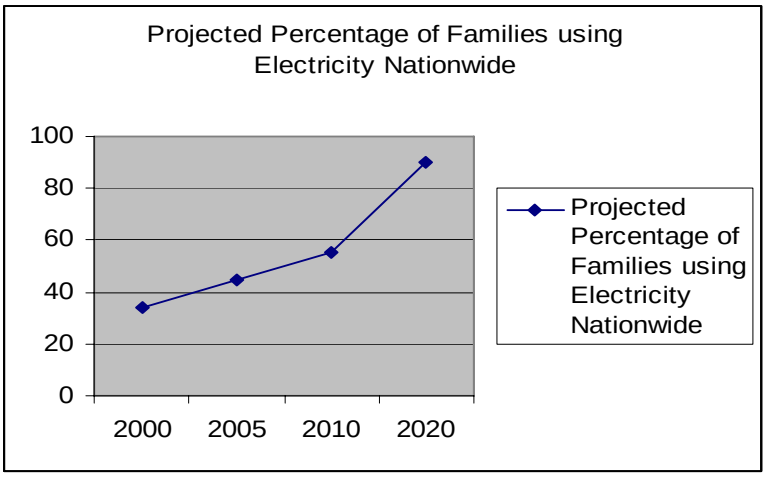
Table 15: Peak Demand for Four Riparian Nations

	2000	2020
Peak Power Demand	20,089 MW	80,880 MW
Annual Energy Demand	124, 954 GWh	507, 200 GWh

Demand across the four nation region in 2000 was per year and is estimated to rise to per year by 2020. Peak demand is estimated to rise from 20,089 MW in 2000 to 80,880 MW in 2020. Such estimates are based largely on GDP growth estimates, and more particularly FDI projections and the growth and type of processing, manufacturing, transport and mining that it is believed will be set up. The demand

and estimates of the growth of alternative power sources such as solar and nuclear are also the basis for hydro-power planning on the rivers of the Lao PDR.

Figure 32: Household Electrification Projection to 2020



Projections for peak demand for six provinces in SA-1L (table and figure below) illustrate that it is Luang Phabang and Xayabouli that are expected to continue to forge ahead, followed by Oudomxay. Oudomxay is not a wealthy province but has a relatively high rate of urbanization.

In the graph below annual growth rates in peak 'demand' in the provinces of SA-1L are estimated to range from about 0.4 MW to 2.6 MW per annum depending on the province and date. This should depend on the real cost and thus price. We do not know the subsidy here and the other assumptions behind these figures.

(Economic) electricity demand (a combination of real and subsidized demand) is increasing at about 80 GWh per year. Two opposing affects may result in a similar rate of increase into the future. On the one hand the government is likely to decrease subsidies and on the other investment is increasing.

Figure 33: Peak Electricity Demand Projected for Six Provinces in SA-1L

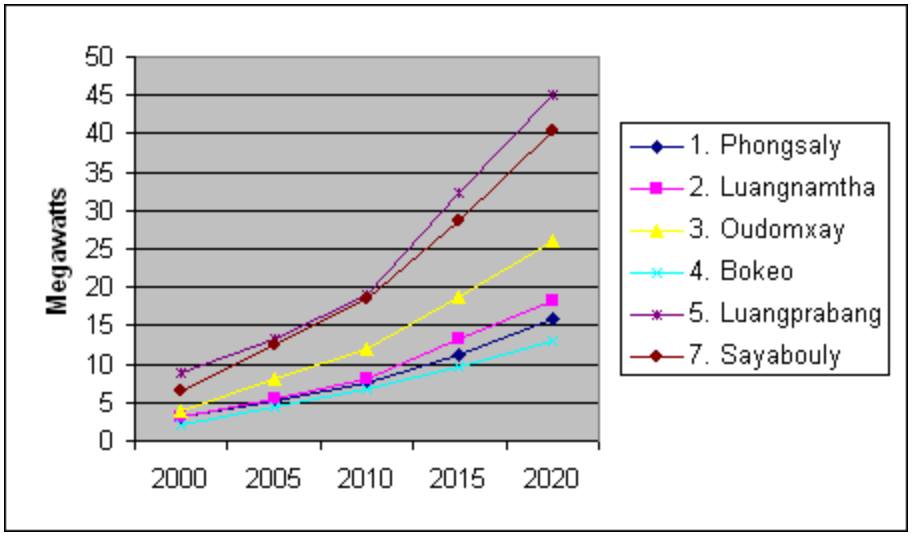


Table 16: Peak Demand Forecast (MW) of Sub-area 1L

	2000	2005	2010	2015	2020
Phongsaly	3	5.3	7.5	11.2	16
Luangnamtha	3	5.5	8.2	13.2	18.3
Oudomxay	4	8.1	12	18.8	26.1
Bokeo	2.1	4.5	6.7	9.6	12.9
Luangprabang	8.8	13.3	19.1	32.4	45.1
Xayabouli	6.4	12.5	18.6	28.6	40.3

Annual growth rates in peak demand are estimated to rise over time. They range from about a 0.4 MW to 2.7 MW per annum. For high growth rates from small beginnings the percentage figures are misleading. They depend on the detail of the calculation so it is better to consider the annual rises.

Table 17: Peak Demand Growth Rates

Mean Annual Growth Rate of Peak Demand over Five Year Periods (MW/year)				
	2000 - 2005	2005 – 2010	2010 – 2015	2015 - 2020
Phongsaly	0.5	0.4	0.7	1.0
Luangnamtha	0.5	0.5	1.0	1.0
Oudomxay	0.8	0.8	1.4	1.5
Bokeo	0.5	0.4	0.6	0.7
Luangprabang	0.9	1.2	2.7	2.5
Sayabouly	1.2	1.2	2.0	2.3

Any serious OPEC led 'oil crises could increase the demand for and the price of electricity, but this would be temporary. The long term depletion of global oil and gas reserves will however eventually result in a steady rise in electricity prices especially if there is more global agreement on global warming.

The Feasibility of Hydro-electricity:

How accurate are the four nation projection and what proportion is subsidy demand which could well fall? This figure might be compared with the Lao physical potential of 18,000 MW, but:

- Power prices have declined after the 1997 collapse.
- And gas from Burma and Southern Thailand is a new competitive energy source.
- Electricity generation from large dams has a long lead time which makes the production price uncertain.

- So now fewer hydropower sites are feasible, even without considering the many socio-economic and environmental costs.

Easy financial conditions for future dams will depend on several conditions:

- optimum and low impact project configurations
- well qualified and financially capable developers
- competitive construction and developing costing
- equitable agreement terms for the government

Power prices have so declined with combined cycle gas plants that now few hydropower sites are feasible.

Careful comparison of sites is needed to choose those most prospective on economic, social and environmental grounds.

All medium to large generating plants must be connected to the national grid. This creates an important cost for potential plants now distant from the grid.

Electricity generation from large dams has a long lead time which makes the market to be tapped highly uncertain. Power prices have so declined after the 1997 collapse and with gas as an energy source that now fewer large hydropower sites are feasible. Those from the smaller more widely scattered pica and micro-hydro that are now being built in Lao PDR in increasing numbers are more certain investments based on local demand. There are many appropriate sites, technically and socio-economically for off-grid electrification. These sites are not the poorest and least accessible ones as sufficient repayment capacity is required. Solar power does not produce enough energy for water pumping but the house lighting provides a lift in the standard of living.

The hydro sites are variously called pica, village, micro, mini and small with increasing megawatt generating capacity from a few kW up to about 10 MW. They have varying seasonal capacities from less than half a year up to one year because of seasonality of rainfall in Laos and differing water storage capacities. Solar energy is well available year round in SA-1L except on the far eastern side. In some cases it may be cost-effective for a group of villages to share a hydro scheme and a solar array to guarantee year round electricity. Very small hydro schemes that depend on weirs not storage take no water from the river although they may more or less dewater it for a reach between the weir and the pelt on generator. In such cases fish passes are needed. Small scale irrigation however always takes a large proportion of the stream flow out of the stream. The question is whether the extra environment created for the fish in the canals and rice fields compensates for the loss of stream, and how is relative access to fish affected for all villagers.

Only two small dams (about 1MW) and several very small schemes have so far been constructed in SA-1L. Small-medium sized hydro-electricity generation plants are planned for the Nam Beng catchment and near Luang Phabang city.

SA-1L has more than 12 constructed small and micro hydropower schemes ranging from 1.5 MW on the Nam Ko in Oudomxay to several schemes supplying 5 kW (0.005 MW).

One small-medium hydropower project is under-construction in SA-1L and four other projects have had MOU's signed

Table 18: Existing Small/micro Power Plant in Sub area 1L, February 2003

Province	River/stream	Installed Capacity (MW)	Average Energy Generation (GWh)
Phonsaly	1. Nam Poun	0.11	
	2. Nam Khoun	0.005	
	3. Nam Nguay	0.120	
	4. Haukha	0.005	
Luangnamtha	1.NamLi	0.046	
	2. Hauykhibuan	0.050	
	3. NamPoung	0.030	
Oudaomxay	1. Nam Ko	1.5	6.5
Bokeo			
Luangphabang	1. Nam Dong	1	5
	2. Nam Pa	0.016	
	3. Nam Mong	0.070	
Sayaboury	1. Nam Ham	0.180	

Several coal-powered electricity plants are also under construction or planned. The need in the sub-area is massive although the demand (ability to pay) is low. Much of the nation's electric power generation is exported, but in the North domestic demand may eventually use a major proportion.

The 1994 study of Run-of-River hydropower schemes ranked these four northern Lao sites as second priority, and requiring further study.

Table 19: Run-of-River Hydropower Proposed on Mainstream *in SA-1L*

	Electricity Generating Capacity (MW)
Pak Beng	1230 (1000-1,800)
Luang Phabang	970 (1300-2600)
Xayabouli	1260 (600-1200)
Pak Lay	1010 (1200-2,000)

In 2001 a small project using part of the flow over the Khone falls wholly within Laos is being planned but none in the North. All four of the Northern projects are also wholly within Laos. Energy production in a 1994 study for run-of-river projects cost at 5.4 cents/kWh for reliable generation and 20 cents/kWh for secondary generation, (Mekong Mainstream Run-of-river Hydropower}. Quite apart from socio-environmental objections, these prices put them out of contention at present market prices. The MRC Hydropower Development strategy notes probable Thai energy prices at 4-5 cents/kWh and for non-firm energy 1.5 – 2 cents/kWh. Nam Ngeun electricity at present sells for about 3 cents/kWh.

EEHB (2001) say average production costs of proposed candidates with future confessional financing (low interest loans) for part of its generation development are expected to be around 3.0 UScents/kWh. The case for subsidization of electricity is greater for rural electrification.

EEHB estimates that the limiting export price of electricity will be around 4.3 UScent/kWh for primary energy and 2.4 UScents/kWh for secondary energy. The energy projects considered *economically* feasible are all in the Centre and South of Laos. Hongsa lignite is considered marginally feasible.

Have any surveys been done on the feasibility of run-of-river on the tributaries? If they are run-of-river in actuality as well as in name together with effective, well researched and tested fish ladders, they have less impact on the environment than storage dams.

In-river current floating turbines that are now being on the market are an even more attractive proposition from the point of view of the environment.

2.3.5. Navigation and River Works

River travel and transport have long histories when land is rugged and covered in thick forest. Many of the early people who came to live in Northern Laos, notably the Lao themselves, probably entered the region from the north by boat along the Mekong, the Ou and other rivers. Land tracks were made gradually after river settlements were established. The major old towns are sited on the rivers for transport and communication as well as agricultural production.

'Navigation' or river transport depends mainly on river or channel depth, river or channel width, water turbulence, and slope are other factors. River depth depends on the morphology of the river channel and the river flow or discharge both of which vary in space and change over time from natural causes and human intervention, the seasonal change in flow being the most important. Erosion and sedimentation create on-going changes in channels that also require attention. Rock protrusions and sand bars in the channels in the upper reaches of the Mekong have drawn the attention of river traders particularly from China. Many obstacles have recently been blasted and dredged.

Transport is most convenient in the dry season down to Hyasai. The Nam Ou can carry boats up to 3.5 tones for some distance from the mouth.

Seven new ports are due to be constructed in Northern Laos However there is only one port Luang Phabang that is a border checking point.

Four riparian nations (China, Lao PDR, Myanmar, and Thailand) signed an Agreement on Commercial Navigation on 20 April 2000 that covers two reaches of the Mekong: Houakhong-Houaysai and Houaysai-Luang Prabang.

Table 20: Navigation Data

	Houakhong-Houaysai	Houaysai - Luang Prabang	Luang Prabang-Vientiane	Vientiane-Savannakhet	Savannakhet Pakse	Pakse-Khinak
Mekong Length (kilometer)	301	304	426	459	256	
Mekong tributaries on the left bank			1.Nam U 2.Nam Khane 3.Nam Seuang 4.Nam Ngum	1.Nam Ngum 2.Nam Ngiep 3.Nam San 4.Nam Kading 5.Se Bang Fay 6.Se Bang Hieng	1.Se Don	
Mekong Width (meter)	50-700	50-700	150-1600		90-2100	
Current (meter/second)	3.5 to >6					
Important ports	1.Huakhong 2.Xieng-Kok 3.Ban-Mom 4.Houays-ai			1.Port Km4 2.Thakhek 3.Keng Kabao 4.Savannakhet	1.Savannakhet 2.Pakse	
Obstacles (Rocks and islands)	20	14	8 with some rocks of 10-12 m height harming the navigation in dry and rain seasons	6	11	
Boat capacity (ton) Dry season	50	30	30	30		
Boat capacity (ton) Rain season	100	80	80	300	50	
Annual variation in the level of the Mekong (meter)	278	35 at Pakbeng 22 at Luang Prabang	at Ban Pho Phieng 30 at Ban Kok			

River transport is important for those a long distance from roads, a common situation in SA-1L.

'Navigation' or river transport is an important form of transport in Sub-Area 1L where road construction is made extremely difficult and expensive per-capita due by the steep topography and to the sparse population. But river transport is only relatively easy in the wet season. In the dry season numerous rapids and shallow rocks make it dangerous in many reaches.

River works include ports, blasting and dredging, and bank protection. Only the first three are primarily concerned with navigation. Bank protection is primarily concerned with riverside land values and thus is really a different sector that has as much relationship to flood protection and perhaps tourism as to navigation. Bank protection's relationship to navigation comes in the effect that boat waves have on bank erosion, but erosion and collapse has multiple causes including natural causes, vegetation removal, global warming, quarrying of stream sediment, flood levees, watershed degradation in general and other bank protection. This is a complex issue that needs more study and dialogue.

Bank protection is primarily concerned with riverside land values and thus is really a different sector.

Erosion and collapse has multiple causes including:

- Boat waves (navigation);
- Natural causes;
- Vegetation removal;
- Global warming;
- Rapid river level drops;
- High groundwater levels at banks;
- Cultivation of banks;
- Quarrying of stream sediment;
- Flood levees;
- Watershed degradation in general; and
- Other bank protection.

Bank erosion and collapse and the resulting 'mass sedimentation' at least temporarily change the channel cross section and flow characteristics. This is a complex issue that needs more study and dialogue.

Many obstacles have recently been blasted and dredged in the upper part of SA-1L facilitating navigation, but disturbing local aquatic ecosystems, at least temporarily. Survey has been done on bank erosion and collapse in Bokeo (17.5 km and 144 ha lost) in Tonpheung and Houaysai districts (LNMC, 2002) and Xayabouli (3.6 km) but we have little data from elsewhere in SA-1L. Note that humans are inviting difficulty if they build near to naturally eroding river banks that are usually on the outside of a meander.

Table 21: State of Navigation on the Mekong River in the SA-1L

Stretches	Length of Navigable Mekong river (km)	Boat Capacity (ton)		Difficult Rapids			Aid to navigat-ion Beacons
		Dry season	Wet Season	Low WL	Middle WL	High WL	
1. Lao-china border	220	30-200	50-500	2	1		
2. Huaysai-Luanprabang	303	30	150	11	2	1	26
3. Luanprabanhg Vientiane	426	30	150	6	5		126

Table 22: Navigation Route in the Tributaries of Mekong River in the SA-1L

Tributaries' Name	Length (km)	Boat Capacity	
		Dry Season	Wet Season
NamTha	230	0.2	1.0
Nam Ou	498	0.5	3.5
Nam Suang	130	0.5	1.0

Table 23: Number of existing Ports on the Mekong River in the SA-1L

Name of Port	Type of Port	Width (m)	Length (m)	Year of Completion	Remarks
1. Huaysai port (Bokeo province)	ramp concrete	6	140	1991	Fund AIDAB
2. Parkbeng port (Oudouxay province)	ramp concrete	6	200	1990	Local fund + AIDAB
2. Luangprabang port (Luangprabang province)	ramp concrete	5	120	1990	Fund AIDAB

Source: Inland Waterways Division / Dept. of Communication (MCTPC).

Table 24: Number of Planned Ports on the Mekong in the SA-1L and in Lao PDR

Province	Port Name	Distance from Vientiane (Km)	Remark
1. Luangnamtha	Sai village	1,027	Plan (SA 1L)
	Xiengkok village	893	Plan(SA 1L)
2. Bokeo	Morn village	74	Plan(SA 1L)
	Tonpheung	781	Plan(SA 1L)
	Huaysai	730	Plan(SA 1L)
3. Oudomxay	Pakbeng	584	Plan (SA 1L)

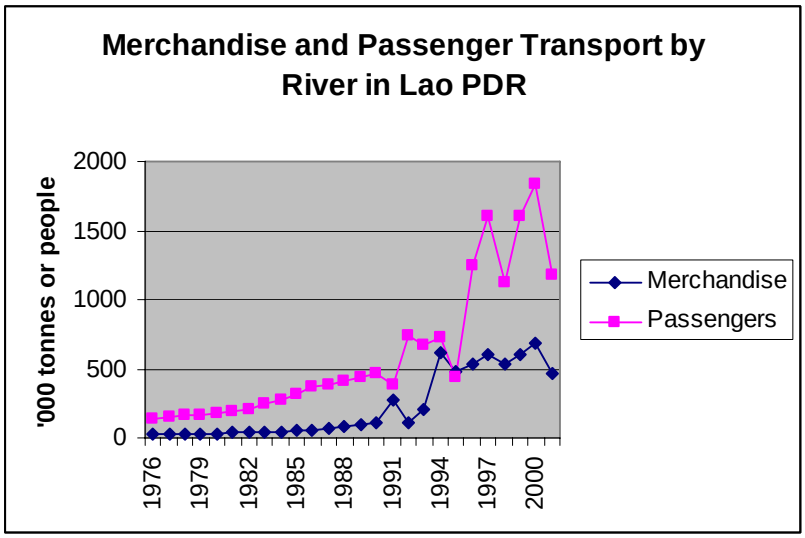
Province	Port Name	Distance from Vientiane (Km)	Remark
4. Luanprabang	Lunaprabang	428	Plan for domestic and internal port (SA-1L)
5.Sayaboury	Thaxuang	561	Planned (SA-1L)
	Thadua-pakkorn	75	Existing domestic port (SA-1L)
	Paklai	216	Existing domestic port (SA-1L)

The graph shows:

- A significant increase in both forms of traffic nationwide in early 1990s with continuing if not uncertain growth in passenger numbers.
- This sudden increase indicates a need for regulation.
- Why has merchandise weight stagnated in the last ten years?

The figure below shows a significant increase in both forms of traffic nationwide in early 1990s with continuing if not uncertain growth in passenger numbers. This sudden increase indicates a need for regulation. Why has merchandise weight stagnated in the last ten years? Is this due to a combination of fall in the Centre and South and rise in the North?

Figure 34: Trends in River Transport



The current strategy is to:

- To maintain current transport capability by river.
- To improve navigation aids and information for safe travel.

- To encourage use of river transport in the wet season instead of poor roads.
- To protect riverbank from erosion.

Organizational Strengthening has been carried out for all six main Northern provinces in SA-1L. Work plans are in place for:

- Improvement of river transport associations and companies
- Improvement of statistical collection.
- Seeking a consensus on navigation signalization and aids to navigation

From 2002-2005 plans include:

- Implementation of four nation decisions on the northern reaches of the river
- Opening of navigation from Semao to Vientiane.
- Setting up of river boat patrol unit
- Study of project to establish an Inland Clearing Centre at ports that lie on the path of the East-West Corridor of the Asian Highway.

It is notable that no studies are mooted on the location, timing and causes of riverbank erosion. Neither is any work planned on the methods of regulating boat waste discharge, speed and noise. Boats could be obliged to discharge waste in provided receptacles at ports, and travel more slowly past susceptible banks, and boat engines could be obliged to have silencers like motorbike engines.

River Works:

In the last 10 years

Embankments have been built at Bokeo

Ports have been built at Ban Xay and Xieng Kok in Luang Namtha Province and Ban Mom in Bokeo Province.

Navigation has been improved recently from China to Bokeo for up to 150 tone boats but environmental disputes are on-going.

River bank protection built on the Thai side is said to have caused bank erosion on the Lao side at 11 sites in Bokeo.

For the next twenty years, efforts will focus on:

- Using local products in the protection of the river embankments.
- Constructing or improving ports and services according to international standards.

- Using navigation aids agreed upon by all parties.
- Improving the navigation lane from the Chinese border down to Luang Prabang.

2.3.6. Tourism and Recreation

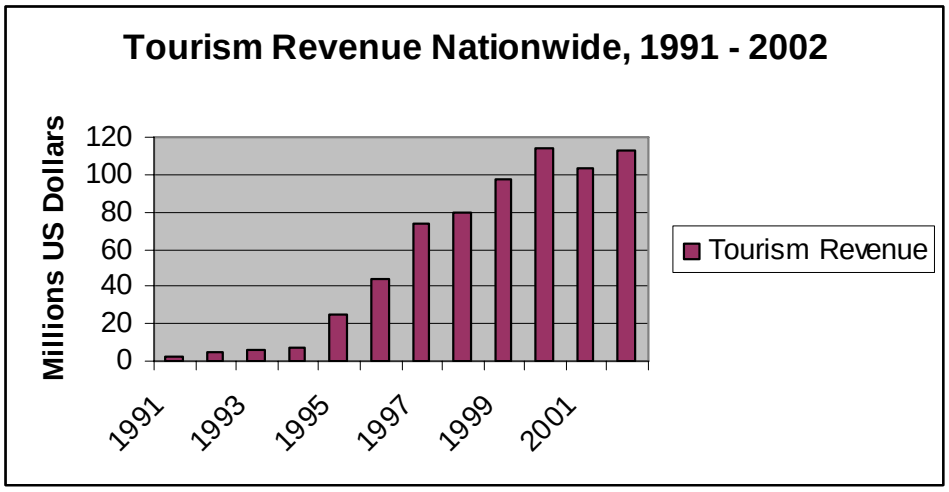
Tourism is now the top foreign exchange earner for Laos. Tourism here means only foreign arrivals and recreation refers to local activities. Tourism brings foreign currency and can be regarded as an export. It is now the top foreign exchange earner for Laos. Moreover it clearly still has high potential in Sub-area 1L. Most is focusing on old or ancient towns and sites on the one hand, and ethnic diversity on the other. 'Environmental tourism' is another attraction. The majority of tourists to the North are careful spending 'backpackers' who nevertheless stay for many days. Nevertheless they are probably appropriate tourists as they tend to appreciate what the government is promoting: 'pro-poor, community-based tourism' (NSR). This would include the growing area of 'eco-tourism' or the wider concept of 'eco-cultural tourism' that depends strongly on environmental and cultural conservation respectively. Backpackers should be valued also as largely young intelligent tourists who will take home and remember their experiences to the benefit of Laos in future tourism, and even trade and politics.

Sub-regional co-operation for tourism is an important idea that will share tourists with neighbours hopefully extending their overall stay by offering a greater range of destinations. This will require coordinated overseas advertising, convenient travel routes between nations and easy border processing to be successful.

Table 25: Number of Tourist Arrivals, Revenue from Tourism, and Average Length of Stay, 1992-2002

Year	Number of Tourist Arrivals	Change (%)	Average Length of Stay (Days)	Revenue From Tourism (Dollars)
1990	14,400	NA	NA	NA
1991	37,613	161.2	NA	2,250,000
1992	87,571	132.82	NA	4,510,000
1993	102,946	17.56	3,50	6,280,000
1994	146,155	41.97	5.07	7,557,600
1995	346,460	137.05	4.25	24,738,480
1996	403,000	16.32	4.12	43,592,263
1997	463,200	14.94	5	73,276,904
1998	500,200	7.98	5	79,960,145
1999	614,278	22.81	5.5	97,265,324
2000	737,208	20.01	5.5	113,898,285
2001	673,823	-8.6	8	103,786,323
2002	735,662	9.18	6.5	113,409,883

Figure 35: Revenue from Tourism in the Lao PDR



It still has high potential to rise in Sub-Area 1L. Most is focusing on ancient towns and sites, and ethnic diversity. 'Environmental tourism' is another attraction.

Recreation numbers are unknown.

The government is promoting: 'pro-poor, community-based tourism' (National Sector Review). This depends strongly on environmental and cultural conservation.

Luang Phabang clearly dominates the tourist numbers in Sub-Area 1L, but the numbers are influenced by: (i) Security conditions; and (ii) Health scares as can be seen for the drop in numbers in Luang Phabang in 2001.

Table 26: Tourist Numbers

Province	1997	1998	1999	2000	2001	2002
Bokeo	16,543	19,002	21,120	25,286	42,561	65,045
Luang Namtha	18,032	18,600	20,700	24,770	41,704	19,319
Phonsali	NA	NA	NA	NA	NA	8,500
Udomsay	5,438	NA	NA	NA	18,654	36,000
Luang Prabang	30,769	44,538	61,034	165,222	51,207	94,846
Sayabuli	NA	8,300	6,200	7,446	9,014	10,840

Tourism Trends in SA-1L:

Luang Phabang clearly dominates the tourist numbers but it is also clearly susceptible to fluctuations due to local security conditions which need to be seriously reviewed. Health risks also cause fluctuating numbers. Bokeo and Luang Namtha are doing well, although the latter dropped in 2002. Oudomxay is rising and even Phongsali seems to be rising at last, but Xayabouli's numbers are stagnant.

The number of rooms for tourists is of course more stable than that of the arrival numbers and revenue, the number of rooms in Oudomxay province seems to have dropped in 2002.

Figure 36: Tourist Rooms SA-1L

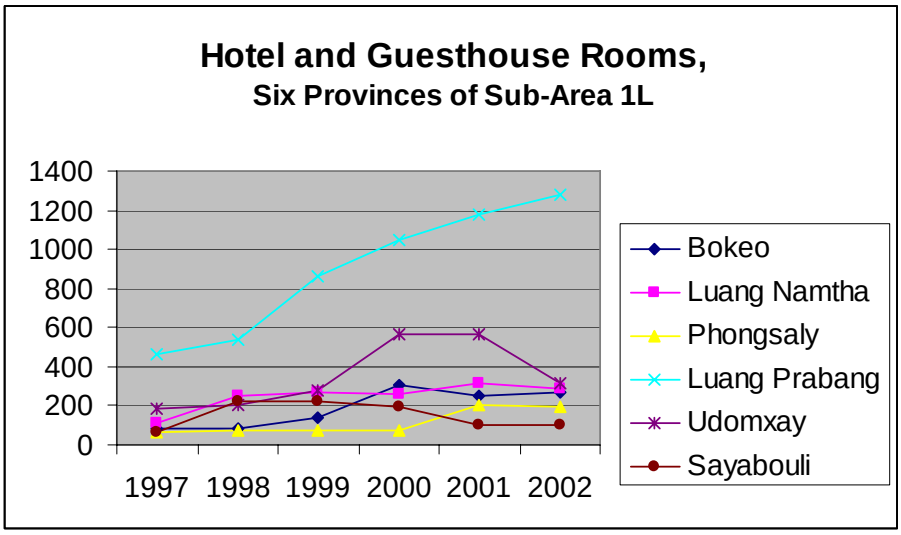


Table 27: Tourists, Accommodation and Restaurants

Province	No. of Tourist	No. of Tourism Site	Hotels and Guest Houses	No. of Restaurants
1. Phongsaly	8,500	6	28	22
2. Luangnamtha	19,319	11	31	18
3. Oudomxay	36,000	105	44	30
4. Bokeo	65,045	5	21	18
5. Luangprabang	94,846	29	128	58
6. Huaphanh	2,819	7	10	6
7. Xayabury	10,840	13	7	20
8. Xiengkhuang	16,223	15	23	16
Total	**253,592**	**191**	**292**	**188**

2.3.7. Water Supply and Sanitation

Water supply is in a contradictory position for the MRC:

- Domestic supply on the one hand is a basic need and has been regarded as a top priority;
- But on the other hand this consumption has very little effect on other nations;

- MRC should state clearly that all or not all priority projects need be trans-boundary.

Water supply in the sense of domestic supply is a basic human need and is thus considered to be a first priority of water management. However water supply in general is not of greater importance than irrigation which of course helps augment production of another basic need, that of food. If a 'conflict of interest arises between irrigation and industrial, mining and other non-basic needs this should be resolved by political, general social and economic considerations'.

Cleaner and more plentiful and/or convenient water supplies raise health standards. Control of pollution of water supplies by human body and industrial waste raises health standards. Irrigation raising agricultural productivity and conservation farming, raising long-term land productivity, increase health levels. But better health reduces death rates and thus increases population and thus impact on land and water resources unless birth control programmes are effective.

But ordinary people value better water supplies mainly for the convenience, the pleasure of having plentiful water, and the production possibilities.

National town and village water consumption is only about 5% of annual national irrigation consumption of about 3000 Mm3 in round figures.

Nationwide piped water using 36 treatment plants is supplied at the rate of 0.157 Mm3 per day or 57Mm3 per year but this is about half (0.525) a million or only 38% of the town population. This is about 300 litres/cap/day (National Sector Review) (Half this figure, 158 lcpd, is used for projections), but this includes industrial and other non-domestic urban use. Industrial consumers are thought to account for about 1.56Mm3 per year, only 2.7% of this figure (Data from National Sector Review). About 85 percent is river water (about 0.04 percent of the Mekong's discharge) and 15 percent is groundwater. Thus most waste water is from domestic use. If we assume that other people (900,000) use 50 l/c/d this is an additional 16.5Mm^3 per year giving an urban total of about 75 Mm^3.

The rural population of about 75% of 5 million i.e. about 3.75 million can also be assumed to use 50l/c/d which gives a total consumption of 68Mm^3 per year. Rounding this gives a national total of about 140Mm^3. This is only a very small percentage of national irrigation consumption.

Table 28: Nationwide Domestic, Office and Industrial Water Consumption Estimates.

	Average Per capita Consumption	Annual Consumption (Mm^3)
Urban piped	300	57
Industrial		1.6 (part of above)
Household urban systems	50 (assumed)	16.5
Total urban		74
Rural	50 (assumed)	68
Total National		142

The government aims to increase the present coverage of rural water supply from 60% to 90% by 2020 and sanitation from a present 41% to 80% by 2020 NSR).

Sub-Area 1L:

In SA-1L Luang Phabang, Oudomxay and Luang Namtha at least have piped water supply systems. Other towns and rural people use wells, springs (both from groundwater), stream water and occasionally rainwater from roof catchments. The only major pumping station for Domestic Water Supply is at Luang Phabang on the Nam Khan pumping at about 8,000 m^3/day or 3 Mm^3/year.

In 1995 most people in towns and lowland villages were still using river water except for Oudomxay, Bokeo and Northern Xayabouli and Luang Namtha where wells were more common. Piped water with taps was only common in and around Luang Phabang town and the road to Xayabouli.

SA-1L's percentage of national population is about 27%. Given that it is more rural and less developed on average it is estimated that the sub-area uses about 30Mm^3 per year.

Domestic, office, and industrial use in SA-1L is smaller than even the small irrigation consumption at 200 Mm^3 per year.

The issue is not the total consumption but the people's access to sufficient quality water and sanitation facilities, and water pollution locally.

We have no other data on town consumption mining use or waste water discharge to water bodies in SA-1L.

Rural Water Supply and Sanitation in Northern Lao PDR and SA-1L:

In the table below Xayabouli (having a lot of flat/undulating land) stands out as a well served province with a large number of dry privies, at least in towns. Bokeo has the best coverage of clean water (domestic supply).

Table 29: Percentage of Households with Services in SA-1L in 1997-98

	Clean Water	Improved Sanitation
Phongsaly	27	12
Luang Namtha	27	29
Oudomxay	32	16
Bokeo	45	18
Luang Phabang	37	25
Xayabouli	33	70

Table 30: Percentage of Population using various Drinking Water Sources, Northern Laos PDR, 2000

Piped into dwelling	5.4
Piped into yard or plot	6.3
Public tap – mainly GFS	5.6
Tube well / borehole with pump	3.2
Protected dug well or protected spring	8.5
Bottled water	0.3
Rain water collection	0.1
Unprotected dug well or spring	12.0
Pond, river or stream	43.8
Tanker or truck vendor	0
GFS	13.6
Other	1.2
Missing data	0
Total	100
Total with officially safe water	**43.0**

Table 31: Percentage of Population using various Means of Excreta Disposal, Northern Lao PDR, 2000

Flush to sewerage system or septic tank	0.3
Pour flush latrine (water seal)	30.8
Traditional pit latrine	13.7
Bush or field	55.0
Other	0.2
Missing data	0
Total	100
Total using sanitary means	45.0

Factory and Mining Waste Discharge:

- Factory waste discharge is not important now as factory numbers and sizes are small, but monitoring should start.
- Mining waste discharge is also probably minor, but two moderately large mines are situated in SA-1L. Seepage from mine dumps can pollute streams and groundwater. The collapse of tailings dams can result in serious pollution of rivers with massive fish kills and poisoning of people who eat fish. Monitoring and inspection of mines and dialogue with mine managers should start. Regulation is needed.

Mining is fairly new in Northern Laos so little is known about either water consumption or mining discharge to streams or groundwater. Two large moderately large mines are situated in SA-1L: a gold mine in Luang Phabang and the Lignite mine in Xayabouli so initial monitoring of their waste management methods and discharges would be appropriate. Chemical discharge may enter surface or sub-surface water bodies. Sediment discharge only enters surface bodies directly although it may give rise to chemical discharge. Mine waste, which is usually called tailings, is properly maintained in well constructed dams, but dams may leak vertically or horizontally or even break. The collapse of tailings dams can result in serious pollution of rivers with massive fish kills and poisoning of people who eat fish.

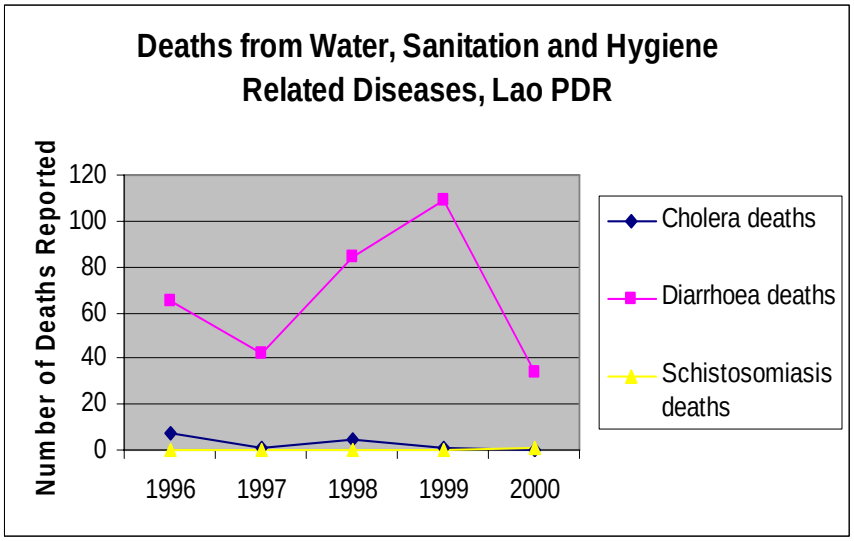
Table 32: Factory Numbers of various Sizes in Six Provinces of SA-1L

Provinces	Large Scale Factory (>99 workers)	Medium Scale Factory (10 - 99 workers)	Small Scale Factory (<10 workers)
Bokeo		23	486
Luang Namtha	3	9	423
Phongsali			1548
Luang Prabang	1	29	2259
Udomsay		12	1492
Sayabuli	1	37	1213

Water Related Health:

Cleaner and more plentiful and/or convenient water supplies and control of pollution raises health standards. Diarrhoea deaths nationwide are declining very uncertainly. A major rise took place between 1997 and 1999. What caused this epidemic?

Figure 37: Deaths from Water-related Diseases



- Better health reduces death rates thus increases population and thus impact on land and water resources; and
- Either birth control programmes or resource management must be stepped up, or preferably both.

2.3.8. Flood Control and Management

Floods in Laos occur mainly in the South, and to some extent in the Centre where the largest areas of flat land are found, but some does occur in the north. About 80 percent of rural flooding and 20 percent of urban flooding is caused by tributaries. Damage was largest in the south but was recorded in the north in 1976 and 2002. In 2002 Phongsali and Xayabouli were hardest hit with estimated losses at 0.7 million and 0.5 million US dollars respectively.

- The seasonal variation in Mekong mainstream flow is decreasing.
- But floods on tributaries are said to be increasing.
- Watershed degradation exacerbates mainly local flooding on tributaries and is likely to be contributing to the increased tributary flooding.
- Flash floods and possibly mud flows occur on small tributaries.
- Moderate floods have significant benefits as they help recharge flood plain aquifers and replenish the flood plain with nutrients for plants, both natural and cultural, and the aquatic ecosystems.
- Fish and nutrients reach the flood plain wetlands including the rice fields.

Increased flooding not only results from:

- Heavier storms; and
- Changed sloping land use in case of small to medium watersheds; but also
- Population and settlement growth and design on the flood plain.

The 'flat-lowlanders' must realize their own responsibility for flooding problems.

A few floods do occur in the North. Damage was recorded in 1976 and 2002. Loss of life is not recorded.

Flood prevention:

- Is being undertaken nationwide mainly in relation to irrigation areas.
- Expanding at the rate of 3.5 % per year.
- It is to be hoped however that by building embankments that a false sense of security is not created.

The seasonal variation in Mekong mainstream flow is decreasing. But floods on tributaries are said to be increasing. Watershed degradation exacerbates mainly local flooding and is likely to be contributing to the increased tributary flooding. Minor 'local' flooding also occurs as a result of storm over the plain.

Moderate floods have significant benefits as they replenish the flood plain with nutrients for plants, both natural and cultural, and the aquatic ecosystems. Floods deposit most of their load in the channel much of the finer silt and clay is deposited on the plain with the coarser material forming a natural levee and the finer clay deposited further from the river in the 'back-swamp'. Fish and nutrients reach the flood plain wetlands including the rice fields. 'Fish in the rice field' an increasingly used form of 'production management' depends on the flood, local and riverfed, to maintain the stock.

Flood plains and wetlands are part of the riverine system. If you live and work on the flood plain you are tempting the river spirits! Problems down-catchment depends not only on rainfall, the natural environment and up-catchment activities but also on the down-catchment activities. Increased flooding not only results from heavier storms and changed sloping land use in case of small to medium watersheds but also population and settlement growth on the flood plain. It is interesting to note that the earliest farmers in the Lower Mekong Basin at Ban Chiang some 5000 years ago farmed land above the low wide flood plains.

The 'flat-lowlanders' must realize their own responsibility for flooding problems. When they are city people also generating high levels of air pollution the responsibility is becoming two fold.

Although the major floods and damage occurs in the South a few floods do occur in the North. Damage was recorded in 1976 and 2002. Loss of life is not recorded.

Figure 38: The Cost of Floods in the Lao PDR

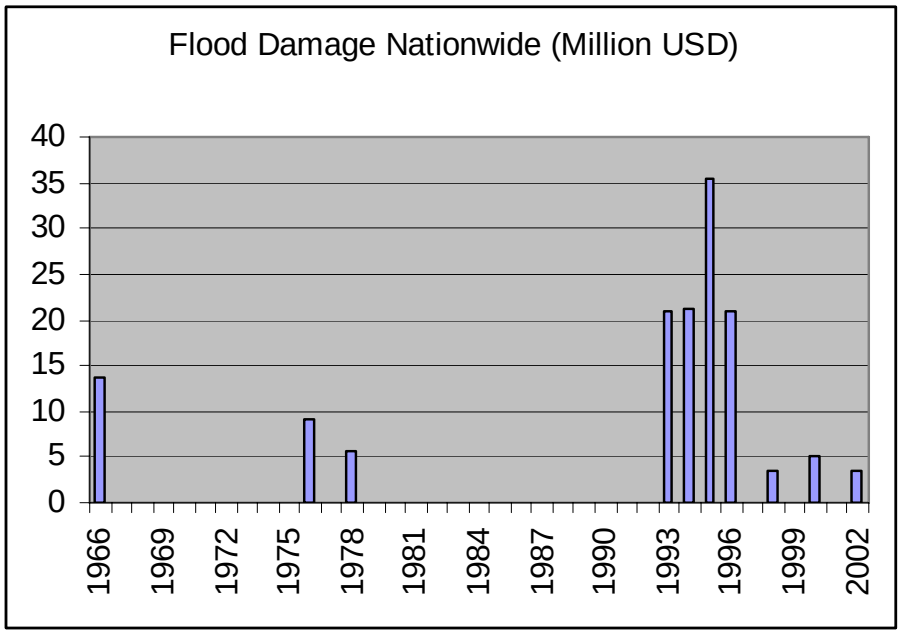


Table 33: Irrigation Activities lost during Flooding in 2002

Province Name	Project Affected	Flooded Area (ha)	Area Damaged (ha)	Estimated Cost (mill. kips)	US Dollars (1$=10,000kips)
1. Phongsaly	132	1,778	961	7,277	727,700
2. Luangnamtha	16	212	138	2,489	248,900
3. Oudomxay	40	1,975		1,794	179,400
4. Bokeo	4	140	140	368	36,800
5. Luangprabang	17	467		1,031	103,100
6. Xaygnabouly	9	603	325	5,180	518,000

Source: Department of Irrigation, Ministry of Agriculture and Forestry.

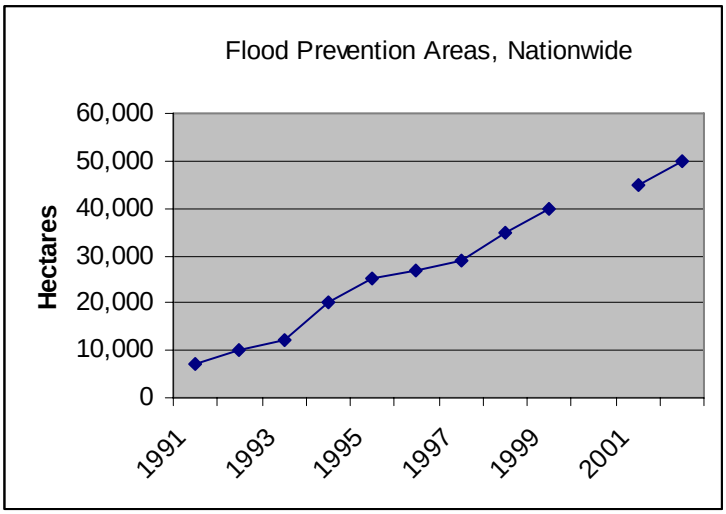
Table 34: Effects of Floods in SA-1L

Province	People Affected		Households Affected		Villages Affected	
	2001	2002	2001	2002	2001	2002
1. Bokeo	1,468	1409	240	273	24	40
2. Xayyabouly	105,478		824		48	
3. Phongsaly		12,405	238	2,280	14	68

Flood prevention is being undertaken in relation to irrigation areas. This is expanding nationwide at the rate of 3.5 percent per year. Flood protection works have been built in major river towns. However, little work is recorded in rainfed agricultural areas.

Flood prevention is being undertaken nationwide mainly in relation to irrigation areas. This is expanding at the rate of 3.5 % per year. It is to be hoped however that by building embankments that a false sense of security is not created.

Figure 39: Flood Prevention Areas in the Lao PDR



There are essentially *three types of flood mitigation that can be carried out: structural, ecological and socio-economic*. The structural type involves levees, dams, channelling and drainage. The ecological type involves a greater density, height, diversity and permanence of vegetation in the watershed, a topic which has been covered under watershed management. The socio-economic type includes measures to either persuade or prevent people using the lowest areas of the flood plain for relatively permanent land uses. When this fails flood forecasting and timely media broadcasting can enable the people to prepare individually and collectively for a serious flood. These measures are not substitutes but compliment one another.

Flood mitigation must take into account the physical changes in the flood plain that change the flow patterns. Flood levees constraining high river levels mean that the natural flood 'storage' in that area is diminished and as a consequence more water than would have been the case flows on downstream to flood over the banks at the next opportunity. Elevated land such as a road in one area increases the problems nearby unless drainage enhances the flow rate at that point. Land use plans should include controls on building and raising land height on the lowest land that are the most important natural floodway.

2.4. Water Resources

Lao PDR constitutes 25 percent of the area of the whole Mekong Basin but contributes about 35 percent of the mainstream flow rate estimated at 5270 m^3/sec. The contribution of Sub-area 1L can be roughly estimated at about 1500 m^3/sec or 47,000 Mm^3/year that is 28% of the Lao total. Notice that this stream flow is the whole of SA-1L not just six provinces. It will be compared with water consumption by riverfed irrigation and town piped supply.

Rainfall data is widely scattered and interpretation gives very variable results. We do not have a rainfall figure to compare with the stream flow. The water resources of Sub-area 1L depend on a moderate rainfall but the spatial variation is significant. The regional evapo-transpiration is poorly known but has been drastically reduced by the destruction of dipterocarp forest and its replacement by permanent and semi-permanent degraded ecosystems, agriculture, villages, towns, roads, quarries and mines. Tree plantations, mainly of teak and fruit trees cover only a small area.

The area contains four larger tributary catchments, Namtha, Ou, Seuang, Khan, and many smaller areas. Mountainous and hilly steep sloping topography cover nearly of Sub-area 1L. Plain areas are found mainly in Xayabouli, with smaller areas in southern Bokeo, southern Oudomxay, and Northern Luang Namtha. Elsewhere stream flats are narrow.

Runoff and Water Use:

To a mainstream input from PR China estimated at 2,688 m^3/sec (84,770 Mm^3/ year). Runoff from all tributaries in SA-1L is about 1500 m^3/sec or 47,000 Mm^3 {mega cubic meters}. Compared with that used by vegetation which is more or less half of rainfall, irrigation is a minor user, consuming a mere 200 Mm^3 and town and village water supply, including minor industrial uses consuming a much smaller amount still.

Hydro-electricity:

Several sites have been proposed for medium to large hydroelectric dams. Many small and very small ones have and are being built. Because of the very small area of flat land irrigation is not a major option which restricts the possible benefits of dams. Electricity might be able to be exported but the economics of future markets for large dams is uncertain. Cost-benefit studies done of nearly all medium and large proposed dams and reservoirs in SA-1L show that the costs of generation will be similar to or above that of likely market prices for electricity of about 4 cents/KWh.

Increasingly very small hydroelectric schemes are being constructed on small streams in Northern Laos to provide electricity to local communities. These rely only on small weirs and so do not affect downstream flows to any marked extent.

Flow Changes:

The flow in the Mekong has been shown to be changing over the 40 – 50 years since records were first kept. The seasonal flow variation is evening out a little. Wet season flows are decreasing and dry season flows are increasing. This is said to have been a gradual rather than a stepped change. As rainfall so far has hardly changed over this period the changing flow regime has been attributed to the construction of many small dams.

Tributary Catchments:

Although this study is of a sub-area of the Mekong basin, ultimately each sub-basin or tributary catchment should be studied separately and as a whole. It is sub-optimal to develop river cage fisheries in one river, pump irrigation in another and hydropower in another without reference to all sectors and themes for each catchment or sub-basin. Simply a 'balance of sectors and themes' for the sub-area is not appropriate.

It will be worthwhile for sub-area staff to consider each of the major tributary catchments or watersheds separately. Geology and topography, rainfall, evapo-transpiration, land cover-land use, populations, location in relation to other phenomena, etc., may create special constraints and offer special opportunities.

- Ultimately each sub-basin or tributary catchment should be studied and planned separately and as a whole.
- It would be best to chose on medium sized catchment such as that of the Nam Beng to organize a model integrated study and development project. As well as make selected studies of the whole area where data are weak.

Precipitation:

The precipitation in the Lower Mekong Basin falls mainly as rain [probably with some hail in the high mountains in the cooler months] nearly all in a wet season from May to October. However in higher parts of the Upper Lancang Basin in

China much of the precipitation occurs as snow and melts in spring and early summer roughly through April to July.

The standard map of rainfall distribution in the Lao PDR published by the National Geographic Office based on data from the Department of Meteorology shows rainfall maxima of more than 3,000 mm in an E-W zone in the highlands just south of the Xieng Khuang Plateau and another of more than 3,000 mm in a zone from Northern Bokeo-Southern Luang Namtha through to central Oudomxay. Significant high rainfall zones cross the Nam Tha, Nam Beng and Nam Khan tributary catchments.

This interpretation has been challenged by the Mekong River Basin Diagnostic Study using data up to 1993 showing similar maxima in the mountains of Bolikhamxay and northern Vientiane provinces, the latter stretching into southern Luang Phabang but with no more northerly maximum.

The JICA Master Plan Study has yet another interpretation which shows the first maximum of 2800 mm further south actually cantering in Northeast Thailand well outside SA-1L, and the second maximum of much less significance at 1,800-1,900 mm in Phongsali Province in the Nam Ou catchment.

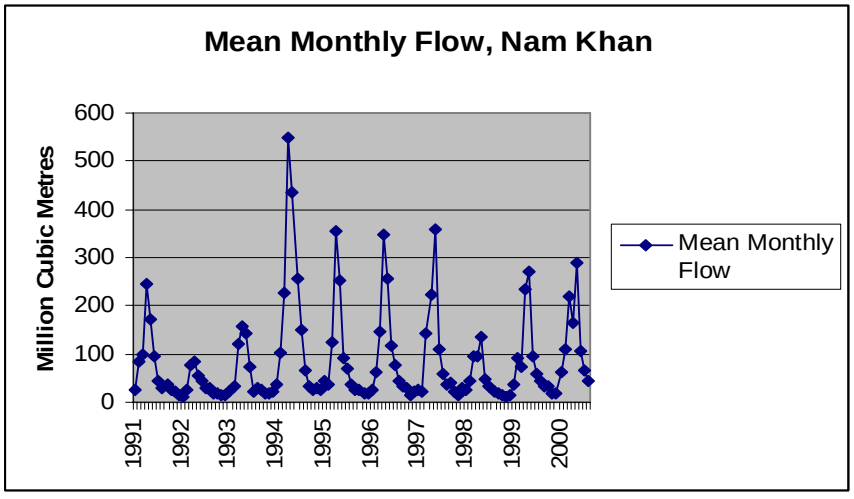
Evaporation estimates range from 1,500 to 1,800 mm.

The University of Colorado study for the Mekong Committee in 1990 estimated that under conditions of global warming the driest month in Luang Phabang may remain December or change to January, while the wettest month may remain as August or move to July. No suggestion of higher rainfall was made by that early report on the effects of global warming.

Catchment Discharge:

Seven river gauges are sited in SA-1L, five on tributaries, and two on the mainstream, all but one within easy reach of Luang Phabang city.

Figure 40: River Flow Variation from Year to Year



River flows obviously vary with the season and weather, in particularly the rainfall. The hydrograph below shows the flow variation for the Nam Khan in Luang Phabang Province over 10 years 1991 to 2000. Notice drought years in 1992, 1993 and 1998.

Table 35: Tributary Hydrological Data

River	Gauge Site	Drainage Area (sq km)	Period of Record	Average Discharge (m^3/sec)	Annual Discharge (Mm^3)
Nam Ou	Muong Ngoy	19,700	mainly since 1987	403	12,700
Nam Seuong	Ban Sibounhom	5,800	Mainly since 1987	86.9	2740??
Nam Pa	Ban Kok Van	700	Mainly since 1988	8.54	
Nam Khan	Ban Pak Bak	5,800	Mainly since 1985	86.1	2715
Nam Khan	Ban Mixay	6,100	From 1960	94.3	2974
Mekong	Chiang Saen	189,000	Mainly since 1960	2,688	84,768
Mekong	Luang Phabang	268,000	since 1914 with gaps	3,807	120,058
Mekong	Pak Lay		since 1913 with gaps		

From the table above it can be seen that the tributary catchment water yields are remarkably similar to each other and to the Mekong, mainly lying between 12 and 15.5 l/sec/km2. The Nam Ou is the exception having a value of 20.5 l/sec/km2. This does seem to be consistent with the JICA interpretation of rainfall showing a moderately high rainfall zone in Phongsali. Moreover the forest cover is relatively high in the upper Ou catchment in Phongsali. Why the Nam Pa should be lower than the rivers on either side of it is not clear as the forest cover is not high. Does the catchment lie in a minor rain shadow and/or could a proportion of its flow at the gauge site be taking place in gravel or limestone aquifers beneath the river?

Table 36: Estimates from Rainfall and Runoff Ratio

River Catchment	Catchment Area (Km^2)	Annual Rainfall (MCM)	Average Annual Runoff Ratio	Average Annual Runoff (Mm^3)
Nam Tha	8,990	13,865	0.58	8,042
Nam Beng	2,120	3,270	0.58	1,896
Nam Ou	24,500	31,957	0.58	18,535
Nam Seuang	6,580	7,404	0.58	4,295
Nam Khan	7,380	12,931	0.58	7,500

Table 37: River Discharges per Unit Catchment Area

River	Gauge Site	Catchment Area (sq km)	Period of Record	Maximum Discharge (m^3/sec)	Minimum Discharge (m^3/sec)	Average Yield l/sec/km^2
Nam Ou	Muong Ngoy	19,700	mainly since 1987	9288	48.2	20.5
Nam Seuong	Ban Sibounhom	5,800	Mainly since 1987	1,480	0.82	14.98
Nam Pa	Ban Kok Van	700	Mainly since 1988	188	1.05	12.2
Nam Khan	Ban Pak Bak	5,800	Mainly since1985	819	3.06	14.84
Nam Khan	Ban Mixay	6,100	From 1960	5280	3.50	15.46
Mekong	Luang Phabang	268,000	since 1914 with gaps	25,200	652	14.2
Mekong	Pak Lay		since 1913 with gaps			

Water Balances:

River discharge data is available for three of the tributary catchments of Sub-Area 1L in Northern Laos. Annual runoff/rainfall ratios in all Lao tributaries have been estimated to mainly be in the range 0.5-0.6 but range from 0.8 in the Nam Lik, Nam Kading, Nam Xane to very low in the XeDone.

It can be expected that overland, groundwater and soil water discharge to streams, or as a whole stream flow (assuming the groundwater flow beneath the stream is negligible) will be significantly more than half of rainfall to the extent that rainfall is heavy and the catchment is covered by non-forest vegetation. The question is whether catchment rainfall can be estimated accurately enough from the small number of gauges sited in complex topography, and from remote sensing, to test the effect of vegetation differences.

More rainfall gauges are needed. A study comparing the various interpretations of rainfall is also recommended.

2.5. Environment

Fisheries:

The average annual catch in the Mekong basin is estimated at 1.5 million tones, valued commercially at about USD1000 million. But the size of fish caught is decreasing markedly. The total tonnage remains roughly stable by catching smaller fish in large numbers. The total must decline eventually.

River fisheries are being badly affected mainly by:

- Small irrigation weirs;
- Soil erosion, transport and deposition; and
- Increasingly over-fishing as the environment has reduced the sustainable catch.

Hydropower:

- The fragmentation of the riverine system;
- Evaporation and evapo-transpiration in reservoirs;
- Chemical and temperature changes in reservoir water;
- CO2 and CH4 (greenhouse gases) release from reservoirs;
- Risk of earthquakes in large, especially in deep reservoirs;
- Reduction in flood support for wild fisheries;
- The loss of flood-based natural fertilizer on flats and plains;
- Channel and bank erosion downstream of the dam;
- Destruction of the environment at the dam and around the reservoir; and
- Introduction of new diseases into local communities by dam workers and water-based disease vectors.

2.6. Trends

- Population growth;
- Increasing of water use for agriculture and industry;
- Increasing of foreign and domestic investment on infrastructure development;
- Regional integrated cooperation development, especially cross-border trade;
- Increasing of employment rate;
- Promotion of consumption of agricultural and industrial products in SA-1L;
- Expansion of the city urbanization (population migration);
- Electricity generation increasing to supply the power demand for domestic consumption and for exports;
- Expansion of eco-tourism;
- Improvement of living condition of people in Sub-area 1L;
- etc.

2.7. Trans-boundary Issues

- Soil erosion (sedimentation/ land sliding);
- River bank erosion (exploitation of sand and gravel in the Mekong River/ Turbulent wave of navigation increasing river bank erosion);
- Decline in fisheries (deep pool management along the Mekong River); and
- Water quality.

3. The Agenda for Development

3.1. Policy

This study of Sub-Area 1L acknowledges the Northern Region Development Strategy (NRDS) developed by the Committee for Planning and Cooperation with ADB support, which itself builds on the government's long-term plans and especially the National Poverty Eradication Program (NPEP).

The NPEP has three key goals: eradication of mass poverty by 2010, elimination of opium production by 2005 and phasing out of shifting cultivation by 2010. It also has three pillars or objectives:

- Rapid growth with equity;
- Socio-cultural development; and
- Conservation of the environment.

That together can guide this water resources planning process. It is this government desire to balance and integrate development that enables an integrated water resources or catchment planning to proceed easily.

Table 38: National Development Policies

Sector	Development Policy
Irrigation	Achieve food self-sufficiency; increase commodity production and reduce shifting cultivation
	Involve all stakeholders in irrigation development and management;
	Coordinate irrigation schemes with other means of increased agricultural production;
Watersheds	Develop watershed management.
Fisheries	Collection of information on the extent and nature of capture fishery;
	Develop infrastructure and human resources in fishery management;
	Promote development of aquaculture; and
	Regulate fishing activities
Hydropower	Reduce imported fuel;
	Support rural development and reduce regional power imbalance;
	Encourage private sector investment in hydropower development;
	Earn foreign currency for socio-economic development;
	Minimize environmental impacts;
Tourism	Promote eco-tourism and cultural and historical based tourism hand in hand with water resource and environment protection

Sector	Development Policy
Navigation	Maintain current transport capability by river;
	Improve navigation aids and information for safety travel;
	Encourage use of river transport in wet season to reduce road transport traffic;
	Riverbanks erosion protection;
Water supply and waste water	Urban water supply, sanitation and waste water
	Increase amenity of life in urban areas by providing affordable, reliable and quality services in commercial water supply and in sanitation.
	Rural water supply and sanitation
	Improve water supply and environmental health in rural areas;
	Focus on inaccessible, poverty-ridden areas; and
	Encourage private water supply and sanitation ventures in easy-to-reach areas.
Floods	Protect against flood damage

New strategies for government to overcome low per person productivity in town and countryside are important. Even present productivity in sloping land is falling due to shorter fallow periods, and before it can be raised it must be at least stabilized and for that to happen requires totally different farming and tree planting systems and/or out migration from the steep land.

But it should be recognized that low productivity is a symptom or outcome of the history of several agricultural peoples moving through, interacting and living in a hilly and mountainous environment, and the colonialism and wars they have suffered. A complex geography and history must be understood to understand the present conditions and thus to propose better ways forward. This is evident in the government call for the integration of growth, equity, socio-cultural development and environmental conservation.

In the cities and for major infra-structural projects, greater reliance on open market mechanisms with better government supervision is required. This is at least relevant to hydropower projects, river bank works, and river transport and tree plantations.

3.2. Key Development Objectives

- Management and utilization of water and water related resources for sustainable development and people's well-being in sub area 1L;
- Promote the cooperation and stimulate the awareness, responsibility and ownership of among water users;
- To create awareness of people's participation on the environmental conservation and natural resources management (conservative forest, aquatic ecosystem);
- Ensure food security (poverty reduction etc.);

- Ensure accessibility of supply water and clean drinking water;
- Promote eco-tourism and cultural tourism;
- Develop sub area 1L to be the corridor for trade transit for neighbouring countries;
- To reduce shifting cultivation and eradicate opium practices through agricultural land allocation and create permanent job;
- Hydropower development to supply power demand for rural electrification, agricultural and industrial development; and
- Deep pool management.

3.3. Identification of Assets

The major assets of the Sub-area have been identified by the Working Group are as follows:

- Mekong River and tributaries;
- Forest;
- National Biodiversity Conservation Area (NBCA);
- variety of wildlife;
- Archaeological sites;
- Fertile soil;
- Unique customs and culture;
- Variety of ethnic groups;
- Wetland; and
- World heritage.

3.4. Development Opportunities

- Tourism development leading to the centre of tourism (eco-tourism, cultural tourism and world heritage);
- Agricultural and forest products development;
- Economic corridor networks (transportation networks) to Thailand, China and Vietnam;
- Mekong river navigation route connecting to neighbouring countries;
- Free trade zone;
- Increasing of employment rate (low labour cost);
- Potential Hydropower development; and

- Mineral resource exploitation.

3.5. Constraints

- Low education;
- No consistent enforcement of laws and regulations;
- Poor communication network;
- Health and sanitation are not in good conditions (less accessibility of clean water);
- Malnutrition;
- Resistance to change the lifestyle of rural people;
- Low infrastructure development;
- Rural electrification networks is not well developed;
- Lack of manpower;
- Low food production; and
- Unskilled labour.

3.6. Risks

- Forest degradation;
- Land sliding;
- Drought;
- Forest fire;
- Flood; and
- Intrusion of protected areas.

4. Sub-area Scenarios and Development Strategies

4.1. Sub-area Scenarios

The possibility event could happen by the year 2025 are likely described with the initial three scenario of the basin development planning in SA-1L.

Scenario 1(Low): Eight sectors program and cross-cutting issues involved water and related water sources under the framework of BDP concept in SA 1L are assigned as the current situation.

Scenario 2 (Moderate): Some sector programs and other key development issues are most likely implemented in SA 1L.

Scenario 3 (high): All sector programs of BDP have fully implemented. Water and related water resources in the BDP concept are highest likely developed with environment conservation.

Scenario 1	Scenario 2	Scenario 3
– Little population growth 2.6 %; – Low population density 18 per/km^2; – High incidence of poverty 50 %; – High ethnic group; – Less animal husbandry, traditional method for local consumption; – Lowland rice area (63,900 ha 2002) is less than upland rice field (87,016 ha); – Estimated water consumption for Lowland rice area (63,900 ha) is about 1,386 Mm^3 and 92 Mm^3 for irrigated rice area (4,361 ha); – Mostly small irrigation system ≤100 ha; – 1,500 m^3/s or about 47,000 Mm^3 contribution to the Lower Mekong River Basin; – National Bio-diversity Conservation (NBCA) 775,600 ha; – Forest cover 2,976,777 ha or 39.6% in SA-1L; – Existing power generation 6.4	– Moderate population growth (1.8 million); – Population density increased in cities; – Poverty incidence gradually decreases; – Hardly expanding of agricultural area in the future due to 90 % of SA 1L area is hilly and mountainous; – Expansion of rice harvested area is possibly in Xayabouly and Luangprabang province; – Upland rice field decreases gradually; – The balancing of population density in urban and rural area will be improved; – Increasing of livestock for domestic consumption; – Increasing of aquatic consumption; – Fish are adversely impact by unsustainable hunting; – Sustainable fishery will be promoted;	– High population growth (2.3 million); – High urban resident; – Poverty incidence decreases; – Expansion of upland rice field has completely eliminated; – Livelihoods has been improved; – Changes in hydrological regimes; – Encroachment are degrading watersheds and more strict enforcement of law and regulation to protect environment; – Power demand in SA-1L 206 MW; – Hydropower projects are fully developed with total installed capacity 1,398.8 MW to supply the domestic demand and for export; – Development of electricity transmission links; – Flow contribution in SA-1L to Mekong river reduced;

Scenario 1	Scenario 2	Scenario 3
MW; – Hydropower development plan (Total installed capacity 1,398.8 MW): + Nam Ou 2 (630 MW); + Nam Fa (150 MW); + Nam Sim (7.8 MW); + Nam Beng (30MW); + Nam Khan 2 (145 MW); + Nam Khan 3 (237 MW); and + Nam Seuang 2 (195 MW). – Improvement of navigation in the upper Mekong river , four riparian countries Agreement on Commercial Navigation in the upper Mekong river on 20 April 2000 (China, Laos, Myanmar, Thailand); – River transportation created huge and turbulent wave leading to accelerate river bank erosion; – Some main existing ports in SA-1L; (Huaysai, PakMorm, Paklai, Parkbeng and Luangprabang port); – Eight new ports are planned; – Tourism service improved, particularly in Luangprabang province, the World heritage; – Estimated domestic and industrial water consumption in SA-1L is about 30Mm^3; – Water supply consumption in Luangprabang about 8,000 m^3/day or 3Mm^3/year pumping at the Nam Khan river; – Serious flood disaster is rare to occur; – Exploitation of sand and gravel in the Mekong river caused river bank erosion;	– National Bio-diversity Conservation are threatened; – Logging is reduced and made sustainable and significant areas of re-growth; – Soil quality is expected to further deteriorate in SA-1L; – Enforcement of law and regulation for environment conservation; – Power demand increases 100MW; – Some hydropower projects are developed; – Increasing of exploitation of biological resources; – Deteriorate of water quality has more attention; – Well development waterway on the Mekong river and its tributaries; – River trade is increasing rapidly (Laos, Thailand , Burma and China) facilitated by clearing of rapids and sand bars; – More public participation in development activities; – Decentralization; – Imported taxes are lessened for ASEAN products and trade increases; – Trade taxes with China are reduced on both sides; – The regional trade and cooperation in SA-1L are more improved; – Rapid increasing and improving of Tourism service; – Grant assistance	– Fisheries habitats are threatened; – Increased fish demand consumption; – Water related diseases are serious public health; – Aquatic eco-systems are being degraded; – Grant assistance (Multilateral, bilateral and NGO) is stable and continues to fund a range of urban and rural development in SA-1L; – Deep pool management is more concentrated; – Increasing of Grant assistance (Multilateral, bilateral and NGO) is stable and continues to fund a range of urban and rural development in SA-1L; – Sedimentation is intensifying; – Wilde life is adversely impacted by development activities and unsustainable hunting; – Decentralization policy is promoted to manage on local development; – More public participation in development activities; – Transparency and accountability; – Timber production will decline and rely only on the few species grown in timber plantations; – Eco-tourism increased; – Flood mitigation improved;

Scenario 1	Scenario 2	Scenario 3
– Increasing of aquatic consumption; – Impacts on water flow due to Dam construction on the upper Mekong river in China; – Rural women has still low in social position; and – Poor awareness of methods for sustainable using natural resources.	(Multilateral, bilateral and NGO) is stable and continues to fund a range of urban and rural development in SA-1L; – Changes in hydrological regimes , high fluctuation of water level in Lower Mekong river by dam construction in upper Mekong river (China); – Local investors focus on tourism, timber plantations, livestock, aquaculture; – More protected deep pool management along the Mekong river and its tributaries; – Increasing of water consumption; and – More awareness of methods for sustainable using natural resources.	– Most of government budget is used for urban and major rural infrastructure; – Foreign investment on medium sized dams, hotels, tours, garment factories, timber plantations and industry; – Increasing of Water use for water supply, livestock and power generation; – Flow discharge of tributaries contributed to the Mekong river is reduced; – Shallowness of natural river; – Minimized impacts on down stream water users through good management; – Awareness for sustainable using natural resources has been well developed; and – Infrastructure development and facilities are well developed.

4.2. Development Strategies by Sectors

4.2.1. Irrigated Agriculture

Irrigation construction by the government expanded rapidly from 1998-2000. However the flatland village people have long had their own small scale irrigation schemes, gravity fed from weirs on streams.

Government constructed irrigation is also riverfed, gravity fed from weirs and pumped from the river. Pumps involve lower initial costs and perhaps most importantly do not interrupt fish migration routes like concrete weirs do, but have much higher recurrent costs. Does the government or the local people cover this?

Water Consumption:

Irrigation in SA-1L thus uses about 200Mm3 per year. But this is less than half a percent of the contribution of SA-1L's stream flow to the Mekong so the strategy does not have to be at all concerned about excess water demand.

The decline in the wet rice areas in Oudomxay seems to be a special case that deserves attention. Most importantly for Sub-Area 1L from 2005 total government agricultural investment capital investment will equal recurrent expenditure. Irrigated areas will increase very little.

Government effort on irrigation will be aimed at running and improved management of existing schemes. Pump fuel and repair etc may take much of this budget. Irrigation construction will gain relatively less promotion.

The key strategy is to upgrade the management of already constructed schemes. Improved water efficiency will enable either a larger area to be irrigated in the dry season or in the case of pump lift, less fuel to be used.

Pesticide use has been reduced markedly in Lao PDR since the early 1990s so the risk of water pollution from this source has all but disappeared. The government will continue to discourage use. Mineral/chemical fertilizer will continue to receive support.

4.2.2. Watershed Management

Water shed management is to be organized according to government and watershed hierarchies. Dialogue and training are needed to ensure a balance of technical and villager planning.

A more integrated approach to analysis using several methods and data sources is needed to monitor land cover/use changes accurately. All organizations involved in this process might consider communicating their efforts and results through presentation and discussion, perhaps at national and four nation regional seminars. For example the two sources of satellite imagery could be compared to examine the strengths and weaknesses. Also manual and computer classification, statistical sampling and ground trusting or verification could be discussed. Perhaps most importantly satellite data analysis from SPOT and Landsat and village surveys could be carefully compared for sample areas. Remote sensing of course shows 'land cover' or 'non-cover'! Land use must be interpreted, so other sources of data are required to, for example, show whether villagers or organizations are logging forest.

Supporting forest re-growth wherever it is found has several environmental values that timber tree plantations lack.

- Forest has a natural biodiversity that provides a range of timber and non-timber products (NTFPs).
- Semi-subsistence cultivators rely on this diversity, especially in the dry season and after crop failure.

- Forest creates a higher proportion of infiltration and higher evapo-transpiration. This results in lower wet season runoff ameliorating local flooding than that of tree plantations but probably higher dry season subsurface runoff.

For progress in poverty alleviation and watershed management, the land allocation methodology needs reassessment and probably improvement. Tree planting from teak to leguminous bushes needs land security. This process could be better integrated with 'extension' (dialogue and training on cultivation, livestock including aquaculture and timber systems) including training in new techniques of permanent sedentary farming including contour cultivation and diverse tree and crop culture. During the time of transition to sedentary farming productivity may well fall further and so land areas allocated should be larger.

Planting and maintenance of timber tree plantations in areas of degenerate ecosystems and low re-growth, is appropriate where it is too steep for sedentary farming systems, but well away from tall or re-establishing forest. But many farmers are selling their land with the timber and are thus losing livelihoods. Micro-finance in the form of savings and loan groups and bank loans is needed.

Greater legal enforcement of forest conservation and training in selective logging is needed to preserve forest for sustainable use, including tourism and recreation, careful selective logging by companies, villager subsistence, limited villager commercial exploitation of timber and non-timber products, and watershed management.

The mountainous and hilly areas need strong support for forest regeneration around existing small forest areas especially in the degraded areas of central SA-1L

Greater effort could be put into certification of tropical timber that comes from sustainable logging perhaps without any socio-economic exploitation.

The Kyoto protocol, when signed by sufficient large nations such as the USA and Russia, will provide Lao PDR with support to grow timber plantations and encourage forest re-growth. Pilot projects using micro-finance and perhaps Vetivia contour strips should be started now to prepare for Kyoto or its replacement. Research might be conducted on the hydrological consequences of forest re-growth and timber tree plantations.

Northern Laos is subject to earthquakes and clear felling, but data on landslides and mudflows is poor. Anecdotal evidence should be sought from provincial staff. A major effort in dialogue, micro-finance and training is needed to raise the number of head of livestock in the north.

The results of watershed management are deceptive as especially the coarser sediment does not travel as far and fast as many assume. Most sediment is deposited locally and moves on a little in the next heavy rains. The results of watershed management are thus long term for large catchments. The rate at which a reservoir is filled by sediment depends on inflow and trap rate (efficiency!) and the density of sediment that increases over time.

Rainfed agriculture will gain more support due to the focus on recurrent costs in the government's long-term agriculture plan. The latter will be promoted through research and extension which will contribute to watershed management.

4.2.3. Fisheries

It is especially important that the stream fisheries are conserved for the riverine and urban people. Community management could be improved in some areas. Fish is increasingly recognized as the preferred protein source for humans because of the associated oils. Prices will inevitably rise and so fish could produce a major export industry for Laos.

While fingerling production for aquaculture is promoted conservation of wild fisheries should be promoted by paying attention to:

- Preserving migration routes, including those from rivers to floodplain wetlands, by preserving reasonable flood flows and minimizing the cutting of tributaries with concrete and rock structures and building wide fish passes where structures are unavoidable;
- Reducing soil erosion, transport and deposition by watershed management;
- Minimizing the introduction of alien species and varieties to native areas by escape from aquaculture water bodies during flooding. More effort could be put into breeding native species;
- Stopping over-fishing where it occurs by supporting community management or state regulation; and
- Studying the effect of traditional irrigation on local fisheries.

4.2.4. Hydropower

Lao PDR's physical hydropower potential of 18,000 MW and the possible benefits for navigation and irrigation must be considered carefully given the economic, social, ecological and other environmental constraints.

Exploitation of only a small proportion of the physical total may be advisable or even possible given the likely substantial costs and limitations that can be divided into three types: A. direct financial costs, B. life, livelihood and cultural costs for the community displaced, and C. environmental costs/risks and associated livelihood costs as follows.

Nevertheless some limited construction of medium sized hydropower dams may be advisable to spread the environmental degradation effects of development especially if disruption to the river regime can be minimized and those people that suffer, both upstream and downstream can be well compensated.

A very small number of profitable low impact medium dams (say about 10-15m dam height or generating say 10-100MW), but flooding very little agricultural land, together with several small, and many very small hydropower generation plants,

real run-of-river schemes, in-river current turbines and solar power may create the lesser of the development problems.

If the riverine environment and its products are to be conserved it should be accepted that less than maximum power generation is possible from any roughly medium site and that a significant proportion of electricity revenue will have to be used to compensate people who are disadvantaged by the project both upstream and downstream of the dam.

Dams should be designed and operated so they can release water to go as far as possible towards mimicking the timing and nature of the natural flow in quantity, chemically, in temperature and with sediment load. This may of course make some projects unviable for the immediate future.

Very small hydro schemes provide a suitable electricity source for more widely scattered villages. They usually have little effect on stream water and sediment and fish movement and are more certain investments based on local demand. They together with solar power should be supported to an increasing extent

Electricity Supply/Use/Demand:

Bokeo, Luang Namtha and Phongsali are relatively under-serviced with electricity. They might be better served but real demand is important. Meeting basic needs is more important than subsidizing electricity. Four nation regional demands are high and rising but price/cost is critical including all the non-construction costs and dam lifetime. Local demand from villages to towns will justify some small dams.

Dam Design and Regulation:

If irrigation uses a major proportion of the dry season releases from dams the flow is correspondingly reduced. But the irrigation potential in SA-1L is small. Moreover the river transport is believed to be largely small scale and local so will hardly react to the deeper water. The water held back in such dams in the wet season will have an ameliorating effect on small floods but not large floods.

Fish passes or navigation locks (when they work) are required for a fuller maintenance of the fish environment but even with a fish ladder/way the native fish are affected by the reservoir geography, hydrology, chemistry and temperature as well as the usual introduced species and genetic varieties with which they have to compete. Research is needed on fish passes to make sure they work for local species

Dialogue is needed with the wild-capture bio-aquatic sectors to determine what degree of regulation is needed and the importance of fish passes to maintain the riverine ecosystems to a reasonable extent in any dammed river.

Future Hydro-electricity Schemes:

Dams on the mainstream in China by 2016 will cause a major decrease in wet season flow, a major increase in dry season flow and decrease in sediment load in the mainstream which will:

- Reduce floods, improve navigation (downstream of the lowest dam at least), and reduce dry season pump irrigation head;
- But will increase channel erosion, reduce flood plain sedimentation, degrade native fisheries. Because most of the Mekong sediment is eroded from the Tibetan Plateau the dams will have a major effect on the sediment load.

An international political strategy is needed to react to this plan.

4.2.5. Navigation, Transportation and River Works

'Navigation' or river transport is an important form of transport in Sub-Area 1L where road construction is made extremely difficult and expensive per-capita by the steep topography and to the sparse population.

The key river works, bank protection, is a response to bank erosion that is a complex issue with at least eleven causes that needs more study and dialogue. The significant increase in both forms of traffic nationwide in early 1990s with continuing if not uncertain growth in passenger numbers indicates a need for regulation.

The government has ten policies/strategies to improve navigation especially on the mainstream link to China:

- New port construction;
- Riverbank protection using local products;
- Safer travel;
- Better transport organizations;
- Better data collection;
- A study project to establish an inland clearing centre;
- Setting up joint ventures;
- Organize cooperative ventures with Yunnan province;
- Introduce electronic methods on the boats; and
- A river boat patrol unit.

As navigation has negative affects:

- It is notable that no studies are planned on the location, timing and causes of riverbank erosion/collapse and proposed solutions.

- Neither is any work planned on the methods of regulating boat waste discharge, speed and noise.

Study is needed of the likely impact of these two roads from China to Thailand, one through Myanmar and one through Lao PDR before more major fixed investment is placed in navigation.

4.2.6. Tourism and Recreation

Tourism is now the top foreign exchange earner for Laos. It still has high potential to rise in Sub-Area 1L. Most is focusing on ancient towns and sites, and ethnic diversity. 'Environmental tourism' is another attraction.

The government is promoting: 'pro-poor, community-based tourism'. This depends strongly on environmental and cultural conservation.

Luang Phabang clearly dominates the tourist numbers in Sub-Area 1L, but the numbers are influenced by:

- Security conditions;
- Health scares.

As can be seen for the drop in numbers in Luang Phabang in 2001.

Tourism, including water-related tourism was increasing rapidly, but is sometimes hit by security and health scares. It is advisable to continue to develop new tourist destinations and ideas and continue to improve promotion methods.

Water-related tourism has potential on the streams for long arrival and departure trips shorter 'day trips' and to a lesser extent on new reservoirs. Safety is probably the key issue for tourists. The government could organize more training for boat owners and captains on this matter.

Research might be useful on integrated eco-cultural tours from Phongsali and Luang Namtha towns that would attract larger numbers.

4.2.7. Domestic Water Supply and Sanitation

Nationwide urban piped water aim is supply all town people with a piped water supply by 2020. This will be done using funds generated by charging real costs to existing consumers. The issue is not the total consumption but the people's access to sufficient quality water and sanitation facilities, and water pollution locally.

The government goal is to reach the figure of 90% clean water coverage by 2020, as the Government's development policy is:

- To improve water supply and environmental health in rural areas;
- To focus on inaccessible, poverty-ridden areas; and
- To encourage private supply and sanitation ventures in easy-to-reach areas.

Rural water supply will be provided on a commercial basis where possible. The poorer communities will be assisted to build and manage water and sanitation systems. To facilitate this policy/strategy cheaper easily repaired facilities such as dug wells with counter-levered buckets and pit privies could be provided as a first step. Monitoring and inspection of factories and mines and dialogue with mine managers should start. Regulation is needed.

4.2.8. Flood Control and Management

The seasonal variation in Mekong mainstream flow is decreasing. But floods on tributaries are said to be increasing. Watershed degradation exacerbates mainly local flooding and is likely to be contributing to the increased tributary flooding, especially flash floods on small streams.

Moderate floods have significant benefits as they replenish the flood plain with nutrients for plants, both natural and cultural, and the aquatic ecosystems. Small to moderate floods that do not destroy large areas of crops must be accepted if not promoted in rural areas. Those that settle on the plain must be encouraged to maintain their ancient adaptation to flooding especially houses on stilts. On the other hand severe destructive floods can be mitigated by physical and biological works and human actions at several locations in the catchments.

Flood prevention is being undertaken nationwide mainly in relation to irrigation areas. This is expanding at the rate of 3.5 % per year. It is to be hoped however that by building embankments that a false sense of security is not created.

There are essentially three types of flood mitigation that can be carried out: structural, ecological and socio-economic. The structural type involves levees, dams, channelling and drainage. The ecological type involves a greater density, height, diversity and permanence of vegetation in the watershed, a topic which has been covered under watershed management. The socio-economic type includes measures to either persuade or prevent people using the lowest areas of the flood plain for relatively permanent land uses. When this fails flood forecasting and timely media broadcasting can enable the people to prepare individually and collectively for a serious flood. These measures are not substitutes but compliment one another.

Flood mitigation must take into account the physical changes in the flood plain that change the flow patterns. Flood levees constraining high river levels mean that the natural flood 'storage' in that area is diminished and as a consequence more water than would have been the case flows on downstream to flood over the banks at the next opportunity. Elevated land such as a road in one area increases the problems nearby unless drainage enhances the flow rate at that point. Land use plans should include controls on building and raising land height on the lowest land that are the most important natural floodway. The flood plain is part of the river.

A flood mitigation strategy could have the following elements:

- Watershed management;

- Medium sized dams and 'conservative' operation;
- Selective dredging where channels have become choked;
- Flood levee construction;
- Natural drainage maintenance and possibly some extra construction;
- Land use planning, including limits on building on and especially building up land, on the lowest parts of the flood plain;
- Maintain traditional house design on stilts;
- Flood forecasting and broadcasting of results;
- Special methods for flash floods in remote areas;
- Minimizing population on the flood plain;
- Supporting opportunities for protecting property and people; and
- Support escapes methods.

4.3. Development Strategies by Cross-cutting Issues

The development strategies by cross-cutting issues are as followings:

- Poverty;
- Gender;
- Environment;
- Human Resources Development; and
- Public Participation.

4.4. Proposed Project Ideas

The followings are the proposed projects that were identified during Forum 2, which was held in April 08-09, 2004 in Xayabouly:

1. Integrated Watershed development and management
2. Water for livelihoods, drinking and industrial use
3. Education (training) for sustainable water resources management
4. Irrigation system development and water storage
5. River bank protection and management

6. Tourism development (Eco-tourism, Ethnic group livelihoods, Historical site and Culture)
7. River transportation development in the main stream and tributaries
8. National Bio-diversity Conservation Area (NBCA) management
9. Land and permanent job allocation to conserve upper forest of original sources of waters
10. Reforestration and plantation
11. Shifting cultivation elimination
12. Hydropower Development
13. Water Demand Study
14. Development of Hydro-Meteorology network
15. Management and treatment of sewage from large towns and industry
16. Flood monitoring and management
17. Upland fishery development
18. Development of gender role on water and water resources management

5. Glossary

Acid soils (or sulphur acid soils): Soils that have been rendered acid due to formation of sulphuric acid by oxygenation of pyrite (natural iron sulphide, FeS_2), often due to human interference (lowering of the groundwater table by drainage, or excavation of ponds for aquaculture). Such soils are unsuited for cultivation, effluents leaking from such areas can be poisonous to fish (because acid can dissolve aluminium), and the process can be practically irreversible.

Alluvial: Formed by river sediments. An alluvial river flows in a landscape formed by its own sediments.

Analysis (of hydrological data): Processing, involving a sometimes comprehensive transformation and interpretation, in order to arrive at some desired knowledge. Data analysis is often carried out stage-wise and in different contexts: On-line processing in the field, off-line processing, further synthesisation for model input, etc. In general, data analysis involves both hidden and explicit assumptions about the relation between primary data and final results. (As one example, a flow rate in a river can be calculated assuming that the current measurements were made simultaneously, even if they took a whole day). Such assumptions can affect both the accuracy and the validity of the results. A suitable quality is supported by an adequate transparency of the analysis.

Aquaculture: Cultivation, aiming at commercial production, of aquatic plants or animals, such as fish, prawns, shellfish, etc.

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Basic minimum needs: These can comprise food and water, shelter, primary education, vital health care, and personal integrity.

Biodiversity: The number of species (of plant and animals) that actually live in an area (or biotope) where they belong. Agenda 21 (Chapter 17.7) states about coastal biodiversity: 'Coastal States, with the support of international organizations, upon request, should undertake measures to maintain biological diversity and productivity of marine species and habitats under national jurisdiction. Inter alia, these measures might include: surveys of marine biodiversity, inventories of endangered species and critical coastal and marine habitats; establishment and management of protected areas; and support of scientific research and dissemination of its results'.

Brackish water: A mixture of sea water and freshwater, found at places where inland waters discharge into the sea: River mouths, fjords, estuaries, lagoons, inland seas, etc. The salinity will be higher than nil, but lower than the ocean salinity of 35 PPT. Stratification is common in brackish areas, and the salinity will often vary highly, both in time and place.

Catchment (or drainage area): An area (delineated by a watershed) that drains through a specific river cross-section.

Development objective (or overall objective, or development goal, or mission): A desired future situation, which is supported by a plan (or programme or project) that is targeted towards it. The plan (or programme or project) cannot in itself assure achievement of the development objective - this is subject to a number of assumptions on related developments that are outside the control of the plan (or programme or project). Some authors recommend that only one development objective be applied from case to case, and that it is specified in time, space and quantity. See also immediate objective.

Discharge: Net flow or net sediment transport through a fixed cross-section of a river.

Dispersion: Mass transport determined by the transverse current velocity gradient and the concentration gradient (and always in the direction of the concentration gradient).

Driving force: A circumstance that has a major (positive or negative) influence on pursuance of a set of planning goals. It can be physical, climatic, economic, social or political, and can appear as a trend, a cycle, or an event. A driving force cannot be fully controlled by the participants in the planning process. It can be unpredictable, or not well understood, or even unknown.

Dublin Principles (from International Conference of Water and the Environment, Dublin 1992): (1) Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment; (2) water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels; (3) women play a central role in the provision, management and safeguarding of water; (4) water has an economic value in all its competing uses and should be recognized as an economic good.

Ecological demand of stream flow: The minimum stream flow required for prevention of irreversible ecological degradation. This value varies over the year and from one place to another. To maintain a healthy environment, the flow must be higher in the wet season than in the dry season, because many aquatic species have annual cycles that reflect their natural habitat. Sometimes, the water-level is critical, rather that the flow rate.

Endemic: Occurring only in one specific geographical area (for example one country, one river basin, or one island).

Eutrophication: Excessive supply of nutrients, resulting in a high primary production. Eutrophication can have negative ecological effects, such as large fluctuations of dissolved oxygen between night and day, or damage to benthic vegetation due to shading by algae.

Flow: Volume transport per time unit (for example through a cross-section of a river).

Frequency: Number of cycles (or units or events) per unit time.

Gauging: Measuring at a fixed point; a gauge is a measuring device (e.g. for water-level or pressure).

Gross domestic product (GDP): the total output of goods and services for final use produced by an economy, by both residents and non-residents, regardless of the allocation to domestic and foreign claims. It does not include deductions for depreciation of physical capital or depletion and degradation of natural resources.

Immediate objective: The intended situation that is achieved as the direct result of orderly implementation of a plan (or programme or project). The immediate objective is the result of a number of outputs, which, between them, are necessary and adequate for achieving the immediate objective. Some authors recommend a maximum of 3 immediate objectives, and that these are specified in time, space, quantity, and quality and target group. See also development objective.

Integrated farming: An area-intensive and labour-intensive combination of different parallel productions, like a fish pond, paddy, fruit trees, livestock, cash crops and vegetables. Integrated farming can give yields that highly exceed monoculture yields.

Integrated Water Resources Management (as defined by Global Water Partnership): A process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Opportunity costs: The cost difference between one course of action and another (better) course of action. In a wider sense, the implications of one course of action are relative to alternative strategies. In development projects, the opportunity costs can reflect the time lag from when a new technology emerges and until it becomes available to the target group. There is often an opportunity cost related to doing nothing.

Photosynthesis: The primary production (by plants, algae and some bacteria) of simple carbohydrates (such as sugar), normally from (inorganic) carbon dioxide, and using energy supplied by the sun.

Phytoplankton: Photosynthetic aquatic micro organisms (algae).

Pollutant: A compound that is harmful or otherwise undesired in the environment, either absolutely, or at an elevated concentration level. See also contaminant and xenobiotic compound.

Pollution: Release to the environment of a substance that can harm it.

Salinity (of sea water): Relative mass of the salt contents, given in PPT (parts per thousand) (kg per 1,000 kg), or in PSU (practical salinity units) (which is very nearly the same as PPT).

Scenario: A hypothetical combination of events and physical conditions, describing a possible future situation.

Sector planning: Planning for a specific source of income, like agriculture, fisheries, hydropower, industry, service, tourism, etc.

Seepage: Slow movement of water in the ground, or from the ground to the surface.

Stakeholder: A person, group or institution that has a particular interest in an activity, project, programme or policy. This includes both intended beneficiaries and intermediaries, winners and losers, and those involved in, or excluded from the decision-making process. A key stakeholder is one who can significantly influence or who is otherwise important to the success of the activity, project, programme or policy.

Strategy: (1) A conceptual plan for how to reach a goal; (2) a plan, method or series of actions designed to achieve a specific goal or objective.

Subsistence economy: An economy in which agricultural, hunting and other activities are undertaken primarily to meet household consumption requirements.

Transparency (of a procedure): The insight conveyed to the data user about how the data were produced, for example for assessing the validity of the data for a given, possibly unforeseen, purpose. An acceptable transparency is obtained by documentation and can be supported by using standard procedures.

Vector-borne disease: A disease transmitted by an organism (for example malaria).

Water availability: The flow into an area from upstream, plus the (surface and groundwater) resources generated by net rainfall in the Sub-area, minus the ecological demand within the area and at its downstream boundary. The availability changes slowly, from one decade to the next, due to medium-term climate variations, or due construction of reservoirs or diversions. The availability can be measured, and/or determined by numerical modelling, often with a high accuracy (subject to the coverage and quality of the basic hydrological data).

Water demand: The amount of water required for a given purpose, for example litre per person per day, or mm per crop. The demand can be present or future, and it can be actual (i.e. related

to an available infrastructure) or potential (assuming full infrastructural development and no water shortage). The serviceable (part of the) demand is limited both by infrastructure and water availability.

Water pricing: A tool for management of water allocation between areas, sectors and individual users, assuming that an 'optimal' allocation (or just a sustainable allocation) can be determined on the basis of a water price that reflects the full costs (and hereby the full value) of water (for example, in economic theory, by charging the full costs and relying on free market mechanisms for allocation). Such a strategy can improve water efficiencies and reduce waste of water. It will often give preference to industrial allocations rather than irrigation. See valuation and cost of water.

Watershed: A line in the landscape (e.g. a ridge) that delineates a catchment. The surface runoff on each side of the watershed will proceed towards different locations.

Wetland: An area that is covered by water in at least a part of the year. A wetland can represent a special ecological habitat, sometimes with a high biodiversity, and can serve as a fish breeding ground. The Ramsar convention defines wetlands quite broadly as 'areas of marsh, fen, peat-land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including marine areas with a depth less than 6 m at low tide'.

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