

Draft

Past and Future

Analysis

for Mekong BDP,

Sub-Area 1L, Lao PDR

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4 March 2004.

The analysis is based on data from:

- Data collection and collation by district and provincial staff in Sub-Area 1L
- Collation by the Lao National and Sub-Area BDP Working Group,
- Collation and review by National consultants (National and Sub-Area Sector Reviews)
- Mekong River Commission maps, data bases and reports
- the Jica/MAF Agricultural Master Plan Study
- and some other sources

This sub-area report comes in six parts:

Part A Summary, Table of Contents, Introduction and Objectives

Part B Short Sector Analyses, Scenarios and Strategies

Part C Full Sector Analyses, Scenarios and Strategies

Part D Cross-Cutting Strategies, Integrated Scenarios, Integrated Strategies, Conclusions, Projects and Matrix of Changes and Consequences in Catchments

Part E Time Series Proformas

Part F References

A Final Work Record Report with attachments has also been produced

*Part A: Summary Analysis, TOC,
Introduction and Objectives*

**for the Lower Mekong BDP
Sub-area 1L, Northern Lao PDR**

SUMMARY

Introduction

This whole document (Parts A-F) was written over about 3 months in a 4 month consultancy at LNMC from November 2003 to March 2004.

This summary provides a summary of the main facts and ideas but it is not enough to lead to a satisfactory understanding of this complex issue. All readers are urged to also read at least Part B: the 'Short Analysis'. The sources of data are only given in Part C: 'the Full Analysis'. This study is largely based on six provinces wholly within Sub-Area 1L (SA 1L) of the Mekong Basin except where maps are available of the whole sub-area.

The development challenge in Northern Lao PDR seems enormous. The severest poverty is predominantly in the hills and mountains. It is perhaps the very high infant mortality and poor access to food that are the most serious issues.

Government policies and strategies are supporting balance and integration in development, making water resource planning relatively easy. Two important but underrated concepts, diversity and learning, can help understand the issues.

Water and Related Resources

The contribution of SA 1L to the Mekong flow can be roughly estimated at 47,000 Mm³ per year. Water consumption through human activity in the sub-area is less than one percent of this figure.

Because of the large proportion of people living near subsistence lives, their main use of water 'consumptive' and 'non-consumptive' is for domestic water, rainfed agriculture and multi-forest products, aquatic wild harvesting, irrigation and local river transport.

Urban and related growth is giving rise to changing demand for water-related products and new waste. The neighbouring nations present both opportunities and threats.

Ultimately each sub-basin or tributary catchment should be studied and planned separately.

Watershed Management

Because about 90 percent of land in the Sub-Area 1L is hilly and mountainous, watershed management is the most important sector. Despite several major studies, the data on land cover/land use, in particular that on the area of shifting cultivation, are hard to reconcile. More effort is needed to study time-series data and compare methodologies used by various agencies and teams.

Deforestation seems to have increased in the 1990s due to the growth in roads and some other infrastructure. Forest covers only a very small percentage of the central part of SA1L. Wild harvesting by villagers (NTFP) in the forests here is severely threatened by forest loss.

The forest area is still declining, so if shifting cultivation is declining this must be due largely to logging. Although timber plantations are needed they are not an alternative for conserving forest and promoting forest regrowth. Forests are better moderators of water movement. If SA1L is to develop in a balanced way in the long-term, as a minimum:

1. logging must be made sustainable
2. land allocation must be improved and
3. diverse and contour-based, sedentary permanent farming, timber planting and micro-finance must be taught to shifting cultivators.

Bio-diversity, bio-density, contour planting and careful cultivation to conserve soil, are needed to reduce in-situ and down-catchment degradation.

Better furniture design for export, support for regrowth around small remaining forest areas, training using interactive radio and in-village, whole-village face-to-face interaction, timber certification, community management of forest, should also be promoted. Timber plantations and support for forest regrowth may take off if the Kyoto agreement is implemented. Pilot projects are needed now.

Land slides and mud flows may occur, especially where clear felling of forests is still occurring. Eroded soil that becomes sediment does not travel as fast as many assume. The results of watershed management are thus long term for large catchments

Fisheries

Most of the people of the Lao PDR depend on fisheries, including aquatic invertebrates, for their protein input to some extent. Wild (capture) fisheries are particularly important for subsistence farmers. The volume of this traditional production seems stable but fish size is decreasing. Community-based management systems that can control over fishing are important to maintain native aquatic biota. Aquaculture has overtaken wild fisheries production and has been growing rapidly from 2000 supported by government fingerling production. Most aquaculture is practiced commercially, not for subsistence. Extension and micro-finance is needed for aquaculture to contribute to poverty reduction.

But alien aquaculture species and varieties grown in low diversity conditions will suffer disease and will escape and degrade native fish stock, so research is needed on ways to minimize this. River fisheries are now being badly affected mainly by small irrigation weirs, watershed degradation and increasingly over-fishing. Alien fish will contribute to degradation in the future. Any dams and large weirs, especially those without large effective fish passes, will badly affect future native fisheries. It is especially important that the native stream fisheries are conserved for preferred consumption and because aquaculture is dependent on inputs from native fisheries worldwide.

Electricity Use/Demand and Hydropower

Lao PDR landscape has the physical potential to generate a maximum of about 18,000 MW of electricity. For the four riparian nation region the peak demand is about 20,000 MW, projected to grow to 80,000 MW by 2020, hinting at the export potential. But long-term prices are uncertain under competitive conditions and large hydropower systems take many years to build. Only one medium site on the Nam Beng to supply only northwestern demand in SA1L seems likely to be built in the foreseeable future. The very long list of, socio-economic, ecological and other environmental constraints makes medium and large scale hydropower even less viable.

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 negative impact dams, flooding very little agricultural land, with researched fish ways, together with a large number of low impact very small hydro schemes based on local demand, including, in-river floating turbines and perhaps real run-of-river schemes on tributaries, integrated with solar power, will be feasible.

The storage in medium dams will reduce downstream flow in the wet season, increase flow through the dry season, and strongly reduce sediment movement. The full cascade of dams in China will have a marked influence on the water and sediment flow in the Mekong. All medium and large dams have a combination of positive and negative effects, including those on livelihoods, that should be carefully evaluated.

Dialogue is needed at least with the wild-capture bio-aquatic sectors to determine what size, timing and quality of releases are needed and the importance of fish passes to maintain the riverine ecosystems to a reasonable extent in any dammed river.

Irrigation

Riverfed irrigation covers small areas in SA1L. Irrigation construction by the government expanded rapidly in 1998-2000 but has now slowed considerably. Total irrigated areas in the wet and dry season are about the same at 18,000 hectares. Water consumption by irrigation in six provinces of SA1L uses about 200Mm³ per year which is less than half a percent of the contribution of SA1L's stream flow to the Mekong.

From 2005 total government agricultural investment capital investment will equal recurrent expenditure. Government effort on irrigation will be aimed at improved management of existing schemes. Pump schemes favour fish migration but incur large recurrent fuel, maintenance, repair, rehabilitation and replacement costs. Research is needed to see if large fish passes on weirs are a more cost-effective solution for communities and the nation.

Future water consumption will depend on increase in irrigation area, the rate of change from rice to row crops and any rise in application efficiency. Irrigation is now

nearly half the rainfed wet rice area so annual water consumption may nearly double to about 400Mm³ by 2020. Oudomxay experienced a decline in the area of wet season wet rice after 1990.

Traditional irrigation schemes may be tending to deplete small streams but supply alternative aquatic environments for fish. Research is needed on the change in access to fish.

Water Supply and Waste Water

Domestic, office and industrial water consumption in SA1L consumption is now about 30Mm³. In most towns and villages people individually use pond and river water, but also wells and springs. Most still defecate in the field or bush. We have little accurate data about the state of repair of facilities or the number of water and sanitation systems in good working order. Diarrhoea deaths nationwide are declining uncertainly. Waste water discharge, including that from mines, needs monitoring.

The proportion of rural population to be covered by clean water and sanitation is projected to increase to 90 and 80 percent of the population respectively by 2020. The urban population will all be using piped water. Water consumption in SA1L will increase to about 100Mm³. The government will achieve this by privatization in accessible areas and stronger efforts to help hill and mountain people.

Navigation and River Works

River works include ports, blasting and dredging, and bank protection. The latter is primarily concerned with riverside land values and thus is really a different sub-sector. Riverbank erosion and collapse have at least eleven causes which need more research. Surveys have been done in some areas on the mainstream. Many 'obstacles' have recently been blasted and dredged in the upper part of SA1L facilitating navigation but disturbing local aquatic ecosystems, at least temporarily.

The sudden increase in both passenger and merchandise traffic nationwide in early 1990s indicates a need for regulation. Growth in the China-Lao river trade may be paralleling the Yunnan-Thai trade that has been growing at 40% per year. But continued growth in the Northern river trade could be jeopardized by the finishing of two roads from China to Thailand. The government has ten policies /strategies to improve navigation especially on the mainstream link to China.

Floods and Mitigation

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. Flash floods occur on small tributaries. Moderate floods have significant benefits as they replenish the flood plain with nutrients for plants, both natural and cultural, and the aquatic ecosystems.

Increased flooding not only results from watershed effects but population and settlement growth and design on the flood plain. There are essentially three types of flood mitigation that can be carried out: structural, ecological and socio-economic.

Given the motivation that flood plain people have for avoiding the worst floods, progress on several mitigation approaches on the flood plain should be among the easiest.

Tourism and Recreation

Tourism is now the top foreign exchange earner for Laos topping USD100M per year. Luang Phabang clearly dominates the tourist numbers in Sub-Area 1L, but the numbers are influenced by security conditions and health scares. The rate of rise of revenue from tourism at about US15million per year over the last 10 years has fallen recently. Long-term growth may be irregular perhaps averaging US10 million per year.

The government is promoting: 'pro-poor, community-based tourism' which depends strongly on environmental and cultural conservation and research into new tour ideas. Safety may be a key issue for water-related tourism.

Conclusion

Watershed management is undoubtedly the major challenge in hilly and mountainous SA1L. There is a major overlap with poverty reduction. A combination of research, training of staff and then villagers and companies in sustainable forest management and permanent steep land farming is necessary. Future production on sloping land may be increasingly dominated by production for the market, especially fruit, timber, other tree crops and livestock with decreasing areas of rice. Electricity can undoubtedly be generated using a wide range of small to very small socio-environmentally convivial schemes, including solar power, and very few medium hydro schemes with researched fish passes. For the region to maximize and spread benefits and minimize costs of all types, electricity staff should continue their dialogue at least with the fisheries staff.

Irrigation and all domestic, office and industrial water consumption may rise from about 230 Mm³ or 0.5 percent of the SA1L's contribution to the Mekong in 2000 to about 500 Mm³ or about 1.3 percent of the sub-area contribution by 2020. But as rainfall is likely to increase the percentage will be less. Study is required on riverbank erosion/collapse, boat regulation and the effect of irrigation and its weirs and dams on fisheries, among other topics. Flash flood warning needs attention. River tourism could be promoted.

Integrated scenarios are found in Part D

Projects

The collection of time-series data in several sectors has been fruitful. The value of additional data and subsequent analysis, especially in some areas, has led to several proposals for data and study projects. Many of these projects would best be run nation-wide or basin-wide. Projects have been proposed on global warming, rainfall, tributary flow, bank erosion/collapse, mass movement and sedimentation, boat regulation, and particularly a time and space study on land cover/land use. But data is also needed on earthquakes, and reservoir characteristics.

Other projects are proposed on HRD topics and methods, MRC-national Mekong agencies/line agency institutional relationships, drought, small area forest regrowth, timber plantations, furniture design, control of alien fish species and varieties, traditional irrigation and fisheries, a base-line study before a medium or large dam, comparison of the costs and benefits of pump and weir/gravity irrigation on tributaries, flash floods and the potential of water-tourism.

Oudomxay as a province stands out as needing support due to a combination of high poverty, forest degradation, weak development of timber plantations and decline in rice area. Also a medium dam is planned on the Nam Beng. An integrated project led by LNMC is proposed for the Nam Beng Catchment as a small model of the larger Mekong Basin project.

All projects should include *learning support* for staff at all levels to increase long-term national capacity.

It is realised that only a few of these projects are obviously trans-boundary, but some will have long-term long-distance effects. Many could be implemented basin-wide and all are important for SA1L.

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ACRONYMS

ADB	Asian Development Bank
BDP	Basin Development Planning
CH4	Methane
CO2	Carbon Dioxide
FDI	Foreign Direct Investment
GTZ	German agency for International development
ha	Hectares
HIV/AIDS	Human Immunodeficiency Virus/ Auto Immunodeficiency Syndrome
HRD	Human Resources Development
ID	Irrigation Department
IWR	Integrated Water Resources
Jica	Japan International Cooperation Agency
km	Kilometres
LA/LUP	Land allocation/Land use planning
LNMC(S)	Lao National Mekong Committee (Secretariat)
lpcd	Litres per capita per day
MAF	Ministry of Agriculture and Forestry
MIH	Ministry of Industry and Handicrafts
m	Metres
mm	Millimetres
M	Mega
MRC	Mekong River Commission
MW	Megawatts
NGO	Non-Government Organization
NPEP	National Poverty Eradication Programme
N, E, S, W	North, East, South, West
NBCA	National Biodiversity Conservation Area
NFI	National Forest Inventory agency
NSC	National Statistics Centre
NTFP	Non-Timber Forest Products
NRDS	Northern Regional Development Strategy
OPEC	Organization of Petroleum Export Countries
Lao PDR	Lao Peoples Development Republic
PR China	People's Republic of China
SAIL	Sub-Area 1 Lao
SAWG	Sub-Area Working Group
TOC	Table of Contents
UN	United Nations
USD	United States Dollars
UXO	Unexploded Ordnance (Bombs)
WM	Watershed Management

INTRODUCTION

Following the 1995 agreement between Cambodia, Lao PDR, Thailand and Vietnam for the cooperation for the sustainable development of the Mekong River basin, the Basin Development Planning (BDP) Unit of the Policy and Planning Division of the Lao National Mekong Committee Secretariat (LNMCS) has been given the mandate to prepare integrated water resource plans for four sub-areas, known as 1L, 4L, 6L and 7L of the Lower Mekong Basin within the Lao PDR. Although planning for all sub-areas is proceeding more or less in parallel, planning for Sub-Area 1L covering most of northern Lao PDR is more advanced. Sub-Area 1L contains four major tributary catchments {sub-basins} and many smaller ones. The planning process is outlined in a series of Mekong River Commission documents. Some suggestions on the process have been made in monthly reports and others can be found in parts of this 'past and future analysis' report.

This report was prepared over about three months within the period 5 November 2003 to 4 March 2004. The focus asked of the consultant was to use data and reports available at LNMCS and being assembled from the line agencies and CPC by national consultants in the BDP team.

Six provinces of the Lao PDR wholly within Sub-Area 1L (SA1L) 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.

Basin development planning (BDP) for SA1L covers water and water-related eight sectors and four themes. This report covers analysis of the past and projections and plans, scenarios and strategies for each sector. The scenarios and strategies for each sector are discussed immediately after the 'historical' analysis for the sector in order to make them more understandable. Readers will notice that it is not always easy to separate the strategy and the scenario. Really what is needed is alternative strategies to go with each scenario.

Short and Full versions of the 'sector analyses, scenarios and strategies' are provided quick and detailed consideration. The short version was originally prepared for 'screened' presentation.

Two integrated scenarios, one with a focus on growth and one with a greater focus on poverty reduction and conservation follow consideration of the four cross-cutting themes. These scenarios are followed by a section on projects which starts with suggestions on project selection and then a suggested 'long list' that importantly is derived from the overall analysis. Time-series proformas that can be used to help collect data precede the references.

The six parts to the report are as follows:

Part A Summary Analysis, Table of Contents, Introduction and Objectives

Part B Short Sector Analyses, Scenarios and Strategies

Part C Full Sector Analyses, Scenarios and Strategies

Part D Cross-Cutting Strategies, Integrated Scenarios, Integrated Strategies,
Conclusions, Projects and Matrix of Changes and Consequences in Catchments

Part E Time-Series Proformas

Part F References

OBJECTIVES

Management and Development Objectives

During an early stage of the planning process provincial staff in a grouping known as the Sub-area 1L Working Group expressed support for the following development objectives:

This analysis and its summary form is part of the basis for a reconsideration of these objectives at the next SAWG meeting.

Suggested Objectives, Strategies and Methods for the Water-related Development in Sub-Area 1L

Overall Objective (Goal): To manage water-related resources to maximize the benefits of the people of Sub-area 1L and the Lower Mekong Basin in the long-term.

	Sector Objectives	General Strategies		Specific Methods
1	Access to sufficient clean water and sanitation for household (domestic) use	1. Decentralization/Vertical and horizontal dialogue 2. Public Participation/Community management of development 3. Human Resources Development (Training and other learning support for staff and the public)	1.	<ul style="list-style-type: none"> Increased support for construction, maintenance and repair of water supply and sanitation in hill and mountainous villages Support for community management of water supply and sanitation, including micro-finance. Support the private sector in easily accessible places.
2	Food security	4. Gender Mainstreaming 5. Conservation of natural ecosystems where at all possible	2	<ul style="list-style-type: none"> Promote research, access to material inputs, extension, micro-finance and self-management for irrigation. Promote conservation of environments supporting wild foods on land and in water.
	Rice			
	Fish			
	Meat			
	Fruit & veg			
3	Conserving forest, soil and aquatic ecosystems	6. Research on development issues and problems closely related to action programmes 7. Pricing government services at real cost where possible, except where providing basic needs to the very poor 8. Support micro-finance including savings and loans groups and bank loans. 9. Improve alternative job creation/income generation using training and micro-finance.	3	<ul style="list-style-type: none"> Eliminate opium growing Reduce shifting cultivation. Improved land allocation Effectively stop all clear felling and gradually reduce all logging until it can be shown that logging is sustainable. Specific forest regrowth programs around the smallest remaining forest areas. Planting timber trees supported by training and micro-finance. Support for NBCAs Support stream environments
4	Expanding river trade	10. Raising the standard of regulation of the private sector	4	<ul style="list-style-type: none"> Supporting trade-related organizations through training Improving navigation. Improve speed, safety, discharge and noise regulation of river traffic.
5	Flood mitigation with wetlands conservation	11. Supportive policies, laws and regulations, strategies, operational methods, including adequate incentives for staff	5	As for 3. plus levees, drainage and settlement/land use planning, improved building siting and design, broadcasting, remote gauges.
6	Expanding eco-cultural tourism	12. Budget for initial and operating costs at all levels 13. Revenue enhancement	6	<ul style="list-style-type: none"> Conserve environment especially at selected sites and all culture. Improve entry procedures Micro-finance for new entrepreneurs.
7	Develop appropriate hydropower sites		7	Conduct a regional study of very small, run-off-river and in-river turbine hydro-power potential in SA1L. Make the results public and invite private investment. Conduct Socio-economic and Environmental Impact Analyses on any proposed medium and large dams.

Cross Cutting Objectives

<i>Objectives</i>	<i>Strategies</i>
Poverty Reduction	Support 47 poor districts. Participation/sincere dialogue and training are the most important methods
Gender equity	Promote women's participation in all fields Supports schooling for girls Support women's recruitment, skills and promotion at work Promote fair work burdens in the households
HRD for all levels of people	Support training (learning support) to achieve basic needs improved livelihoods, regional development and environmental conservation.
Environmental conservation	Promote biodiversity and biodensity in all environments, soil conservation. Minimize pollution.
Stakeholder participation at all levels	Decentralization, dialogue between levels, bottom up approach, using mass media,
Food security	
Income generation/job creation	Promote private investment, particularly SME, vocational training, road (infrastructure) building, extension, micro-finance, marketing support,

Proposed Summary Basin-wide Objectives

Comprehensive basin-wide objectives have been proposed by MRC staff. Here a short or summary version is proposed to help focus attention of the key issues.

Overall Objectives

While promoting the livelihoods, culture and happiness of the people of each nation in the Lower Mekong Basin, and allowing for the poorer nations in the basin to more or less catch up to the richer ones in material development, each nation sincerely aims to:

A. Strive to minimize negative changes to the basin environment due to external and internal influences including atmospheric and water pollution, disease, trade, migration, travel, investment construction etc.

B. Strive for a water flow regime into down-catchment nations and past across-stream nations at quantities and qualities (and with the sediment load), and with velocity and surface roughness as close as possible to the ‘baseline’ (1995?) level.

Specific Objectives

1. Watershed: Maintain and improve the biotic diversity and density, and the stability of soil and river bank material, in each watershed of the basin
2. Storage and Diversion/Extraction: Minimize the changes in stream water flow and associated material flow regime that may be caused by storage or diversion/extraction, especially as it might affect aquatic and flood plain ecosystems and environments.
3. Excavation and Building up: While managing severe flooding and promoting navigation, minimize the changes in water flow regime and material flow regime that may be caused by changes to the stream channel and flood plain.
4. River Craft Regulation: Minimize the effect of ships, boats, barges and ferries on the river environment, especially surface roughness, water quality, collisions, sinking and noise.
5. Waste Water and Materials: Minimize the pollution caused to streams and groundwater by waste water and materials discharge from cities, towns, villages, waste dumps, logging areas, irrigation, aquaculture, rainfed agriculture, tree plantations, factories, quarries and mines.
6. Cultural/Social Conservation: In consultation with the local people, while promoting critical material livelihood development, support local people to maintain communities and cultures as close as possible to their desired state.

***Part B: Short Sector Analysis,
Scenarios and Strategies***

**for the Lower Mekong BDP
Sub-area 1L, Northern Lao PDR**

INTRODUCTION

References to sources of data are not provided in this Part C but can be found in the Part D: 'Full analysis'.

Largely based on Six provinces of the Lao PDR wholly within Sub-Area 1L (SA 1L)

1. Bokeo,
2. Luang Namtha,
3. Phongsali,
4. Oudomxay,
5. Luang Phabang and
6. Xayabouli,

You will see many gaps and uncertainties in the data that need to be filled in and resolved. The data gathering process is in need of improvement.

The Local Challenge

The development challenge in Northern Lao PDR seems enormous. Some important conditions in SA1L are

1. Land that is about 95 percent steeply sloping, excluding Xayabouli.
2. Most of the forest has gone in the central zone of SA1L.
3. The people are 'materially poor' by modern standards, but not necessarily by their own standards.
4. Many have poor health. In some hill and mountain villages about one in three children dies in its first year.
 - But the people are culturally rich.

Two important concepts can help understand the issues diversity and learning.

Diversity is critical for ecological and socio-economic stability,

Learning at all levels is needed to maximize future benefits and minimize the costs or problems

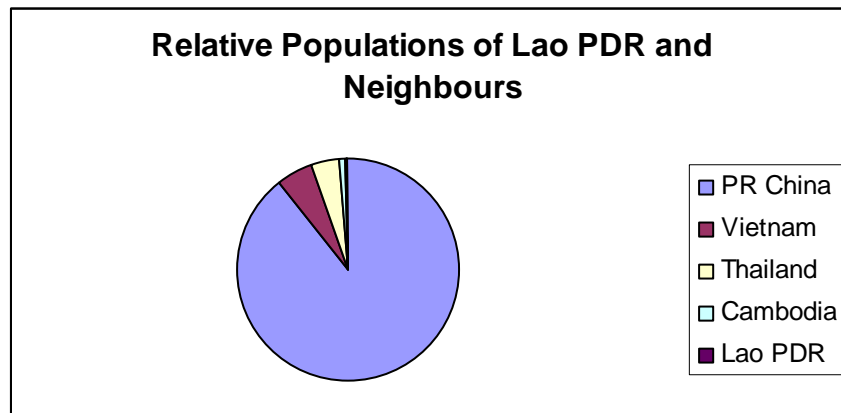
Government policies and strategies

The NPEP has three 'pillars' or objectives:

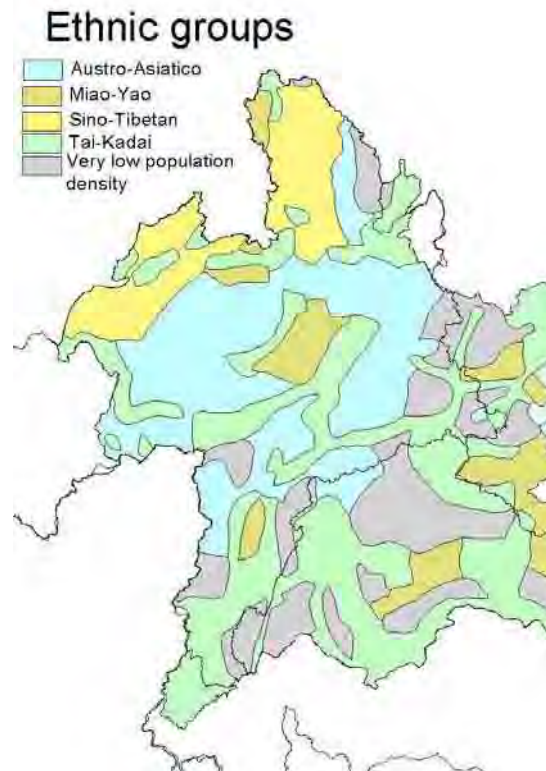
1. Rapid growth with equity,
2. Socio-cultural development and
3. Conservation of the environment,

POPULATION AND PEOPLE

The large and rapidly growing neighbours are both an opportunity and a threat



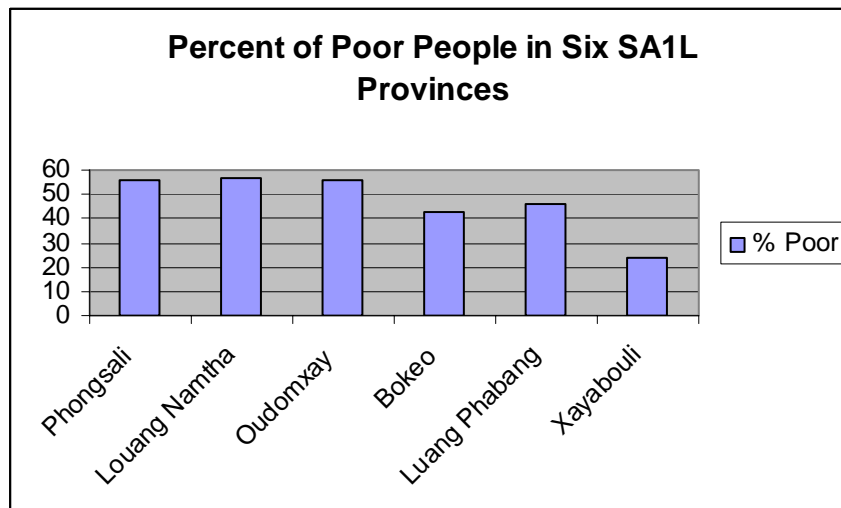
The ethnic groups in SAIL can be seen in the map below. Phongsali has by far the highest proportion of ethnic minority population at 92.4 percent.



Livelihoods and Living Standards

Notably in Xayabouli province has a lower incidence of poverty with its large areas of plains and undulating land.

The greatest poverty thus must be in the hills and mountains



The People's Opportunities to Gain from Water Resources Development

Because of the large proportion of people living near subsistence lives, their main use of water is for domestic use:

1. rainfed agriculture,
 2. multi-forest products,
 3. aquatic wild harvesting (fishing plus)
 4. irrigation
 5. local transport,
- (roughly in that order).

Rural and Urban Populations

From about 10 percent urbanized in 2000 the urban population may reach perhaps 17 percent of the sub-area by 2020 .

This will give rise to a

1. higher demand for urban water supply,
2. higher industrialization,
3. greater income,
4. demand for a greater variety of rural products, including those from water resources such as irrigated peanuts and river transport,
5. much greater waste discharge to water bodies.

WATER MOVEMENT AND RELATED PROCESSES

The contribution of Sub-area 1L to the Mekong flow can be roughly estimated at 1500 m³/sec or 47,000 Mm³ per year

The data on transportable earth materials (soil and sediment) is also very poor. At this stage we need anecdotal evidence on sedimentation and mass movement from provincial staff.

Proposed General Technical Strategy

- More effort is needed on data collection and analysis.
- Ultimately each sub-basin or tributary catchment should be studied and planned separately.
- Data should be organized according to catchments. Local organizations should be set up for each major catchment and groups of minor catchments.
- Simply a ‘balance of sectors and themes’ for the sub-area is not appropriate.
- It would be best to chose on medium sized catchment to organize a model integrated study and development project as well as make selected studies of the whole area where data are weak.

WATERSHED MANAGEMENT

- Because there is so little flat land in the Sub-Area 1L watershed management is the most important sector.

The watershed classification map should be used flexibly as it is based on slope and soil, and takes no account of villager preferences.

Land cover – Land use

Data on land cover /use comes from two sources of remote sensing (Landsat and SPOT) and village survey.

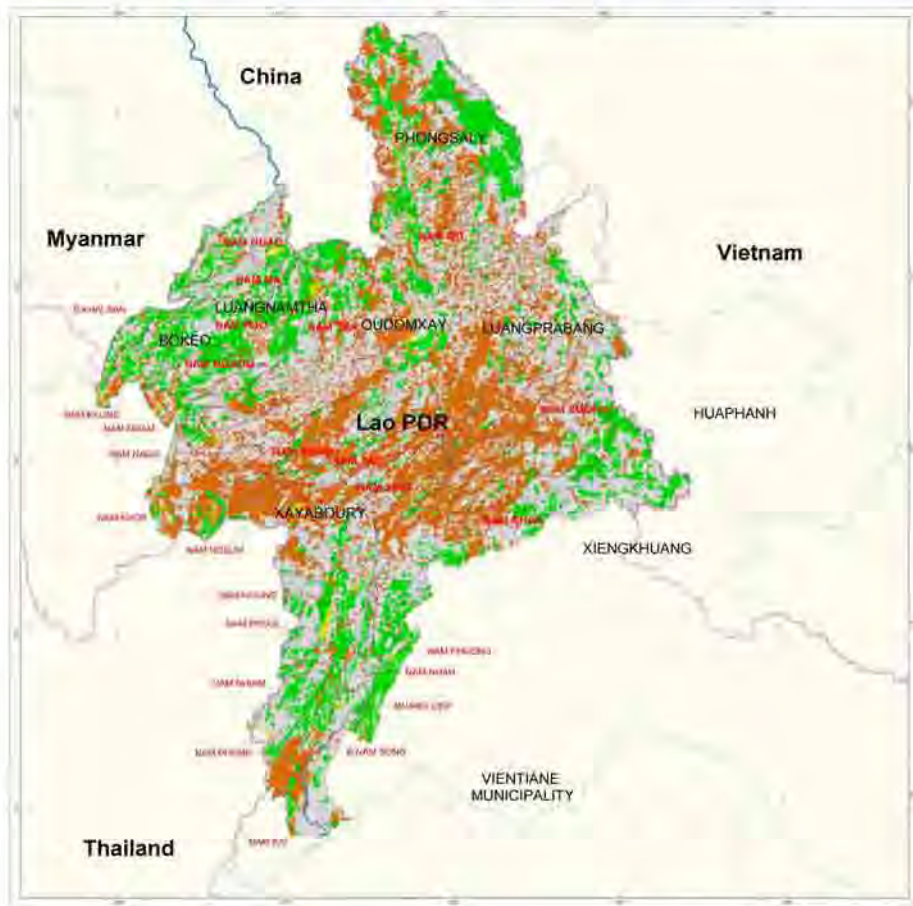
The numbers are hard to reconcile

Percent Area of Shifting Cultivation

	1982	1989	1993	1995	1997	2000	2005	2010
MAF (SPOT) /Jica	3.6%					3.87%	3.9%?	
MRC Landsat Map			approx 25%		approx 5%		0%?	
Survey of Villages				2%		1.2%	0.5%?	0%?

It is notable that Luang Namtha, Bokeo and central Xayabouli have very little shifting cultivation in these maps. Could this be true?

**Forest Cover Map in 1993 of "1L" of
The Basin Development Plan Sub-Areas**



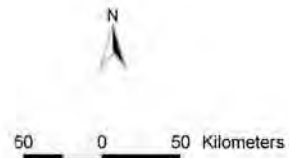
Prepared by
Mekong River Commission Secretariat, Sep 2002



Mekong River Commission

- Land cover**
- Dense Forest
 - Mosaic Forest
 - Mangrove
 - Wetlands
 - Plantations
 - Upland Agriculture/
Shifting cultivation
 - Agricultural land
 - Water body
 - Shrubland, grassland,
other

- Legend**
- Country boundary
 - Sub-Catchment boundary
 - Basin boundary
 - River (water body)
 - Provincial boundary



If shifting cultivation area decreased at this rate between 1993 and 1997 shown in these MRC maps it should have been eliminated by now.

Forest Cover Map in 1997 of "1L" of The Basin Development Plan Sub-Areas



Mekong River Commission

Prepared by:
Mekong River Commission Secretariat, Sep. 2002.

Land cover		Legend		 
	Dense Forest		Country boundary	
	Mosaic Forest		Sub-Catchment boundary	
	Mangrove		Basin boundary	
	Wetlands		River (water body)	
	Plantations		Provincial boundary	
	Upland Agriculture/ Shifting cultivation			
	Agricultural land			
	Water body			
	Shrubland, grassland, other			

The government survey by interview of villagers showed that for Northern Laos:

- The number of families is shown to be falling in parallel.

	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%

If this fall is real how is it occurring?

This said reduction from 1990 or 1995 to 2000 could be due to

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

As the number of families is also dropping the fall in area does not seem to be mainly due to farmers lying about the area they farm in order to avoid taxes.

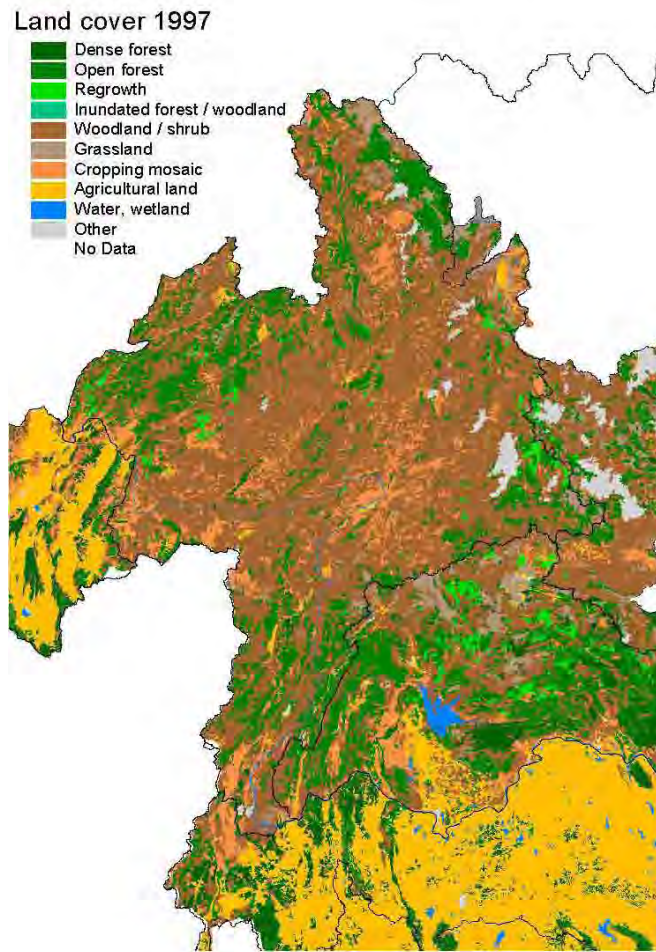
Is it possible that some families denied they were doing any shifting cultivation in order to avoid taxes or other penalty?

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

Forest Destruction

According to both the 1993 and 1997 Landsat images the forest cover in SA1L has been severely depleted, especially in central Luang Phabang province and directly to its west in Oudomxay and northern Xayabouli.

- 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
- Forest is now thought to cover about 41 - 47 percent of Laos depending on the source of data.
- Deforestation seems to have increased in the 1990s due to the growth in roads and some other infrastructure.
- But it only covers about 20-25 percent of Sub-area 1L and only about 5 percent in most of the central part of SA1L. This is where most of the population live (see below)
- 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 regrowth around the remaining stands should be most intense.



- This deforested area and much of the rest of the north is covered by low forest regrowth, scrub, bamboo, and shifting cultivation fields.

Different elements of the population have been practicing

1. Shifting cultivation in the hills for many hundreds, perhaps more than a thousand years
2. Logging by clear felling or rough selection for many decades,



1 0 1 2 Kilometers

Central Phongsaly - deforestation

Where vegetation is

1. not diverse and/or
2. dense and
3. is disturbed by cultivation,

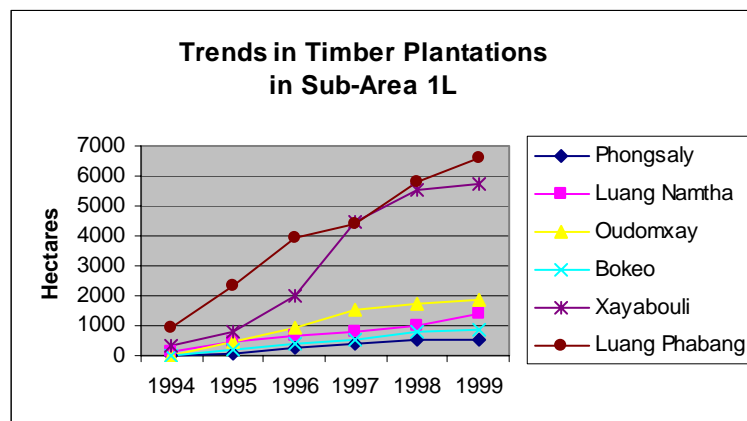
Rainfall and runoff is erosive

- Depleting erodible soil,
- Causing small streams to fill rapidly with muddy water
- That may be deposited behind weirs and in reservoirs and irrigation canals,
- 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

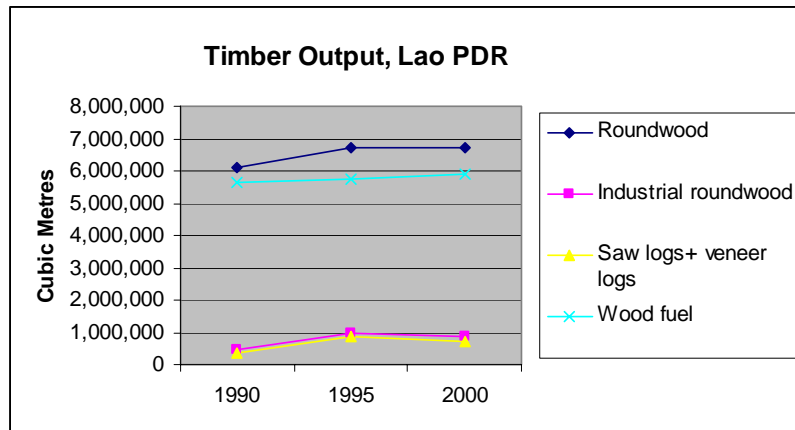
Oudomxay, a large province with reduced forest needs support with timber plantations.



Timber output

The graph below shows

1. The predominance of roundwood in timber output
2. A promising plateauing out of roundwood output from 1995 to 2000.
3. Roundwood exports are said to have declined 20% in recent years.



Present Trends in Deforestation

- The forest area still seems to be declining. This must be largely due to logging if shifting cultivation is markedly decreasing in area.
- Legal measures are resulting in decreased logging. Decreased forest cover is resulting in increased runoff, erosion and groundwater recharge.
- Any reduction in shifting cultivation may take several decades to result in sufficient regrowth to identify as forest.

Land cover/use Scenarios

Two Forest/Plantation Scenarios

1. Optimistic

If logging is reduced and made sustainable and significant areas of regrowth revert to diverse forest as opposed to low diversity grassland, bamboo or 'scrub', that the area of forest could grow and serve as a long term resource for

- A. small scale wild harvesting sustainably, (discuss, added value, culturing
- B. selective logging,
- C. tourism and recreation, and
- D. furniture and other livelihoods
- E. a moderator of overland runoff, erosion and recharge.

2. Pessimistic

If not, then the future is bleak.

- a) Timber production will decline and rely only on the few species grown in timber plantations.

- b) Rapid surface and groundwater runoff will grow and erosion will grow at first but may eventually stabilize as low diversity low productivity ecosystems become established in poorer soils.
- c) Groundwater levels may rise to waterlog flat areas.
- d) Subsistence villagers will suffer further;
- e) eco-tourism and cultural tourism will die, and
- f) the towns and cities will have large numbers of underemployed poor.

Sloping Land Farming Scenarios

A reduction in shifting cultivation seems to be taking place but the rate at which it is taking place, the way in which this is happening and the total area remaining is uncertain. This is included in the integrated scenarios in Part E.

Forest or Timber Tree Plantation Scenarios

In Luang Phabang the government is discouraging teak planting as the villagers are losing their land to urban investors. The rate of planting has slowed but we have not statistics on this. Micro-finance assistance is needed.

If the Kyoto protocol comes to fruition and the emission trading provisions are used in Laos, a careful training and micro-financing plan will be needed to make sure that the benefits are well spread.

Following the slowing at the turn of the century it is expected to pick up following a new development plan.

Timber Plantation Scenario					
Year	1999	2000	2005	2010	2020
Annual Expansion Rate	2,000	1000	1,000	2,000	
Total Area	17,000	18,000	23,000	28,000	48,000

Watershed Strategies

Three land uses offer some hope for the degraded steep slopes.

- Forest regrowth near existing forest
- Timber tree planting
- Permanent, diverse and integrated farming systems
- Livestock, where not in conflict with crop-based farming.

The Value of Remaining Forest

2. Can provide sustenance and subsidiary sales for the people living a subsistence life nearby
3. Attract tourists.
4. Allow **careful** selective logging in a few larger areas
5. Support infiltration to interflow and groundwater zones.
6. Moderate runoff

Forest Conservation

- Further enforcement of laws is probably needed.
- Training in careful ecological selective logging is probably required.
- Certification of tropical timber is resulting in higher prices in Europe. This process should be supported.
- Support for Community management of forests
- Furniture Exports: Huaysai and Luang Namtha towns that has some close-by remaining forest and will soon have a new bridge to Thailand seems to offer the best prospects of furniture making and export. Assistance is needed with design.
- The central area needs strong support for forest regeneration around existing small forest areas as these have the best hope of regenerating to natural high diversity forest.

Timber Plantations

Planting and maintenance of timber tree plantations is appropriate

1. in areas of degenerate ecosystems and low regrowth,
2. where it is too steep for sedentary farming systems, but
3. well away from tall or re-establishing forest.

Timber plantations and support for forest regrowth may take off if the Kyoto agreement is implemented.

Timber plantations offer secure future income to the owner

- 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.
- Vetivia grass strips along contours may be advisable to reduce erosion
- It is best to start promotion slowly and evaluate progress.

Forest and Plantations Compared

Forest regrowth is better than timber tree plantations in three ways because.

1. Forest has a natural biodiversity that provides a range of timber and non-timber products (NTFPs).
2. Semi-subsistence cultivators rely on this diversity, especially in the dry season and after crop failure.
3. Forest is better watershed manager
 - a higher proportion of infiltration
 - less erosion (more protective undergrowth and litter)
 - higher evapo-transpiration
 - a. This results in lower wet season runoff ameliorating local flooding
 - b. but probably higher dry season subsurface runoff.

The mountainous and hilly areas need strong support for forest regeneration around existing small forest areas especially in the degraded areas of central SAIL.

Stabilizing Shifting Cultivation Strategy

Further progress it is planned will mainly take place by training the farmers in new techniques of permanent sedentary farming including contour cultivation and diverse tree and crop culture.

Each family may need a larger land area during the transition to permanent farming

Conclusions

The results of watershed management are deceptive as

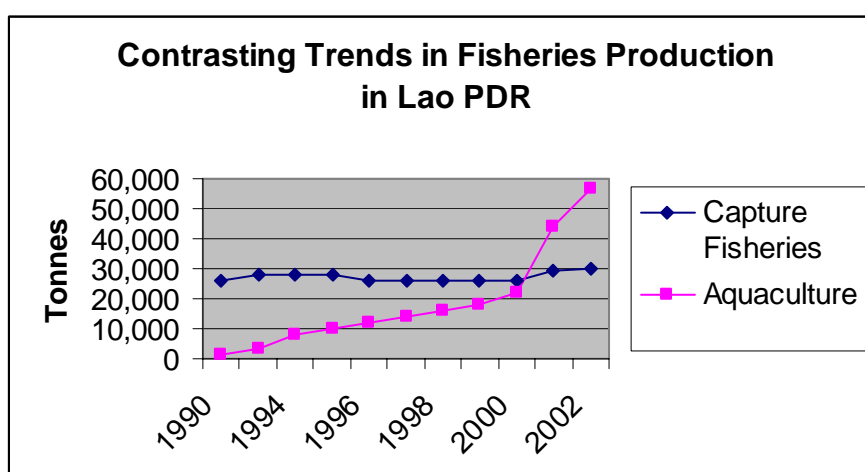
- Sediment does not travel as far and fast as many assume.
- Most sediment is deposited locally and moves on a little in the next heavy rain.
- The results of watershed management are thus long term for large catchments. Do it for your children, grandchildren and beyond.
- The rate at which a reservoir is filled by sediment depends on inflow and trap rate (efficiency!) and the density of sediment, that increases over time.

The future of watershed management depends now on provincial and district operations.

We have no quantitative plans on the area to be covered in each province and district

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.
- Total fisheries production in 2001 was about 72,000 tonnes
- Aquaculture is taking off from 2000 and has overtaken wild/capture fisheries production. Most aquaculture is practiced commercially, not for subsistence.



- 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.

- Community-based management systems are important to maintain living aquatic resources.
- Aquatic animals account for about half of the animal protein intake in these communities.
- Native fish from the wild rivers are more popular with the urban consumers.
- Water consumption by the wild fisheries sector is non-consumptive.
- It is thus especially important that the stream fisheries are conserved.

Environmental Degradation

The average annual catch in the Mekong basin is estimated at 1.5 million tonnes, valued commercially at about USD1000 million.

But the size of fish caught is decreasing markedly. The total tonnage remains stable by catching smaller fish in large numbers.

River fisheries are being badly affected mainly by

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

Aquaculture

In Northern Laos all provinces are involved in fingerling production indicating a potential for growth in aquaculture.

Only 22 million fingerlings are produced in SA1L, but each province has a hatchery operating or under construction.

Village wetlands and Community ponds in some villages. Study and mapping needed management. Wild fisheries

Fisheries Scenario

The four major negative impacts on this 'natural' sector have been and/or are likely to be

1. watershed degradation,
 2. dam and concrete weir construction and
 3. introduction of alien species.
 4. overfishing
- The impact of dams on the wild bio-aquatic sectors is covered below in general under 'Hydropower'.
 - Insufficient data is available to the quantitatively predict the impact.

Fish demand (production-supply) in Lao PDR are estimated at nearly 200,000 tonnes by 2020.

With the present strategy the future of fisheries will largely be in managed fisheries in ponds and reservoirs, amounting to 160,000 tonnes by 2020.

Strategy

- Everyone agrees that better watershed management is needed. This will contribute to the maintenance of wild fisheries.
- On the other hand it is not easy to agree on the best balance between 'modernization' such as electrification from hydro-power and the maintenance of wild fisheries. This is a choice between the most basic needs and less basic needs
- Aquaculture should be promoted with awareness of the risks and thus carefully. Aquaculture could contribute to the overcoming of rural poverty using extension and micro-finance.
- Alien species such as African Tilapia and non-native carps introduced to reservoirs and ponds compete with the diversity of local species and escape up and down river to gradually degrade the local diversity.
- Diverse and thus ecologically stable aquaculture depends on healthy wild ecosystems to provide inputs.
- Thus the wild environment must be protected.

ELECTRICITY USE/DEMAND AND HYDROPOWER

Lao PDR landscape has the physical potential to generate about 18,000 MW of hydropower depending on the source from more than 60 promising sites.

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.

Demand Projections/Scenarios

The annual rate of domestic use/expansion is projected to result in about 90% household coverage by 2020.

Peak Demand		
	2000	2020.
Four Riparian Nations	20,089 MW	80,000 MW
Lao PDR	167MW	

This 2020 four nation peak demand might be compared with the Lao physical potential of 18,000 MW, but

1. Power prices have declined after the 1997 collapse
2. And gas from Burma and Southern Thailand is a new competitive energy source
3. Electricity generation from large dams has a long lead time which makes the production price uncertain.
4. So now fewer hydropower sites are feasible, even without considering the many socio-economic and environmental costs.

Only two small dams (about 1MW) and several very small schemes have so far been constructed in SAIL.

Small-medium sized hydro-electricity generation plants are planned for the upper Nam Beng catchment and near Luang Phabang city

Any serious OPEC led 'oil crisis' 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.

Environmental and Social Issues

This physical potential and the possible benefits for navigation and irrigation must be considered carefully given the economic, social, ecological and other environmental constraints.

Only a small proportion of this 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.

A. Direct Financial Costs/Risks

1. The international market price of electricity,
2. The costs of navigation locks and fish passes
3. Sedimentation in reservoirs limiting reservoir lifetime

B. Life, Livelihood and Cultural Costs for the Community Displaced

4. The loss of reservoir land and ecosystems,
5. The resettlement of displaced villagers and full new livelihood costs (USD16,000 per household is a rough estimate)
6. Displaced and dispersed people's loss of extended family and community networks and culture,

C. Environmental Costs/Risks and Associated Livelihood Costs

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

Flow Regulation Scenarios

Large and medium scale hydro-electricity generation using the head created by deep and wide storage reservoirs inevitably causes changes to the flow regime, not only in the reservoir but also in stream below the dam.

The dam may be operated to mainly generate electricity, especially at peak demand times, but other sectors require consideration.

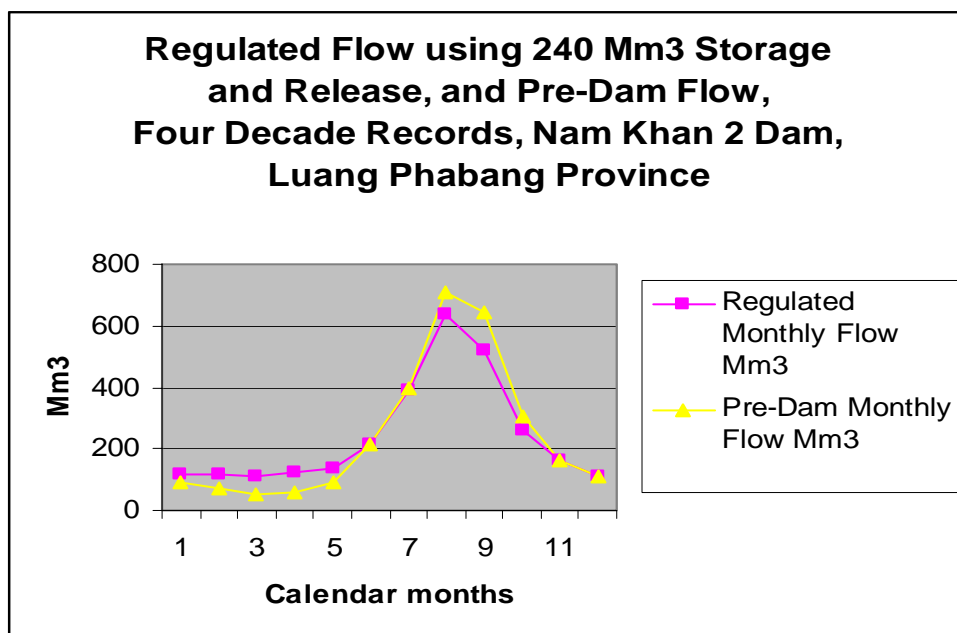
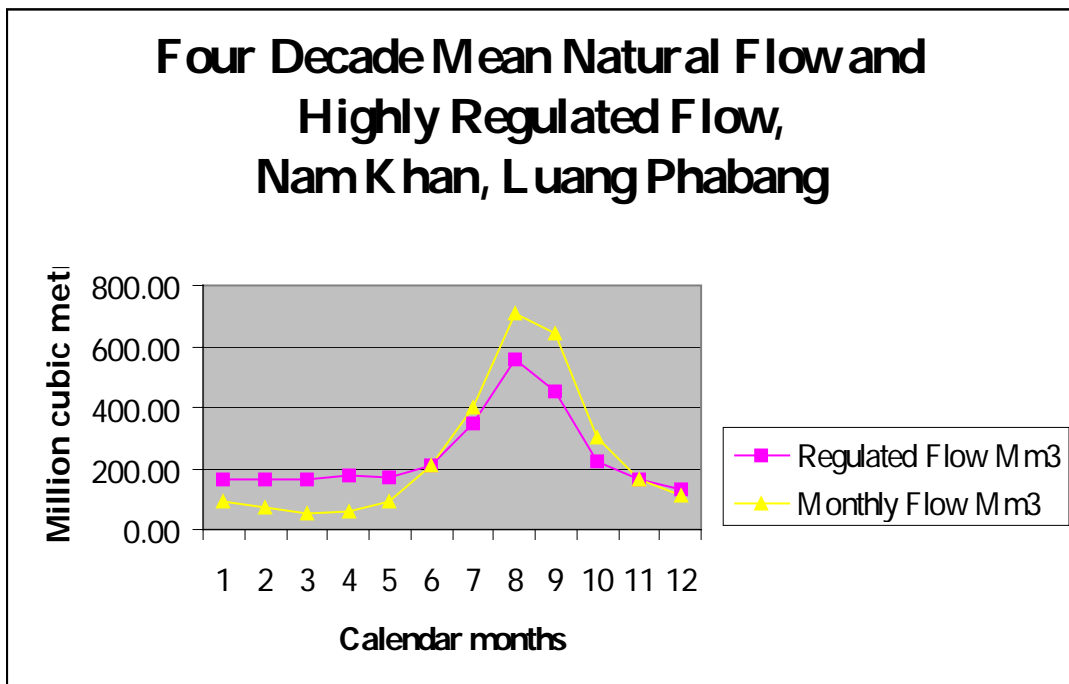
The storage will reduce downstream flow at the height of the wet season and increase flow through the dry season.

Two examples are given below of the operation of a proposed Nam Khan 2 dam (145MW) or a smaller dam on the site in Luang Phabang Province on the Nam Khan (Mean annual flow = 2715 Mm³).

The examples show pre-dam hydrographs and regulated hydrographs. The regulated flow hydrographs are partly arbitrary.

1. In the first example, nearly the whole live storage capacity of 480 Mm³ is filled and in turn released in the dry season. (17% (0.17) regulation)

2. In the second example 50% of the storage is used and released whether from the same dam or a smaller dam. (9% (0.09) regulation)



Even in the smaller storage example the dry season flow could nearly double the natural flow in some months if no large extractions are made.

But

1. The irrigation potential in the valley is small.
2. River transport is believed to be largely small scale
3. The stored water will only lessen small floods which are really desirable.

The full live storage capacity may not be used, as in the second scenario, to allow for occasional late season flood inflows and to minimize the impact on the tributary riverine ecology.

Would a smaller dam run at full capacity be more cost-effective than a large dam used with consideration for all sectors.

It would not be able to hold a late flood, but its full capacity operation would have less effect on the riverine (in channel and flood plain) ecology.

Moreover the storage reservoir would flood less land and displace fewer people.

Of course fish passes are required for a fuller maintenance of the fish environment. Research is needed on fish passes to make sure they work for local species. The higher the dam the more expensive they are.

Dialogue is needed with the wild-capture bio-aquatic sectors to determine what size, timing and quality of releases are needed and the importance of fish passes to maintain the riverine ecosystems to a reasonable extent in any dammed river.

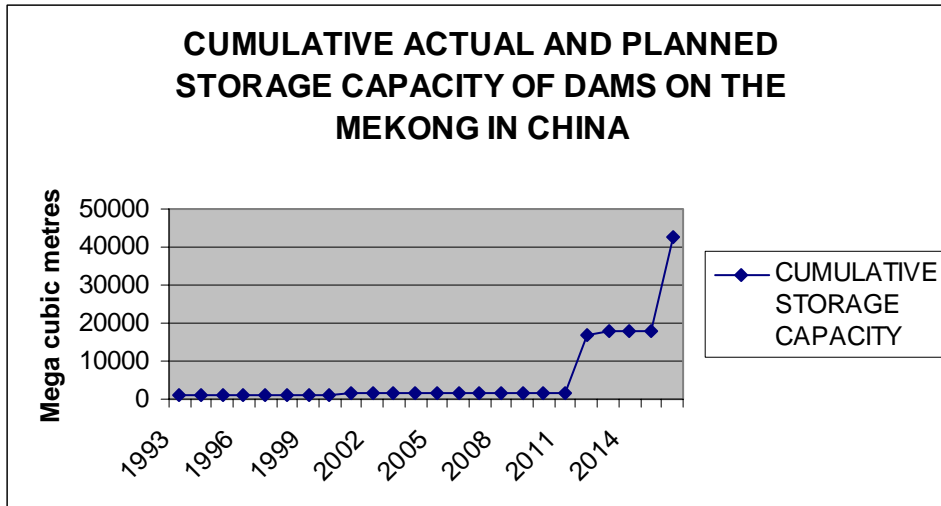
Future Hydro-electricity Schemes

It is the Nam Beng dam that seems most likely to go ahead, supplying local demand rather than export. Its expected date of completion is 2008. Mean monthly flow data are being sought.

A further 40 or so very small hydro sites are being considered and should come 'on stream' in the next 15 years. This number could very probably be increased if support were there.

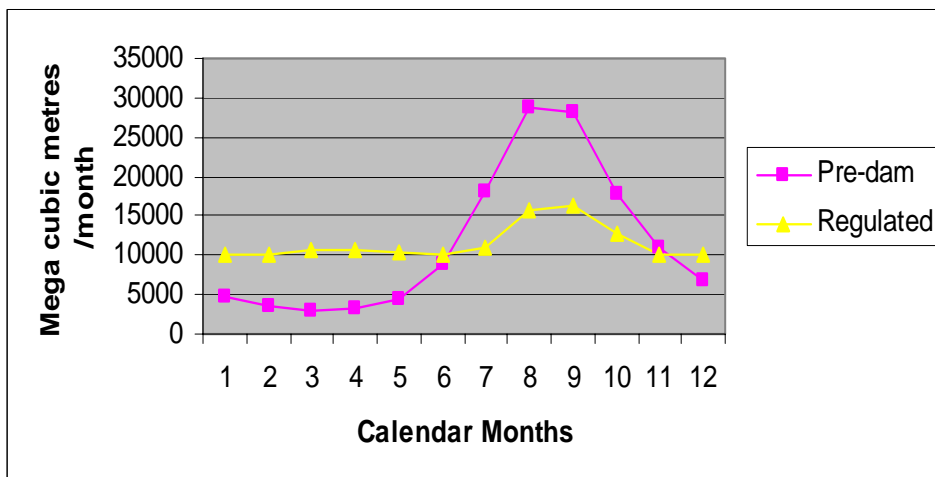
Hydro-electricity Dams in the Upper Mekong Basin

- China has built two large hydroelectricity dams on the Mekong mainstream and is planning to build more.
- This thought to have already reduced suspended load as far down as Pakse
- Figure below illustrates the major increase in storage that can be expected between 2010 and 2016.



Total mainstream storage as a proportion of annual river flow (same units) will increase from 0.02 from two dams in 2004 to 0.77 from five dams in 2016.

Pre-dam and China Regulated Hydrograph on the Mekong at Vientiane



This will cause a decrease in wet season flow, a major increase in dry season flow, at least until major non-dammed Lao tributaries contribute, and decrease in sediment load in the mainstream. This will

- reduce floods, improve navigation (downstream of the lowest dam at least), and reduce dry season pump irrigation head, reduce needed water supply filtration and reduce dry season salinity in the delta.
- but will increase channel erosion, reduce flood plain sedimentation, stop fish migrating above the lowest dam without effective passes, otherwise degrade native fisheries. Because about half of the Mekong sediment is eroded from the Tibetan Plateau the dams will have a severe effect on the sediment load.

Hydropower Strategies

Profitable, Low Impact Dams

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 negative impact dams together with a large number of very low impact schemes may create the lesser of the development problems.

1. say one medium sized dam about 10-15m dam height, 20-15 Mm³ active storage, or generating say 10-100MW,
2. with researched fish ways
3. submerging very little agricultural land,

Together with:

Some run-of-river schemes (insignificant storage)

Some in-river current floating turbines that are on the market. Isolated villages

Also several small, and many very small hydropower generation plants

- 12 very small hydro-schemes in 2003 were supplying just over 3 MW of electricity in SA1L, and 6.4 MW nationwide.
- These rely only on small weirs and so have very little effect on downstream flows.
- Used for isolated villages but with roads as the villagers must have cash.
- These are more certain investments based on local demand.

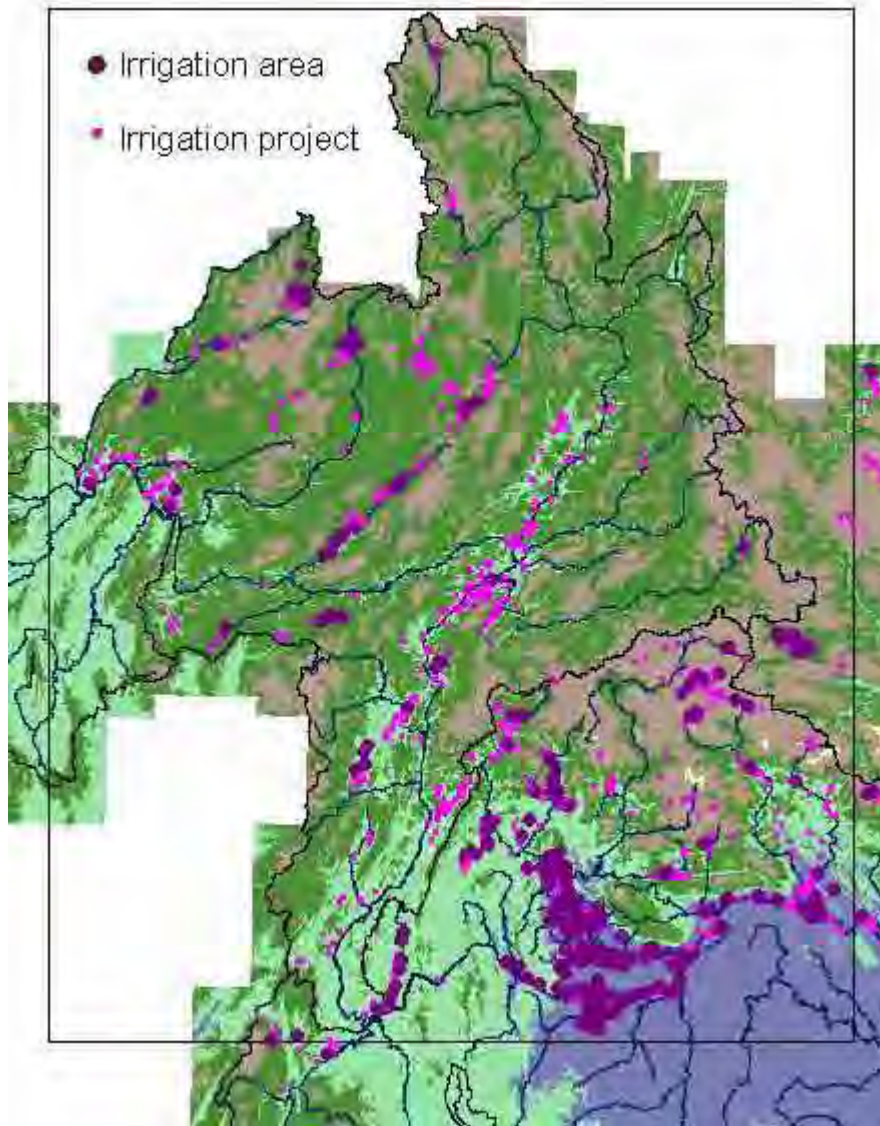
It should be noted that worldwide almost all people displaced by dams are now worse off than they were before the dam was built.

Dams should be designed and operated so they can release water to go as far as possible towards mimicing the timing and nature of the natural flow in quantity, chemically, in temperature and with sediment load.

IRRIGATION

Irrigation is almost always the largest consumer of water.

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

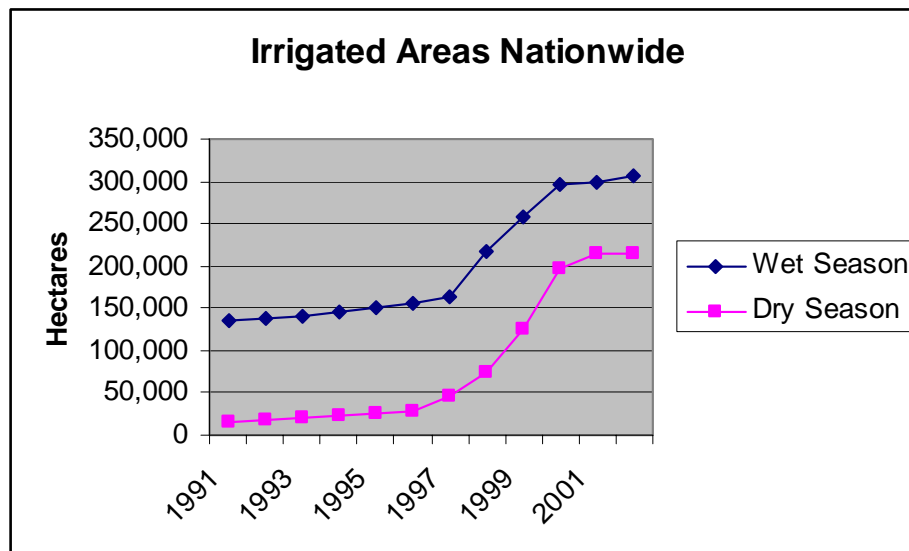


The village people living on small streams have long had their own small scale irrigation schemes, gravity fed from weirs, even though each scheme only irrigates very small areas. These are set up on very small streams and may deplete the stream below the weir although offering a fish friendly environment in the scheme. Research is needed to determine whether access to irrigation and associated fish is equitable and the spatial variation in conditions.

Irrigation

1. increases household and sub-regional food security and nutrition
2. reduces migration to towns
3. perhaps hinders malaria reduction.

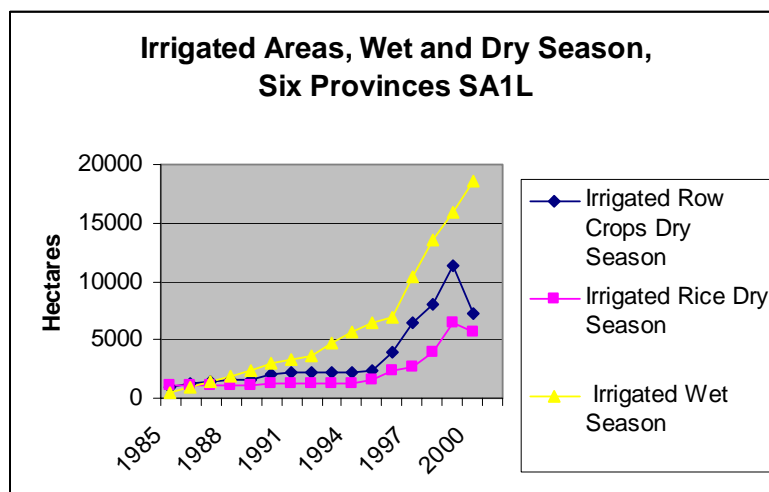
Irrigation construction by the government expanded rapidly in recent years.



(Sector Review)

The irrigated wet season rice area for six provinces has been rising steadily over 15 years from very little to about 18,000 hectares.

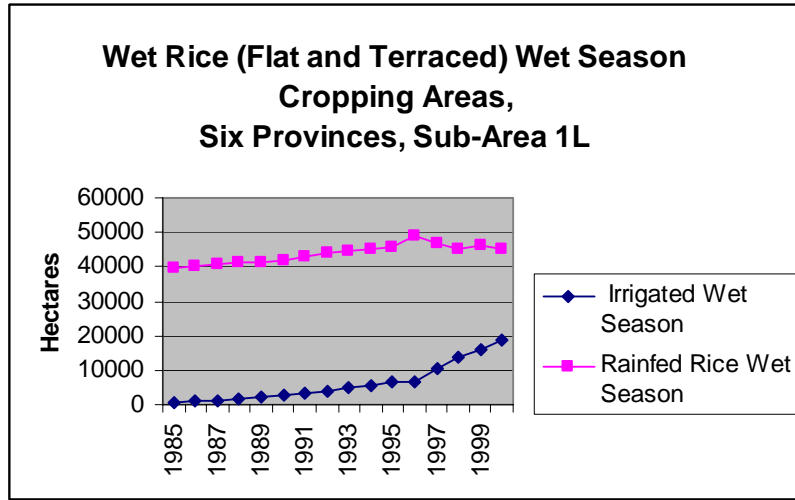
Total irrigated areas in the dry season are about the same.



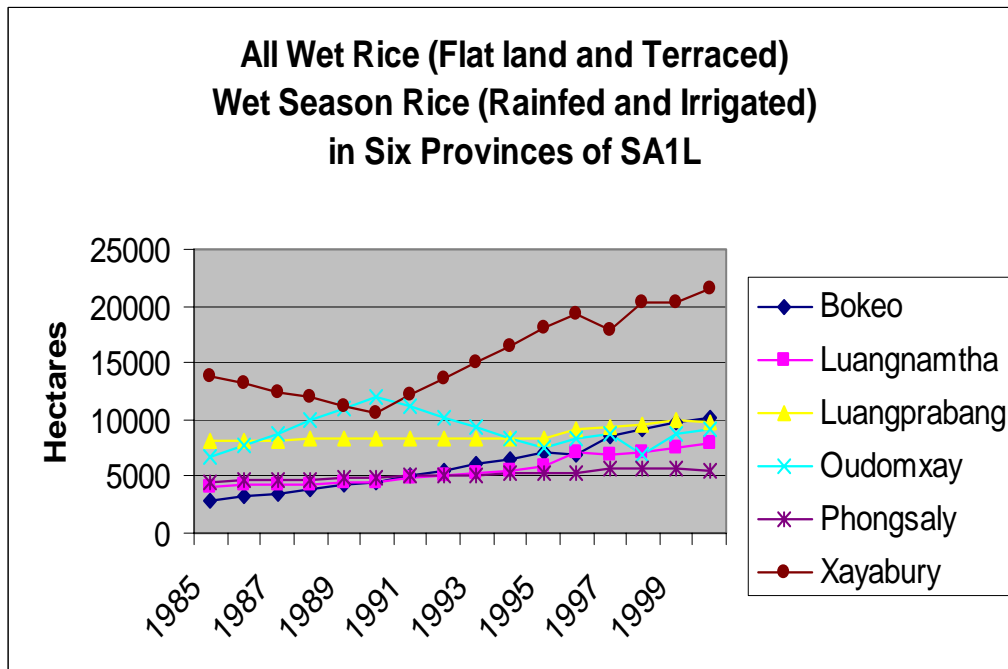
Water Consumption

	Irrigation Depth	Irrigation Volume
Wet season	0.4 m	72 Mm ³
Dry Season	0.7m	126 Mm ³
Total		198 Mm ³

Irrigation in six Provinces of SA1L thus uses about 200Mm³ per year. But this is less than half a percent of the contribution of SA1L's stream flow to the Mekong.



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

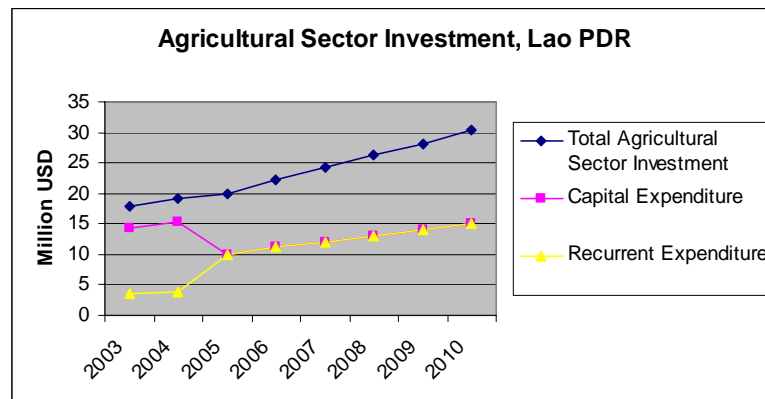


Note decline in the area of all wet season wet rice in Oudomxay after 1990
 What is reason?
 Should they be helped?

Irrigation Strategy

Government Investment in Agriculture

Most importantly for Sub-Area 1L from 2005 total government agricultural investment capital investment will equal recurrent expenditure.



- Government effort on irrigation will be aimed at running and improved management of existing schemes.
- Irrigation will gain relatively less promotion. Rainfed agriculture, will gain more.
- The latter will be promoted through research and extension which will contribute to watershed management.

Weirs or Pumps?

- Government constructed irrigation is riverfed: gravity fed from weirs and pumped from the river.
- Pump schemes implies large recurrent fuel, maintenance, repair, rehabilitation and replacement costs to run the pumps. This will take a lot of future recurrent budget.
- But pumps involve lower initial costs and perhaps most importantly do not interrupt fish migration routes and trap sediment like concrete weirs may do.
- Fish passes on weirs may be a more cost-effective solution.

Irrigation Scenarios

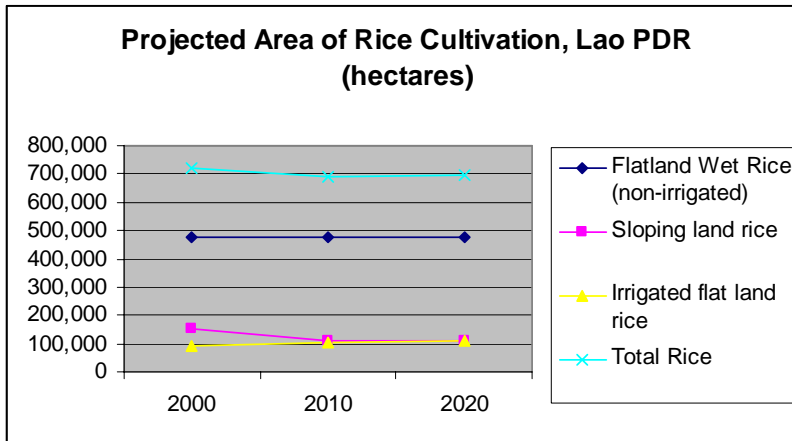
Future irrigation water consumption will depend on the expansion of the irrigation area, the 'depth' of irrigation, ie the volume supplied per unit area, both for the wet and dry season.

Different crops require quite difference irrigation depths. As farmers move from rice to a variety of 'row' crops under dry season irrigation the 'depth' required will fall.

As the efficiency of the supply process is rarely very high, the crop transpires only a proportion of the water taken from the water body, in this case the streams. If the efficiency increases the area could expand or the pumping or diversion time could decrease.

Rice Area Projections

- Irrigated areas will increase very little following projected reduced capital investments in agriculture noted above.



Irrigation area is unlikely to expand rapidly because of

1. Over investment in irrigation in 1997-2000,
2. the changing government policy to make recurrent and capital costs equal and
3. the limited area of flat land will limit irrigation expansion.

Irrigation in SA1L is now estimated to use about 200Mm³ per year

The growth rate from 1997 to 2001 was 2800 hectares per year but the area may be hardly expanding in 2003.

Future growth is very difficult to predict but may average a modest 1000 hectares per year. This could vary from a low of say 700 to a high of 1500 hectares per year. The areas and water consumption figures for 2020 are given in Table.....

(Assuming total wet and dry season irrigation depth of 0.7 + 0.4 m = 1.1m)

Irrigation Consumption Scenarios

Expansion Rate	Hectares per year	Area in 2020 (hectares)	Water Consumption in 2020 (Mm ³)
Probable	1000	38,000	420
Low	700	32,000	224
High	1500	48,000	528

Expansion is also likely to be greatest in Xayabouli given the relatively large area of flat to undulating topography.

Oudomxay might be given some special assistance to regain past areas.

Luang Phabang is as prominent as Xayabouli in dry season rice irrigation, both provinces booming notably from 1995 and might be expected to continue to grow faster than other provinces without a strategy change.

Row crops (or 'upland' crops) (ie non-rice) under irrigation will continue to grow in Luang Phabang particularly if the tourism numbers grow steadily.

Waste Water or Return Flow from Irrigation

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.

Mineral/chemical fertilizer use is however on the increase so irrigation return flow to streams and groundwater will contain increasing concentrations of nitrates and surface water bodies to a lesser extent phosphates.

WATER SUPPLY AND WASTE WATER

Domestic, Office and Industrial Water Consumption Estimates

	Average Per Capita Consumption	Annual Consumption (Mm3)
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

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

In SA1L at least Luang Phabang, Oudomxay and Luang Namtha have piped water supply systems.

Most other towns and rural people use wells, springs (both from groundwater), stream water and occasionally rainwater from roof catchments.

Domestic, office, industrial and mining use in SA1L is smaller than even the small irrigation consumption at 200 Mm3 per year.

We have no data on mining use or waste water discharge to water bodies in SA1L.

Rural Water Supply and Sanitation in Northern Lao PDR and SA1L

- 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).

Percentage of Households with Services in SA1L 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

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
Tubewell / 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

We need data on the state of repair of facilities or the number in good working order.

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

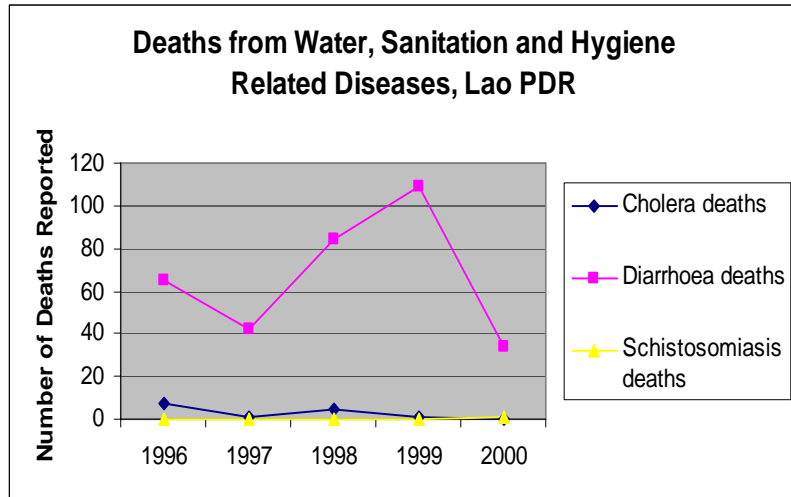
Factory and Mining Waste Discharge

- Factory waste discharge is not important now as factory numbers and sizes are small.
- Mining waste discharge is also probably minor, but two moderately large mines are situated in SAIL.
- 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 or drink the water.

Water Related Health

Cleaner and more plentiful and/or convenient water supplies, improved hygiene and control of pollution raises health standards.

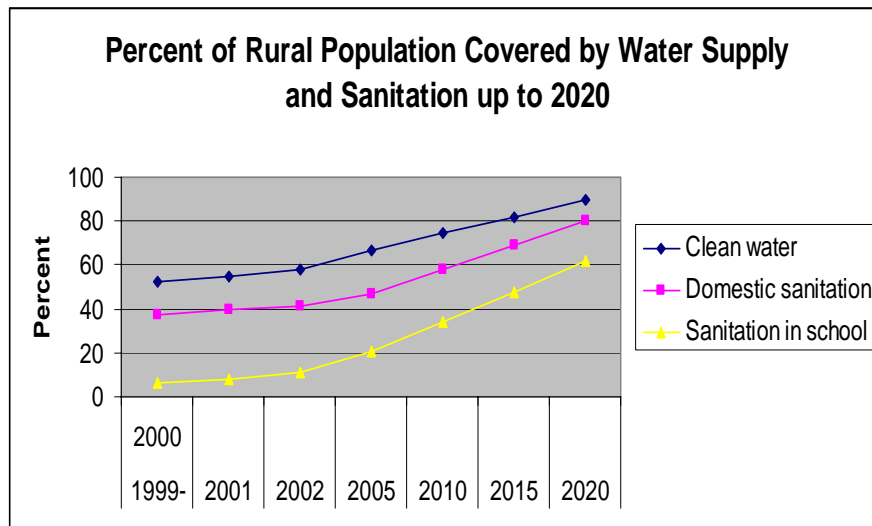
Diarrhoea deaths nationwide are declining very uncertainly. A major rise took place between 1997 and 1999. What caused this epidemic?



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

Water Supply and Sanitation Scenario

The proportion of population to be covered by clean water and sanitation is projected to increase as is shown in the figure below. Even this increase will still have only a very minor impact on national water consumption.



Sanitation in towns and countryside in the form of pour flush latrines are gradually replacing dry pit privies and field defecation. This is contributing to better health and population growth, but may be polluting the nearby down-slope groundwater and occasionally streams.

Based on national population growth, urbanization and the likelihood of full urban coverage with piped water by 2020 and per capita rises, it is estimated that the national

water supply consumption including all types of water system will be about 700 Mm³ per annum.

Table National Water Supply Consumption Estimate for 2020

	2020	lpcd	Mm ³ /year
Urban	2,952,000	500	539
Rural	5,248,000	70	134
TOTAL			673

SA1L's population may be about 30% of the national total so its water supply use may be about 100 Mm³.

Water Supply and Sanitation Policy/Strategy

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 and multilateral loans.

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

The government rural 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;
- focus on inaccessible, poverty-ridden areas; and
- 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 water and sanitation systems.

As can be seen from the tables above for Northern Laos as a whole in 2000 44% of people still use river water for drinking and 55% of people are still defecating in the bush or field.

To facilitate this policy/strategy cheaper for remote villages easily repaired facilities such as dug wells with counter-levered buckets and pit privies could be provided as a first step.

- Monitoring factory waste discharge should start to prevent long-term problems.
- Monitoring and inspection of mines and dialogue with mine managers should start. Regulation is needed.

NAVIGATION AND RIVER WORKS

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.

Erosion and collapse has multiple causes including

1. boat waves (navigation)
2. natural causes,
3. vegetation removal,
4. global warming,
5. rapid river level drops
6. high groundwater levels at banks
7. cultivation of banks
8. quarrying of stream sediment and blasting of river rocks
9. flood levees,
10. watershed degradation in general and
11. other bank protection.

Bank erosion and collapse and the resulting ‘mass sedimentation’ at least temporarily changes the channel cross section and flow characteristics.

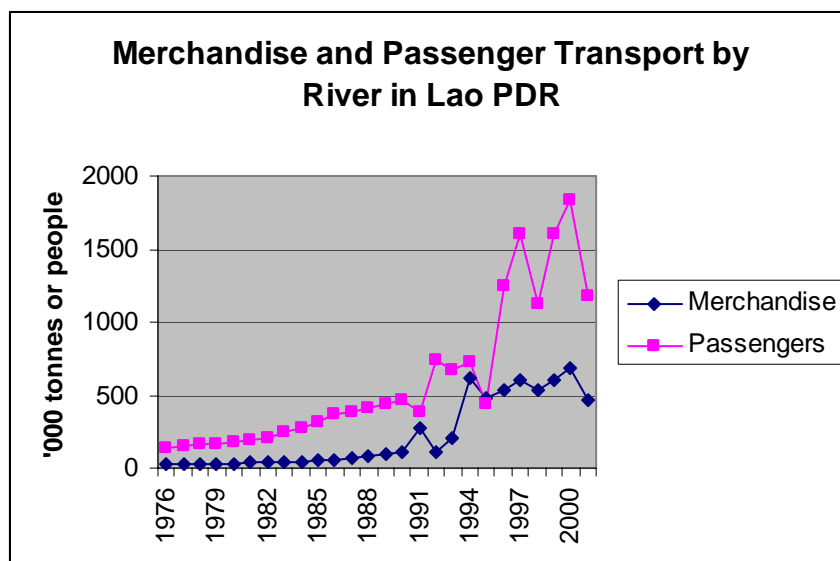
This is a complex issue that needs more study and dialogue.

Many ‘obstacles’ have recently been blasted and dredged in the upper part of SA1L 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 SA1L.

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?
- Is this due to a combination of fall in the Centre and South and rise in the North?



Navigation and River Works Scenario

- River trade is increasing rapidly driven by the massive technological growth in Thailand and PR China and facilitated by clearing of rapids and sand bars.
- The Yunnan-Thai trade has been growing at 40% per year but most trade between Yunnan and Thailand still goes by sea.
- Presumably similar growth is being experienced by the China-Lao river trade.
- But continued growth in the Northern river trade could be jeopardized by the finishing of two roads from China to Thailand, one through Myanmar and one through Lao PDR.

Policies/Strategies

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

1. New port construction,
2. Riverbank protection using local products,
3. Safer travel,
4. Better transport organizations,
5. Better data collection,
6. A study project to establish an inland clearing centre,
7. Setting up joint ventures,
8. Organize cooperative ventures with Yunnan province,
9. Introduce electronic methods on the boats,
10. 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.

* For example, row crops grown on river banks just above the falling water level in the dry season denies this zone permanent vegetation to secure the sedimentary soil.

* If the growers could use new hydro-electricity they could pump water to the riverside flats and promote permanent water-tolerant vegetation on the banks.

- 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 before more major fixed investment is placed in navigation.

FLOODS

- 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 aquifers beneath the plains 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

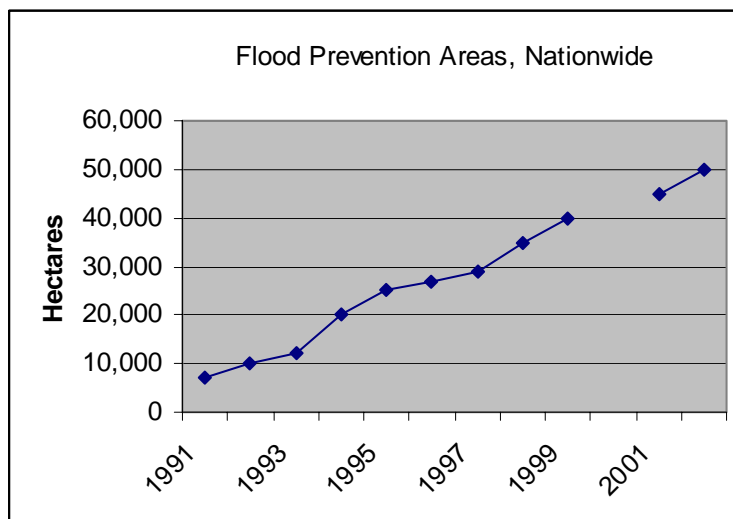
1. heavier storms and
2. changed sloping land use in case of small to medium watersheds but also
3. population and settlement growth and design on the flood plain.

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.



Strategy

There are essentially *three types of flood mitigation that can be carried out: structural, ecological and socio-economic.*

1. The structural type involves levees, dams, channeling and drainage.

2. 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.
3. The socio-economic type includes
 - A. Measures to either persuade or prevent people using the lowest areas of the flood plain for relatively permanent land uses.
 - B. Flood forecasting and timely media broadcasting can enable the people to prepare individually and collectively for a serious flood.
 - C. In areas where flash floods are a probability villagers can be trained in rainfall measurement and flood risk.

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 Scenario

A flood scenario would need to be based on progress in

1. The quantity and quality of watershed management,
2. Prospective dam siting, designs and their operational procedures,
3. Training and gauge installation for villages at risk of flash floods
4. Changes to the river channels including quarrying, and serious sedimentation and erosion
5. Plans for flood levee construction and drainage
6. Actual and planned land use, including building up land, on the flood plain
7. House design
8. Flood forecasting
9. The population on the flood plain and the opportunities they have for protecting property and people or escaping from the worst floods.

This is obviously a complex issue even if good data were available.

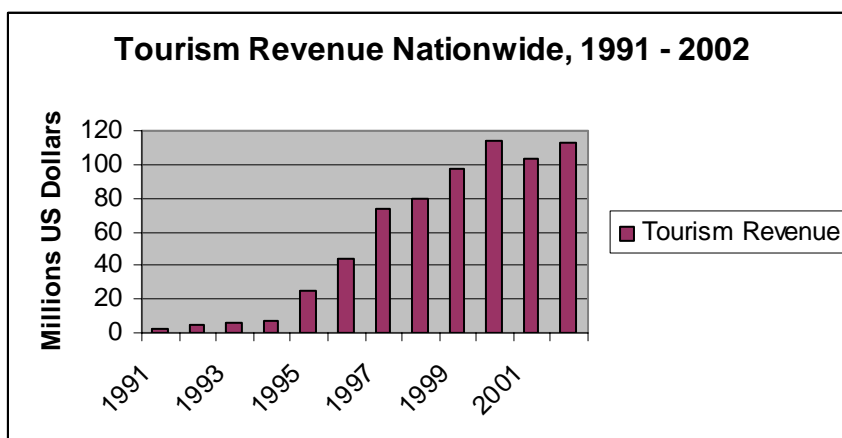
Given the motivation that flood plain people have for avoiding the worst floods, preparation under processes 4-9 above should be easier to organize.

The most promising scenario is thus one in which

1. the government leads the lowland people towards a substantial effort in this area,
2. several 'medium' dams are built,
3. watershed management progresses well especially in those catchments without dams, and includes flash flood provisions, and
4. moderate floods are accepted and even encouraged in rural areas.

TOURISM AND RECREATION

- Tourism is now the top foreign exchange earner for Laos.



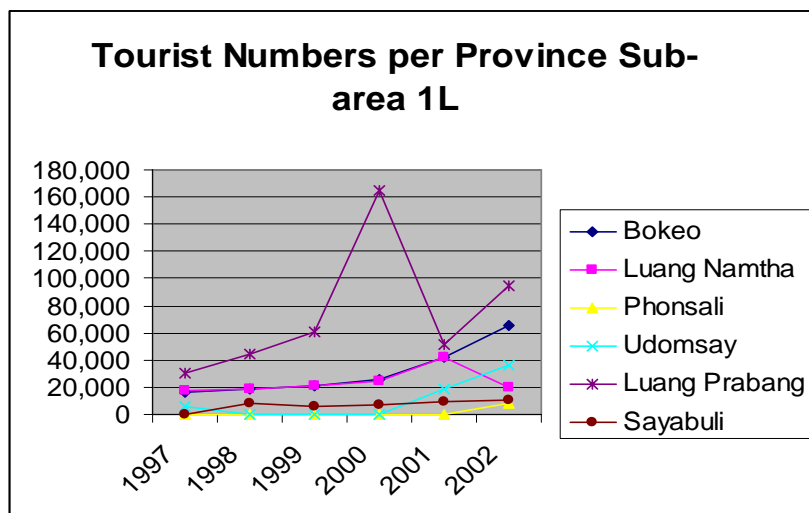
- It still has high potential to rise in Sub-Area 1L. Most is focusing on ancient towns and sites, and ethnic diversity. 'Environmental tourism' is another attraction.

Recreation numbers are unknown.

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

1. Security conditions
2. Health scares

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



Tourism Scenario

Tourism, including water-related tourism is increasing rapidly, but is sometimes hit by security and health scares.

Revenue has been rising at about US\$15 million per year over the last 10 years. Is continued growth at this rate possible given that

1. the first flush tends to be rapid 'tourist fatigue' as people look for a new destination.
2. because of the uncertain disease and security environment.

Perhaps growth of an average of US\$10 million per year could be achieved over the next twenty years. This would bring nationwide revenue to about US\$250 million at constant prices.

Tourism Strategy

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

Because of 'tourist fatigue' is thus advisable to continue to develop new tourist destinations and ideas and continue to improve promotion methods.

Only in Luang Phabang is the number of rooms rising markedly. The old buildings here are easier to promote as they are all within walking distance of each other.

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

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. A premium price can be charged for trips that have obvious safety factors.

***Part C: The Full Analysis:
Introduction, Sector Situation
Analyses, Scenarios and Strategies***

**for the Lower Mekong BDP
Sub-area 1L, Northern Lao PDR**

1. INTRODUCTION

Six provinces of the Lao PDR wholly within Sub-Area 1L (SA1L) Bokeo, Luang Namtha, Phongsaly, 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.

Figure: 1 The Provinces of Sub-Area 1L



This report will cover

- population and people
- national finance
- an introduction to water-related processes
- the eight sectors to be covered in the planning process as follows:
 1. Forestry/watershed management
 2. Fisheries
 3. Hydropower
 4. Irrigated agriculture
 5. Water supply and wastewater
 6. Navigation-river works
 7. Flood control/management
 8. Tourism and recreation

The four cross-cutting themes are also covered in the next part.

1. Human resource development
2. Socio-economic issues (including poverty and gender)
3. The Environment
4. Public participation

Integrated scenarios are covered in the next part.

Although this report focuses on SA1L is relevant to some extent to other sub-areas in the Lao PDR.

Basin Development Planning {BDP} is concerned first with understanding the interaction of human and water-related resources and processes, both in the recent past and immediate future. It then proposes an integrated set of aims, strategies and actions in order to maximize human benefits. This report is concerned primarily with Sub-Area 1L but also considers the whole of the Mekong basin and important influences from outside the basin.

The MRC ‘vision’ is for ‘an economically prosperous, socially just and environmentally sound Mekong River Basin’.

1.1 Information Required

The reader will notice many gaps and uncertainties in the data that need to be filled in and resolved in the near future. The data gathering process is in need of improvement. Below is listed in one place that data that is still needed to fill out this report. Some of this will be available in Vientiane and some may be in the provincial and district offices. Some will require field and/or desk studies.

In the longer term all government agencies should start to organize the data according to districts and tributary catchments as well as by provinces. This will probably require the setting up of catchment committees or an equivalent structure.

Table Information that would be Valuable for Study of Sub-Area 1L

<i>Information Required</i>	<i>Possible Source</i>
Sub-Area 1L	
1. Lists All ongoing and planned projects in SA1L to be financed by <ul style="list-style-type: none"> ◆ Lao government, ◆ Known private Lao ◆ Foreign donor, ◆ Loans ◆ Foreign investment {direct} 	CPC
Rainfall, River flow, Storage, Floods, Navigation, Erosion, Sedimentation and Pollution	
2. Mass movement, from survey or anecdote	Provincial staff
3. Information on the significant areas of bank erosion in the mainstream and tributaries of (in tables or reports or maps)	CTPC? Provincial agencies
4. Information on changes in sand bars {surveyed or anecdotal}	Provincial agencies
5. Any data on sedimentation in dam and weir storage areas	ID,MAF or ED, MIH
6. Mining discharge to water bodies and any projections	Provincial MIH

7. Factory {processing and manufacturing} discharge to water bodies and any projections	Provincial MIH
8. Flood area, duration and depths for each province	Provincial Irrigation
9. Data on earthquakes from location, magnitude, and frequency	MIH geology and mines department
Water Supply	
10. Water used by all the various non-agricultural uses and plans	Provincial Nampapa and Nam Saat
11. Waste Water treatment	Provincial Nampapa and Nam Saat
Hydropower	
12. Storage volumes, flow changes, resettlement numbers, submerged land areas and fish passes for dams actual and planned	MIH Electricity Department
13. Are run-of-river dams on tributaries to be considered?	LNMC or MIH
Agriculture and Fisheries	
14. Information on fisheries production in streams over at least 5 years and any projections	Provincial fisheries
15. Data on irrigation water supply in wet and dry seasons to existing and planned irrigation projects.	ID, MAF
16. Any plans/projections on wet and dry season irrigation areas, production and depth etc over at least 5 years	Provincial Irrigation

Small Areas of Three Provinces

Three provinces, Huaphan, Xieng Khuang and Vientiane, have small areas within SA1L. It was decided early on in the BDP process for SA1L that if village survey data from the whole of these three provinces were used it would bias the overall view of SA1L. Inspection of district maps shows that even use of district data would be inappropriate. 'Khet' {former Tasseng} data would be better. But even if this were easily available it would take time to obtain and incorporate for limited improvement of the overall view of SA1L. So it was decided to leave out village survey data from these three provinces until a later stage of planning refinement. Data from the first two provinces above is nearly all in the Nam Khan tributary catchment. The area in Vientiane province is in the Nam Phuong 'tributary zone' of several small tributaries. If these catchments are to be studied in detail the data from the relevant khets would be necessary.

On the other hand, any special project data from these areas such as dams or tree planting that can easily be extracted from the provincial or district data or reports was used. Data obtained from remote sensing for the small areas of these three provinces is already incorporated in the SA1L maps without any trouble.

Figure 2 *The Major Tributary Catchments of Sub-Area 1L*



(MRC)

1.2 The Local Challenge

The development challenge in Northern Lao PDR seems enormous. The conditions in SA1L are

5. Hilly and mountainous
6. Multi-ethnic
7. Sparsely populated
8. The density of roads and communication infrastructure is still very low.
9. The rainfall ranges from about 1200 mm to about 3500 mm falling heavily, mainly in a well defined wet season
10. Land that is about 95 percent steeply sloping, excluding Xayabouli.
11. Most of the forest has gone in the central zone of SA1L.
12. The people are 'materially poor' by modern standards, but not necessarily by their own standards.
13. Many have poor health. In some hill and mountain villages about one in three children dies in its first year.

- But the people are culturally rich.

The Northern region also has positive features that give hope for the future.

The North is a major tourist attraction for several reasons: Luang Phabang city as a world heritage site, the diverse ethnicity and the striking landscapes. As well there is much surviving forest in the peripheral areas and substantial rainfall.

1.3 Two Important Concepts

Two important concepts can help understand the issues.

Diversity

- Diversity of organisms is a critical concept.
- High diversity, as in a tropical forest or an integrated farm, helps ecological stability and thus sustainability.
- Low diversity, as in a tree plantation, helps short-term material growth.
- But low diversity brings risks. Bird flu in factory chickens, teak leaf disease are recent examples. The risk in factory farms is particularly high when one farm has an ecological connection to the natural ecosystems from which diseases can jump to sensitive animals. Disease prevention is important. Price collapse in predominant crops such as coffee and job's tears in low diversity farms also seriously affects these farms.
- A balance between stability and growth is best, but what balance? The choice should be made at the local level, but after support for learning.

Learning

1. Learning is critical to development. It is the key process in HRD
2. Learning is a wider issue than training. Training is just one way to assist learning.
3. All the people from remote villagers to senior government staffer in SA1L will need to learn rapidly to face not only the local challenge but that coming from many directions.
4. The challenge includes giant growing neighbours, that are sources of ideas and markets, and can be seen as a 'land link' opportunity, but must also be recognized as a risk or threat. The threat may come in the form of government debt, private debt, illegal migration, plant, animal or human disease, or bribery associated with investment.
5. The challenge also includes global pollution, global disease and technological change/growth.
6. The learning must be rapid if Laos is to face this challenge, prosper, remain at peace, and stay culturally and politically independent.

The key issues are

- Who will learn.
- What will they learn
- How will they learn.

These are the most important issues of all

1.4 Government Policies and Strategies

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:

1. rapid growth with equity,
2. socio-cultural development and
3. 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.

The table below illustrates the government's policies in the eight sectors.

Table 2 National Development Policies

<i>Sector</i>	<i>Development Policy</i>
Watersheds	<ul style="list-style-type: none"> • Develop watershed management.
Fisheries	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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; • Minimise environmental impacts;
Irrigation	<ul style="list-style-type: none"> • 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;
Water supply and waste water	<p><i>Urban water supply, sanitation and waste water</i></p> <ul style="list-style-type: none"> • Increase amenity of life in urban areas by providing affordable, reliable and quality services in commercial water supply and in sanitation.
	<p><i>Rural water supply and sanitation</i></p> <ul style="list-style-type: none"> • 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.

Navigation	<ul style="list-style-type: none"> • 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;
Floods	<ul style="list-style-type: none"> • Protect against flood damage
Tourism	<ul style="list-style-type: none"> • Promote eco-tourism and cultural and historical based tourism hand in hand with water resource and environment protection

New strategies for government to overcome low per person productivity in town and countryside is 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.

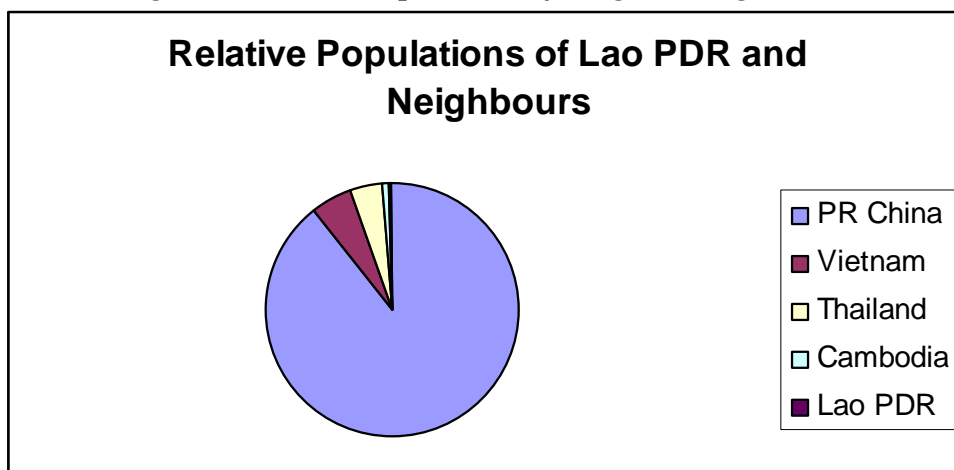
But it should be recognized that low productivity is a symptom or outcome of the history of several agricultural peoples moving through, interacting and living in a hilly and mountainous environment, and the colonialism and wars they have suffered. A complex geography and history must be understood to 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, river transport and tree plantations.

2. POPULATION AND PEOPLE

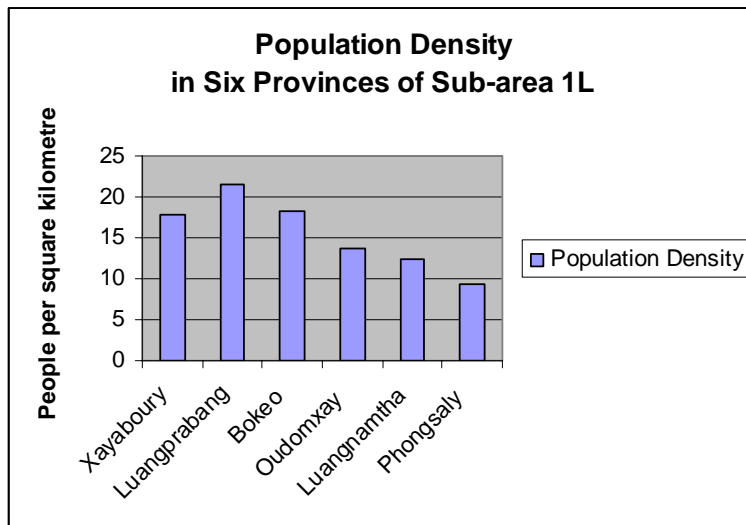
As is shown in the figure below the Lao PDR is a tiny nation mainly among giants, that have either grown rapidly or are growing rapidly. This provides not only opportunities but also actual and potential threats.

Figure 3 Relative Populations of Neighbouring Nations



Within SA1L 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 Chiangrai and Xayabouli because of its flat to undulating land.

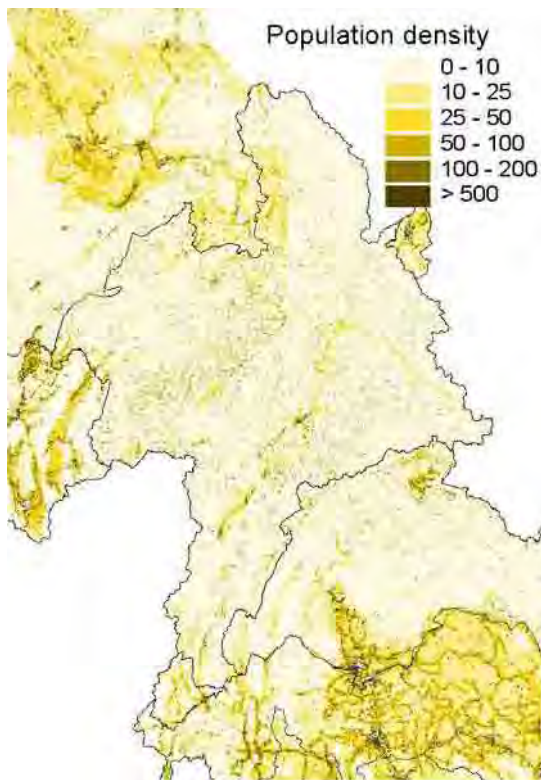
Figure 4 Provincial Population Density



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 kilometer.

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.

Figure 5 Population Dot and Shading Map for Sub-Area 1L



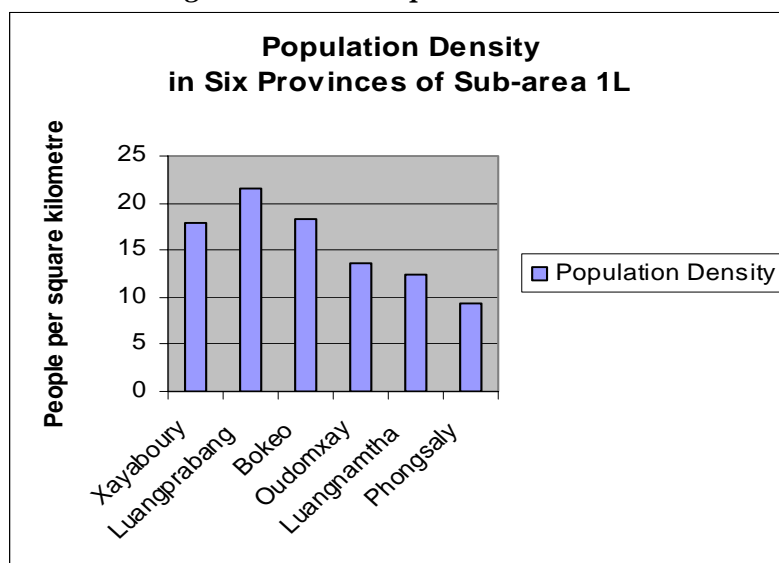
Luang Phabang has the largest population and density presumably due to it having the ancient regional center despite an unfavourable topography. Nevertheless it is the topographic-related density that is important.

Table Provincial Populations and Densities, SA1L

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 6 SA1L Population Densities



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

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

Feature	Phong-saly	Luang-namtha	Oudom-xay	Bokeo	LPB	Xaya-boury	Total
Area Km ²	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./km ²	11	14	16	21	25	21	

(National Statistics Center 2001)

Population Growth Rate

The population of Northern Laos, that includes not only the six provinces of SA1L but also Huaphan, Xieng Khuang and Xaysomboon Special Zone, has been growing at the moderately fast rate of about 2.4 percent per year

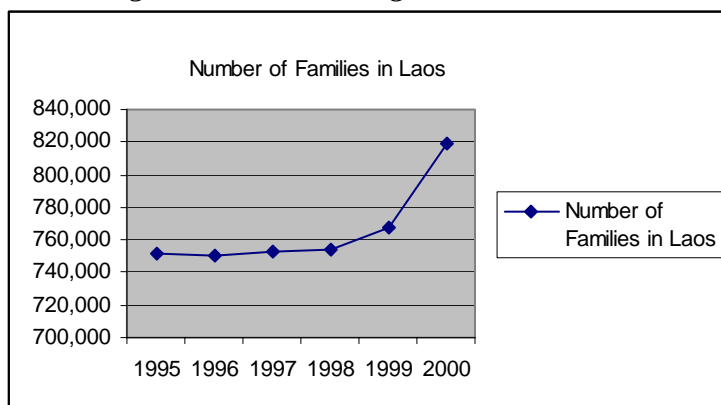
Table Population Growth in Northern Lao PDR

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

(Jica/MAF pap8-3)

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

Figure 7 Household growth in Lao PDR



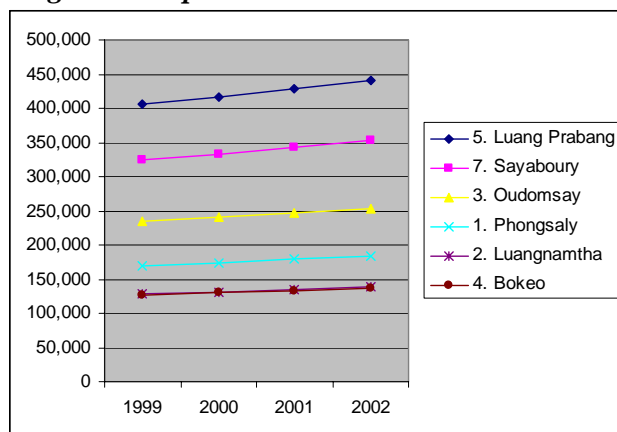
Six provinces of SA1L have populations growing at similar rates annually between the rates of 2.621 and 2.631.

Table Provincial Population Growth in SA 1L

	1999	2000	2001	2002	Annual Growth rate (Percent)
5. Luang Prabang	406,000	416,000	428,800	440,693	2.624
7. Sayaboury	324,700	333,000	342,900	352,424	2.622
3. Oudomsay	233,900	240,000	247,100	253,910	2.627
1. Phongsaly	170,100	174,000	179,600	184,626	2.623
2. Luangnamtha	127,700	131,000	134,900	138,596	2.621
4. 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)

Figure 8 Population Growth in Six Provinces



(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.

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 SA1L

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.

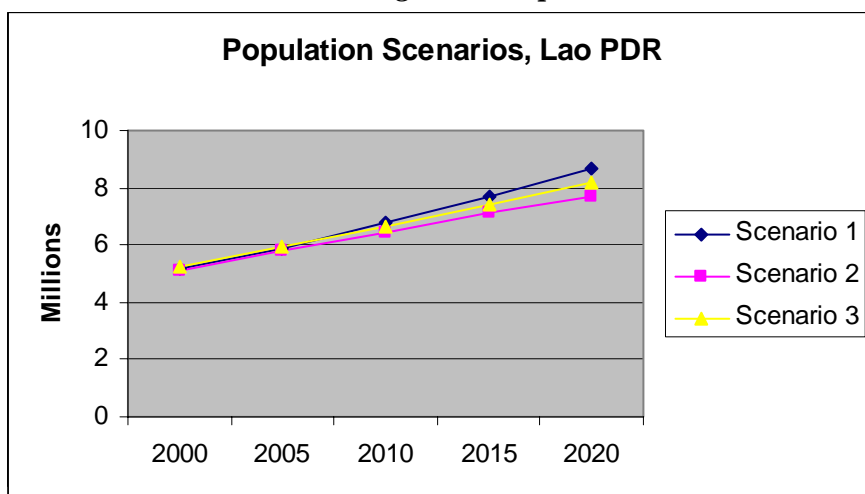
Population Scenarios

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 below.

Table National Population Scenarios (000')

	2000	2005	2010	2015	2020
Scenario 1	5200	5900	6800	7700	8700
Scenario 2	5100	5800	6400	7100	7700
Scenario 3	5234	5921	6651	7415	8207

Figure 9 Population Scenarios



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

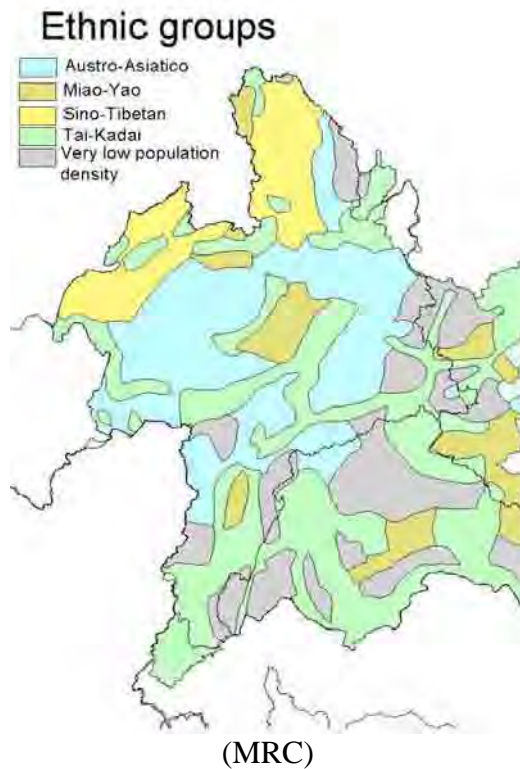
years. They are thought to have evolved from the Hoabinian cultural population that is recognized from 10,000 years ago. It is probable that the Mon-Khmer initially lived mainly in the lower flatlands. Into this northern region of Laos various other ethnic groups have been migrating from the north and 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 SA1L are

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

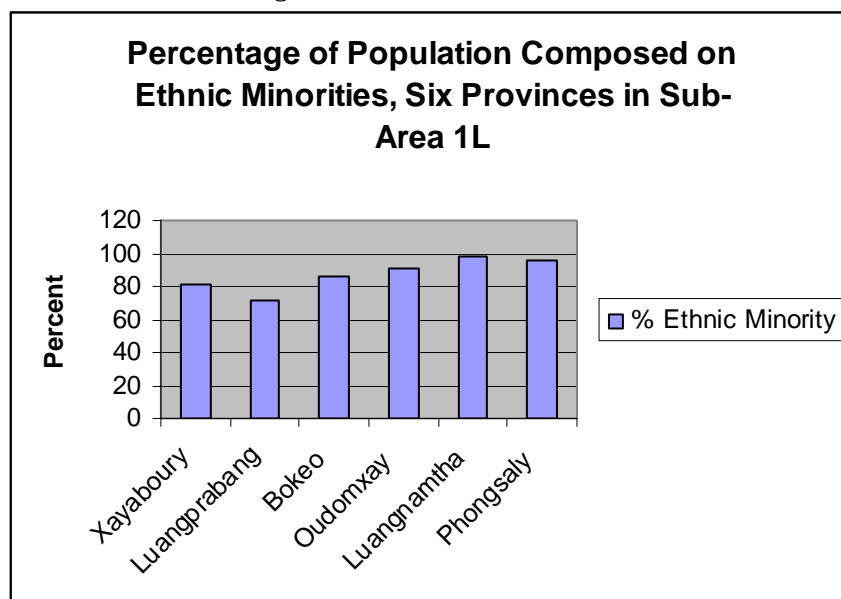
The Mon-Khmer are the predominant group in Oudomxay and Luang Phabang but are also numerous in southern Luang Namtha, eastern Bokeo and southern Phongsali. Tibeto-Burman people are concentrated in Phongsali, Luang Namtha and Bokeo. The Hmong-Mien groups, more scattered across SA1L, are common in southeastern 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}.

Figure 10 Ethnic Groups of Sub-Area 1L



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

Figure 11 Ethnic Minorities



(Data from MRC)

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

2.1 Livelihoods and Living Standards

Livelihoods and Living Standards

The hill and mountain people mainly live traditional subsistence lives far from towns and even roads. They live under very rough conditions, suffering low health and life expectancy. Facilities and government services are rare. Nevertheless total populations are growing partly due to services where the people have moved to near roads or where roads have been built near them, and also to the wider vaccination and other health programmes that have reached isolated villages.

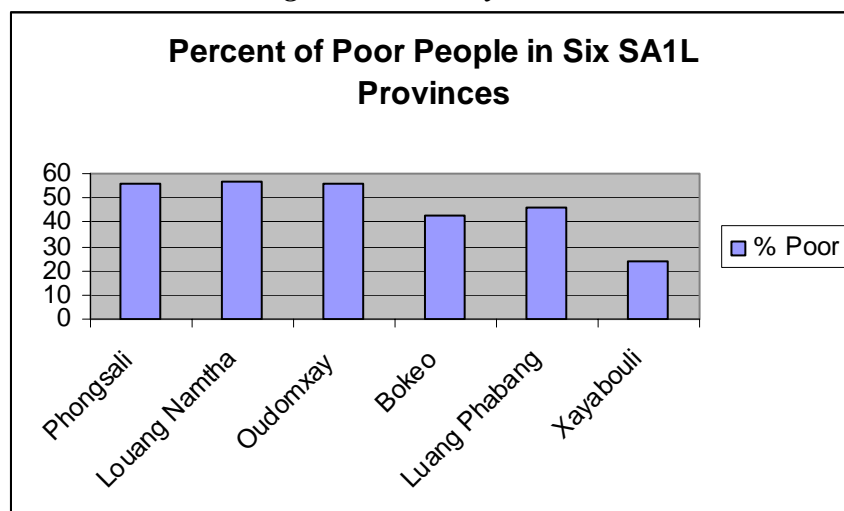
Material poverty is widespread in the SA 1L but is notably lower in Xayabouli province with its large areas of plains and undulating land (see table below). But we should keep in mind that poor families are poor wherever they are. At the district level in Xayabouli some districts have very low poverty incidence and others very high, so as the government has indicated, it will target poor districts rather than provinces. But even so poor families in an otherwise ‘wealthy’ district may feel neglected.

Table Poverty in Six Provinces of SA1L

Province	Total Number of Rural Villages in Province	Population 2000 (Estimated mid-year)	Families 2000?? NSC	Poor Families	Percent poor
Phongsali	562	174,000	27,525	15,414	56
Louang Namtha	382	131,000	23,193	12,236	57
Oudomxay	677	240,000	40,043	22,331	56

Bokeo	346	130,000	22,870	9,446	43
Luang Phabang	895	416,000	64,881	29,546	46
Xayabouli	480	333,000	56,783	13,730	24

Figure 12 Poverty in SA1L



The people of the North have long developed pre-industrial trade routes along rivers and mountain passes for trade in products with a high value to weight ratio. This trade was initially between cultural groups in different regions and now with the relatively new national borders, across them into other nations.

Material poverty is widespread in the SA1L, probably the poorest sub-area in Laos. Notably in Xayabouli province has a lower incidence with its large areas of plains and undulating land. The greatest poverty thus must be in the hills and mountains. Note the high values in Oudomxay in the table below.

We have no time-series data on poverty. How is it changing in various places?

Table Sub Area 1L Poverty by District

1 Phongsaly province		4. Bokeo province		5. Luangprabang province	
District	Poverty Incidence	District	Poverty Incidence	District	Poverty Incidence
Phongsaly	47.9	Houay Xai	30.4	LuangPrabang	41.8
May	83.1	Ton Pheung	10.1	Xieng Ngeum	27.7
Khoa	45.3	Moeng	24.5	Nan	52.3
Samphanh	96.2	Pha Oudom	63.0	Pak Ou	30.0
Boun Neua	54.2	Pak Tha	45.5	Nam Bak	49.5
Nhot Ou	79.0	Total	37.4	Ngoy	53.4
Boun Tay	40.0			Pak Xeng	78.4
Total	64.2	3. Oudomxay province		Phonxay	89.1
2. Luangnamtha province		District	Poverty Incidence	Chomphet	50.4
District	Poverty Incidence	Xay	59.2	Viengkham	64.7
Namtha	44.0	La	60.6	Total	49.4
Sing	56.7	NaMo	92.5	6. Xaygnaboury	
Long	37.4	Nga	66.7	District	Poverty Incidence
ViengPhoukha	90.3	Beng	72.6	Xaygnaboury	31.9

Nale	79.7	Houn	80.5	Khop	22.9
Total	57.5	Pak Beng	63.5	Hongsa	18.7
		Total		Ngeun	6.4
				Xieng Hone	61.4
				Phiang	33.6
				Pak Lai	10.1
				Kenethao	17.3
				Botene	6.8
				Total	21.2

The People's Opportunities to Gain from Water Resources Development

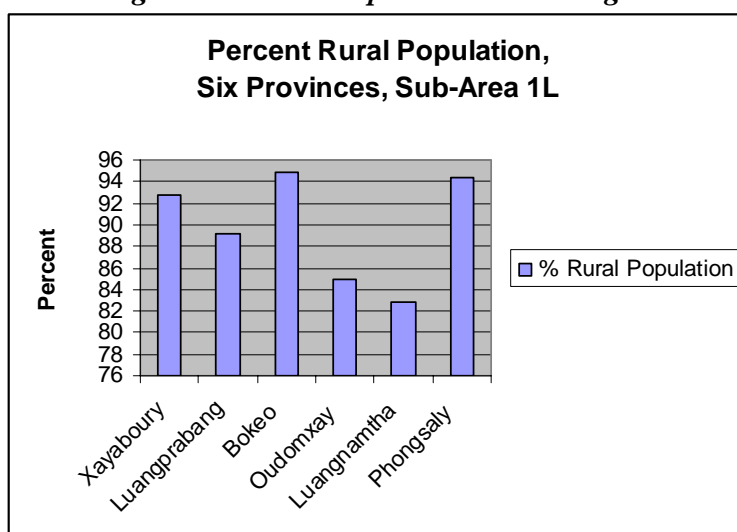
Because of the large proportion of people living near subsistence lives, their main use of water is for domestic use:

1. rainfed agriculture,
 2. multi-forest products,
 3. aquatic wild harvesting (fishing plus)
 4. irrigation and
 5. local transport,
- roughly in that order.

2.2 Rural and Urban Populations and Conditions

Urbanization just means that the percentage of the population in towns and cities is growing relative to the rural areas. From the figure below it can be seen that Luang Namtha is the most urban province followed by Oudomxay. On average the northern region is about 10 percent urban totaling about 150,000. The four largest urban settlements are Luang Phabang, Oudomxay, Luang Namtha and Xayabouli.

Figure 13 Rural Population Percentages



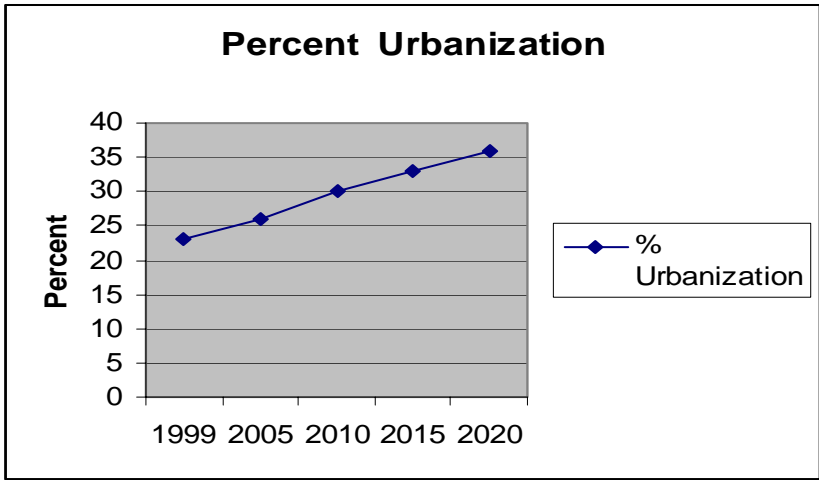
As SA1L has no major towns that attract large numbers of migrants from other regions of Laos. The growth rate due to migration may be lower than the national average, but immigration from China, Vietnam and Burma could be significant.

Table Urbanization Scenario, Lao PDR

	1999	2005	2010	2015	2020	2025	2030
% Urban	23	26	30	33	36	39	43

The annual growth rate falls from about 5.5 percent to about 3.5 percent over 20 years.

Figure 14 Urbanization Scenario



At an annual urban population growth rate of 5.5 percent falling to 3.5 percent it is projected to reach over 35 percent of the nation by 2020. This will give rise to a higher demand for urban water supply, but most importantly will be associated with higher industrialization, wealth demand for a greater variety of rural products, including those from water resources, and giving rise to greater waste discharge to water bodies. Urbanization in the SA1L is at about half the national level at about 10 percent and will take place at a lower rate than the national average reaching perhaps about 17 percent in 2020 largely because a large proportion of the rural population have no roads and belong to minority groups. It might be relatively faster if the focal area strategy continues to move people to lower locations. Note however that urbanization is merely a population percentage and does not necessarily mean development.

Education

The adult literacy rate is highest near Luang Phabang along the road to Xayabouli, in Xayabouli Province and some other scattered districts. Low rates are found in Phongsali and Luang Namtha and parts of Bokeo. The pattern for young adults especially is a little different with very low rates in a strip through northwest Luang Phabang to southeast Oudomxay. Mainly this reflects the presence and absence of primary schooling, and in turn reflects ethnicity. In most part these are Tibeto-Burman and Mon-Khmer people. The

exception is the Mon-Khmer area in Northern Luang Phabang that has a relatively high degree of primary schooling.

Unexploded Ordinance (UXO)

Unexploded Ordinance or live bombs, nearly all of which were dropped by the US Air Force between 1964 and 1973, litter the countryside and injure and kill the rural people, including those in SA1L, especially in Luang Phabang, Luang Namtha and eastern Phongsali. The high risk to many farming people is a serious impediment to development that must be taken account of in any rural work programme. In fact clearing of UXO must be considered priority work, so the areas with UXO should not be avoided but given special consideration especially in the poorest districts.

Cross Border Comparisons

The people in the same ethnic groups across the border in China are said to be progressing faster than those in the Lao PDR (NRDS, 2003) but regional topography and technological development must be taken into account.

Focal Sites

Some areas are so rugged, infertile and sparsely populated that normal development processes involving improved access to services and markets are very expensive. The government has recognized that a different approach is needed.

The government is moving people to focal sites along roads to facilitate the provision of services. There is some evidence that the in-migration is creating high population-resource ratios in these limited areas (NRDS).

By comparing the number of households in focal sites and the incidence of poverty in the six SA1L provinces, Bokeo is doing fairly well and Phongsali appears to have fared less well.

Table Focal Sites and Poverty

Province	No. of Villages	Focal Site (FS) Households	Poor (P) Households	Ratio of FS to P
Phongsali	12	481	15,414	0.03
Louang Namtha	11	833	12,236	0.068
Oudomxay	35	2,303	22,331	0.103
Bokeo	53	3,330	9,446	0.352
Luang Phabang	79	4,600	29,546	0.156
Xayabouli	44	2,377	13,730	0.173

Growth Corridor

North-South Transport Corridor between Yunnan and Chiangrai through Luang Namtha and Bokeo is planned to be completed in 2006. This road will prove a population and

investment magnet, with employment opportunities. This will cause a massive commercialization and at first a cultural diversification, and over time a cultural homogenization of the strip through which it passes.

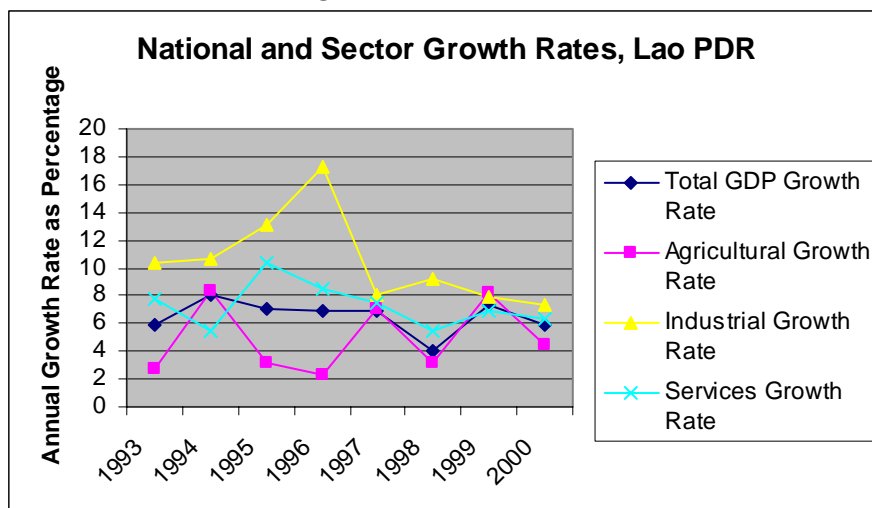
The countryside along the road will suffer from farming production pressure but may be able to convert rapidly to modern permanent farming systems. The demand for water in the form of industrial and commercial water supply and irrigation supply will rise markedly.

Luang Namtha and Bokeo towns will need good planning in order not to sink into inefficiency, pollution, and social disharmony. Planning staff for these two towns should be offered training and other learning support in town planning if not already part of the small towns project. The agricultural staff should be offered special support in modern steep-land farming and timber tree culture. All staff should be offered training in general development together with associated funds so that the shock of a sudden massive international intrusion can be well handled. The prospects of sales, investment, jobs, cultural diversity and tax revenue, could be accompanied by poorly designed and regulated logging, water, air and noise pollution, prostitution, HIV/AIDS and other diseases, drugs, people smuggling, conflict, theft, gangsterism, etc if not well managed.

2.3 National and Regional Financial/Economic and Social Indicators

It can be seen from the figure below that national sector production is highly variable. The price of industrial output was of course hit by the 1997 financial crisis particularly in Thailand following the early 1990s boom both of which are clearly evident. On the other hand agricultural growth is very much affected by the weather, varying for example from 2.7 to 8.3 percent in one year. The services growth rate showed a long decline from 1995.

Figure 15 Growth Rates



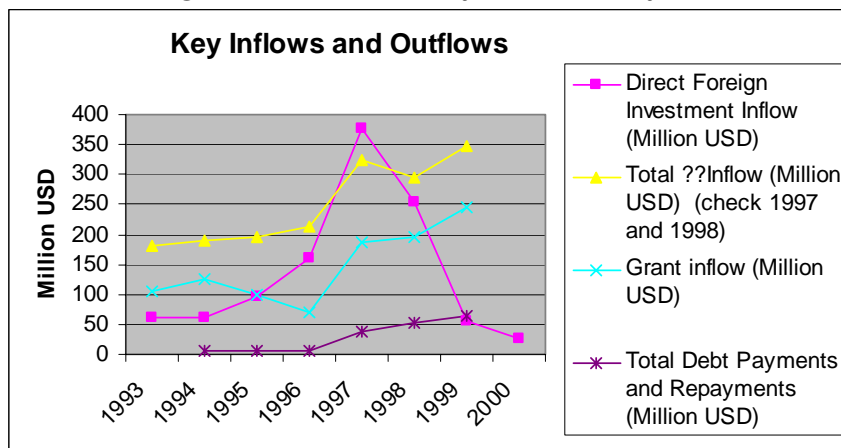
(Data source: Jica/MAF study)

We might assume that such a rising boom and following bust will not happen again in the near future, but this may be foolhardy. Enthusiastic investment in Southeast Asia will be followed by more leading almost inevitably to another boom of some kind. The risk of

political crisis if not major terrorism, herd financial movement and even war will always be there. Financial or economic scenarios for wider regions produce highly uncertain results if they are not foolhardy. Here emphasis is best put on action that can protect the nation and Northern region against uncertainty rather than merely trying to anticipate and gain from high growth rates. Government and private planning should include a balance of safe and adventurous risky investments, a balance of internal self-sufficiency and export oriented investments, and keep some financial reserve for difficult times.

Financial inflows to, and outflows from, the Lao PDR are critical indicators (see Figure) that must be monitored carefully. Direct Foreign Investment sank in 1998 and 1999 and until recently it was assumed that this inflow would continue in its turn of the millennia doldrums, but in 2002 it picked up markedly and continued to rise into 2003 to US\$155 million. Grant inflow rose from 1997 and the following two years. Note the significant rise in debt servicing from 1997. This is the danger trend that can rise to take up a large proportion of government revenue and ultimately hinder government led development.

Figure 16 Financial Inflows and Outflows

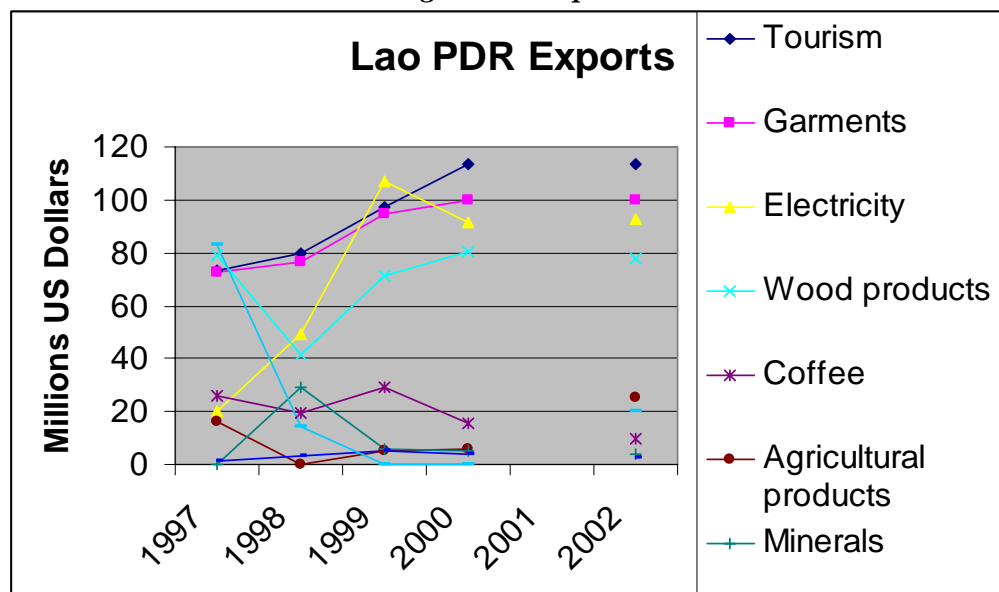


DFI and grant inflow (Bilateral, UN and NGO projects and a small proportion of multi-lateral bank inflow) loan inflow and debt outflow can all potentially affect the rate of progress on SA1L. The benefit from grants is greater than that for an equivalent amount of loans or DFI if the grants are well managed. The potential for DFI in the north lies mainly in tourism timber plantations and wood processing, mining, manufacture, hydropower generation and transmission. Labour-intensive industry could take off in Bokeo and Luang Namtha along the new China-Thailand road. Tourism may be another area of growth in FDI.

Grant aid is mainly directed at rural development, covering roads, agriculture, watershed management, health and schooling, but also very small hydropower and solar power.

Tourism is now Laos' most important 'export' followed by garments, electricity and wood products.

Figure 17 Exports



Tourism is now Laos' most important 'export' followed by garments, electricity and wood products. All four have remained stagnant in the last two years. Of these four garments have the most uncertain future as the low tariffs offered by the European Union will soon become global. The other four sectors face uncertainties but will certainly grow.

The biggest challenge is to move the wood exports from unprocessed 'roundwood' to sophisticated wood products such as furniture. The figure shows a hopeful plateauing out of roundwood output from 1995 to 2000. Roundwood exports are said to have declined 20% in recent years. Practical furniture skills exist in-country, but Laos needs assistance with design that probably will come mainly from FDI. The potential for furniture is limited in the North as most of the forest has gone, but Huaysai that has some close-by remaining forest and will soon have a new bridge to Thailand seems to offer the best prospects. Training in sustainable selective logging for concessionaries may also be needed.

Human Development and Gini Index

The Northern Region's Human Development Index (HDI) is growing 0.035 per year. Given that this includes the immediate aftermath of the 1997 collapse, this could pick up in the future say to 0.04% per year say till 2007, by which time it would be 0.77 but as it rises further it would slow down as further increments become harder to achieve.

1998	2001
0.426	0.531

(Concept and data from UNDP)

But the Gini coefficient of the Lao PDR has grown

1992/93	1997/98
0.286	0.357

This means inequality is growing. When one person owns everything the figure is 1. This growing inequality is partly regional but is mainly urban-rural.

3. WATER MOVEMENT AND RELATED PROCESSES

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 m³/sec. The contribution of Sub-area 1L can be roughly estimated at about 1500 m³/sec or 47,000 Mm³/year that is 28% of the Lao total. Notice that this stream flow is the whole of SA1L 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 depends 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 data on transportable earth materials (soil and sediment) is also very poor. At this stage we need anecdotal evidence on sedimentation and mass movement from provincial staff.

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, Northern Luang Namtha. Elsewhere stream flats are narrow.

Tall forest is mainly confined to peripheral areas in areas of varying stages of regrowth. Dominant land cover is now low forest regrowth, scrub, bamboo, and temporary cropping.

Soils

The soils are well leached and acid belonging mainly to gleyic Acrisols, with significant areas of ferric Luvisols and eutric Cambisols.

- Acrisols have an argillic B horizon with base saturation of less than 50 percent. These soils are moderately strongly leached. Gleyic Acrisols have some hydromorphic properties due to some waterlogging.
- Luvisols have an argillic B horizon with base saturation greater than 50 percent. Ferric Luvisols show red mottles or concretions, with apparent cation exchange capacity of the clay fraction less than 24 milliequivalents/100grams.
- Cambisols are brown earths without an argillic horizon but with a structural B horizon.

Runoff and Water Use

To a mainstream input from PR China estimated at. 2,688 m³/sec {84,770 Mm³/ year}. runoff from all tributaries in SA1L is about 1500 m³/sec or 47,000 Mm³ {mega cubic metres}. Compared with that used by vegetation which is more or less half of rainfall, irrigation is a minor user, consuming a mere 200 Mm³ 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 SA1L 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.

Dams and electricity are considered in more detail below.

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 3000 mm in an E-W zone in the highlands just south of the Xieng Khuang Plateau and another of more than 3000 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 centering in Northeast Thailand well outside SA1L, and the second maximum of much less significance at 1800-1900 mm in Phongsali Province in the Nam Ou catchment.

Evaporation estimates range from 1500 to 1800 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 SA1L, five on tributaries, and two on the mainstream, all but one within easy reach of Luang Phabang city.

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.

Figure 18 River Flow Variation from Year to Year

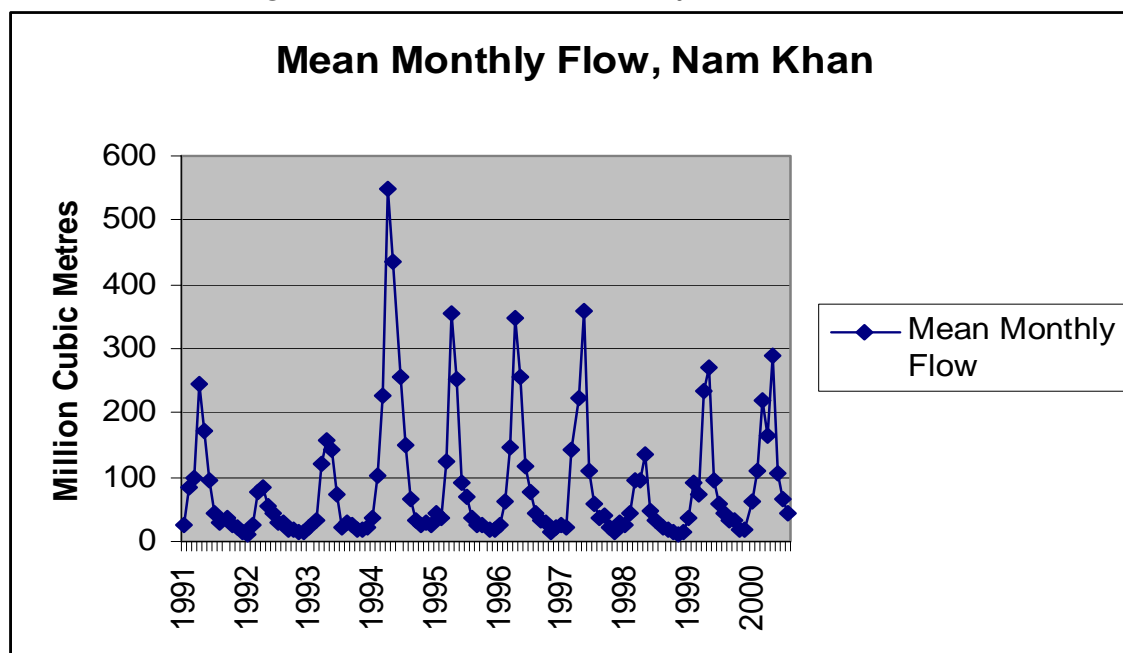


Table Tributary Hydrological Data

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		

(MRC Hydrological Yearbook)

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 River Discharges per Unit Catchment Area

River	Gauge site	Catchment area	Period of record	Maximum discharge	Minimum discharge	Average Yield
-------	------------	----------------	------------------	-------------------	-------------------	---------------

		(sq km)		(m3/sec)	(m3/sec)	l/sec/km2
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 since 1985	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			

(MRC Hydrological Yearbook)

Table Estimates from Rainfall and Runoff ratio

River Catchment	Catchment Area (Km2)	Annual Rainfall (MCM)	Average Annual Runoff Ratio	Average Annual Runoff (Mm3)
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

(Jica/MAF Study)

These figures are much lower than those estimated from rainfall.

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.

Trans-boundary Issues

Trans-boundary issues are usually mentioned in the international context, but the effect of activities in up-catchment provinces on down catchment provinces should also be considered. The more general point can be made that all relatively up-catchment activities should be sensitive to down-catchment people and livelihoods. This must be considered at several hierarchical levels depending on the stream network but also groundwater flow paths.

The importance for down-catchment people depends on the volume and timing of water flow in relation to the channel available, the suspended and bed load, chemicals transported and of course the activities of those down catchment. For example, increased flooding not only results from heavier storms and changed land use in case of small to medium watersheds but also population and settlement growth on the flood plain. The 'flatlanders' must realize their own responsibility for flooding. When they are city people also generating high levels of air pollution the responsibility is two fold.

Moreover trans-boundary issues are not only water-based but air-based. Polluted air from other regions and air and water-vapour flows due to activities elsewhere are also trans-boundary issues. And of course human (political, economic and social) relationships are also trans-boundary.

3.1 Proposed General Technical Strategy

- More effort is needed on data collection and analysis.
- Ultimately each sub-basin or tributary catchment should be studied and planned separately.
- Data should be organized according to catchments. Local organizations should be set up for each major catchment and groups of minor catchments.
- Simply a 'balance of sectors and themes' for the sub-area is not appropriate.
- It would be best to chose on medium sized catchment to organize a model integrated study and development project as well as make selected studies of the whole area where data are weak.

4. WATERSHED MANAGEMENT: forests, degraded ecosystems, trees, and rainfed agriculture

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.

4.1 Organized Watershed Management

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)

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.

Figure 19 Physical Watershed Classification in SAIL



Table Watershed Management or IWRS Projects in SAIL

<i>Watershed</i>	<i>Province</i>	<i>Area (km²)</i>	<i>No. of Villages</i>
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

4.2 Land cover – Land use

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 Percent Area of Shifting Cultivation from Three Sources

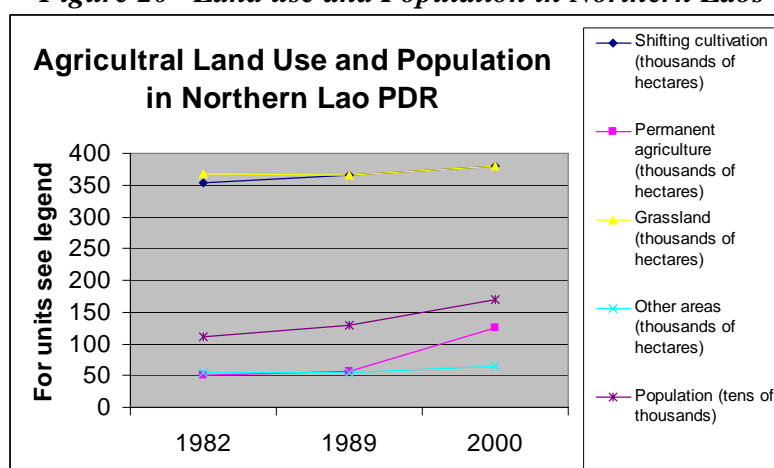
	1982	1989	1993	1995	1997	2000	2005	2010
MAF Study/Jica	3.6%					3.87%	3.9%?	
MRC Landsat			approx 25%		approx 5%		0%?	
Survey of Villages				2%		1.2%	0.5%?	0%?

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.

	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%

(Jica/MAF study p. 3-43)

Figure 20 Land use and Population in Northern Laos



(Data from Jica/MAF)

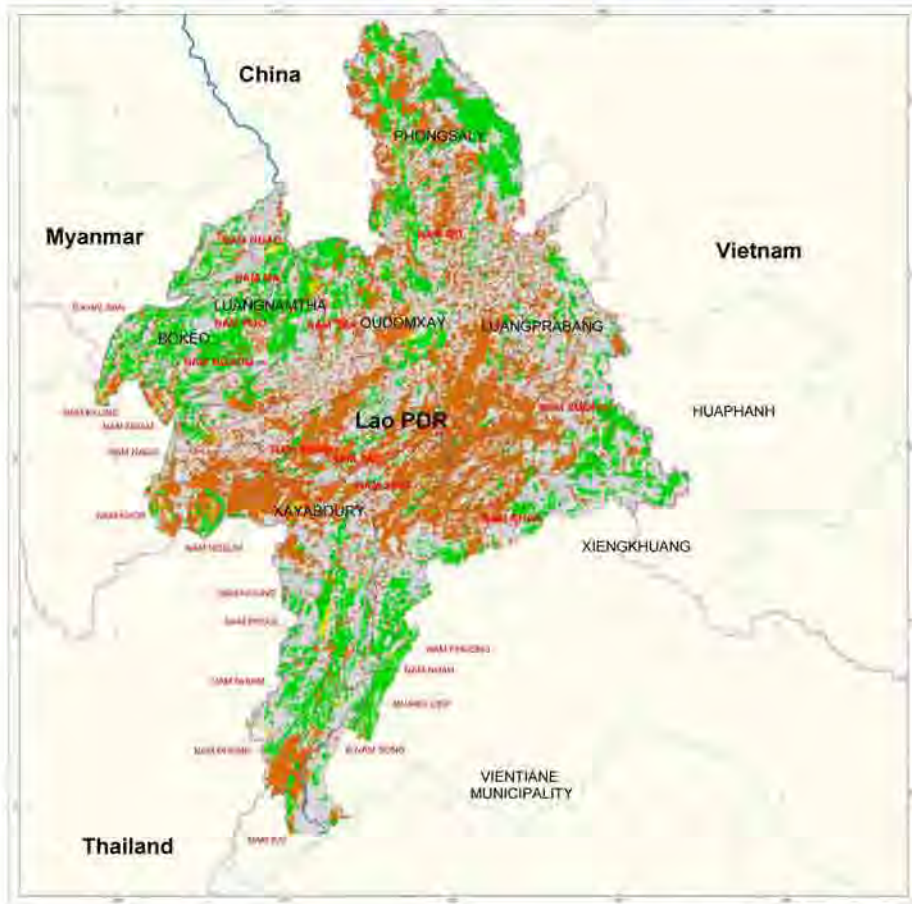
According to this study the percentage of total area covered by shifting cultivation ranged from 3.6% to 3.87% over 18 years, 1982 - 2000

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.

It is notable that Luang Namtha, Bokeo and central Xayabouli have very little shifting cultivation in this map. Could this be true?



Figure 21 1993 Land cover-Land use Map SAIL

**Forest Cover Map in 1993 of "1L" of
The Basin Development Plan Sub-Areas**



Prepared by Mekong River Commission, September, 2002

 Mekong River Commission

<p>Land cover</p> <ul style="list-style-type: none"> Dense Forest Mosaic Forest Mangrove Wetlands Plantations Upland Agriculture/ Shifting cultivation Agricultural land Water body Shrubland, grassland, other 	<p>Legend</p> <ul style="list-style-type: none"> Country boundary Sub-Catchment boundary Basin boundary River (water body) Provincial boundary 	<p>N</p>  <p>50 0 50 Kilometers</p> 
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Below is a map that shows the land use/ land cover for SA1L 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 22 1997 Land cover-Land use Map SA1L

**Forest Cover Map in 1997 of "1L" of
The Basin Development Plan Sub-Areas**

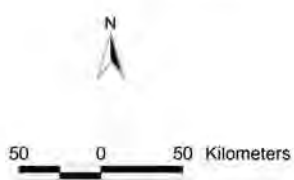


Mekong River Commission

Prepared by
Mekong River Commission Secretariat, Sep. 2000

- Land cover**
- Dense Forest
 - Mosaic Forest
 - Mangrove
 - Wetlands
 - Plantations
 - Upland Agriculture/
Shifting cultivation
 - Agricultural land
 - Water body
 - Shrubland, grassland,
other

- Legend**
- Country boundary
 - Sub-Catchment boundary
 - Basin boundary
 - River (water body)
 - Provincial boundary



To what extent is the 1997 shrubland really regrowth 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 regrowth in the cycle and that outside the cycle that is either degraded and stable or recovering to forest.

Administrative Forest?

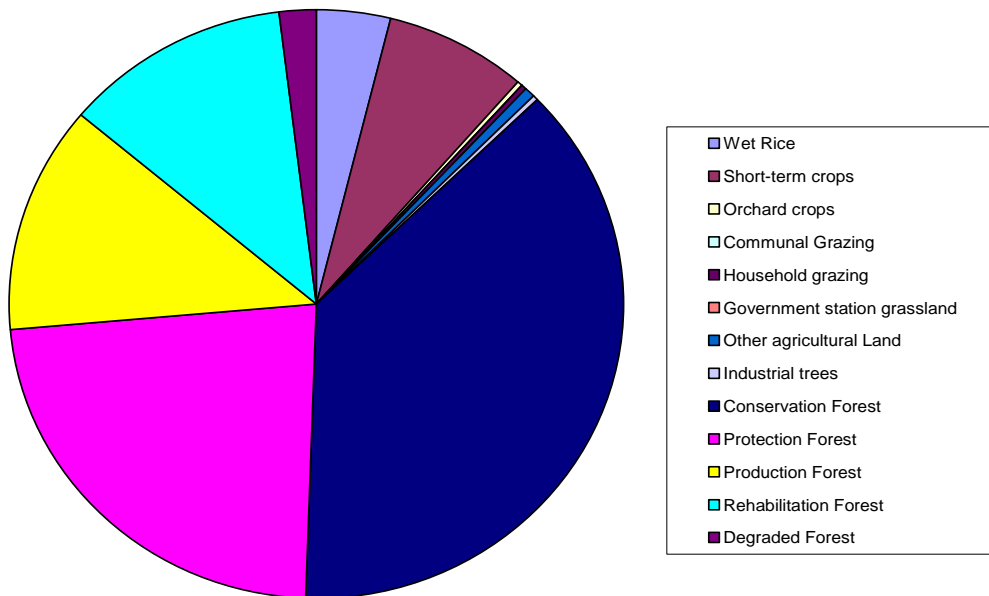
The chart below is another interpretation of land cover –land use. This shows very large areas of forest of various types that are inconsistent with all other data. They probably have administrative significance.

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

(Data from Jica/MAF)

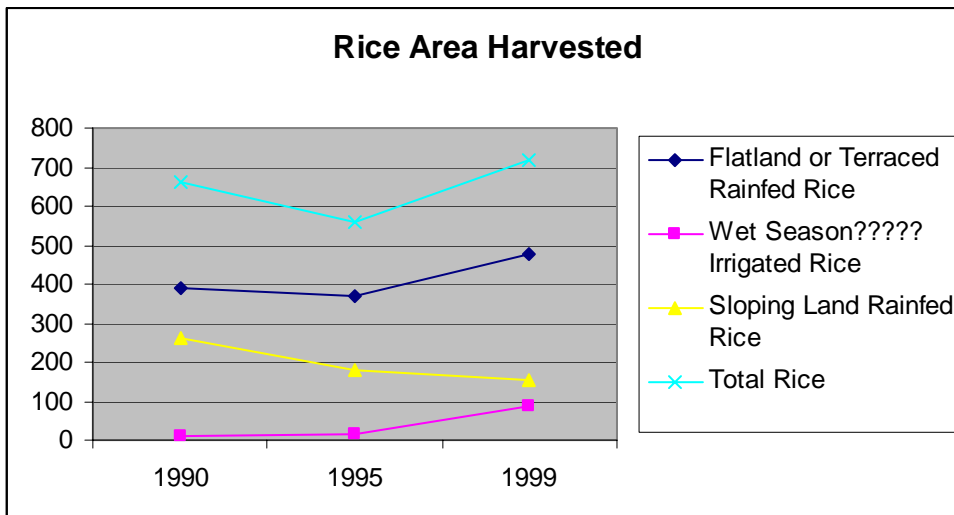
Figure 23 Northern Land Use Pie Chart

Forest, Other and Agricultural Land in Northern Laos



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 24 Rice Areas



(Data interpreted from 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.
- and 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.

Table 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%

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

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

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 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 *

* 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 Land use for Allocated Land in Six Provinces in SA1L

Category	Province					
	Phong Saly	Luang Namtha	Oudom-xay	Bokeo	Xaya-boury	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	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

(Jica/MAF)

Summary

Total Agricultural Land Allocated	410,200
Total Forest Land Allocated	2,957,557
Total Land and Forest Allocated	3,367,757

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

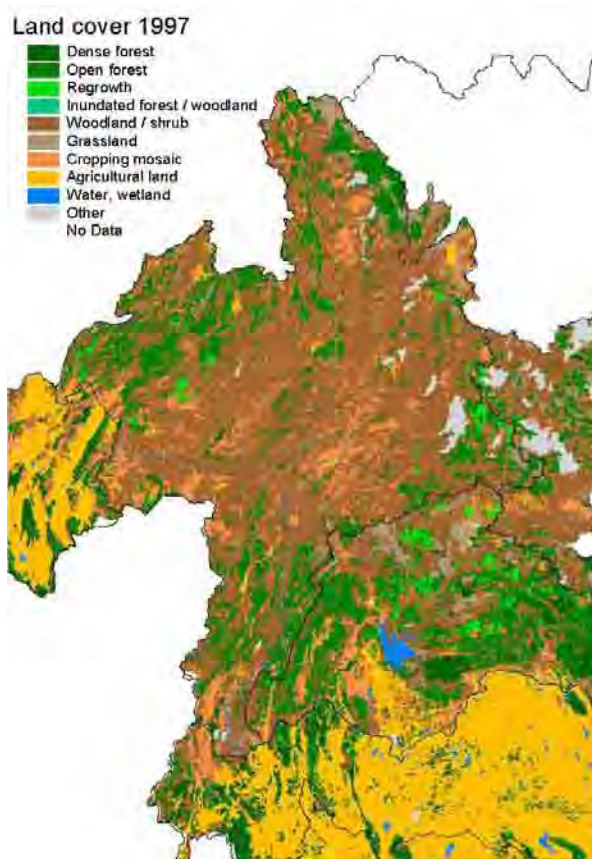
- Shifting cultivation in the hills for many hundreds, perhaps more than a thousand years
- Logging by clear felling for many decades,

As a result the forest cover in SA1L 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 regrowth 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 SA1L. This is where most of the population live.
- This deforested area and much of the rest of the north is covered by low forest regrowth, 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

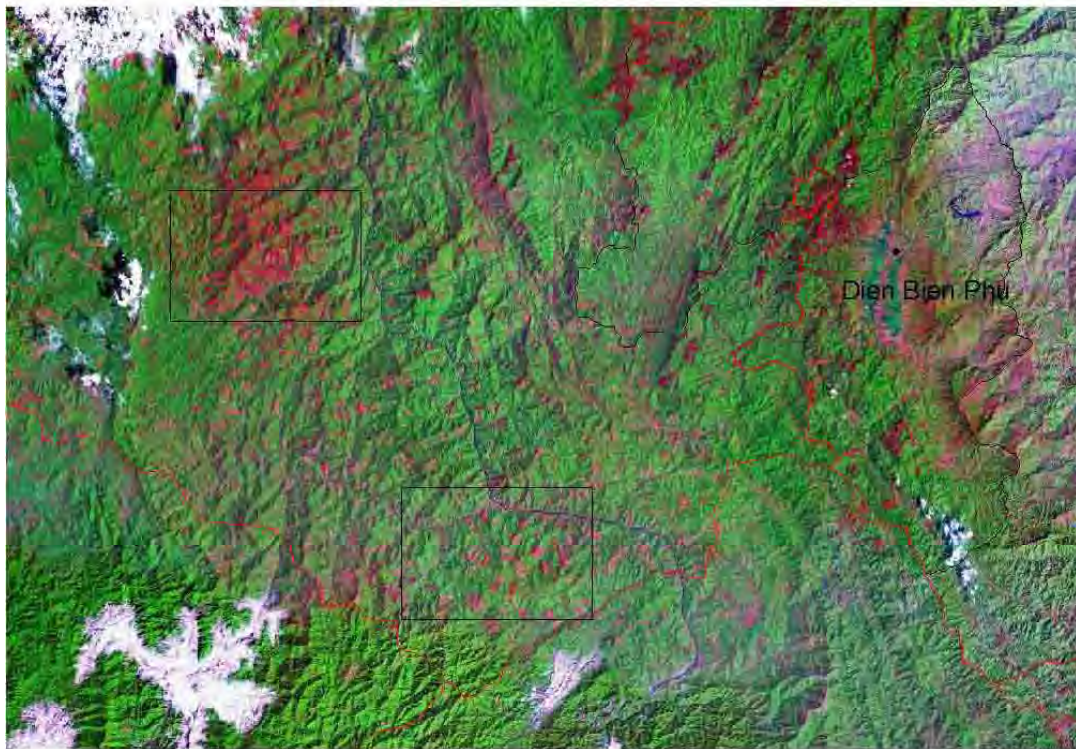
Wild harvesting by villagers (NTFP) in the forests is severely threatened by forest loss especially in the central east-west zone. It is here that efforts on forest conservation and supporting regrowth around the remaining stands should be most intense.

Figure 25 Land Cover, 1997, SA1L



(MRC)

Figure 26 Types of Deforestation in SA1L



10 0 10 Kilometers
(Landsat image from MRC)

Phongsaly and Dien Bien Phu

Figure 27 Clear Felling SA1L



1 0 1 2 Kilometers
(Landsat image from MRC)

Central Phongsaly - deforestation

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 SA1L and GTZ/MRC analysis for 1997 (Landsat) it covers 18 percent.

Table 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%	Population (2000)	Population Density (persons/km ²)
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 regrowth forest as non-forest while the NFI team has more or less consistently interpreted regrowth 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 regrowth 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.

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

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

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

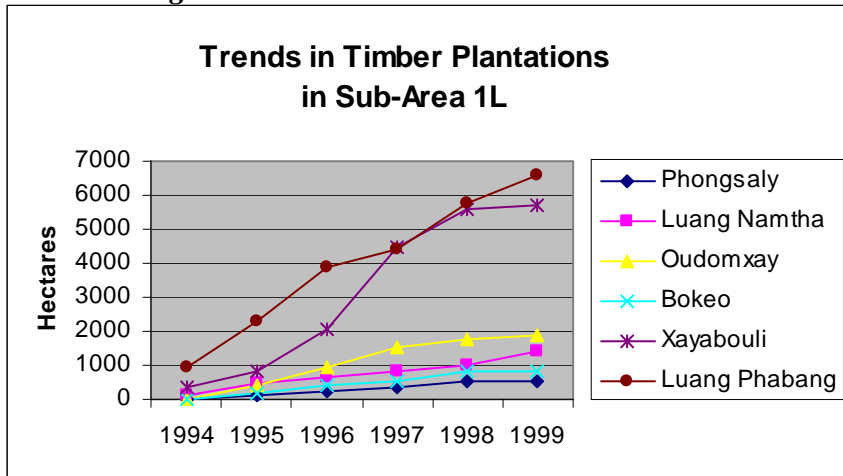
Timber Tree Plantations and Logging

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

Planting and maintenance of timber tree plantations in areas of degenerate ecosystems and low regrowth, 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 28 Timber Plantations in Six Provinces



(Data from Jica/MAF)

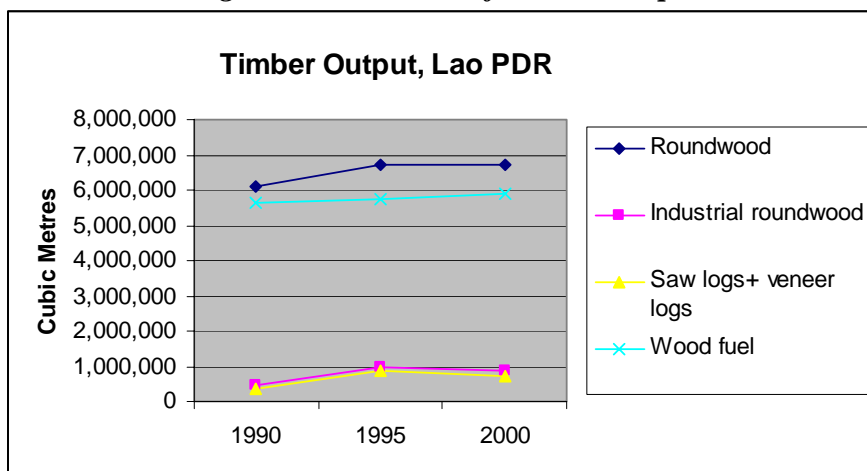
Timber output

The graph below shows

4. The predominance of roundwood in timber output
5. A promising plateauing out of roundwood output from 1995 to 2000.
6. Roundwood exports are said to have declined 20% in recent years.

This is promising for Laos.

Figure 29 A Decade of Timber Output



(Data from Jica/MAF)

Mass movement

Mass movement includes:

1. Landslides,
2. Mudslides,
3. Rock fall
4. Soil creep

Landslides come in two types: deep and shallow.

1. Shallow ones are usually due to the action of water on subsoil weakened by the removal of deep rooted vegetation i.e. trees.
2. Deep landslides are due to earthquakes and thus rock and deep soil failure often in permanently saturated ground, and so occur beneath all types of land cover on slopes.

Mass movement is an often forgotten form of sediment movement to streams. Landslides can also block streams quickly creating a temporary dam and reservoir that will be likely to suddenly give way to create a muddy flood or mud flow that can engulf nearby downstream villages. In Southeast Asia mud flows appear to mainly take place following clear felling of forest.

Northern Laos is subject to earthquakes and clear felling, but data on landslides and mudflows is poor. Data gathering could start by gathering anecdotal evidence from provincial staff.

Sediment Movement by Surface Water

The results of watershed management are deceptive as sediment does not travel as far and fast as many assume. Most sediment is deposited locally and moves on a little in the next flood. 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 density of sediment that increases over time.

4.3 Watersheds Scenarios

In contrast to the data in the table above the MRC Landsat-based maps for 1993 and 1997 show shifting cultivation dropping from 15-20% to 3-5% of the total area in four years. The latter figure is closer to a Jica/MAF estimate. The apparent progress shown on the MRC maps would give hope that shifting cultivation would have already been eliminated but this does not seem to have happened. Another survey by interview of villagers showed that the area of shifting cultivation was even smaller and falling markedly from 2% to 1%. A reduction seems to be taking place but the rate at which it is taking place, the way in which this is happening and the total area remaining is uncertain. This makes useful scenarios very difficult. More effort is needed to resolve the inconsistencies and increase understanding of past processes.

Logging Scenario/Strategies

At the same time however forest area still seems to be declining, so this must be due to logging. Legal measures are resulting in decreased logging, reduced runoff, erosion and groundwater recharge. This must be causing migration to towns. But logging exports are continuing in some areas and given anecdotal evidence of rates it is likely they are coming from clear felling or rapid selection. Not only enforcement of existing laws but training in ecological selective logging is required.

Certification of tropical timber that comes from sustainable logging perhaps without any socio-economic exploitation may be resulting in higher prices in Europe. Thus it is probably becoming economically worthwhile not only for the long-term value for the nation but also for short-term gain to practice careful selective logging.

That proportion in the reduction in shifting cultivation that has taken place by the relocation of villages to wet rice land or urban areas has not yet resulted in sufficient regrowth to identify as forest. This may take several decades. But at least the mountainous and hilly areas need strong support for forest regeneration around existing small forest areas as these have the best hope of regenerating to natural high diversity forest. Further remote sensing work is needed to identify such areas.

Two Forest/Plantation Scenarios

1. Optimistic

If logging is reduced and made sustainable and significant areas of regrowth revert to diverse forest as opposed to low diversity grassland, bamboo or 'shrub', that the area of forest could grow and serve as a long term resource for

- F. small scale wild harvesting,
- G. careful selective logging,
- H. tourism and recreation, and
- I. a moderator of overland runoff, erosion and recharge of groundwater.

2. Pessimistic

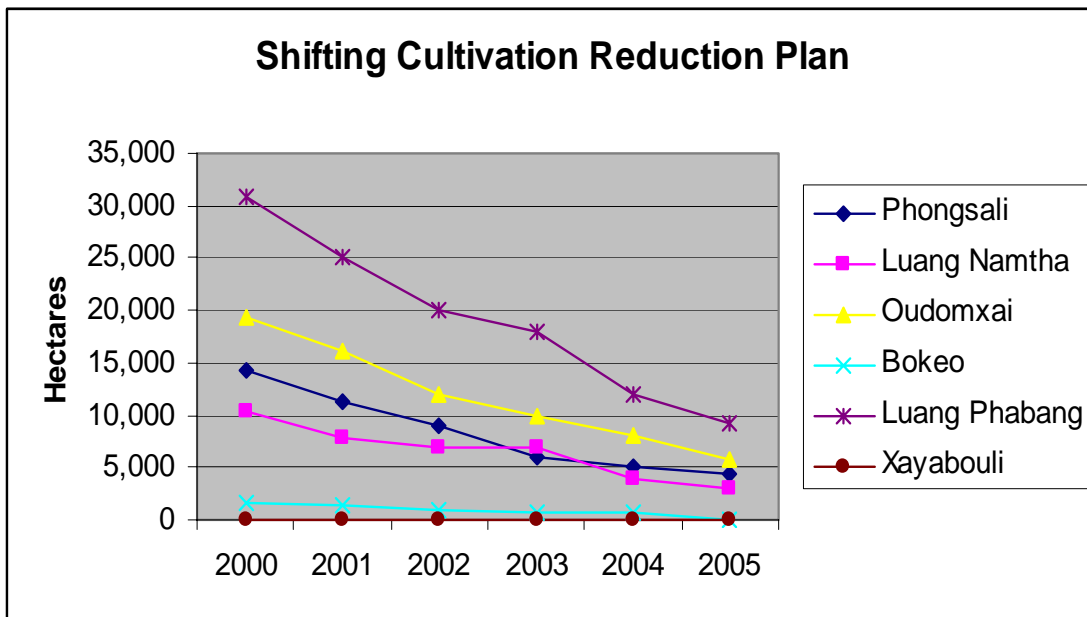
If not, then the future is bleak.

- g) Timber production will decline and rely only on the few species grown in timber plantations.
- h) Rapid surface and groundwater runoff will grow and erosion will grow at first but may eventually stabilize as low diversity low productivity ecosystems become established in poorer soils.
- i) Groundwater levels may rise to waterlog flat areas and contribute to riverbank collapse.
- j) Subsistence villagers will suffer further;
- k) eco-tourism and cultural tourism will die.

Sloping Land Farming Scenarios

To whatever extent the government has been successful in reducing shifting cultivation by resettlement of the practitioners to other areas, it is planning/has planned to reduce shifting cultivation further by training the farmers in new techniques of permanent sedentary farming including contour cultivation and diverse tree and crop culture. It should be possible to assess progress on this plan (see figure below).

Figure 30 Five Year Plan to Reduce Shifting Cultivation



(Data from Jica/MAF study)

It might be noted however that if sedentary farming is to sustain viable livelihoods each family may need a larger area than under 'late shifting cultivation'. This is needed to maintain even the frugal living these people have now as land productivity may fall in the short term while new systems are being established. The land allocation process may have been allocating too small areas to try to reduce shifting cultivation possibly especially where villages are moved to sites along roads but still in hilly country.

Sloping land rice (shifting cultivation) areas is probably falling, but at an uncertain possibly slow rate. Let us assume that shifting cultivation can be more or less eliminated by migration to towns and transfer to permanent farming not by 2010, but by 2020. But to do this it would seem a larger rural development budget is needed.

Timber Tree Plantations Scenarios

Planting and maintenance of timber tree plantations in areas of degenerate ecosystems and low regrowth, may be appropriate where it is too steep for sedentary farming systems, but well away from tall or re-establishing forest. However research is needed to show that teak plantations are less erosive than diverse farming systems. Timber tree plantation area established so far may be slightly reducing runoff and stabilizing soil.

Timber plantations in Luang Phabang and Xayabouli are growing at the rate of about 1000 hectares per year. At a simple extrapolation this would bring them to about 26,000 hectares each in 2020 but at least in Luang Phabang the government is discouraging teak planting as the villagers are losing their land to urban investors. Micro-finance assistance is needed.

If the Kyoto protocol comes to fruition and the emission trading provisions are used in Laos, a careful training and micro-financing plan will be needed to make sure that the benefits are well spread. This should start immediately before pressure from Kyoto, or a revised agreement, forces a rapid and thus poorly planned expansion. Probably it would be good to start in at least one of the two well established plantation provinces as well as Oudomxay as it has much degraded land, but very little forest.

A timber plantation programme should start slowly at say 100 hectares a year and pick up speed to 2000 -3000 hectares after five years when a good methodology becomes established and eventually at a faster rate, say 20,000 hectares a year when feedback eliminates problems. The whole of SA1L is about 10 million hectares and the degraded portion that is unlikely to ever revert to forest may be about a quarter of this, say 2.5 million hectares (a guesstimate) so even at this rate it would take 125 years. In no sense is this a prediction, but merely one possibility. The important point is one well understood in Laos that it is best to start slowly and evaluate progress.

Following the slowing at the turn of the century it is expected to pick up following a new development plan.

Table Timber Plantation Scenario

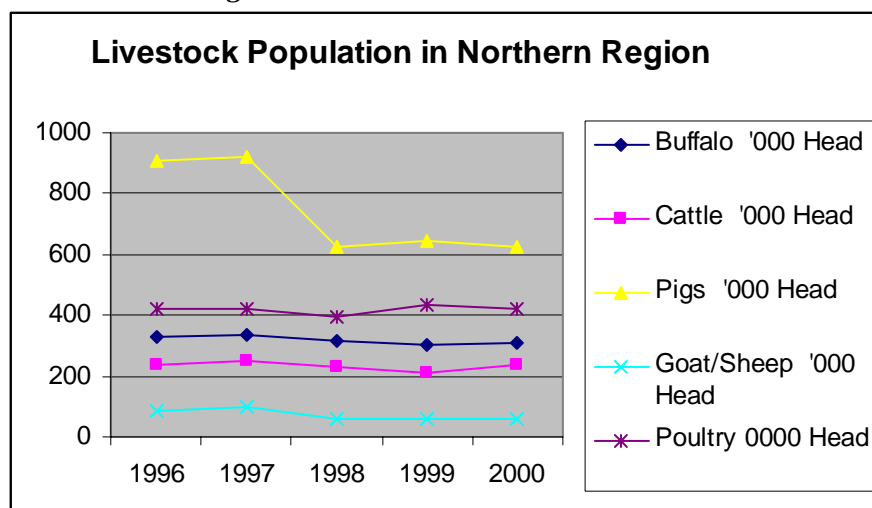
Year	1999	2000	2005	2010	2020
Annual Expansion Rate	2,000	1000	1,000	2,000	
Total Area	17,000	18,000	23,000	28,000	48,000

The effect on runoff and erosion will depend on whether the plantations are simple low diversity ones or whether water resources are considered in the plan. Teak leaves produce highly erosive drops so it could be worthwhile to strip plant along contours with vetivia grass. At least some undergrowth should be encouraged. This needs research.

Livestock Scenarios

Livestock populations are steady to falling. A major effort in dialogue, micro-finance and training is needed to raise the number of head of livestock in the north. In so far as livestock raising takes off, runoff will be high in wet and dry season, but erosion would be moderate.

Figure 32 Livestock in Northern Laos



Xayabouli is leading the way in large livestock raising (buffaloes and cattle) except for, primarily due to its large plain areas. It also leads in Chicken raising (at least until the Bird flu epidemic). Luang Phabang is leading in pigs and goats/sheep. Oudomxay comes in third in all types.

Table Animal husbandry in Six provinces (Thousand heads)

Province	Buffaloes		Cattle		Pigs		Goat & sheep		Poulties	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
1Phongsaly	31.4	32	15.6	16.5	50.8	67.7	1.3	2.4	309.5	310
2Luangnamtha	20.8	20.8	19.1	20.2	77.8	80.9	4.8	5	260.4	256.5
3Oudomxay	45.3	46.2	31.5	33.3	82.2	81.4	12	12.2	471.6	502.9
4Bokeo	22.3	22.7	18.5	19.6	32.9	52.4	3.3	3.4	62.8	370.9
5Luangprabang	61.4	62.5	42.1	38.1	126.2	140.4	21.4	22.3	938.2	1,003.7
7Xayabury	66.9	67.8	63	65.8	100.3	110.7	4	3.9	1,307.2	1,457

(Sub-Area Sector Study)

4.4 Watershed Strategy

Four land uses offer some hope for the degraded steep slopes.

- Forest regrowth near existing forest
- Timber tree planting
- Permanent, sedentary, diverse and integrated farming systems
- Livestock, where not in conflict with plant-based farming.

The value of remaining forest:

1. Can provide sustenance and subsidiary sales for the people living a subsistence life nearby
2. Attract tourists.
3. Allow careful selective logging in a few larger areas
4. Support infiltration to interflow and groundwater zones.
5. Moderate runoff

Forest Conservation/Regrowth Strategy

Forestry and tree plantation management can be divided into three sub-sectors:

1. Conservation and protection of tall growth forest ecosystems and associated regrowth, both inside and outside NBCAs
2. Production of timber and NTFPs from tall forests, regrowth and degenerate ecosystems.
3. Planting and maintenance of tree plantations in areas of degenerate ecosystems and low regrowth. These are very largely if not wholly monoculture stands and should not be called forest. The terms forest regeneration and reforestation should be carefully distinguished.

Forest Conservation

- Further enforcement of laws is probably needed.
- Training in careful ecological selective logging is probably required.
- Certification of tropical timber is resulting in higher prices in Europe. This process should be supported.
- Support for Community management of forests
- Furniture Exports: Huaysai and Luang Namtha towns that has some close-by remaining forest and will soon have a new bridge to Thailand seems to offer the best prospects of furniture making and export. Assistance is needed with design. By supporting furniture you generate a lobby group for sustainable forestry as well as generating good jobs.
- The central area needs strong support for forest regeneration around existing small forest areas as these have the best hope of regenerating to natural high diversity forest.

Planting and maintenance of timber tree plantations may be appropriate

4. in areas of degenerate ecosystems and low regrowth,
5. where it is too steep for sedentary farming systems, but
6. well away from tall or re-establishing forest.

Timber plantations and support for forest regrowth may take off if the Kyoto agreement is implemented. Pilot projects are needed now.

Timber plantations offer secure future income to the owner.

- 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.
- Vetivia grass strips along contours may be advisable to reduce erosion
- It is best to start promotion slowly and evaluate progress.

Forests and Plantations Compared

Forest regrowth is better in three ways than timber tree plantations because.

4. Forest has a natural biodiversity that provides a range of timber and non-timber products (NTFPs).
5. Semi-subsistence cultivators rely on this diversity, especially in the dry season and after crop failure. When the area of nearby forest declines they appear to 'over harvest' NTFP but really it is as much due to forest destruction as a whole.
6. Forest is better watershed manager
 - less erosion (more protective undergrowth and litter)
 - a higher proportion of infiltration
 - higher evapo-transpirationThis results in
 1. lower wet season runoff ameliorating local flooding
 2. but probably higher dry season subsurface runoff.

The mountainous and hilly areas need strong support for forest regeneration around existing small forest areas especially in the degraded areas of central SA1L

Timber output from Lao PDR trees is mainly unprocessed roundwood and wood fuel. Wood fuel comes from shifting cultivation clearing so is not an additional loss of forest to what is already recorded under this form of agriculture, and a form of selective gathering and cutting that concentrates on dead or dying wood. It only damages the forest if done with high intensity including live wood, perhaps for charcoal manufacture for sale, or for sale directly.

National Biodiversity Conservation Areas

The map below shows the area of NBCAs (National Biodiversity and Conservation Areas). Is conservation of forest is largely taking place in Preservation forest and Conservation forest in NBCAs or in all forest allocated to villages right across the country? Where are the production forests and the logging concession areas?

National Biodiversity Conservation Area (NBCA) in Sub area 1L

Name of NBCA	Area (ha)	Province
Yot Nam Thoon (Phou Dendin)	222,000	Phongsaly
Phouleuy	150,000	Huaphan, Luangprabang, Xiengkhuang
Nam Et	170,000	Huaphan, Luangprabang
Nam Ha	222,400	Luangnatha
Nam Phoun	191,200	Xayaboury

(Sub-Area Sector Review)

Figure 33 NBCAs in SAIL



Kyoto agreement

1. Tree plantations and real forest regrowth support are of particular importance because of the Kyoto protocol.....when it is signed.
2. A poor country like Lao PDR can sell their carbon pollution rights (or credits) to another nation, an industrial nation that pollutes more than its population justifies.
3. In selling its rights it gains assistance with tree plantations or forest regrowth that will use carbon dioxide in their growth.

{The Kyoto protocol has weaknesses and should be improved in the long-term but it is a hopeful first step and could promote tree plantations and forest in poor nations suffering forest loss and degradation}

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.

Research might be conducted on the hydrological consequences of forest regrowth and timber tree plantations. Raindrops from teak leaves being particularly large are especially erosive. It is likely that tree plantations, well managed will produce a higher economic return but they can lead to gross inequality as peasant growers are tempted to sell their land to urban buyers.

Stabilizing Shifting Cultivation Strategy

Further progress it is planned will mainly take place by training the farmers in new techniques of permanent sedentary farming including contour cultivation and diverse tree and crop culture. This is best associated with micro-finance and assistance with storage, processing and marketing.

Each family may need a larger land area than the average of 1.4 hectares during the transition to permanent farming. If sloping land farmers are not allocated more they may ignore the land allocation programme which will mean that the government will have less influence over the land used and the crop planted. The poor want more rice but this may not be possible. Northern farmers may well do better to produce more for the market and buy more rice. The NRDS emphasises that the market can determine the best land use, but that assumes that farmers have a good knowledge of the long term consequences of growing for the immediate market. The government must organize a better training programme for farmers.

Food Security or Commercialisation in Steepland Areas

The government has two policies, food security and commercialization of agriculture, that in some areas are partly incompatible. But at what spatial scale should food security be considered: household, village, province, region or nation? Where rice is very largely grown for home consumption, an increase in commercialization may best require a gradual change to 'cash crops' such as fruit trees and 'row or upland crops' implying that rice would be increasingly purchased even internationally. This means that food security at the household level is reduced.

If food security for each household is to be the prime aim, then rice in steep sloping land areas where population density is too high for sustainable shifting cultivation, rice cultivation must be promoted as a row crop intercropped and rotated with edible and forage legumes. In the short-term this may be tried, but it is likely that villagers near roads will come gradually to prefer tree and a variety of row crops and a higher degree of participation in the market.

Livestock

In Northern Laos livestock numbers were stagnant through the 1990s except for pig numbers that plummeted from 1997 to 1998. This drop did not take place in other regions.

Given the steady numbers of livestock numbers from 1996 to 2000 can the projected increase shown in the table below be achieved? The northern hills and mountains appear to offer opportunities, but conflict with cultivators is increasing. It is unreasonable to expect cultivators to bare the cost of fencing. Large livestock owners should herd or confine their animals.

Table National livestock targets for 2000 and 2020

2000		2020			
Population	Production	Population	Production	Annual	Linear

	(million head)	('000 Tonnes)		('000 Tonnes)	Population Increase	Annual Rate of Population increase
Buffalo	1.0	16.6	1.5	25	25000	2.5
Cattle	1.1	16.4	3.7	53	130000	12
Pigs	1.4	27.7	2.4	51	50000	4
Poultry	13	18.3	53	78	2000000	15
Total meat		77		205		
Eggs		10		41		
Milk		0.27		1.2		

(Data from Jica/MAF study)

4.5 Conclusions on Watersheds

The results of watershed management are deceptive as 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.

Northern Laos is subject to earthquakes and clear felling, but data on landslides and mudflows is poor. This data could be collected anecdotal as part of the watershed management process.

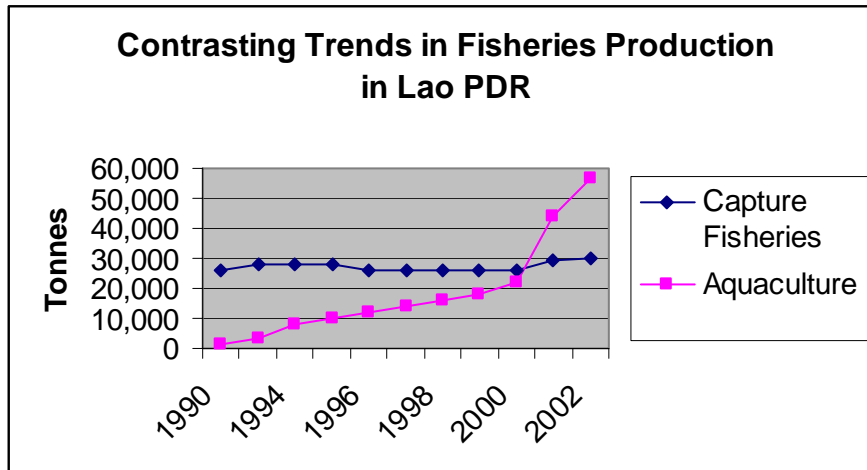
The future of watershed management depends now on provincial and district operations. We have no quantitative plans on the area to be covered in each province and district, nor have we any data on what is specifically to be done under the heading of watershed management as opposed to activities that are called forestry or agriculture. A scenario can be written based partly by combining the scenarios of these sectors, but WM will have a catchment focus that is highly spatial with each catchment planning forest regrowth, timber plantations, and permanent farming including livestock raising, contour farming, integrated farming, 'agro-forestry', etc to try to modify runoff and soil transport to the local stream. This will be partly based on the physical watershed classification but must be based firstly on the villagers' preferences after dialogue and training. It must also be recognized that villagers' preferences will change with knowledge, understanding and markets.

Comparative research might be conducted on the hydrological/sedimentological consequences of forest regrowth and timber tree plantations. This could be done in the suggested medium catchment project (see below).

5. 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 34 National Fisheries Trends



(Data from Sub-Area Sector Review)

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 about 72,000 tonnes 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 mollusks, crustacans, 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 SA1L so the sub-area total can be assumed to be about 23 million US dollars.

Environmental Degradation

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

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

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 SA1L but each province has a hatchery operating or under construction.

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

<i>Provinces</i>	<i>Stations for fingerling production</i>		<i>Fingerling Production (million)</i>	<i>Remarks</i>
	<i>State</i>	<i>Private</i>		
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 2. Nam Tin			Under construction On proposal
5. Luangprabang	Na Luang	1	9.5	Operating
		1	3.8	
6. Sayabouri	Nam Tan Dam		4.2	Operating
			22.17	

(National Sector Review)

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.

5.1 Fisheries Scenario

The impact of dams on the wild bio-aquatic sectors is covered below in general under 'Hydropower'. Insufficient data is available to the quantitatively predict the impact.

The four major negative impacts on this 'natural' sector have been and/or are likely to be

1. watershed degradation,
2. dam and weir construction, especially without effective fish passes.
3. introduction of alien species.
4. overfishing

Reservoirs have an uncertain impact mainly increasing overall catches and sometimes decreasing them, but larger scale fisheries enterprises tend to take over from the individual fishers on the streams.

- The impact of dams on the wild bio-aquatic sectors is covered below in general under 'Hydropower'.
- Insufficient data is available to the quantitatively predict the impact.

The three major negative impacts on this 'natural' sector have been and/or are likely to be watershed degradation, dam and weir construction and the introduction of alien species. Everyone agrees that better watershed management is needed. On the other hand it is not easy to agree on the best balance between 'modernization' or even the continuation of irrigation 'tradition' and the maintenance of wild fisheries. The range of impacts is

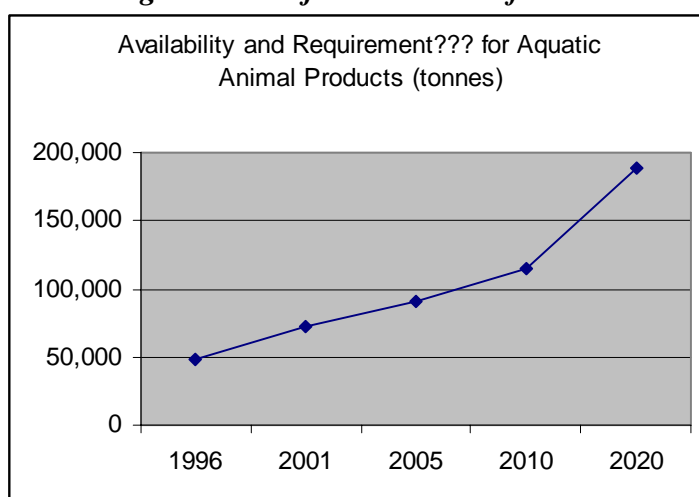
spatially highly variable so local people should be able to make a contribution to the key decisions. Continuing inter-sectoral dialogue and research are needed.

The Ganga (Ganges) Basin probably provides a reasonable scenario of dam growth without thought for the fisheries sector. The larger fish whose life cycle tends to depend on long migration routes have been devastated by the dams on all the Ganga tributaries. These fish are undoubtedly ‘trans-boundary’ in the Mekong context.

The projected national consumption of fish is based on population increase and an increase in mean consumption per person, rising from 10.2 kilograms in 1996 to 32 kilograms in 2020 closer to present average for the four LMB nations.

Demand for fish is estimated at nearly 200,000 tonnes by 2020. Fish production in the future will merely be what Laos can produce in competition with other resource uses and environmental limitations.

Figure 35 Projected Demand for Fish



(Data from Jica/MAF)

It is estimated that by 2020 fish production in the Lao PDR from aquaculture will be as follows:

Table Aquaculture Lao PDR, 2020

	tonnes
Urban fish ponds	33,000
Reservoirs	60,000
Caged fish culture in rivers	20,000
Rural aquaculture (ponds, reservoirs, cage culture and fish in rice fields)	48,000
Total	161,000

(Jica/MAF)

Thus about 40,000 tonnes must come from wild fish and imports to satisfy the projected demand.

From the trends shown above it is clear that with the present strategy the future of fisheries will largely be in managed fisheries in ponds and reservoirs.

Rural aquaculture has potential in almost all flatland areas so will be mainly of relevance to Xayabouli Province in SA1L, but smaller areas are found in other provinces.

Diverse and thus ecologically stable aquaculture depends on healthy wild ecosystems to provide inputs. Thus the wild environment must be protected. Alien species such as African Tilapia and non-native carps introduced to reservoirs and ponds compete with the diversity of local species and escape up and down river to gradually degrade the local diversity. Efforts should be made to keep alien species in their managed water body.

Indigenous species are said to be decreasing in number in the Nam Ngeum reservoir since 1988 but the decrease was halted for a time when the local spawning ground was protected from harvesting.

The MRC is at present having some success in breeding native species for release into reservoirs. This is very promising.

5.2 Fisheries Strategy

Policy and Strategy

Government policy is focusing on project planning to minimize impacts on the environment. Fisheries are being developed following FAO guidelines that encourage HRD, infrastructure, credit, processing and cold chain, marketing.(National Sector Review) It is aimed to integrate fishing further into the rural livelihood aiming at

- Food security for rural people
- Poverty reduction through complimentary incomes
- Integration of aquaculture into agricultural mixed farming for employment
- Supplementary food for the urban population from peri-urban production.

The government strategy for wild or capture fisheries involves

1. decentralization of management,
2. reducing destructive fishing,
3. introducing rights-based fishing,
4. promoting awareness
5. rehabilitating and restoring habitats for migratory fish,
6. restocking with indigenous fish species,
7. encouraging culture-based fisheries

The National Sector Review suggests that the strategy for aquaculture or managed fisheries might be as follows:

1. Investing in aquaculture development.
2. Integrating aquaculture into rural development.
3. Improving culture-based fisheries.
4. Managing aquaculture health including nutrition and genetics.
5. Improving food fish quality and safety for consumption.
6. Promoting market development and trade.
7. Strengthening institutions.
8. Strengthening linkages with regional and interregional agencies.

Also suggested are:

1. Rehabilitation of fish hatcheries and expansion of fish seeds production and distribution.
2. The development of small scale breeding facilities at local level.
3. Rural aquaculture development.
4. Fish feed improvement.

Possible investment opportunities are said to include

1. Pangasias farming and production in the south
2. R&D for indigenous ornamental fish for export
3. A fish sauce factory
4. A fish feed mill

- Everyone agrees that better watershed management is needed. This will contribute to the maintenance of wild fisheries.
- On the other hand it is not easy to agree on the best balance between 'modernization' such as electrification from hydro-power and irrigation and even the maintenance of irrigation 'tradition' and the maintenance of wild fisheries. This is partly a choice between the most basic needs and less basic needs.
- Aquaculture should be promoted with awareness of the risks and thus carefully. Aquaculture could contribute to the overcoming of rural poverty using extension and micro-finance.
- Alien species such as African Tilapia and non-native carps introduced to reservoirs and ponds compete with the diversity of local species and escape up and down river to gradually degrade the local diversity.
- Diverse and thus ecologically stable aquaculture depends on healthy wild ecosystems to provide inputs.
- Thus the wild environment must be protected. Research should be continued on ways to limit the escape of alien species into the wild and on effective fish passes at every scale. Watershed management should be further promoted and all effort put into wide range of options for electricity generation.

6. ELECTRICITY USE/DEMAND AND 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. Hydropower in a wider concept that includes the mechanical power created by water wheels. 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. Its 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 metres 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.

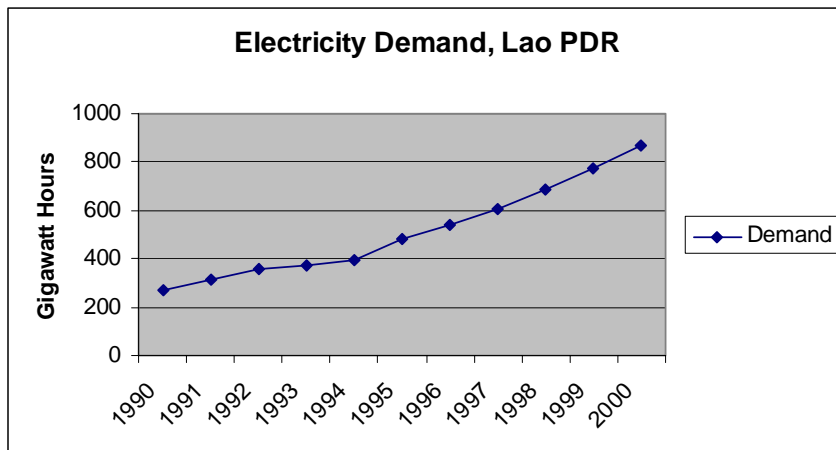
6.1 Electricity Supply/Use/Demand

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.

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.

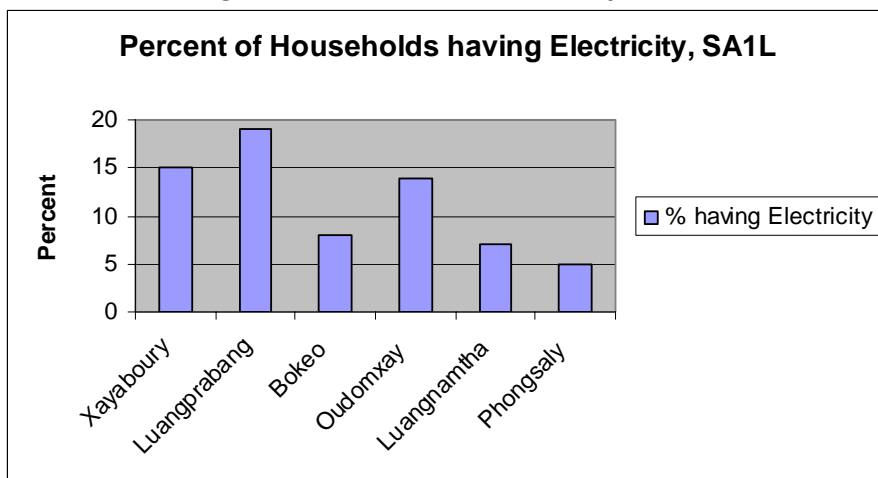
Figure 36 Trends in Nationwide Electricity Demand



(National Sector Review)

In SA1L large differences in household electrification are apparent between provinces.

Figure 37 Sub-Area 1L Electrification

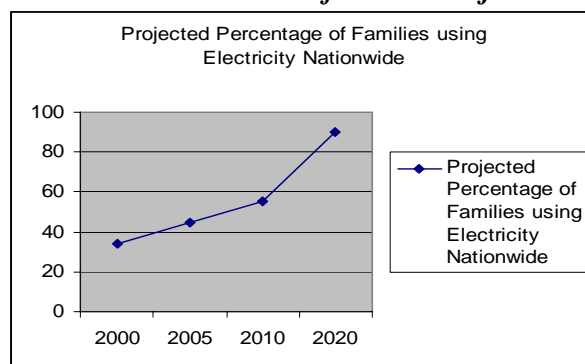


(MRC Data base)

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.

Figure 38 Household Electrification Projection to 2020



(Data from National Sector Review).

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 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

(Power Sector Strategy Study)

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.

Projections for peak demand for six provinces in SA1L (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 SA1L 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.

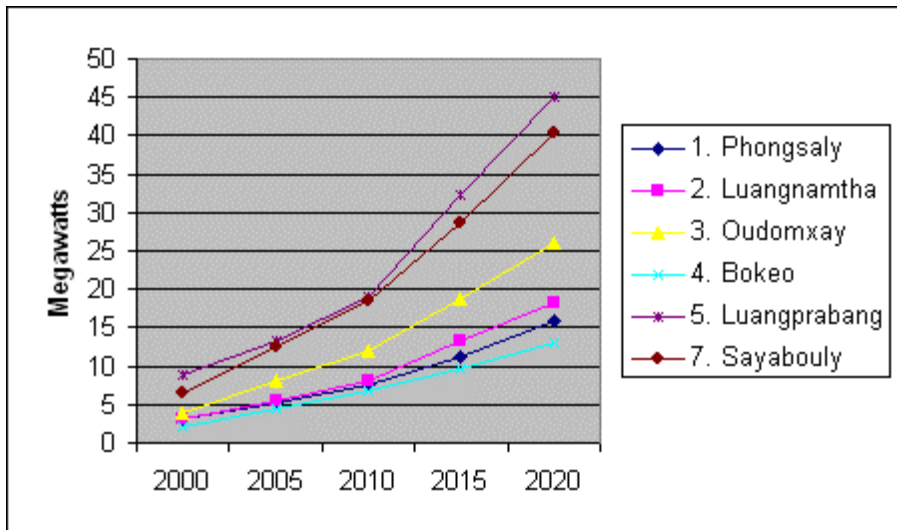
(Economic) electricity demand (a combination of real and subsidized demand) is increasing at about 80 GWh per year. Two opposing affects may result in a similar rate of increase into the future. On the one hand the government is likely to decrease subsidies and on the other investment is increasing.

Table 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
Total					

(Data from Sub-Area Sector Review)

Figure 39 Peak Electricity Demand Projected for Six Provinces in SAIL



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 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 crisis' 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.

6.2 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:

1. optimum and low impact project configurations
2. well qualified and financially capable developers
3. competitive construction and developing costing
4. equitable agreement terms for the government

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

{EE-PSSS}

Careful comparison of sites is needed to chose 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. That 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 accessable 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 {EEHB}.

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 SA1L 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 pelton 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 SA1L. Small-medium sized hydro-electricity generation plants are planned for the Nam Beng catchment and near Luang Phabang city.

SA1L 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 SA1L and four other projects have had MOU's signed

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

Province	River/stream	Installed Capacity (MW)	Average Energy Generation
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. Hauykhivan	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	

(Sub-Area Sector Review)

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 nations 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 Run-of-River Hydropower Proposed on *Mainstream* in SA1L

	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 was costed 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 concessional 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 be on the market are an even more attractive proposition from the point of view of the environment.

Social and Environmental Constraints

Only a small proportion of the physical potential of about 18,000 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.

A. Direct Financial Costs/Risks

17. The international market price of electricity,
18. The costs of navigation locks and fish passes
19. Sedimentation in reservoirs limiting reservoir lifetime

B. Life, Livelihood and Cultural Costs for the Community Displaced

20. The loss of reservoir land and ecosystems,
21. The resettlement of displaced villagers and full new livelihood costs,
22. Displaced and dispersed people's loss of extended family and community networks and culture,

C. Environmental Costs/Risks and Associated Livelihood Costs

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

'The Water Resources Law of 1997 seeks to ensure responsible and sustainable use of water. Approvals for 'large' projects as defined, require a feasibility study and socio-economic environmental plan. The sponsor must contribute to watershed protection and where appropriate provide for multipurpose water use. Logging in the catchment is prohibited and sponsors must assist in and fund resettlement. Existing and proposed large hydropower projects are required to submit EIA under the Environmental Protection Law (1999) administered by STEA. This includes biodiversity management, dam safety, mitigation, and restoration of the environment, and the establishment of an environmental protection fund.(Electrowatt-Ekono-Power Sector Strategy Study)

6.3 Medium to Large Hydro-electricity Scenarios

Flow Regulation Scenarios

Large and medium scale hydro-electricity generation using the head created by deep storage reservoirs inevitably causes changes to the flow regime, not only in the reservoir but also in stream below the dam.

The dam may be operated to mainly generate electricity, especially at peak demand times but other sectors require consideration:

- to maintain the volume of the reservoir
- to help mitigate severe flooding
- to maintain moderate flooding
- to enhance dry season navigation
- for facilitate dry season irrigation
- to maintain downstream ecosystems
- to maintain downstream channel integrity

The storage will reduce downstream flow at the height of the wet season and increase flow through the dry season. But it is not obvious to what extent regulation to generate

electricity, mitigate floods, and perhaps dry season flow for irrigation and navigation can be balanced by the stream channels wetlands ecological and fertilizing values of natural flow regimes.

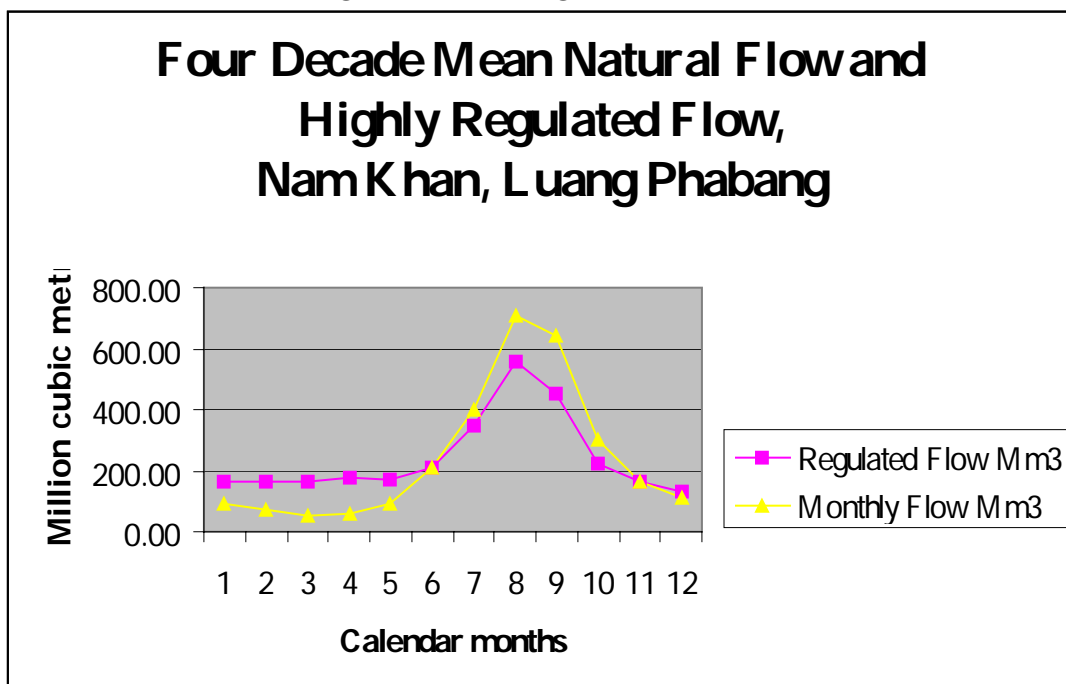
Two examples are given below of the operation of a proposed Nam Khan 2 dam (145MW) or a smaller dam on the site in Luang Phabang Province on the Nam Khan (Mean annual flow = 2715 Mm³).

The examples show pre-dam ‘natural’ hydrographs and regulated hydrographs. The regulated flow hydrographs are partly arbitrary.

3. In the first example, nearly the whole live storage capacity of 480 Mm³ is filled and in turn released in the dry season. (17% (0.17) regulation)
4. In the second example 50% of the storage is used and released whether from the same dam or a smaller dam. (9% (0.09) regulation)

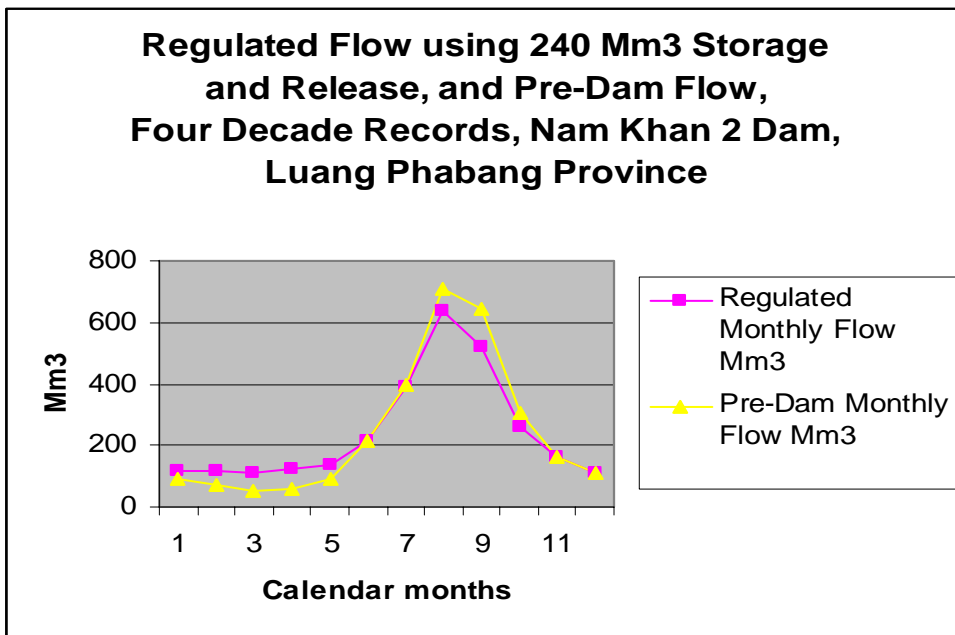
Two examples are given below of the operation of a proposed Nam Khan 2 dam or a smaller dam on the site in Luang Phabang on the Nam Khan. The examples show pre-dam ‘natural’ hydrographs and regulated hydrographs. The regulated flow hydrographs are partly arbitrary. In the first example, nearly the whole live storage capacity of 480 Mm³ is filled and in turn released in the dry season. In the second example 50% of the storage is used and released whether from the same dam or a smaller dam.

Figure 40 Full Regulation Scenario



(Natural flow data from MRC database)

Figure 41 Half Regulation Scenario



(Natural flow data from MRC database)

Even in the smaller storage example the dry season flow could nearly double the natural flow in some months if no large extractions are made. If irrigation uses a major proportion of the dry season releases the flow is correspondingly reduced. But the irrigation potential in the valley is small. Moreover the river transport is believed to be largely small scale and local so will hardly react to the deeper water.

Such storages on a river the size of the Nam Khan are not likely to have a noticeable effect on the mainstream unless many such storages are completed. The concern here is with the tributary. Even in the smaller storage example the dry season flow could nearly double the natural flow in some months if no large extractions are made.

If irrigation uses a major proportion of the dry season releases the flow is correspondingly reduced. But the irrigation potential in the valley 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.

Such storages on a river the size of the Nam Khan are not likely to have a noticeable effect on the mainstream unless many such storages are completed. The concern here is with the tributary.

The full live storage capacity may not be used, as in the second scenario, to allow for occasional late season flood inflows and to minimize the impact on the tributary riverine ecology.

Would a smaller dam run at full capacity be more cost-effective than a large dam used with consideration for all sectors. It would not be able to hold a late flood, but its full capacity operation would have less effect on the riverine (in channel and flood plain) ecology. Moreover the storage reservoir would flood less land and displace fewer people.

How the releases are made from different levels of the reservoir is a more complicated issue that again at least requires dialogue with stream ecologists.

Of course 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 with which they have to compete. Research is needed on fish passes to make sure they work well for high volumes of local species

Dialogue is needed with the wild-capture bio-aquatic sectors to determine what size, timing and quality of releases are needed and the importance of fish passes to maintain the riverine ecosystems to a reasonable extent in any dammed river.

Organizational Concerns

Particularly relevant for the North, EEHB recommend that a separate Rural Electrification Agency be established separate from the existing Electricite du Lao {EdL}. This would parallel the separate rural water supply agency known.

Resettlement

Tributary dams in Laos could force resettlement of 40,000 people. In Sub-Area1L the population that would have to be resettled is not known. Resettlement numbers and land submerged areas for three dams are needed.

Resettlement including the development of a sustainable livelihood in the Boloven Plateau as a result of the Huay Ho, Xe Pian-Xe Namnoi schemes is estimated to cost USD16,00 per household. This sort of figure would presumably be necessary for other resettlement projects.

Earthquakes

Northern Lao PDR lies on the edge of the earthquake zone that stretches through the Himalayas to Southwest China. Earthquakes have been recorded in Northern Laos in the last few years. Thus it must be recognized that any dam or weir structure is at some risk of damage. In the case of weirs the risk is of financial loss, but in the case of dams that store large volumes of water, loss of life downstream is also possible.

We need more data on earthquakes from the Geology and Mines Department

Future Hydro-electricity Schemes

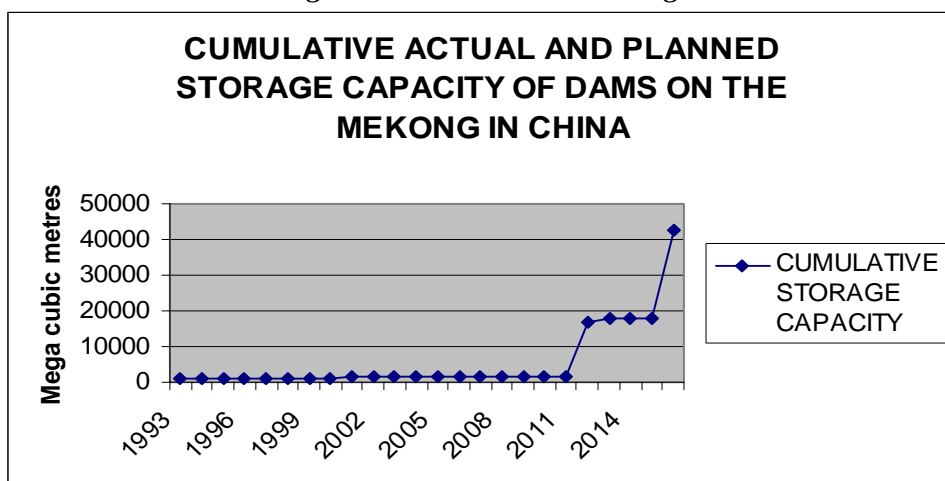
It is the Nam Beng dam that seems most likely to go ahead, supplying local demand rather than export. Its expected date of completion is 2008.

A further 40 or so very small hydro sites are being considered and should come 'on stream' in the next 15 years. This number could very probably be increased if support were there.

Hydro-electricity Dams in the Upper Mekong Basin

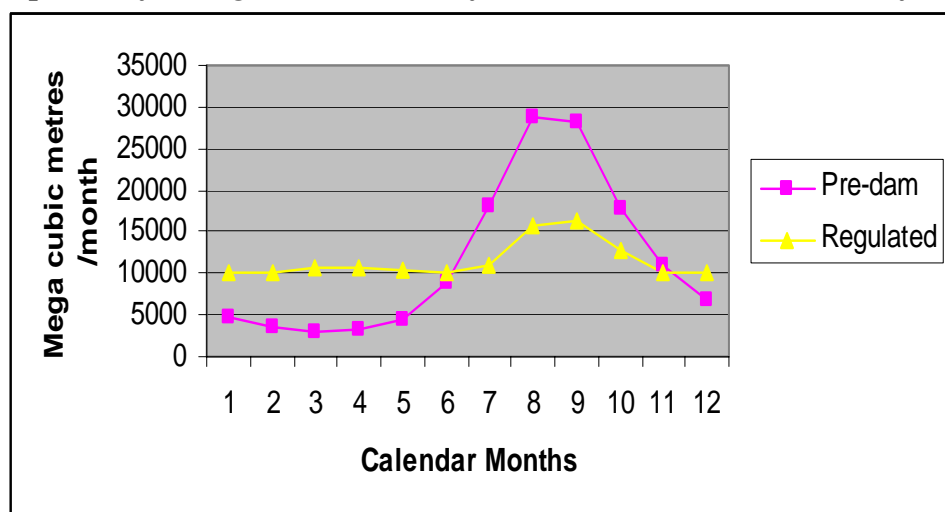
- China has built two large hydroelectricity dams on the Mekong mainstream and is planning to build more.
- This thought to have already reduced suspended load as far down as Pakse
- The figure below illustrates the major increase in storage that can be expected between 2010 and 2016.
- China has built two large hydroelectricity dams on the Mekong mainstream and is planning to build more. This thought to have already reduced suspended load as far down as Pakse probably partly as a result as these dams

Figure 42 China Dam Storage



(State of the Basin Report, 2003)

Figure 43 Pre-dam and Possible Regulated Flow for the Mekong at Vientiane as a consequence of Storage in and Release from the China Dams Cascade after 2016



(Pre-dam data from MRC data base)

Total mainstream storage as a proportion of annual river flow (same units) will increase from 0.02 from two dams in 2004 to 0.77 from five dams in 2016.

A regulated scenario is given for the Mekong mainstream as a consequence of about 90 percent storage in the China dams cascade.

This will cause a usual decrease in wet season flow, a usual 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 severe effect on the sediment load.

A promising move would be to upgrade the dialogue with China on this matter.

6.4 Hydro-electricity Strategies

A Mix of Schemes

Despite the socio-economic and environmental costs 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, say one or two, profitable low negative impact dams

- say medium sized dam about 10-15m dam height, storing say 20 - 250 Mm³ of water or generating say 10-100MW,
- with really effective researched fish ways
- flooding very little agricultural land,

together with many smaller schemes, may create the lesser of the development problems.

These medium sized reservoirs could be combined with:

Some run-of-river schemes on tributaries (insignificant storage) with researched fish passes.

Many in-river floating turbines (that are on the market now)

Also several small, and many very small hydropower generation plants

- 12 very small hydro-schemes were in 2003 supply just over 3 MW of electricity in SA1L and 6.4 MW nationwide.
- These rely only on small weirs and so have little effect on downstream flows, but still need to be designed carefully.
- Used for isolated villages.
- These are more certain investments based on local demand.

Given the risk of nuclear leaks, explosions and weapons proliferation from nuclear power generation in importing nations and the temptation facing Laos to consume and even export a large proportion of its remaining timber resources unsustainably, it would be well to consider the relative benefits of limited hydropower generation especially on a small and very small scale. In the past electricity and timber were Lao PDR's only major

exports but now tourism and garments have risen to challenge them and provide an alternative source of foreign exchange. Other exports will rise in the future, so hydropower exports are not the priority that they once were.

It is the agricultural land flooded and the ecological impact that are in the end most important, than the size of the dam so the key to whether a dam should be supported is the magnitude of the negative impact. It is not really 'medium or small sized' dams that should be considered but profitable low impact dams.

Design, Operation and Compensation for Medium Dams

If the riverine environment and its products are to be conserved it should be accepted that

1. less than maximum power generation is possible from any roughly medium site. What is called the 'plant factor' the proportion of time that an energy generating station generates energy is limited by storage capacity, the desire to store for flood control and other demands for releases that may be greater than that required for generation, or at non-optimal times.
2. 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.
3. Fish passes must not be imported or token but designed for local fish and large enough that a large biomass of fish can pass. Most existing fish passes are either unsuitable for the local fish or allow too few fish to pass to maintain the aquatic biomass and the wild fish harvest.

It should be noted that *worldwide* almost all people displaced by dams are now worse off than they were before the dam was built.

Dams should be designed and operated so they can release water to go as far as possible towards mimicing 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 but electricity prices will probably rise in the future especially when fluid fossil fuels start to run out.

Data Requirements

Data for the actual, planned or 'envisaged' small or large hydropower dams in SA1L are shown below. Some further data is required.

Table Actual and Planned Hydro-power Dams in SA1L

River	Project	Province	Actual or Expected Date of Completion	Electricity Generation Capacity (MW)	Annual Energy Generation (GWh)	Active Storage Capacity (Mm3)	Annual Discharge at gauge {Mm3}
Nam Ko			1970?	1.5			
Nam Dong				1.0			
Nam Long		Luang Namtha		11	53		
Nam Pha	Nampha	“		100/150	350		
	Viengphouka	“		50	363		
Nam Tha	Namtha 3	“?”	200	1.25			
	Namtha 1	Bokeo	2001??	230-272		2000	
	Namtha 4A		2015	54	250		
	Namtha 5		2010	100	430		
Nam Beng	Nam Beng		2008	30	175	101	1200
Nam Ou	Nam Ou 2	Phongsali	2010,18	500/630-950	2628	66,100??	12,700
	Nam Ou 8	“		600	3499		
Nam Khan	Nam Khan 2	Luang Phabang	2005??	145	724	480	2715
	Nam Khan 3	“		47	222		

(Data from Diagnostic Study 1997 and Power Sector Strategy study and Lao Sub-Area Sector review)

The Nam Beng Scheme

The Nam Beng Scheme was originally for a dam with a 51MW capacity but when it was pointed out that the reservoir would submerge a wide agricultural valley in its upper reaches, the planned dam height was lowered a little to that at which it would generate 45MW and flood very little farm land. The generating cost is competitive at 3.5 US cents/kWh but only if low interest loans are offered by a multilateral bank. It now seems to have been lowered further to 30 MW. No mention is made of the cost of fish passes. A feasibility study is recommended.

Very Small Hydro Power : Small Weirs

Increasingly small and 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 usually have little effect on downstream flows. 12 very small hydro-schemes in 2003 supply just over 3 MW of electricity in SA1L and 6.4 MW nationwide. This small amount is however supplying villages that otherwise would not get on the national grid for many years. A further 40 or so sites are being considered and should come ‘on stream’ in the next 15 years. This number could very probably be increased if support were there. The demand for electricity from the smaller more widely scattered very small hydro schemes are more certain investments based on local demand. But these sites do not cater for the poorest and least accessible villages as sufficient repayment capacity is required. That is, these schemes are based on real demand. Because some have only a seasonal capacity, integration with solar power would often be of value.

Resettlement

USD16,000 per household is a rough estimate of financial resettlement costs including the development of a new sustainable livelihood. But we need resettlement numbers and land submerged areas for proposed dams as set out below.

Other Consequences of Dam Construction

River	Project	Actual or Expected Date of Completion	Expected lifetime of Dam	Population whose Houses are submerged	Flat agricultural land submerged	Forest area submerged	Mean Percent change in dry season flow +/-	Percent of Fish Migration Hindered
Nam Ko		1970?						
Nam Dong								
Nam Pha	Nampha							
Nam Tha	Namtha 3	200						
	Namtha 1	2001??						
	Namtha 4A	2015						
	Namtha 5	2010						
Nam Beng	Nam Beng	2008						
Nam Ou	Nam Ou 2	2010						

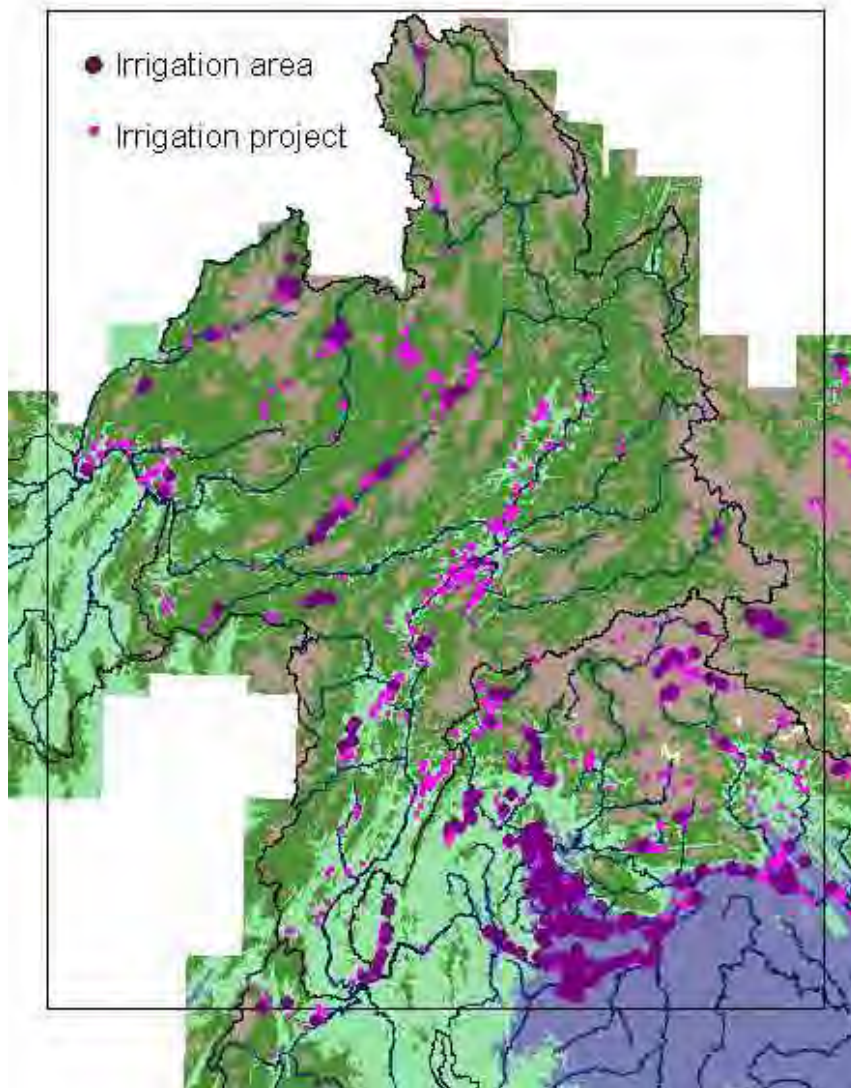
7. IRRIGATION

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 SA1L 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 44 Spatial Trends in Irrigation in Sub-Area 1L



(MRC)

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.

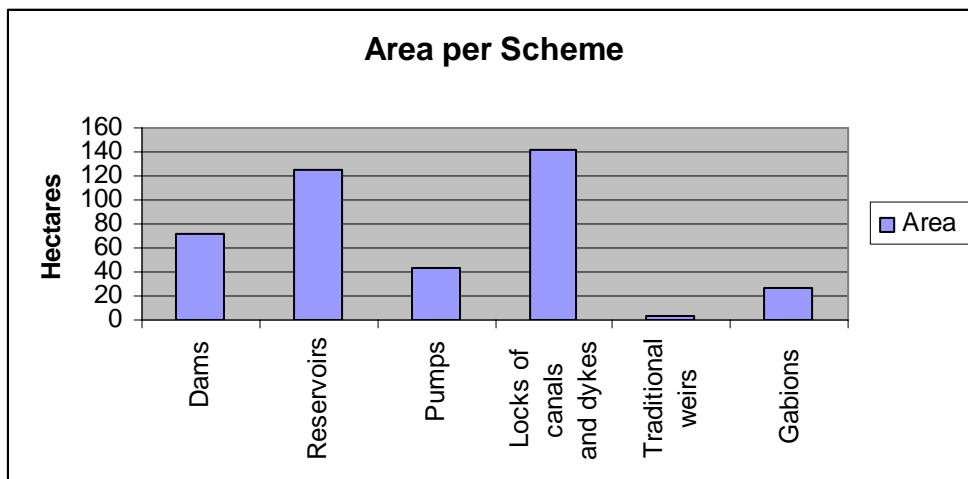
The village people living on small streams have long had their own small scale irrigation schemes, gravity fed from weirs. They can be seen to vastly outnumber those built with outside assistance, but provide irrigation to only relatively small areas. This may be having an evening out effect on these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

Table 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

(National Sector Review)

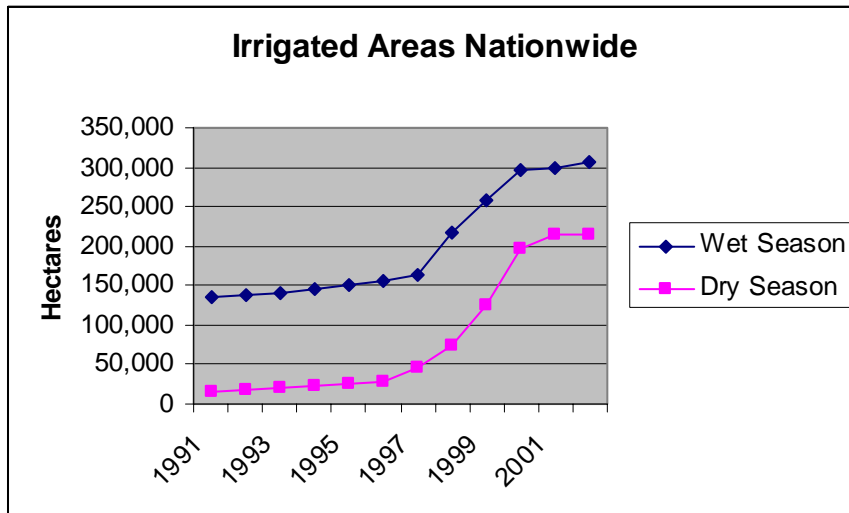
Figure 45 Average Wet Season Irrigated Area per Scheme



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?

Figure 46 Irrigated Areas in the Lao PDR

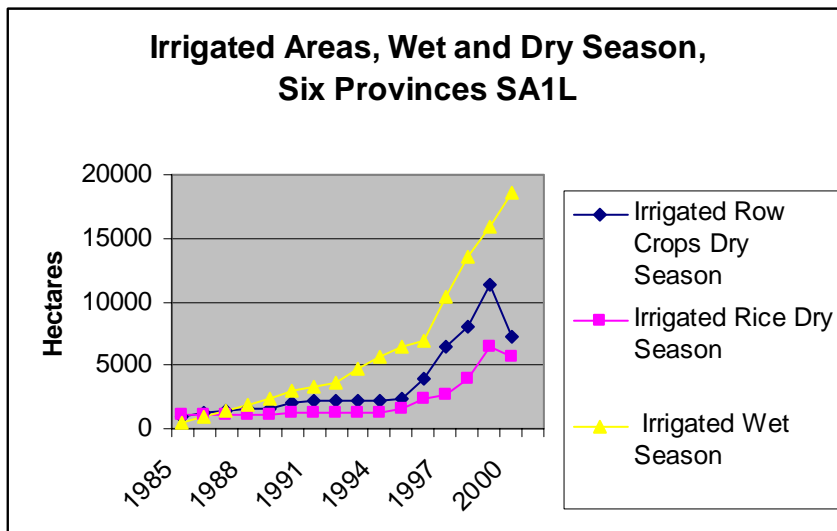


(Data from Sub-Area Sector Review)

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 SA1L 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 47 Wet and Dry Season Irrigation Areas in Six Provinces of SA1L



(Data from Sub-Area Sector Review)

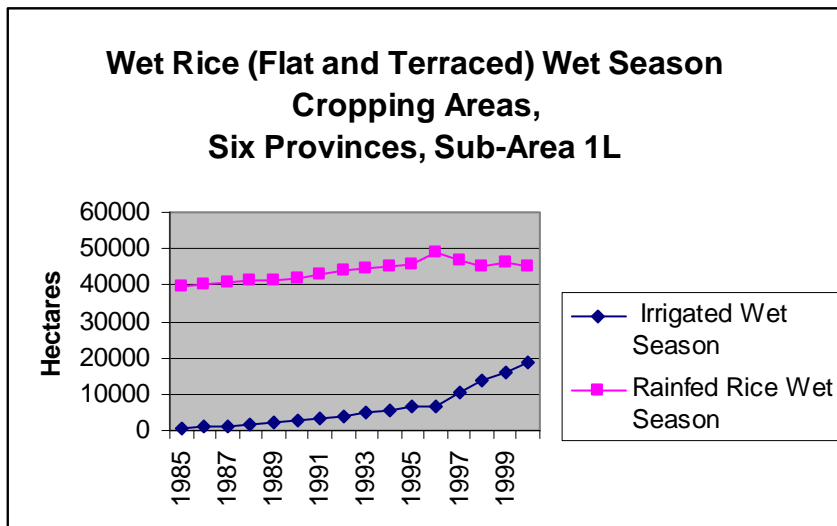
If we assume that irrigated area in the wet season in SA1L is supplied with about 0.4 metres of water, the total volume ‘consumed’ is about 72Mm³. If we assume that a dry season irrigation is about 0.7m the volume consumed is about 126Mm³. Irrigation in SA1L thus uses about 200Mm³ per year. But this is less than half a percent of the contribution of SA1L’s stream flow (1480 m³/sec or 46,620 Mm³/year) to the Mekong).

Table Irrigation Water Consumption SA1L

	Irrigation Depth	Irrigation Volume
Wet season	0.4 m	72 Mm ³
Dry Season	0.7m	126 Mm ³
Total		198 Mm ³

The area of rainfed (non-irrigated) wet rice {flat land and terraced} in the wet season in six provinces of SA1L 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.

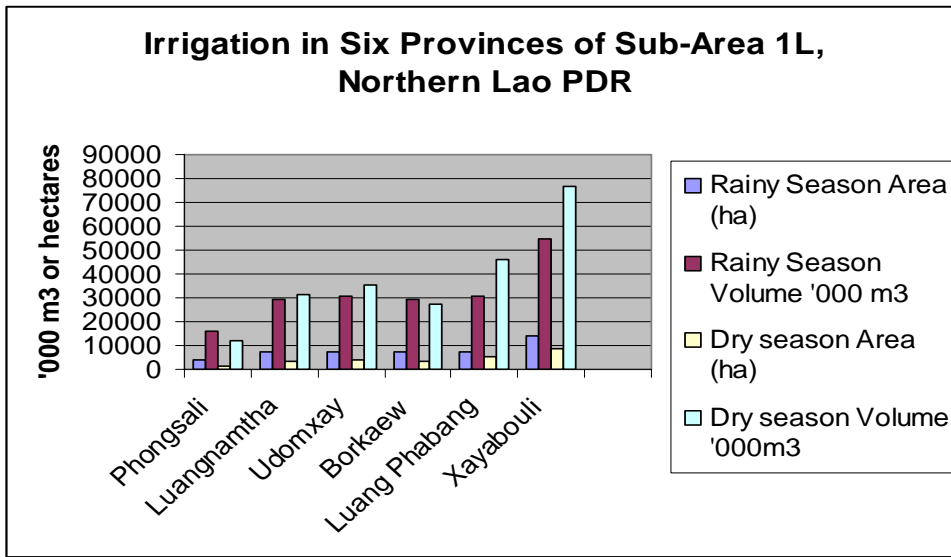
Figure 48 Wet Season Wet Rice Areas



(Data from Sub-Area Sector Review)

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

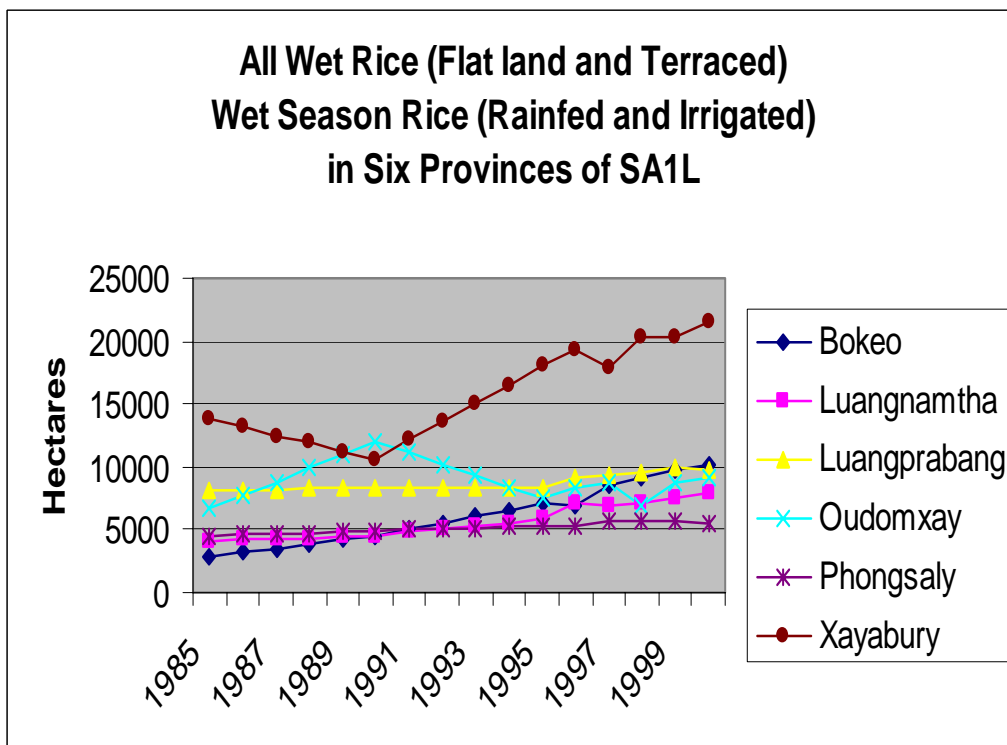
Figure 49 Wet and Dry Season Irrigation Area and Harvested Volume, SA1L



(Data from Jica/MAF)

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.

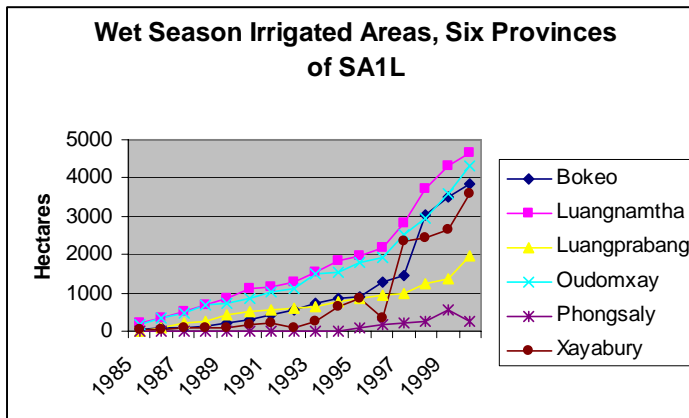
Figure 50 Wet Season Wet Rice Areas



(Data from Sub-Area Sector Review)

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

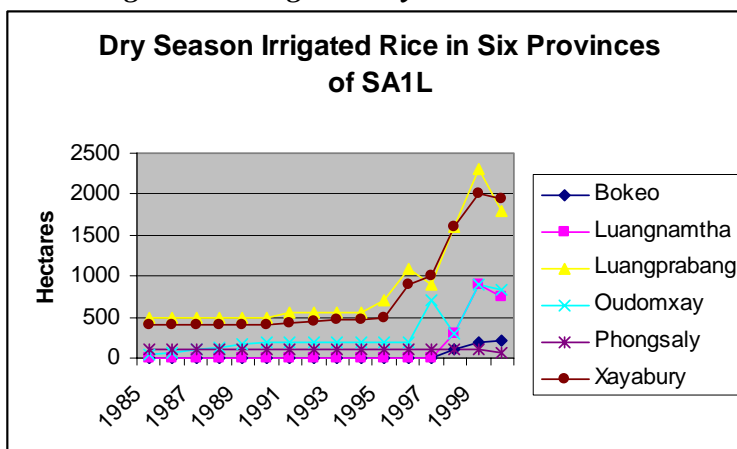
Figure 51 Irrigation Areas in the Wet Season



(Data from Sub-Area Sector Review)

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.

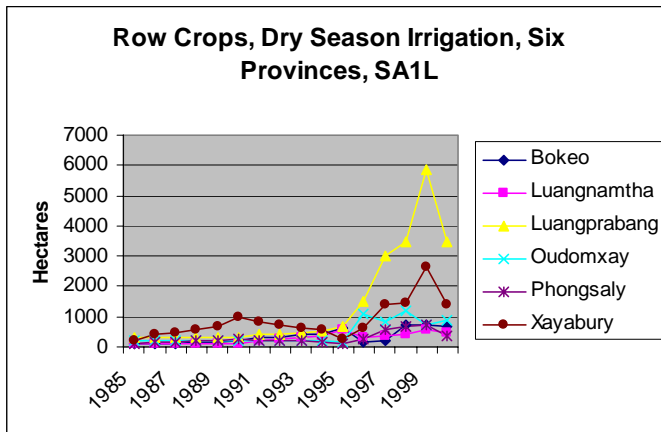
Figure 52 Irrigated Dry Season Rice Areas



(Data from Sub-Area Sector Review)

Row crops (or 'upland' crops) (ie 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 53 Dry Season Irrigated Row Crop Areas



(Data from Sub-Area Sector Review)

7.1 Irrigation Scenarios

Rice Area and Yield Projections

Rice area and yield projections given by the government are shown in the table below.

Table Rice Production Projections for Lao PDR

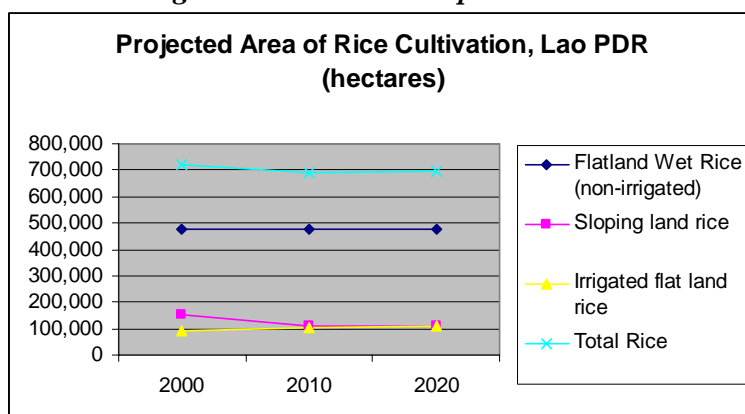
		2000	2010	2020
Flatland Wet Rice (non-irrigated)	Area (ha)	475,500	475,500	475,500
	Yield (tonnes/ha)	3.27	4.3	4.5
	Total Production (tonnes)	1,552,800	2,046,655	2,139,750
Sloping land rice	Area (ha)	152,100	110,000	110,000
	Yield (tonnes/ha)	1.70	1.70	2.00
	Total Production (tonnes)	258,750	187,000	220,000
Irrigated flat land rice	Area (ha)	91,800	101,800	111,980
	Yield (tonnes/ha)	4.25	5.49	6
	Total Production (tonnes)	390,150	559,256	671,880
Total Rice	Area (ha)	719,400	687,300	697,480
	Total Production (tonnes)	2,201,700	2,792,911	3,031,630

(Data from Jica/MAF study)

In the figure below of government projections/plans for rice cultivation notice that

- Traditional flatland rainfed rice areas will hardly change
- Irrigated areas will increase very little following projected capital investments in agriculture noted above.

Figure 54 Rice Areas up to 2020

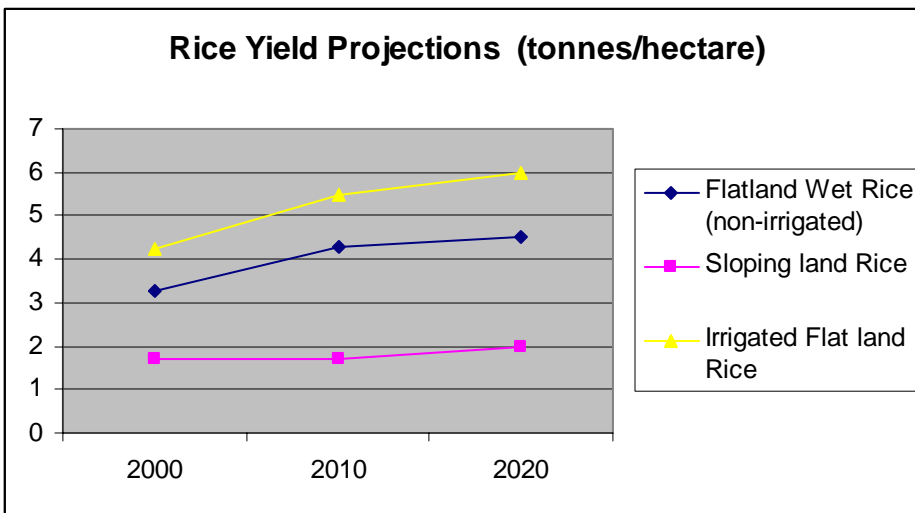


- Sloping land rice (now shifting system), is projected to be grown over a reduced area following the governments aim,
- But the reduction is projected to only take place until 2010.
- Thus the area of 110,000 hectares of sloping land rice remaining in 2010 will be grown as part of sedentary farming systems.

It is thought that yields in all systems will increase.

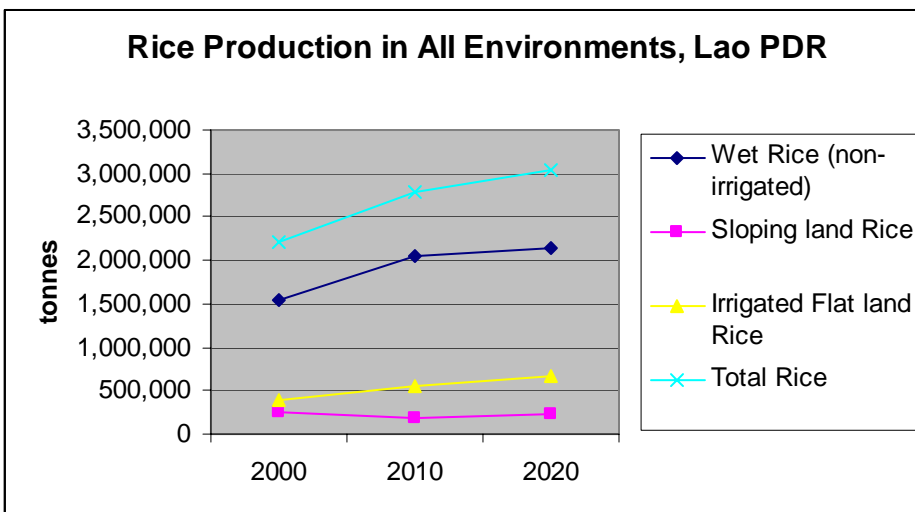
- The yield for flatland rice will increase rapidly to 2010, and slow after that as highest likely yields are approached,
- In contrast the yield for sloping land rice will grow slowly at first due to the current problems with production, and increase more rapidly after 2010.

Figure 55 Future Rice Yields



As a consequence of area and yield rises in flatland rice total production will rise accordingly, Water use by irrigation will increase a little contributing to the increased yield. But sloping land production will remain fairly stable due to shrinking area and rising yield.

Figure 56 Rice Production



The total area of rainfed (non-irrigated) wet rice {flat land and terraced} and irrigated rice in the wet season in six provinces of SA1L is now about 64,000 hectares and is expanding especially since 1997 at about 2,800 hectares per year. The irrigated wet season rice area for six provinces has been rising over 15 years from very little to about 18,000 hectares.

The rainfed wet rice area is now about twice that of the irrigated rice area but seems to be stable probably because any expansion of area is immediately taken up with an equivalent expansion of irrigation. To the extent that flat land is nearly all farmed, the area of rainfed rice will shrink as irrigation expands and as farmers try alternative crops for consumption, barter and sale, especially when they have new irrigation. Irrigation is likely to expand at a reduced rate when topographic limits are increasingly met.

Given the seeming over investment in irrigation in 1997-2000, the changing government policy to make recurrent and capital costs equal and the limited area of flat land will limit irrigation expansion.

Irrigation in SA1L is now estimated to use about 200Mm³ per year about half a percent of the contribution of SA1L's stream flow to the Mekong. Is water use likely to grow to exceed 1% of SA1L runoff in the next twenty years? The growth rate from 1997 to 2001 was 2800 hectares per year but the area may be hardly expanding in 2003.

Irrigation in SA1L is now estimated to use about 200Mm³ per year a tiny proportion of the contribution of SA1L's stream flow to the Mekong. Future irrigation water consumption will depend on the expansion of the irrigation area, the 'depth' of irrigation, ie the volume supplied per unit area, both for the wet and dry season. Different crops require quite difference irrigation depths. As farmers move from rice to a variety of 'row' crops under dry season irrigation 'depth' required will fall. A the efficiency of the supply process is rarely very high the crop transpires only a proportion of the water taken from the water body, in this case the streams. If the efficiency increases the area could expand or the pumping or diversion time could decrease.

Future growth is very difficult to predict but may average a modest 1000 hectares per year. This could vary from a low of say 700 to a high of 1500 hectares per year. The areas and water consumption figures for 2020 are given in the table. (Assuming total wet and dry season irrigation depth of 0.7 + 0.4 m = 1.1m as they cover about the same area)

Table Irrigation Water Consumption Scenarios

Expansion Rate	Hectares per year	Area in 2020 (hectares)	Water Consumption in 2020 (Mm ³)
Probable	1000	38,000	420
Low	700	32,000	224
High	1500	48,000	528

As would be expected given the relatively large area of flat to undulating topography in Xayabouli the largest areas of irrigation seems to be found there. Expansion is also likely to be greatest in Xayabouli. It might be expected to go ahead in irrigation in the near

future, although its irrigation progress has been notably varied. Oudomxay might be given some special assistance to regain past areas.

Note that Luang Phabang is as prominent as Xayabouli in dry season rice irrigation, both provinces booming notably from 1995 and might be expected to continue to grow faster than other provinces without a strategy change. Row crops (or 'upland' crops) (ie non-rice) under irrigation will continue to grow in Luang Phabang particularly if the tourism numbers grow steadily.

Waste Water or Return Flow from Irrigation

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. Mineral/chemical fertilizer use is however on the increase so irrigation return flow to streams and groundwater will contain increasing concentrations of nitrates and surface water bodies to a lesser extent phosphates.

Dialogue

Just as with the hydro-electricity sector the irrigation sector staff should continue a dialogue with fisheries staff on the effects of irrigation schemes of all types on wild (capture) fisheries.

7.2 Irrigation Strategy

Government Investment in Agriculture

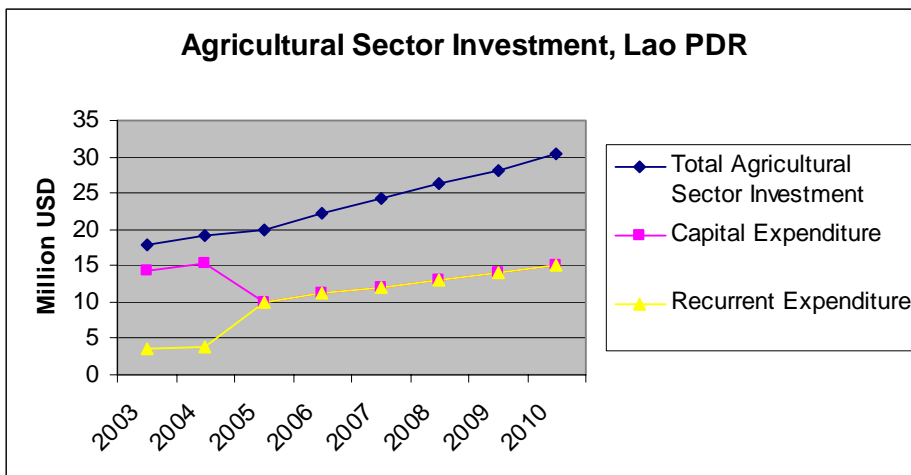
From 2005 total government agricultural investment is planned to grow a little faster than in the past, but most importantly for Sub-Area 1L capital investment will equal recurrent expenditure.

Agricultural Sector Investment Projection, US\$ Million

	2003	2004	2005	2006	2007	2008	2009	2010
Total Agricultural Sector Investment	17.8	19.1	20	22.3	24.2	26.2	28.1	30.4
Capital Expenditure	14.2	15.3	10	11.15	12.1	13.1	14.05	15.2
Recurrent Expenditure	3.6	3.8	10	11.15	12.1	13.1	14.05	15.2

(Jica/MAF)

Figure 57 Government Investment in Agriculture to 2010



This implies that government effort on irrigation will in future be focused on improved management of existing schemes, focusing on community leadership and responsibility, and irrigation will gain less promotion. Rainfed agriculture, promoted through research and extension, will gain more. This will result in a boost for the process of modification of shifting cultivation into permanent agriculture. Whether this recurrent expenditure together with urban employment growth will be sufficient to counter population trends among hill and mountain people will depend on many other factors.

Weirs or Pumps?

- Government constructed irrigation is riverfed: gravity fed from weirs and pumped from the river.
- Pump schemes implies large recurrent fuel, maintenance, repair, rehabilitation and replacement costs to run the pumps. This will take a lot of future recurrent budget, or will the irrigators cover these costs?
- But pumps involve lower initial costs and perhaps most importantly do not interrupt fish migration routes and trap sediment like concrete weirs may do.
- Large fish passes on weirs may be a more cost-effective solution.

8. WATER SUPPLY AND WASTE WATER

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 raises 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 50l/c/d this is an additional 16.5Mm³ per year giving an urban total of about 75 Mm³.

The rural population of about 75% of 5 million ie about 3.75 million can also be assumed to use 50l/c/d which gives a total consumption of 68Mm³ per year. Rounding this gives a national total of about 140Mm³. This is only a very small percentage of national irrigation consumption.

Nationwide Domestic, Office and Industrial Water Consumption Estimates

	Average Percapita consumption	Annual consumption (Mm3)
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 SA1L 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 m³/day or 3Mm³/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.

SA1L'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 30Mm³ per year.

Domestic, office, and industrial use in SA1L is smaller than even the small irrigation consumption at 200 Mm³ 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 SA1L.

8.1 Rural Water Supply and Sanitation in Northern Lao PDR and SA1L

- 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).

Percentage of Households with Services in SA1L in 1997-98

	Clean	Improved
--	-------	----------

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

(National Sector Review)

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
Tubewell / 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

(HRD Plan, 2002, NCEHRWS)

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

(HRD Plan, 2002, NCEHRWS)

We need data on the state of repair of facilities or the number in good working order.

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 SAIL. 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.

Table Factory Numbers of Various Sizes in Six Provinces of Sub-Area 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

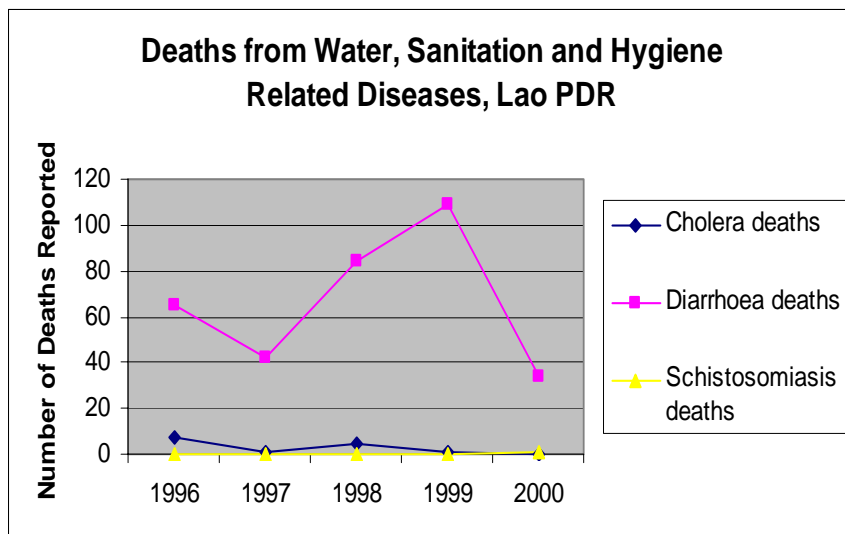
(National Sector Review)

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 SA1L: 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.

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 58 Deaths from Water-related Diseases



(Data from the National Sector Review)

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

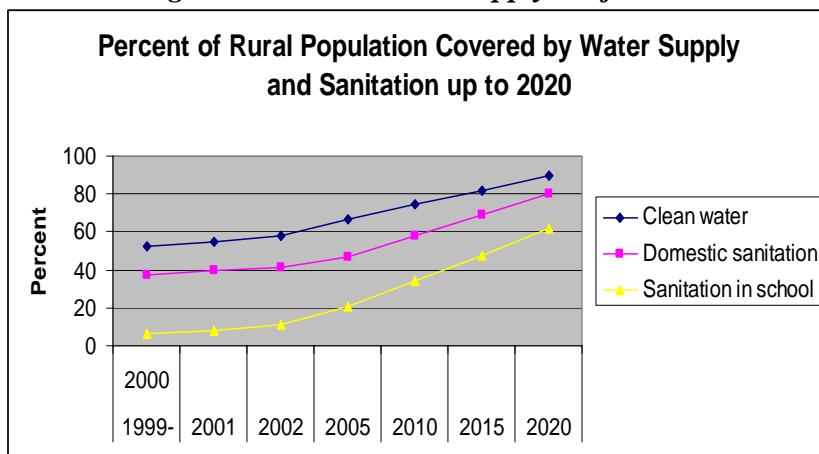
8.2 Water Supply and Sanitation Scenario

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;
- -focus on inaccessible, poverty-ridden areas; and
- -encourage private supply and sanitation ventures in easy-to-reach areas

The proportion of population to be covered by clean water and sanitation is projected to increase as is shown in the figure below. Even this increase will still have only a very minor impact on national water consumption.

Figure 59 Rural Water Supply Projections



(Data from the National Sector Review)

Sanitation in towns and countryside in the form of pour flush latrines are gradually replacing dry pit privies and field defecation. This is contributing to better health and population growth, but may be polluting the nearby down-slope groundwater and occasionally streams.

As can be seen from the tables above for Northern Laos as a whole in 2000 44% of people still use river water for drinking and 55% of people are still defecating in the bush or field.

Based on national population growth, urbanization and the likelihood of full urban coverage with piped water by 2020 and per capita rises, it is estimated that the national water supply consumption including all types of water system will be about 700 Mm³ per annum.

Table National Water Supply Consumption Estimate for 2020

	2020	lpcd	Mm ³ /year
Urban	2,952,000	500	539
Rural	5,248,000	70	134
TOTAL			673

SAIL's population may be about 30% of the national total in 2020, its rate of urbanization lower and the thoroughness of urban coverage by piped supply lower, so its water supply use is estimated at about 100 Mm³.

8.3 Water Supply and Sanitation Policy/Strategy

Nationwide urban piped water aim is supply all town people with a piped water supply by 2020. This will be done using loan funds and funds generated by charging real costs to existing consumers.

The issue is not the total consumption but mainly the rural 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;
- focus on inaccessible, poverty-ridden areas; and
- 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 water and sanitation systems.

As can be seen from the tables above for Northern Laos as a whole in 2000 44% of people still use river water for drinking and 55% of people are still defecating in the bush or field.

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.

Note that protected dug wells with counterbalanced buckets are probably the most cost-effective type of water systems for many remote villages a long way from repair inputs. Also with minimal training and encouragement it would be possible to upgrade the 55% families to traditional pit privies before the funds are available for pour flush latrines. But at the moment pour flush privies are the only type that is regarded as improved. Ecological latrines are another important type that could be further researched. Dry pit and eco-latrines are both less polluting of shallow groundwater.

Waste discharge may be a small problem now but it could grow without notice.

- Monitoring factory waste discharge should start to prevent long-term problems.
- Monitoring and inspection of mines and dialogue with mine managers should start. Regulation is needed.

9. 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 tonnes 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, 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 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.Houaysai			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	6	11	

				seasons			
Boat capacity (ton)	Dry season	50	30	30	30		
	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			

(Table from National Sector Review)

River transport is important for those a long distance from roads, a common situation in SAIL.

‘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

1. boat waves (navigation)
2. natural causes,
3. vegetation removal,
4. global warming,
5. rapid river level drops
6. high groundwater levels at banks
7. cultivation of banks
8. quarrying of stream sediment,
9. flood levees,
10. watershed degradation in general and
11. other bank protection.

Bank erosion and collapse and the resulting ‘mass sedimentation’ at least temporarily changes 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 SAIL 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 SA1L . 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 State of Navigation on the Mekong river in the sub area 1L

Stretches	Length of Navigable Mekong river (km)	Boat Capacity (Ton)		Difficult rapids			Aid to navigation (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. Luanprabang-Vientiane	426	30	150	6	5		126

(Sub-Area Sector Review)

Table Navigation route in the tributaries of Mekong river in the sub area 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

(Sub-Area Sector Review)

Number of existing Ports on the Mekong river in the Sub are 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 Number of Planned Ports on the Mekong in the SA1L 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)
4. Luanprabang	Lunaprabang	428	Plan for domestic and internal port (SA1L)
5.Sayaboury	Thaxuang	561	Planned (SA1L)
	Thadua-pakkorn	75	Existing domestic port (SA1L)
	Paklai	216	Existing domestic port (SA1L)

(Sub-Area Sector Review)

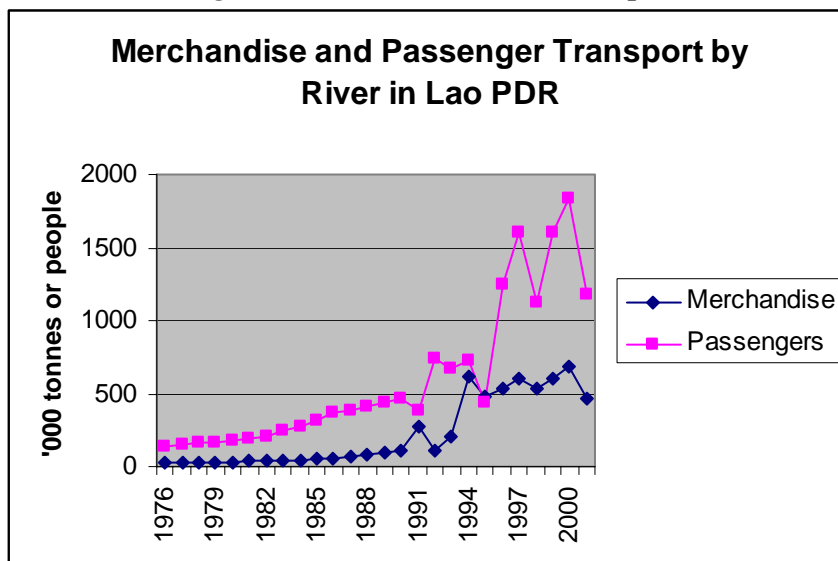
The graph shows

- 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?

Is this due to a combination of fall in the Centre and South

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 60 Trends in River Transport



(National Sector Strategy)

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.

(National Sector Review)

Organizational Strengthening has been carried out for all six main northern provinces in SA1L. 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 Semaio 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 tonne 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.

9.1 Navigation and River Works Scenario

River trade is increasing rapidly driven by the massive technological growth in Thailand and PR China and facilitated by clearing of rapids and sand bars. The Yunnan-Thai trade has been growing at 40% per year but most trade between Yunnan and Thailand goes by sea. Presumably similar growth is being experienced by the China-Lao river trade. But continued growth in the Northern river trade could be jeopardized by the finishing of two roads from China to Thailand, one through Myanmar and one through Lao PDR. Study is needed of the likely impact of these two roads before more major fixed investment is placed in navigation.

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

1. New port construction,
2. Riverbank protection using local products,
3. Safer travel,
4. Better transport organizations,
5. Better data collection,
6. A study project to establish an inland clearing centre,
7. Setting up joint ventures,
8. Organize cooperative ventures with Yunnan province,
9. Introduce electronic methods on the boats,
10. A river boat patrol unit

NRDS recommends completion of the navigation system from Huakong to Vientiane private sector ports, and EIAs for river works.

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.
 - * For example, row crops grown on river banks just above the falling water level in the dry season denies this zone permanent vegetation to secure the soil.
 - * If the growers could use new hydro-electricity they could pump water to the riverside flats and promote permanent water-tolerant vegetation on the banks.
- Neither is any work planned on the methods of regulating boat waste discharge, speed, safety and noise.
- Study is needed of the likely impact of these two roads before more major fixed investment is placed in navigation.

9.2 Navigation and River Works Policies/Strategies

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

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

10. FLOODS

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

1. heavier storms and
2. changed sloping land use in case of small to medium watersheds but also
3. 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.

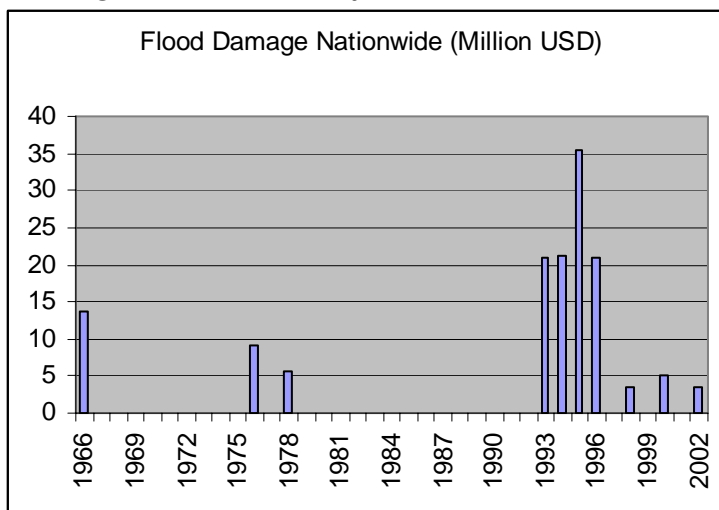
Moderate floods have significant benefits as they replenish the flood plain with nutrients for plants, both natural and cultural, and the aquatic ecosystems. Floods deposit most of their load in the channel much of the finer silt and clay is deposited on the plain with the coarser material forming a 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 depend 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 61 The Cost of Floods in the Lao PDR



(Data from National Sector Review)

Table Irrigation Activities lost during Flooding in 2002

Province name	Project??? Affected	Flooded area (ha)	Area damaged (ha)	Estimated cost (mill. kips)	USDollars (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
Total					

(Department of Irrigation , Ministry of Agriculture and Forestry)

Table Effects of Floods in SA1L

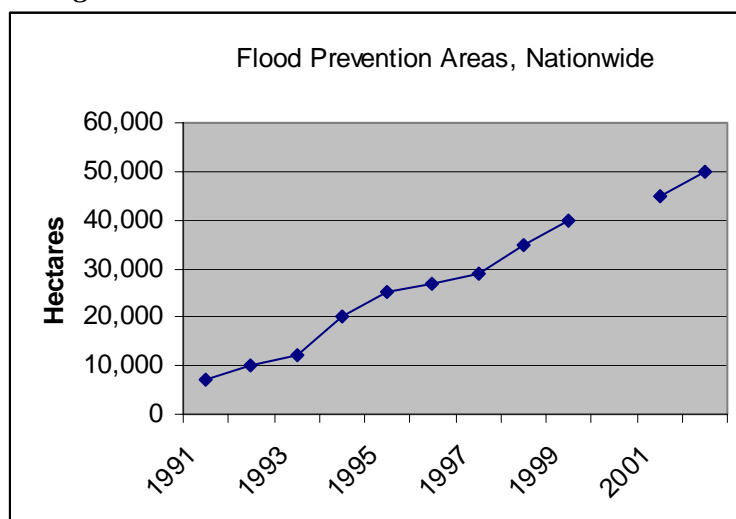
Province	People affected		Households affected		Villages affected	
	2001	2002	2001	2002	2001	2002
1.Bokeo	1,468	1409	240	273	24	40
2. Xayyabouly	105,478		824		48	
4. Phongsaly		12,405	238	2,280	14	68

(Sub-Area Sector Review)

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 62 Flood Prevention Areas in the Lao PDR



(Data from National Sector Review)

There are essentially *three types of flood mitigation that can be carried out: structural, ecological and socio-economic*. The structural type involves levees, dams, channeling 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 floodways.

10.1 Flood Scenario

A flood scenario would need to be based on progress in

1. The quantity and quality of watershed management,
2. Prospective dam siting, designs and their operational procedures,
3. Changes to the river channels including quarrying, and serious sedimentation and erosion
4. Plans for flood levee construction and drainage
5. Actual and planned land use, including building up land, on the flood plain
6. House design
7. Flood forecasting
8. Training and gauge installation for villages at risk of flash floods
9. The population on the flood plain and the opportunities they have for protecting property and people or escaping from the worst floods.

This is obviously a complex issue even if good data were available.

Given the motivation that flood plain people have for avoiding the worst floods, preparation under processes 3-8 above should be easier to organize.

The most promising scenario is thus one in which

1. the government leads the lowland people towards a substantial effort in this area,
2. several 'medium' dams are built,
3. watershed management progresses well especially in those catchments without dams, and includes flash flood provisions, and
4. moderate floods are accepted and even encouraged in rural areas.

10.2 Flood Strategy

Flood mitigation programmes for the next 20 years include river level gauging and the use of satellites and the internet, data compilation and drainage construction.

There are essentially *three types of flood mitigation that can be carried out: structural, ecological and socio-economic.*

4. The structural type involves levees, dams, channeling and drainage.
5. 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.
6. The socio-economic type includes
 - A. Measures to either persuade or prevent people using the lowest areas of the flood plain for relatively permanent land uses.
 - B. Flood forecasting and timely media broadcasting can enable the people to prepare individually and collectively for a serious flood.
 - C. In rural areas where flash floods are a probability villagers can be trained in rainfall measurement and flood risk.

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.

11. 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.

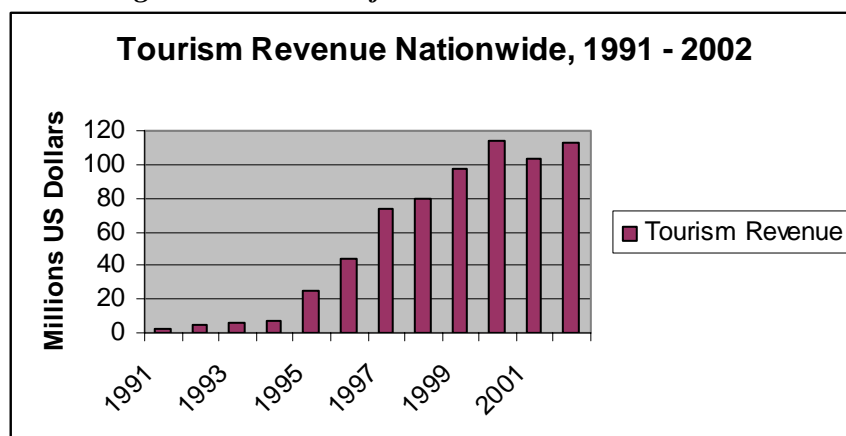
Sub-regional co-operation for tourism is an important idea that will share tourists with neighbours hopefully extending their overall stay by offering a greater range of destinations. This will require coordinated overseas advertising, convenient travel routes between nations and easy border processing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

Table 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

(National Sector Review)

Figure 63 Revenue from Tourism in the Lao PDR



(Data from the National Sector Review)

- 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

3. Security conditions
4. Health scares

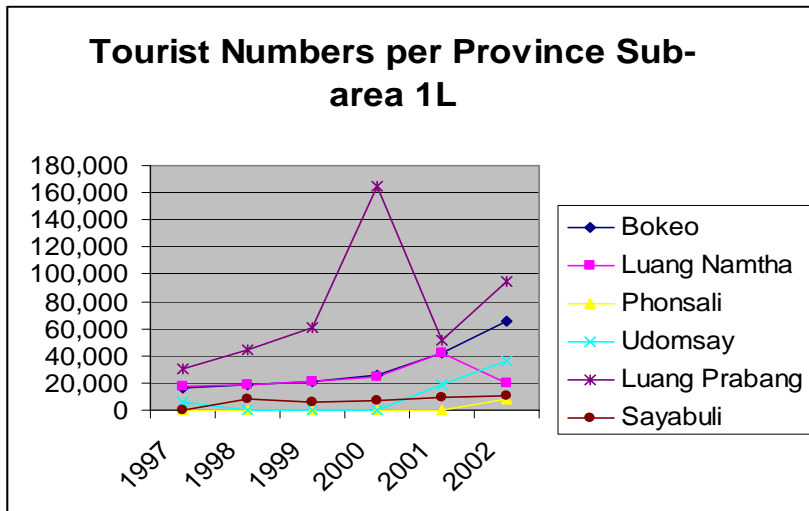
as can be seen for the drop in numbers in Luang Phabang in 2001.

Table 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

(National Sector Review)

Figure 64 Tourist Numbers in SAIL



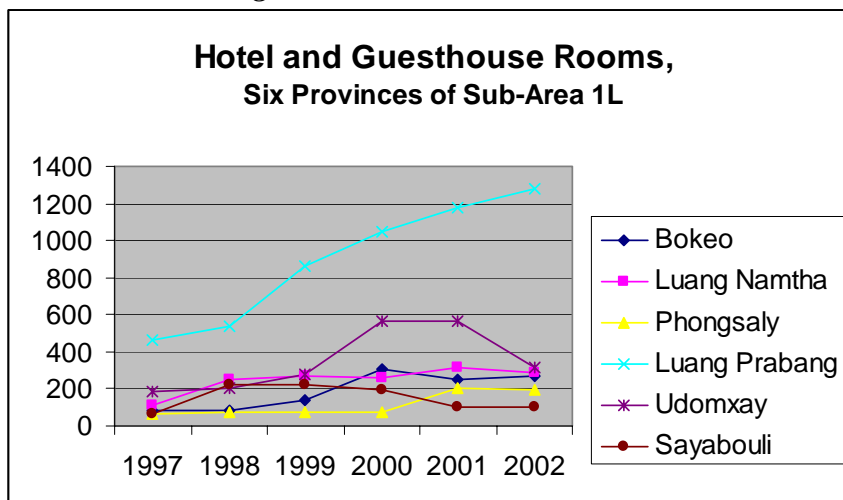
(Data from the National Sector Review)

Tourism Trends in Sub-Area 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 65 Tourist Rooms SAIL



(Data from the National Sector Review)

The number of rooms available for tourists is of course more stable than that of the arrival numbers. Is the drop for Oudomxay real or an error?

Table 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

(Sub-Area Sector Strategy)

11.1 Tourism Scenario

Tourism, including water-related tourism is increasing rapidly, but is sometimes hit by security and health scares.

Revenue has been rising at about US\$15 million per year over the last 10 years. Is continued growth at this rate possible given that

3. the first flush tends to be rapid and ‘tourist fatigue’ as people look for a new destination.
4. the uncertain disease and security environment.

Perhaps growth of an average of US\$10 million per year could be achieved over the next twenty years. This would bring nationwide revenue to about US\$250 million at constant prices.

11.2 Tourism Strategy

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

Because of ‘tourist fatigue’ is thus advisable to continue to develop new tourist destinations and ideas and continue to improve promotion methods.

Only in Luang Phabang is the number of rooms rising markedly. The old buildings here are easier to promote as they are all within walking distance of each other.

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

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. A premium price can be charged for trips that have obvious safety factors.

Revenue has been rising at about US\$15 million per year but continued growth at this rate seems unlikely given that the first flush tends to be rapid and because of the uncertain disease and security environment. Two other uncertain effects tend to have opposite effects: personal recommendations from the early tourists and 'tourist fatigue' as people look for a new destination. It is thus advisable to continue to develop new tourist destinations and ideas and continue to improve promotion methods. Perhaps growth of an average of US\$7 million per year could be achieved over the next twenty years. This would bring nationwide revenue to about US\$250 million at constant prices.

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. A premium price can be charged for trips that have obvious safety factors.

Only in Luang Phabang is the number of rooms rising markedly. The old buildings here are easier to promote as they are all within walking distance of each other. Research might be useful on integrated eco-cultural tours from Phongsalai and Luang Namtha towns that would attract larger numbers.

***Part D: Cross-Cutting Strategies,
Integrated Scenarios, Integrated
Strategies, Conclusions, Projects and
Changes and Consequences Matrix***
for Mekong BDP, Sub-Area 1L, Lao PDR

1. CROSS-CUTTING STRATEGIES

The cross-cutting themes considered here are 'socio-economics' that includes poverty and gender, human resources development, 'the environment' and public participation.

1.1 Poverty

Government Policy

The Government defines rural development as "a set of national policies, programs and projects whose broad goal is to alleviate poverty and to help develop the rural social strata". Because poverty has many causes, rural development involves a wide range of interventions aimed at addressing these causes. Poverty reduction are now focused on 8 provinces where incidence poverty is high, namely: Houaphanh, Oudomxay, Phongsaly, Luang Namtha, Luangprabang, Special region, Sekong and Attapeu. Four of these provinces are in Sub-Area 1L. More specifically the strategy focuses on 72 poor districts and 47 very poor districts. The wider sectors most directly involved in poverty reduction are: infrastructural development, agriculture/forestry, education and public health, but community development and finance have often been neglected. Water sectors are involved immediately in agriculture/forestry, health and infrastructure.

Some Proposals for SAIL

Poverty is extremely widespread especially in remote rural areas especially among minority groups without road or river access. It is widely recognized that poor access to towns exacerbates poverty. Rivers cannot be built, but boats and roads can, and more easily motorbike tracks. Once a motorbike track or road reaches a village, or boat is available, health services can reach there to run training and assist with preventive health infrastructure such as water and sanitation, and patients can more easily get to town. Agriculture-forestry staff can reach there to train villagers and assist with inputs. Traders can reach providing a source of ideas and cash in return for products. These are the four critical types of progress that can immediately help remote villagers.

Following this the community development, finance, schooling and electricity staff can reach a village to contribute. CD staff can teach community planning and self-management. Finance staff can train villagers in micro-finance and help set up a savings and loans group. The schooling staff can build or rehabilitate, equip and staff a primary school. Electricity staff can assess the power potential and demand with a view to linking the village to mains electricity or more likely setting up a very small off-grid scheme, but this will probably have to wait a significant period of trading and savings unless rural electrification is highly subsidized. The villages may become tourist destinations.

Only a few of these processes, trading, tourism and electricity can be handled by the private sector. The government must have adequate staff and finance to carry out most of this work.

Poverty and the Eight Sectors

Where all these, especially preventive health, are in place because of access, birth spacing becomes more important. All services can be upgraded when there is access and more easily the better the access. The water sectors can all contribute in their way. Water supply/sanitation and watershed management are probably the key means to help the poor. WM is inevitably linked to concerns for long-term steep land productivity and native forest conservation. Native fisheries will hopefully continue to provide important food to the poor riverine peoples. Appropriately unsubsidized hydro-electricity will not help the poor, but as vehicle and boat access allows cash generation they will join the upwardly mobile and be able to 'participate'. Irrigation, which has been and still is subsidized, increases rice production for food security for those poor living on the flats, but will increasingly offer better opportunities to grow for the market.

Large modern boats in some areas may contribute to providing transport for the riverine poor but most river transport for the poor is by traditional small boats that can negotiate long lengths of rivers in the dry season. Riverbank erosion may affect the poor in fairly remote locations. Flood protection by watershed management, advice on home siting and design, production protection and public warning against the worst flooding will help the poor. River tourism contributes to the poor's living standards when they live near tourist spots such as caves on rivers and when they belong to culturally interesting minority groups within trekking distance.

1.2 Gender

Gender is one of those ideas that is much written about but occasionally implemented. The problem is that the excellent policies and strategies are not effectively operationalized. They remain largely as ideals that will be neglected until, largely through their own effort, the girls do better at school and university and on their own merits as women rise up the hierarchies of life.

Probably the effort of those concerned is best aimed at village mothers who would keep their daughters at home to help with the house and field work for short term gain when in the long term they would be better off at school. Girls' school attendance can be promoted by providing toilets, books, stationery, school lunches, take home rewards, and transport, for girls especially where it is suitable to discriminate. Unicef is making an effort here. But the government budget for village schooling is so low, considering the children survival boom that is taking place in many areas, that progress will be very slow.

A gender plan for adults in the water sectors can be considered as a general concept rather than sector by sector. If women are offered respect and consideration all other problems fall away. Sincere dialogue between men and women in village and town can lead to improved relationships, greater happiness for all.

Gender at work is mainly concerned with the number of women employed and with their treatment in employment.

There are three basic ways in which women can be helped to join, enjoy their work and get ahead in government.

- Women can be given some preference in intake processes.
- Those that are employed can be given greater consideration.
- Those that are employed can be given extra training opportunities and promotion.

A Gender strategy might include provisions for

- All staff showing sensitivity to the special needs and interests of both women and men
- An information base on gender issues for each sector which is used in planning, implementation and monitoring.
- All staff committing themselves to, and are assisted to, gain the capacity to work on promoting gender equality, including that in recruitment, human resources development and promotion.

In the job women need respect, and consideration in promotion, special time off, possibly special transport, consideration in the timing and placement for learning support, and retraining after time off.

Women are under represented in government except in the health and education ministries, and especially in the provinces. But how such a situation should be approached is not obvious. If special training is offered should this be before or after people enter government, how should the people be chosen and at what level should they work?

Women need consideration in applying for jobs and in the job. In applying for jobs they can be offered special positions or special training before interviews to raise their chances to equal men who have had higher schooling. Or they can be favoured and offered training after selection. Special positions and training before testing and interviewing is being implemented by the National Center for Environmental Health and Rural Water Supply in its Minority Women's Internship Programme.

In Western countries over the last few decades after 15 – 20 years of work, women have been having children later. This is increasingly recognized to be a mistake. Older women are now recommending that women who wish to, should have children in their twenties, probably after a short work period, and come back to work after the children enter school. Thus these women will need acceptance into the same or a similar job, together with some upgrading training to make up for skills forgotten and new ideas and conditions that have eventuated over the intervening period.

1.3 Environment

Government Policy

Augment and refine environmental policy and the legal framework for:

- (i) pollution control including issuance of discharge permits, site inspection, surveillance of discharge self-monitoring, and enforcement actions;
- (ii) adoption ambient environmental
- (iii) standards for air, water, soil
- (iv) integration of environmental protection into national development plans by including a programmatic environmental assessment in subsequent plans;
- (iv) project owner adherence to existing land-use and sector development plans at the national, provincial and district levels during project design; and
- (v) in coordination with line agencies, design and implement a national level environmental and land use awareness and education program for schools and training centers.

Some Proposals

The 'Environment' is a cross cutting theme that has been covered under each of eight sectors and their interaction. However defined, the 'environment' is covered from natural biophysical to cultural biophysical through human-biophysical interaction and human interaction in its interaction with the biophysical environment.

Sustainable development is the key and illusive concept that we can aim for, but in practice is rarely approached because of poor understanding of the processes involved and human self-centredness in space and time. At all scales from globe to farm most conditions continue to decline. Learning or HRD, not only for children, but also for adults at all levels in all places is required, and rapidly at that. The probable scenario must be pessimistic. Laos is not atypical in the conflict of interest between loggers and the people in time and space, between the large storage hydropower sector and the displaced people, and the sediment and water needs for a healthy river, the flood plain and the delta, the fisheries sector, between technical convenience and the basic need of quality food. Government is in a position to reconcile differences, seeking alternatives by better research and planning, deeper dialogue, and wider learning.

All aspects of the environment are covered in other sections.

1.4 Human Resources Development

Government Policy

Following a decision to adopt a more holistic approach to human resources development, the government in 1993 established a Leading Committee for Human Resources Development with responsibility for drawing up plans, policies, projects and measures to improve HRD in Laos. The Lao Government defines HRD as a lifelong process to provide citizens with a good life, health, education and employment, while also enabling them to contribute productively to society. Notice that this is much wider than schooling, or what is usually called 'education'.

Some Proposals

HRD is concerned with learning or skill and knowledge development. It is concerned here with BDP-related staff learning but also hopefully with wider stakeholder learning. HRD is not just training, and is not just schooling, as many seem to believe. It is best thought of as the cradle to grave process of the development of the mind for everyone. Some include the body and mental health but that can be left to the health sector. No nation can progress in a socially and culturally integrated way without treating HRD in a holistic way.

HRD might be covered mainly as schooling at three levels, including vocational colleges. Of the three levels of schooling mainly tertiary study in the form of vocational colleges and the Northern campus of the National University are considered here as there is scope for specialization in water-related topics such as water supply, irrigation, electricity and forestry and steep land farming in vocational colleges, and these same topics plus integrating topics at the university.

Students Enrolled in Vocational and Technical Schools in Sub-Area 1L

	<i>Vocational</i>		<i>Technical</i>	
	Total	Female	Total	Female
Luang Namtha	53	41	443	215
Luang Phabang	774	295	960	169
Total for SA1L	827	336	1403	374

(NRDS)

A vocational school is expected to open in 2004 in Bokeo. The courses are three years and are offered at two levels depending on whether the student has completed lower secondary or higher secondary. All the schools are at the moment government run and graduates are not in widely sought in the private sector. The private sector should be encouraged to invest as the demand is likely to be substantial, following trends in neighbouring countries.(NRDS)

Vocational colleges could be started in every provincial capital, starting by teaching say five subjects in greatest demand. A water resources management course could easily be offered by the NUOL geography department, and economics and politics or political economy could include water resources topics as examples through its senior courses at least.

In Luang Phabang NUOL is expected to offer education, economics and agriculture to 400 students in 2004.

The training that senior government staff provide for lower levels of staff often at lower levels of the hierarchy, and the training that in turn those lower staff provide for villagers is properly part of HRD and very important for all forms of water-related activities. Vientiane staff could provide learning support beginning with training for provincial staff in the Sub-Area Working Groups. These staff can in turn train district staff who could in turn provide training to at least village headmen if not village committees and the LWU leaders.

Learning support includes not only training in short-courses and on the job, but support for locally-led learning through mindful action, regular reading and organized dialogue or exchange learning, coaching and mentoring. Such other learning often requires training to get it going.

Capacity Building in Basin Planning Process

This note is based on the 'National Workshop on Training Needs Assessment for Basin Development Plan (BDP) and 'Results of BDP Training Needs Assessment' including Appendices.

For Laos the staff are divided into three groups.

1. BDP Sub-committee
2. National Working Group/BDP Unit
3. Sub-area Working Group (at Provincial Level)

A table showing skill levels and skills needed was used to recommend a wide range of topics where skills are required for each group, but it is not clear how the results were obtained.

Major competency gaps for the LN BDP WG were listed under:

1. Communication,
2. Facilitation,
3. Project design and planning
4. Public participation and stakeholder analysis
5. Training capacity
6. Technical competencies

The writer emphasizes the importance of considering each individual separately in training. A short course training programme of 13 topics is proposed. An outline of eight of these courses is offered. Some of these follow directly from the 'competency gaps'. The eight courses outlined are as follows:

Topic	Outline provided
1. Facilitation skills and teamwork	*
2. Information analysis and sector review	*
3. Action research and participatory survey techniques	*
4. Training of trainer on participatory training and workshop management	*
5. Trans-boundary issues and causes/effects analysis	*
6. Stakeholder analysis and public participation	*
7. Project identification and formulation	*
8. Communication and efficiency training	*
9. Introduction to Integrated Basin Planning	
10. Use of DSF	
11. Application of Integrated Water Resources Planning	
12. International Experience in Integrated Basin Planning	
13. Skills and using email and internet	

The following steps of analysis and dialogue is suggested here:

1. Analysis of problems/constraints in the national, sub-area planning and related processes. Evaluate the level and type of problems that individuals and teams are facing. Identify 'competency gaps' with the team.
2. Use an individualized approach by focusing on learning rather than training. Re-evaluate the appropriateness of above courses individuals. Brief training is already being proposed for provincial staff as part of the 'forum process' as weaknesses can be observed in the Forum 1 minutes.
3. Discussion of other learning methods. Learning on-the-job through dialogue and comments on reports is ongoing in the BDP Unit and among staff/consultants. Learning should be emphasized, not training. In this way the needs of individuals can be better accommodated and learning is more cost-effective and sustainable.
4. Analysis is recommended of other relevant capacity building such as motivation and resources, such as libraries and translation. Is the library collection appropriate and well organized? What general analytical documents are available for all staff to read? Is translation an appropriate use of funds? How can staff be better motivated?

Suggestion for Subsequent Action:

1. Dialogue with BDPU on the above points
2. Perhaps interviews and/or a questionnaire with a sample of relevant staff.
3. Reporting and presentation
4. Consideration by NWG.

MRC or LNMC may have materials that could be made into a set of short theoretical documents in Lao on each sector. Some have been seen in the library. Those on say cross

cutting issues and especially integration in the context of basin planning in poor countries might be sent to the provinces.

1.5 Provincial and Public Participation

Much as been written about *public* participation, but involving the *provincial staff*, in a useful as opposed to a symbolic way, must be the first step. In the Lao PDR that does not seem to have been achieved yet. Once Vientiane has involved the provincial staff then the provincial staff could play a role in involving the district staff and the wider public.

Communication with the Provinces

As I see it the Forum process is one of communication, which includes elements of dialogue, training, and information exchange between Vientiane government staff and the people in the provinces called the Sub-Area Working Group. The aim is to produce a water resources development plan for each sub-area. The method is to be as participatory as possible within time constraints. But the distance to the provinces, the costs of meetings and probably the type of schooling/education and training already received are constraints on this process. Reading, and experience at Forum 1 in Attapeu, and since in Vientiane, leads me to suggest a number of small innovations.

1. Greater use should be made of faxes to communicate with the provinces. The BDP Unit could periodically communicate by fax with provincial staff making up the Sub-Area Working Group to develop a greater mutual understanding before the Forum. If provincial fax machines are not working the BDP programme could use a little budget to get them repaired. Trial faxes should be sent before the forum meetings to stimulate interest and at least ask about Khet (sub-district) data including a map for three provinces (see below). When the data collation phase has advanced a little it is proposed that together the IA and NC examine the data that is still missing from the provinces and fax each province with a table of data that we would like to receive as soon as possible. At the same time we could prepare a summary situation review of a few pages for faxing in order to stimulate their interest.
2. An initial preparatory provincial meeting might be undertaken to prepare for Forum 2 in SA1L. This first stage could include further participation, training, including a presentation by provincial staff team of provincial data and ideas from each province. This meeting could be held in a province other than that planned for Forum 2. For the other sub-areas, when the methodology is better developed, one provincial meeting may be enough.
3. Working for one day with a wider range of staff from the one province where the meeting is held before the general meeting would be worthwhile. This would set up an example of more intensive communication with the provinces that might be replicated later.
4. A social science graduate should join the BDP Unit in order to facilitate the interaction between the various Vientiane agencies, the interaction of Vientiane and the provincial staff and the interaction with the people or stakeholders as a

whole. Someone with a training and interest in social interaction is needed to work with the staff who are otherwise largely technically trained.

Staff Skills in the Provinces

Without having done a study it is assumed that for the most part provincial staff have a weak knowledge of integrated water resources planning and management. There are several ways this might be improved.

1. Further Training for provincial people in water resources-related processes could be offered as part of the 'forum process'.
2. Possibly staff in one or more advanced provinces could play a leadership role in helping the other provinces in the same sub-area on an ongoing basis? I have no idea whether the staff in one or more provinces stand out above the others, but if they do then they could be given special training then asked to periodically visit the other provinces to coach them in water resources and the planning process.
3. Alternatively a new LNMC staff member could be appointed and based in a suitable province to play this role.

Proposals for Associated Activities to the Forum 2 SAIL Process

The trip to Attapeu was not cost-effective. About 15 people traveled from Vientiane to Attapeu and back (12.5 hours each way) and ran a 1.5 days meeting with about 25 southern staff. Having traveled such a distance the opportunity should be taken to try extend the interaction and learning process for all.

1. Forum 2 or the preparatory meeting could include tributary catchment sub-group discussions separate from the main meeting. At one session Northern participants could be asked to group themselves according to the major catchments or groups of catchments in the Sub-Area 1L, then precede to hold discussions on planning the catchment. This would bring up-catchment provincial staff together with down-catchment staff from another province in several cases. The catchment groups would be asked if they have any information or causal inter-relationships or other ideas that are specific to the catchment (s) that have not been covered in the sub-area data collation and analysis. This sort of up and down discussion will be an important precursor to the later Mekong Basin dialogue. Some discussion groups for small catchments would still have to group several together. Each discussion group could then report back to the general forum.
2. Forum 2 or the preparation stage might include a field trip to places nearby the town to see critical IWRM sites, illustrate water resources-related processes, and discuss with local people. For example: clearing of forest by shifting cultivators, cultivation practices, any example of movement towards permanent farming, a logging area, erosion and sedimentation, flooding zones and effects, small dams and irrigation, micro-hydroelectricity schemes, bank erosion, new sand bars, navigation issues etc. The provinces volunteering for fora should be asked to design a field trip before one is selected.

3. On the way to Xayabouli, the participants could stop off at the soil erosion research and demonstration Centre of the Soil Research organization (IBSRAM) between Xieng Ngeun and Muang Nan in Luang Phabang Province. Here erosion plots demonstrate the erosion rate for various types of ground cover. Along the same road examples of permanent farming may be evident.
4. Just for the province where Forum 2 is to be held, a trial 'stakeholder' meeting, could be advertised to all those interested to be held midway through the forum period. The aim would be to see to what extent this produces useful ideas and raises the interest and commitment of the local people in integrated water-resources planning and management.

Proposals for the Actual Running of Fora Meetings

Apart from being very short the meeting at Attapeu was dominated by professional addresses using computers and microphones. A mental distance was increased between the Vientiane staff and the others. The use of computers for screening probably discourages interaction. The presentations over emphasised facts and offered too few ideas. Many provincial staff said very little. Several suggestions are offered to increase the effectiveness of the interaction.

Sound

1. Sound system should be checked by a technician to make it as clear as possible
2. Keep the staff condensed with less or smaller lighter furniture so a microphone may not be necessary
3. Assign a person responsible for any moveable microphone.
4. The speaker should identify himself first by raising his hand and stating his name and/or province, as the movable microphone makes it hard to see who is speaking.

Visual

5. Use white board and have flip chart available
6. Could have one or more large diagrams of water resource-related processes to use for reference when appropriate, and are available to peruse casually.
7. A couple of large basic maps on the wall would be useful.
8. Avoid screening irrelevant documents when others are speaking.
9. If possible reduce the use of computers as it tends to increase the mental separation of the users from non-users.

Teaching, Interaction, Facts and Explanation

10. The fora should have an independent senior chairman or facilitator separate from senior leadership roles. This person should probably be hired in Vientiane.
11. Maintain a high level of interaction between those with knowledge and others by always inviting questions and comments. The facilitator must allow time for this.
12. The white board and flip chart can be used to facilitate interaction.

13. During brain-storming the ideas might be listed on the flip chart by a full time scribe and pinned up on a long board so people can look at them in a relaxed fashion and write their own comments. They can also be typed onto disk for later modification.
14. Presentations should focus on ideas, only using facts in support. Ideas can be discussed more easily.
15. Statistics should be presented as graphics where possible. Time-series data should be presented as graphs and spatial data as maps.

Ideas and Relationships

16. Leaders should put some emphasis on teaching how to think about the processes of integrated basin planning.
17. Need explanation and discussion of potential of landscapes with attendant water resources.
18. Should separate water related ideas from other socio-economic ideas such as roads that either impinge on the water resources or are influenced by them.
19. Opportunity/desires should have a column next to it of requirements for realization of these desires, including likely constraints, then methods as to how they can be linked.

2. INTEGRATED SCENARIOS BASED ON POLICIES AND STRATEGIES

Several integrated scenarios for Sub-Area 1L are best based on a range of ideas based on national government policies and strategies. At this stage scenarios are given names based on these ideas. Thus the following scenarios are described:

1. Growth Scenario
2. Poverty Reduction and Conservation Scenario

The scenarios are largely qualitative at this stage.

These are not simply rough predictions but rough predictions based on specific sets of assumptions or hypotheses. The assumptions/hypotheses are both social and biophysical. They aim to stimulate thinking, discussion and further analysis.

There is considerable overlap between these scenarios, the differences being

- not merely ones of growth rate, poverty reduction numbers or conservation area
- but differences in the various elements of government policy and strategies that could result from emphasis of different elements of policy and strategy and different operational style at any of the three main levels of government and in the villages.

For international trends we can note the existing trends and accept the predictions of others. National and regional trends, although uncertain like external trends, can be better understood and assessed. Government projections and even plans have a greater degree of predictive value without being at all certain.

External Influences that are Assumptions/Hypotheses Common to Both Scenarios for Sub-Area 1L

1. Global air pollution results in increased rainfall and thus tends to cause flood levels to rise in most streams.
2. China constructs dams on the Mekong at the announced rate with a variety of negative and positive impacts.
3. ASEAN persists with tariff reduction policy.
4. World economic growth is slow.
5. Global technology continues to change rapidly
6. Laos is affected periodically, biophysically and socio-economically, by infectious diseases of people, livestock and crops from outside.
7. Terrorism continues to affect tourism, but to a reduced degree, especially from 2005.
8. The Kyoto protocol is signed by the USA in 2005.

Internal Trends

The main relevant trends that can be identified from the recent past that are likely to continue at a moderately predictable rate, although a wide range is possible, are the following:

Population growth at 2.4% and a 'younging' of the age structure.

Urban population growth at about 4%

Demand for electricity is thought to grow at 2% from 2000 to 2010 and 4.5% between 2010 and 2020.

Other water-related trends are more difficult to predict due to some combination of

1. insufficient field knowledge of conditions,
2. natural variability,
3. poor monitoring,
4. changing policy and strategies and
5. strong external influences.

2.1 The Growth Scenario for SA1L

In the growth scenario growth is short to medium term up to perhaps 20 years but after that growth slows as the environmental and social problems become severe.

1. the population grows a little above the expected rate at about 2.5%,
2. Sub-area growth is fast at 8 percent, so percapita growth occurs at about 3.5 percent, but strongly favours urban areas, especially the largest, and those along good roads near urban areas. Inequality grows strongly.
3. Decentralization is supported with greater emphasis on local revenue development.
4. The government encourages investment with less emphasis on regulation and improvement in the style of regulation. EIAs are only carried out for the largest projects but fail to include public participation.
5. Most state enterprises are gradually sold to the private sector.
6. Trade taxes are lessened for ASEAN products, and trade increases.
7. Trade taxes with China are reduced on both sides
8. Local investors focus on tourism, timber plantations, livestock, aquaculture, passenger river transport, small to very small dams, furniture, agricultural processing and trade and consulting and contracting.
9. The rebound from the post 97 slump in FDI (foreign direct investment) continues.
10. FDI funds medium sized dams, hotels, tours, garment factories, and timber plantations.
11. Private sector production/income, including local and foreign, grows rapidly at 15 percent per year
12. Borrowing by government from multilateral banks rises. This is used to fund roads, transmission lines and the agricultural transition to sedentary agriculture in SA1L and repay previous debt (debt payments are about 20% of government revenue).
13. Grant assistance (Multilateral, bilateral and NGO) is stable and continues to fund a range of urban and rural development in SA1L.
14. Private debt rises markedly as part of borrowing by local companies for investment and trade credit.
15. Government revenue rises due to increased company tax receipts, despite the reduction in import taxes.

16. Most of the extra revenue is used for urban and major rural infrastructure.
17. Material poverty reduction proceeds unevenly, mainly as a bi-product of growth based on private investment, including rural trading. Thousands get jobs in urban and some rural enterprises. Those with irrigation and hill people near old and new roads and along rivers gain from a rise in 'cash cropping'. Production along roads grows at a mean 5 percent per annum and along rivers at 4 percent. Life for those away from easy transport changes very little, growing on average at 1 percent per year with some areas becoming poorer due to falls in soil fertility, and some areas such as hiking tour destinations.
18. Health services grow in urban areas and to some extent along roads but make little extra impact away from roads. Population grows strongly in the served areas.
19. Conservation of forests, soil and aquatic ecosystems is highly uneven gaining in specific places from grant aid and variable implementation of government policy.

Water and Related Resources

The present evening out of the mainstream flow is slowed due to global warming until further large dams are built.

Several medium sized dams are built for hydropower with concessional terms or subsidies. Large dams remain uneconomic and attract opposition.

1. Together with southern hydropower and national connectivity this results in significant increases in electrification in towns and along rural roads that themselves continue to expand. Much is exported.
2. But with minor contributions to irrigation.
3. Reservoirs consume water through evaporation and generate greenhouse gases equal to an equivalent fossil fuel power station.

Watershed management is emphasized in dam catchments but little is done outside these areas.

In dam watersheds:

- In new reservoirs suspended loads raise nutrient levels and
- They start to fill rapidly with eroded sediment but sedimentation slows as integrated WM expands

Outside dam watersheds:

- Logging continues at the present rate with no improvement in standards
- Shifting cultivation area is reduced at a low rate.
- Sedentary farming on steep slopes takes off slowly.

Effects From Medium Sized Dams are designed without fish passes or adequate low outlets, or if with low outlets, are operated mainly to maximize electricity generation.

- Fish habitats are severely degraded below and above dams. Because migration routes of large fish are severely interrupted they die out on those tributaries.
- Although fishing initially increases in reservoirs stagnation sets in after about 10 years due to nutrient runoff, weed growth and poor circulation. Effort to breed native fish overshadowed by the release of alien species.
- Short-term flood damage is reduced on river flats downstream, but this also reduces the natural mud and silt fertilizer to flatland agriculture and wetlands and reduces fish migration to and from wetlands.

Several more small irrigation schemes using pumps and weirs are built by government that take advantage of higher dry season flows downstream of the new dams.

Overall degrading environments leads to a slow decline in the wild fish harvest. The government continues to build new fisheries centers for alien fingerling production. Fingerlings are primarily bought by commercial ventures, and aquaculture production and sales increases. Fish disease threatens aquaculture from time to time. Alien species continue to escape to the wild environment and compete with and interbreed with the native fish stock

Water supply schemes are built ahead of schedule in the towns but at the planned rate in the countryside. Little effort is put into repair and maintenance of rural schemes or controlling waste discharge from towns, factories and mines. Occasional fish kills are recorded due to waste discharge.

River traffic increases particularly due to increased imports from China. Riverbank erosion rises due to

1. continued clearing of riverbank trees
2. continued watershed degradation in most areas exacerbating local floods where dams are not built
3. more variable short-term river water levels due to dams
4. increased boat numbers and average size, poorly regulated
5. continued vegetable growing on banks in the dry season,
6. riverbed blasting, dredging and quarrying.

New dams have little influence on local river traffic.

Riverbank protection is stepped up near towns, villages and important riverside roads.

Flood protection structures continue to be built and advance warning systems prepare plains dwellers for large scale floods, but isolated villages suffer more from flash floods.

Tourism increases markedly due to better navigation, more and better airports and roads. The private sector responds with increased rooms and tours. Disease and security continue to create problems. Some tourism/recreation is established on one or two dams within easy reach of major towns.

Due to increased trade and tourism and illegal migration, STD, drug and human trafficking and other crime increases, especially along major trading routes.

2.2 Poverty Reduction and Conservation Scenario for SAIL.

In the poverty reduction and conservation scenario short to medium term growth is slower but continues at a similar pace past 20 years.

1. Population grows a little slower than the expected rate at 2.3 percent.
2. National growth per capita at 4 percent is slower than in the growth scenario.
3. More emphasis is put on activities that benefit the poor and conserve the environment and culture throughout the SAIL region. The present growth in inequality slows.
4. Decentralization is supported by systematic training for provincial staff who in turn train district staff. Incentives are developed for good work.
5. The private sector, both local and foreign, grows well with government encouragement for investment with increasingly effective support for and regulation of private activities especially those that disrespect human dignity, degrade the environment and culture and cause nuisance to others. EIAs are increasingly required for medium sized projects and more and more include public participation.
6. State enterprises are upgraded with effective training and incentive programmes but those that do not respond are gradually sold to the private sector.
7. The government puts more revenue into operations such as maintenance and learning support than into construction. Sufficient funds are still allocated for rural water supply in off-road sites and motor bike tracks.
8. Transparency and accountability are promoted fostering a better standard of government service at all levels.
9. Import taxes are lessened for ASEAN and Chinese products and trade increases.
10. Dangerous imports such as dangerous chemicals and undesirable cultural imports are restricted.
11. The government puts more effort into promoting national entrepreneurs of all sizes.
12. Local investors focus on guesthouses, restaurants, local eco-cultural tours, timber plantations, livestock, aquaculture, passenger river transport, small to very small hydro schemes, solar power, furniture, agricultural processing and trade, consulting and contracting.
13. The nation benefits from the rebound from the post 97 slump in FDI
14. FDI funds one medium sized dam, hotels, large scale tours with a focus on eco-cultural tourism, garment factories, timber plantations, furniture design and fabrication for export to Europe.
15. Undesirable FDI such as the highly polluting industries is rejected
16. Private sector production/income, including local and foreign, grows well at 9 percent per year
17. Government's borrowing from multilateral banks is reduced a little. This is used to fund roads and motor-bike tracks, and the agricultural transition to sedentary agriculture and repay previous debt (debt payments are about 20% of revenue).
18. Grant aid (Multilateral, bilateral and NGO) grows in response to the governments effort on better regulation and rural development. It continues to fund a range of urban and rural development, but is better integrated with government effort and leads to more sustainable conditions.
19. Private debt increases but government HRD programmes raise the standard of borrowing.

20. Government revenue rises due to increased tax receipts, despite the reduction in import taxes.
21. Much of the extra revenue is placed into better HRD at all levels and types including that supporting rural development, conservation and a better taxation system.
22. Technology that is environmentally convivial, healthy, conserving and employing is promoted by government
23. The government builds a case on wealthy nation responsibility for global air pollution but accepts some responsibility itself.
24. UXO clearance is stepped up in critical watersheds.
25. Material poverty reduction proceeds well, due to better incentives for and training of provincial and district staff who in turn train villagers and assist with implementation. This involves better land allocation, in-village training and input support for community management, rural micro-finance, steep land farming, sustainable forestry, preventive and curative health. Interactive radio programs are used to effectively reach tens of thousands of villagers. Thousands get jobs in urban and some rural enterprises. Those with irrigation and hill people near old and new roads and along rivers gain from a rise in 'cash cropping'. Production along roads grows at a mean 3 percent per annum. More roads and many better tracks are built to reach isolated villages. Production there grows at 10 percent. Life for those away from easy transport improves a little due to incentives for government staff to walk, production growing on average at 3 percent per year except where hiking tours become regular where it grows at 10 percent.
26. Health services grow in urban areas, along roads and tracks and to some extent away from roads due to incentives for staff. Interactive radio programmes and in-village training are used to train villagers. Population grows strongly in the served areas.
27. Conservation of forests, soil and aquatic ecosystems progresses well gaining in specific places from grant aid and widespread implementation of government policy through training and dialogue.

Water and Related Resources

1. One medium sized dam and many small and very small dams and weirs are built with fish passes where appropriate for decentralized off-grid hydropower with very minor contributions to irrigation. Vegetation is cleared from reservoir areas. Several floating turbines are installed.
2. Solar power is also widely promoted integrated with very small hydro.

This results in significant increases in electrification in towns and villages which raises rural learning and productivity, but no new electricity is exported.

Watershed management is emphasized both with a view to increase rural incomes in the short-term and to conserve forest and top soils for long-term productivity.

1. Logging continues after stronger enforcement and training for loggers only as careful selective felling at a reduced rate
2. Effective integrated development and conservation becomes standard in NBCAs.
3. Shifting cultivation is reduced at above the planned rate by a major land and forest allocation programme and extension programme on sedentary farming and microfinance.

4. Small dams receive progressively less eroded sediment. Fish habitats and migration routes are interrupted to some extent.
5. Weirs have a negligible influence on flooding so natural fertilizer additions are maintained.
6. Several small irrigation schemes are built by government using small weirs with fish passes.

Overall degrading riverine environments continue at a lessened rate leads to a continuing decline in the wild fish harvest but at a slower rate than previously and eventually stabilizes and rises.

1. The government continues to build new fisheries centers for fingerling production.
2. Fingerlings are primarily bought by commercial ventures, and aquaculture production increases, but as well the government effectively promotes community and small private pond aquaculture.
3. Native fish are increasingly bred for use in aquaculture.
4. The government runs an experimental programme to try to confine alien species and varieties to ponds and reservoirs.

Effort in irrigation is directed at building community management and training in pump maintenance and strengthening supplies networks.

Water supply and sanitation schemes are built as planned in the towns but faster than the planned rate in the countryside with an emphasis on community self-management of development resulting in better maintenance and faster repairs. Experiments are conducted with alternative technology. A start is made on monitoring and regulation of factory and mining discharge.

River traffic increases particularly due to increased travel by locals and from China.

Riverbank erosion rises due to higher varying water levels due to heavier rainfall induced by global air pollution, increased number and average size of boat traffic, continued vegetable growing on banks in the dry season, and riverbed blasting, dredging and quarrying.

Riverbank protection is stepped up near towns, villages and important riverside roads using locally available materials and vegetation stabilization.

Flood protection structures continue to be built and advance warning systems prepare plains dwellers for large scale floods. The government also puts effort into warning systems for flash floods on small streams in remote areas.

Tourism increases markedly due to better navigation, more airports and roads and improved visa processing. The private sector responds with increased rooms and tours. The government organizes training in eco-cultural tourism and micro-finance for tour operators. Effective steps are taken to protect cultural integrity from the worst influences of commercial tourism.

Although undesirable effects increase due to tourism and especially truck trade, widely targeted HRD and associated regulation mitigate the worst influences.

3. TOWARDS AN INTEGRATED DEVELOPMENT STRATEGY

for Mekong BDP Sub-area 1L, Northern Lao PDR

Introduction

This strategy for SA1L is based on the government policies and national government sector strategies. It attempts to integrate the sector strategies and emphasizes the conditions in the North. It is also based on the past and future analysis provided above.

A reminder of some basic changes likely over the next 20 or so years:

Quantifiable Scenarios

	2000	2020
National Population (millions)	5.1	7.7
Percentage Urban	23	35
Water Consumption (Mm3)	230	600
National Forest cover	41%	?

Scenarios that are Difficult to Quantify

	2020
Rainfall	Higher
Shifting cultivation	Reduced
Erosion	Similar
Sedimentation in and behind structures	Higher
Restrictions on fish migration	Higher
Alien species and varieties release	Much higher
Waste water	Higher
River transport	Higher
Bank erosion/collapse	Higher
Floods on mainstream	Reduced
Floods on tributaries	Higher mainly
Tourism	Much higher

The NPEP has three 'pillars' or objectives:

4. Rapid growth with equity,
5. Socio-cultural development and
6. Conservation of the environment,

Together these three objectives 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.

Strategies that are cross-cutting themes are very important but easily overlooked. They are covered in an earlier section of this report. HRD for all levels must be the key strategy for the region. Gender is of great interest to half the population but they have little

influence on implementation. The public may like to participate but they need HRD and access before this is useful. The environment is covered in every section of this report. Poverty is also widely covered.

Because of the large proportion of people living near subsistence lives, their main use of water is for domestic use, rainfed agriculture, multi-forest products, aquatic wild harvesting (fishing plus) irrigation and local transport, roughly in that order. This reminds us that although modernization is a dominant aim, most people will gain little unless operations are tailored to their needs.

The key strategy responds to the dominance of steep land in the North and a high level of destruction of the forest ecosystem by shifting cultivation and logging in the central east-west part of Sub-Area 1L, but its partial preservation in the peripheral zones. Wild harvesting by villagers (NTFP) in the forests, that safety net that supports livelihoods in an uncertain climate, is severely threatened by forest loss in the central zone.

Watershed management must be the key sector in watershed and indeed sub-basin or catchment planning and management in this sub-area. It is significantly overlapped by poverty alleviation strategies. It is in the most degraded areas that efforts on forest conservation and supporting regrowth around the remaining stands should be most intense. WM reduces tree destruction, rainfall impact and rapid runoff and so reduces erosion and landslides. These not only destroy hillside livelihoods but limit lifetimes and maintenance costs of water storage and diversion structures and degrade fish habitats

But it must be recognized that watershed management is a long-term process. Laos must do this for its own and the basin's children, grandchildren and beyond. It is over the long-term that effects will be felt at a distance and especially trans-boundary.

To overcome poverty and support development needs that is most prevalent in the hills and mountains, the minority peoples must be supported with better preventive and curative health services, including improved water supply and sanitation. Mother and child health programmes and bed nets against malaria can reduce the very high infant mortality and slow the children boom that will stretch schooling and health resources.

Overlapping with watershed management, the hill and mountain minorities must also be supported with dialogue and training and input support ('extension') in agriculture, plantations and forest conservation.

Micro-finance including bank loans and villager savings and loan groups can contribute significantly to agriculture and plantations, water-supply development, village handicrafts, business and processing.

Motorbike tracks, for later upgrading to roads, to remote scattered villages could be considered as a possibly more cost-effective way of helping remote villages. electrification from hydropower and solar power are less important than health and land production to the lives of the villagers, especially if they are not on roads, as they are unlikely to have sufficient cash income to pay.

Tourism might best be promoted

1. at Luang Phabang, but it may soon reach 'overload'.

2. in the Sino-Tibetan areas with remaining forest
3. on the rivers nearby 1 and 2

A few areas of forest in the periphery zone might support careful selective logging.

Timber plantations should be encouraged on the steep slopes in the most degraded zones away from any remaining stands of forest that could expand.

Three land uses offer some hope for the degraded steep slopes.

- Forest regrowth near existing forest
- Timber tree planting on the steep slopes
- Permanent, diverse and integrated farming systems on lesser slopes
- Livestock, where not in conflict with crop-based farming.

Timber plantations and support for forest regrowth may take off if the Kyoto agreement is implemented. Pilot projects are needed now.

Urban population growth and new wealth will give rise to a higher demand for urban water supply, but most importantly will be associated with higher industrialization, demand for a greater variety of rural products, including those from water resources, and very probably give rise to much greater waste discharge to water bodies. Greater attention to water supply and sanitation and waste discharge is needed in the fastest growing towns.

Because of the risk of another boom and bust cycle, terrorism and disease epidemics emphasis is best put on action that can protect the nation and Northern region against uncertainty together with attempts to anticipate and gain from high growth rates. Tourism is now Laos' most important 'export' followed by garments, electricity and wood products. The growing diversity of leading exports supported by SA1L is a good sign. Huaysai and Luang Namtha towns on the new 'land link' road may be future furniture and garment exporters. But special effort is needed to guard against the inevitable negative effects of this road. Rising national debt payments and repayments must be analyzed to avoid a high risk to Northern development. Increased government revenue is needed to fund the proposed SA1L strategy past the special projects that may get foreign funding.

Water Movement and Related Processes

Ultimately each sub-basin or tributary catchment should be studied and planned separately and as a whole. Simply a 'balance of sectors and themes' for the sub-area is not appropriate. It would be best to choose one medium sized degraded catchment to organize a model integrated study and development project, as well as make selected studies of the whole area where data are weak. Rainfall data is widely scattered and interpretation gives very variable results. More effort is needed on data collection and analysis. All major and middle tributaries should be gauged. The Department of Forestry's latest remote sensing analysis should be incorporated into the Mekong 'information base'. More effort is needed to exchange data between MRC and the four national secretariats. Limited sites are appropriate for one or two sector projects.

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 truthing 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 regrowth wherever it is found has several environmental values that timber tree plantations lack.

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

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 regrowth. 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 regrowth 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.

Conclusions

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.

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

- a. 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.
- b. Reducing soil erosion, transport and deposition by watershed management,
- c. 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.
- d. Stopping over-fishing where it occurs by supporting community management or state regulation.
- e. Studying the effect of traditional irrigation on local fisheries.

Electricity Use/Demand and 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 mimicing 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 demand is 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 SAIL 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.

Irrigation

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 SA1L thus uses about 200Mm³ per year. But this is less than half a percent of the contribution of SA1L'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.

Water Supply and Waste Water

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;
- -focus on inaccessible, poverty-ridden areas; and
- -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.
-

Navigation 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:

1. New port construction,
2. Riverbank protection using local products,
3. Safer travel,
4. Better transport organizations,
5. Better data collection,
6. A study project to establish an inland clearing centre,
7. Setting up joint ventures,
8. Organize cooperative ventures with Yunnan province,
9. Introduce electronic methods on the boats,
10. 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 Myanma and one through Lao PDR before more major fixed investment is placed in navigation.

Floods

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, channeling 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 floodways. The flood plain is part of the river.

A flood mitigation strategy could have the following elements:

10. Watershed management,
11. Medium sized dams and 'conservative' operation,,
12. Selective dredging where channels have become choked
13. Flood levee construction
14. Natural drainage maintenance and possibly some extra construction
15. Land use planning, including limits on building on and especially building up land, on the lowest parts of the flood plain
16. Maintain traditional house design on stilts
17. Flood forecasting and broadcasting of results
18. Special methods for flash floods in remote areas.
19. Minimizing population on the flood plain
20. Supporting opportunities for protecting property and people
21. Support escape methods.

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

5. Security conditions

6. 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.

Conclusion

Watershed management is undoubtedly the major challenge in hilly and mountainous SAIL. There is a major overlap with poverty reduction. A combination of research, training of staff and then villagers and companies in sustainable forest management and permanent steep land farming is necessary. Electricity could be generated using a range of small to very small socio-environmentally convivial schemes including very few medium hydro schemes with researched fish passes and solar power

Irrigation requires continuing support for community management and research on the effects of large and small schemes on fisheries. . For the region to maximize and spread benefits and minimize costs of all types, electricity and irrigation staff should continue their dialogue at least with the fisheries staff and those responsible for flood plain productivity.

Study is required on riverbank erosion/collapse, boat regulation and among other topics. Flash flood warning needs attention. More dialogue and perhaps research on the costs and benefits of medium floods would be appropriate. Water tourism with safety and convenience could be promoted.

4. CONCLUSION TO PAST AND FUTURE ANALYSIS

The human and biophysical conditions in and around Sub-Area 1L pose a major challenge but with careful thought, dialogue, study and learning support, progress can be made.

Continuing dialogue between LNMC, CPC and the line agencies and the provinces is obviously important. But this must be linked in a practical way to training and other learning support. Participation without knowledge and understanding is hollow. True sustainable locally driven development cannot be obtained without increased learning. Using foreign finance to run most development programmes must be accompanied by genuine learning to create a local capacity and independence. HRD on water and water-related biophysical and socio-economic processes at all levels should undoubtedly be the key 'strategy' for BDP implementation. Learning can take place face-to-face in a hierarchy of steps, through the mass media or individually using paper and electronic documents.

Specialized and integrated learning in SA 1L should be strived for with support from leaders, trainers, teachers, coaches, mentors and colleagues using a variety of methods including:

- interactive radio: discussions on development topics
- posters,
- useful books in small general and specialized, well designed libraries,
- whole-village and special group in-village training,
- on-the-job training, short-courses, study tours, etc.

The key topics for most people that require learning are believed to be

- ◆ community self-management
- ◆ micro-financial management: credit and debt management, savings and loans groups
- ◆ steep land permanent farming systems, including integration of livestock and trees.
- ◆ marketing
- ◆ preventive and curative health
- ◆ birth spacing

Apart from those above for relevant staff the key topics for many government staff that require learning are believed to be

- ◆ efficient government supervision of the private sector
- ◆ government revenue generation and expenditure
- ◆ work processes and development

Learning must be continuous and closely related to useful practical activities. Leadership at all levels is probably the key need.

Several topics need serious study or research and these are listed below among the proposed projects.

5. PROJECTS

In this section initial thoughts of the method of choosing projects is followed by two lists of proposed projects (in two formats). These projects came out of the preceding analysis.

5.1 Choosing Projects

The professionals in each sector and issue naturally tend to promote projects and programmes in their own area. The government at the general or integrating level can however play an important role in prioritizing and choosing the best projects on integrated grounds. It is important for the nation's and the basin's future that projects with the highest ratio of overall social, cultural, economic, political and environmental benefits and costs be chosen. This means usually that professionals in several non-technical areas, an 'environmentalist' and technical specialists from the sectors concerned are needed for full studies of project proposals. A competent, strong and neutral leader is also required.

Technical sectors may be working under laws, policies or strategies that oblige government agencies to promote the sector's activities whether or not they are economically viable. Usually social, cultural and environmental studies are required by law, but ironically an economic profit for the nation is not mandatory. This means that for example a hydropower dams could be constructed even though on economic grounds it would be better to import electricity. The dam may be built for other reasons.

Trans-boundary Issues

SAIL has three types of other sub-area to consider in trans-boundary issues:

1. Up-catchment which means the influence of the Upper Mekong Catchment in China and Myanma
2. 'Across river' in Thailand
3. Down-catchment in all four nations of the LMB

The influences range from the short term such as boat waves to long term such as watershed activities. It would be best to put most effort on the short-term issues in initial international discussion, while not ignoring the long-term ones

The major up-catchment issue is the cascade of dams built and planned in China that collectively will have a significant influence on Mekong flow, earth material transport, navigation and ecosystems. More effort could be put into dialogue with PR China on the consequences of these dams.

The major across-river issues are those up-catchment, riverbank and in-river conditions and activities that affect the in-river, riverbank and flood plain conditions in Thailand.

Down catchment influences are the same as the longer term influences on across-river zones plus those that are unique to Tonle Sap and the delta.

Under the MRC mandate up-catchment nations are expected to choose projects that have 'trans-boundary' influences. Although this is a fine objective, it is difficult to carry out because while some projects may have an immediate effect on neighbours, others may have a long-term effect. Some projects may have a sudden effect when completed in the distant future, others will have a gradual effect over many years. Some have a certain

effect and others an uncertain effect. A project that has an uncertain long-term trans-boundary effect is still important.

Trans-boundary meetings will be especially difficult and need to be carefully prepared. It would be best to leave such meetings with other nations until after the participating nations have passed the Forum 2 stage, so that data and ideas are well established, without being dogmatic. Options, not one established 'position', should be presented by both sides. This should be agreed beforehand. Documents might be exchanged and commented on before a meeting takes place.

While MRC may wish to promote trans-boundary projects it is inevitable that sub-area analysis results in many development ideas that have largely in-country consequences. There is no reason why MRC should not promote them as well. The reality is that MRC and its national equivalents are probably the leading integrators of water related ideas in each nation, so they are in a position to promote good integrated national development as well as basin development.

Integration of Study and Action

A high priority should be given to a project that simulates many of the issues of the whole Mekong basin in a small catchment. This will provide lessons in the difficulties of engendering a concern for down-catchment peoples and environments in up-catchment people.

A Pilot catchment project including all eight sectors is proposed. Dialogue and training including assistance with savings and loan groups and associated bank loans could be the main field methods used.

Data Collection and Analysis Projects

Improved data collection and analysis is required in all sectors. Projects could be designed around one sector topics, or an integrated project could be run on basic scientific methods. Such projects are probably required for both Vientiane and provincial staff.

Rainfall is not a sector and is not part of BDP but is under WUP. So it may be necessary to recommend to WUP that they run a rainfall project. River gauging likewise needs support.

Apart from rainfall and river gauging, sectors and sub-sectors that stand out in need of assistance in the data and analysis are: global warming, land cover/use, mass movement, sedimentation in all locations, fisheries, the negative impacts of hydropower, water and sanitation facilities in action, factory and mine waste discharge, riverbank erosion/collapse, and water tourism.

Places in Need of Assistance

In each sector provinces and perhaps multi-province zones stand out as needing assistance in one or more sectors. For example, Oudomxay in SA1L stands out for several reasons:

1. It has several high poverty districts
2. Its percentage of forests is low
3. Its rice areas declined in the 1990s
4. It has a very small area of timber plantations given its large slightly forested area
5. It has a low percentage of households covered by improved sanitation.
6. The number of tourist rooms dropped
7. A medium sized dam is likely to be built on the Nam Beng

Thus it is proposed that an integrated project be run in the Nam Beng catchment.

More generally the central area of SA1L roughly around the ancient capital of Luang Phabang extending through Oudomxay and into northern Xayabouli has a very low forest cover. This central area needs assistance in forest conservation. Regrowth should be supported around the small remaining areas of forest. Timber tree plantations could also be promoted, but away from the specific areas where regrowth is supported.

Spearhead Projects

Spearhead projects might be thought of as ones that will have an immediate impact, pilot projects, those that have a high priority, or just easily organized ones with low risk

An example of what could be a rapid impact project would be a study of boat regulation and the immediate implementation of the recommendations. This should of course be done internationally and thus may be controversial.

It easy enough, and in fact preferable, to start with small pilot projects if ideas are new to Vientiane staff or a province. Even for hydropower small dams designed, financed and built by local organizations can be pilots for larger efforts.

The institutional communication project suggested below is one that could be regarded as having a high priority.

The rainfall, flash floods and tourism projects might be easiest to organize of those listed below.

Drought

Drought is not a 'Mekong Sector' or a 'Cross cutting theme' but drought is most definitely about water. It is a regular occurrence that tends to occur in non-flood years. The consumption of large amounts of water in the form of irrigation is often proposed to overcome drought, but of course much of the same sources of water, the absence of which have caused the drought, also tend to make irrigation difficult. But in horizontal and vertical space water may be available. This can be found in dammed reservoirs in catchment regions not suffering drought, in groundwater aquifers and deep soil water that can be replenished in non-drought years, that will inevitably come. When drought occurs in up-catchment regions, down-catchment regions usually suffer, partly because the river in the drought area is used first before the other sources of water are considered. Thinking about drought could be a Mekong activity.

The government can train farmers to better prepare for the regular droughts by planning productive activities that can go on in drought time, whether that involves water or not. Where and when irrigation schemes or adequate gravity river fed irrigation is not available, dug well and especially tubewells with a hand pump, or perhaps an electric pump, can be used to irrigate a quarter hectare or so of corn, vegetables or other crops. A tubewell is better than a dug well as they are deeper and are much less likely to dry up in a drought. Fruit trees and other productive trees will continue to grow and produce through moderate droughts using deep soil water and perhaps shallow groundwater. All farmers should plant say 10 percent of their land to trees and/or sink a small tubewell. Land security through allocation will be needed to provide the incentive to farmers to invest. If all 'landowners' in a village do this together the threat of theft is reduced. Of course handicrafts and many village industries can continue without rain. Fish catches will be reduced.

5.2 Proposed Projects

The following are initial ideas for suggested for possible projects. Except for those focused on Oudomxay and the Nam Beng they could well be carried out nationwide or even basin-wide.

1. Human Resources Development: A study of how the people of the region could best learn to further the effectiveness of integrated catchment or water resources development in SA1L.
2. Institutional Study: A study of how the national Mekong committee secretariats, line agencies and the MRC Secretariat can better understand and best help each other.
3. Global Warming: A study of the likely effects of global warming on the climate of SA1L.
4. Drought: A study of drought proofing strategies for small farmers and a following pilot project.

5. Rainfall Measurement and Analysis in three parts:
 - A. the setting up of several more rainfall gauges in the poorly served parts of SA1L,
 - B. a comparison of the several interpretations of the existing rainfall data,
 - C. an assessment of the value of using remote sensing to assess rainfall in the SA1L.
6. Tributary Flow Gauges: Gauges would be set up on several tributaries in SA1L. Together with a commitment to use and maintain them.
7. Mass Movement and Sedimentation: Evidence would be collected on mass movement and reservoir, weir and canal/channel sedimentation in SA1L.
8. Time and Space study of Land Cover/Use A comparative study of remote sensing data for several sample of areas 10 km x 10 km for the maximum available number of satellite images.
9. Forest Regrowth: A forest regrowth promotion project around the edges of the small remaining forest areas in the highly degraded central zone of SA1L
10. Timber Tree Plantations: Timber tree plantations require support particularly in Oudomxay province. A project could support nurseries and planters including training and microfinance.
11. Furniture Design Training: Furniture design training for small furniture entrepreneurs in towns near major areas of forest that are being logged in a real sustainable fashion.
12. Alien Fish Control: An experimental study of ways of limiting the escape of alien fish species and varieties from aquaculture zones into natural ecosystems.
13. Pump and Weir/gravity Irrigation Study: A study comparing the costs and benefits of pump irrigation and weir/gravity irrigation, especially for fisheries.
14. Traditional Irrigation and Fisheries: A study on the effect of traditional irrigation schemes on fisheries, including stream diversion rate, sedimentation, fish passing and access to irrigation area fish.
15. Riverbank Erosion/collapse: A study of the causes of riverbank erosion and the most cost-effective preventive and repair methods.
16. Boat Regulation: A study of the possibilities of regulating boat safety, pollution, speed and noise.
17. Flash floods: An experimental study of ways of setting up flash flood warnings in vulnerable and remote villages.
18. Tourism A study of how community-based eco-cultural tourism can make best use of water resources.

19. Catchment Development: An integrated tributary catchment development and conservation project in the Nam Beng catchment to serve as a model for other catchments, including up-catchment down-catchment understanding.
20. A Baseline Environment and Resources Study in the tributary catchment most likely to have a medium sized dam built. If this is the Nam Beng then this could be the first phase in the Catchment development project.

Issues and Projects-- Alternative set out

The following are the main issues and problems and initial ideas for responses suggested as possible projects. Except for those focused on Oudomxay and the Nam Beng they could well be carried out nationwide or even basin-wide.

Issue or Problem	Proposed Action
1. The educational level of the people at all levels is well below that required to effectively plan and manage the water-related resources of SA1L	<u>Human Resources Development</u> : A study of how the people of the region could best learn to further the effectiveness of integrated catchment or water resources development in SA1L, and the implementation of pilot projects.
2. The resources of the MRC are not fully engaged to assist the LNMC and vice versa.	<u>An Institutional Study</u> : of how the national Mekong committee secretariats/line agencies and the MRC Secretariat can best help each other.
3. International scientific models predict serious climatic change but few up-to-date details have been summarized for the Mekong Basin.	<u>Global Warming</u> : A summary study of the likely effects of global warming on the climate of SA1L.
4. Drought is a negative water phenomenon that is not well recognized by the Mekong organizations.	<u>Drought</u> : A study of drought proofing strategies for small farmers and a following pilot project.
5. The rainfall data is scattered and interpretations are contradictory	<u>Rainfall Measurement and Analysis</u> in three parts:
a. The density of rainfall gauges in SA1L is very low in most parts	A. the setting up of several more rainfall gauges in the poorly served parts of SA1L,
b. At least three interpretations of the rainfall data are available	B. a comparison of the several interpretations of the existing rainfall data,
c. Remote sensing has not yet been used to assess rainfall	C. an assessment of the value of using remote sensing to assess rainfall in the SA1L.
6. Several tributaries in SA1L do not have gauges.	<u>Tributary Flow Gauges</u> : Gauges would be set up on several tributaries in SA1L. Together with a commitment to use and maintain them.
7. There is no recorded evidence of mass movement or sedimentation in SA1L	<u>Mass Movement and Sedimentation</u> : Evidence would be collected on mass movement and reservoir, weir and canal/channel sedimentation in SA1L.
8. The data on land cover/use is contradictory.	<u>Time and Space study of Land Cover/Use</u> A comparative study of remote sensing data and for

	several sample areas 10 km x 10 km for the maximum available number of satellite images, together with 'ground truthing' for the latest year and a socio-economic survey of the same areas.
9. The central area of SA1L has only 2-3 % forest cover. Small scattered patches remain that are under threat and need not only protection but support to expand.	* <u>Forest Regrowth</u> : A forest regrowth promotion project around the edges of several small remaining forest areas in the highly degraded central zone of SA1L
10. In the central area with little forest Oudomxay province in particular has very few timber tree plantations. This process requires support.	* <u>Timber Tree Plantations</u> : A project in Oudomxay could support nurseries and planters including training and micro-finance.
11. Lao furniture design is not suitable for the Western market. Western acceptance of Lao furniture will be greater if the timber derives from sustainable practices.	<u>Furniture Design Training</u> : Furniture design training for small furniture entrepreneurs in towns near major areas of forest that are being logged in a real sustainable fashion.
12. Alien fish introduced for aquaculture tend to escape and degrade native aquatic ecosystems.	<u>Alien Fish Control</u> : An experimental study of ways of limiting the escape of alien fish species and varieties from aquaculture zones into natural ecosystems.
13. It is not clear whether pump or weir/gravity irrigation is more cost-effective, especially considering fish.	<u>Pump and Weir/gravity Irrigation Study</u> : A study comparing the costs and benefits of pump irrigation and weir/gravity irrigation, especially for fisheries. The weirs would have fish passes.
14. Anecdotal evidence of high levels of stream diversion, poorly known fish pass rates, sedimentation, and narrow control of irrigation, indicates a likely widespread problem.	<u>Traditional Irrigation and Fisheries</u> : A study on the effect of traditional irrigation schemes on fisheries, including stream diversion rate, sedimentation, fish passing and access to irrigation area fish.
15. The understanding of the causes of riverbank erosion/collapse appears to be weak.	<u>Riverbank Erosion/collapse</u> : A study of the causes of riverbank erosion and the most cost-effective preventive and repair methods.
16. No regulations have been developed on boat operations.	<u>Boat Regulation</u> : A study of the possibilities of regulating boat safety, pollution, speed and noise.
17. Flash floods from spatially variable storms not covered by radio broadcasts threaten villages on small streams.	<u>Flash floods</u> : An experimental study of ways of setting up flash flood warnings in vulnerable and remote villages.
18. Water-related tourism is a sector.	<u>Tourism</u> a study of how community-based eco-cultural tourism can make best use of water resources.
19. There is no project in SA1L that seeks to integrate most if not all of the eight sectors and four themes.	* <u>Catchment development</u> : An integrated tributary catchment development and conservation project in the Nam Beng catchment to serve as a model for other catchments. Nam Beng is a small and accessible tributary catchment in one province with several very poor districts and that is highly degraded.

20. If a medium sized dam is to be built knowledge of the environment before the dam is started should be established so that a comparison can be made with with-dam conditions.

* A Baseline environment and resources study in the tributary catchment most likely to have a medium sized dam built. If this is the Nam Beng then this could be the first phase in the Catchment development project.

6. CHANGES AND CONSEQUENCES IN BASINS/CATCHMENTS/WATERSHEDS

POSSIBLE CHANGES/TRENDS/ INTERVENTIONS	LIKELY BENEFITS	POSSIBLE ISSUES, PROBLEMS	MITIGATION METHODS	INFORMATION NEEDED
Global Warming				
Increased rainfall due to global warming will tend to increase river flow level and rate.	Enhance dry season irrigation opportunities and navigation.	Increased soil and bank erosion, sediment transport, reservoir filling or flooding.	Lobby governments and organizations to reduce GHG output. Volunteer to make contribution.	Probable increase in rainfall over next 50 years.
Land Use				
Forest clearing for logging	Timber sold	Sustainable use is lost. Major increase in runoff, erosion, local flooding, sedimentation in reservoirs, behind weirs and in irrigation canals. Reduced tourism/ recreation amenity	Enforce laws on logging, Increase training in furniture design and fabrication and credit for fabricators.	Area of forest lost. Examples of flooding following forest clearing. Collation of clearing and flooding and sedimentation information in small to medium catchments.
Forest clearing for agriculture	Agricultural or plantation production for consumption or sale.		Arrange improved land and forest allocation. Train farmers in diverse contour- based fruit, fibre and timber tree culture on steep slopes. Train people in micro-finance and provide credit. Provide better encouragement for companies to invest in job creating enterprises.	
Forest degradation through excessive selective logging	Timber gained		Enforce laws on logging, increase training in furniture design and fabricating and credit for fabricators.	

POSSIBLE CHANGES/ TRENDS/ INTER- VENTIONS	LIKELY BENEFITS	POSSIBLE ISSUES, PROBLEMS	MITIGATION	INFORMATION NEEDED
Reservoir Storage/ Release				
Storage	Mainly introduced fisheries	Loss of land, forest, livelihood, community,. Require alternative livelihood Excessively reduced flooding Reduced recharge of groundwater on flood plain. Sediment is stored filling up reservoir and prevented from replenishing stream. Fish routes blocked. Fish no longer interchange between river and wetlands, including rice fields. Water birds feed on fish in reservoir. More than 1.5 metres per year is lost to evapotranspiration. Greenhouse gases produced. Water of different chemistry and temperature released from dam. Sediment load released less than before.	Minimize area and depth covered by storage. Invest in alternative livelihoods. Design and operate dams to mimic previous flow regime as far as is possible. Provide effective fish passes Manage watershed to minimize erosion.	Details on proposed alternative livelihoods. Sedimentation rates in existing reservoirs in Laos Studies of gas release in old reservoirs Studies on impacts on fisheries.
Causes wet season flow reduction	Less flood damage.	Reduces natural flood 'fertilizer'.	Together with flushing allow a level of flooding that replenishes flood plain soil.	Long-term studies of the effect of reduced flooding on plain fertility not using chemical fertilizers.
Dry season flow rise resulting from reservoir storage in wet season and release in dry season	Facilitates Pump and gravity diversion irrigation and navigation	In excess may degrade river ecosystems; may reduce fish diversity and production.	Take advice from Fisheries Department on effects of flow levels and rates	Examples from Mekong Basin or elsewhere in region.

POSSIBLE CHANGES/ TRENDS/ INTERVENTIONS	LIKELY BENEFITS	POSSIBLE ISSUES, PROBLEMS	MITIGATION	INFORMATION NEEDED
River Water Diversion / Extraction				
Irrigation Diversion/Extraction	Dry season Irrigation	Irrigation may be excessive, degrading river ecosystems by flow reduction and discharge of chemicals, and/ or salt Water-logging and salinity in irrigation areas. Weirs hinder fish migration	Price irrigation water at full long-term cost. Assist poorest irrigation farmers in other ways. Take advice from Fisheries Department on maximum pollution levels allowed and minimum flow levels Provide by-pass facilities at weirs	Examples of actual or possible problems resulting from lower dry season flow levels and groundwater levels and polluted discharge.
Water Supply Extraction and Waste Discharge	Water supply	In small streams and for groundwater extraction may be excessive, degrading river ecosystems by flow reduction and lowering groundwater levels. Discharge may include excessive chemicals and pathogens from towns, factories, mines etc. Loss of tourism/recreation amenity	Avoid over-pumping small streams in dry season. Drill tubewells away from river to supplement river supply. Monitor groundwater. Regulate discharge to drains, groundwater and streams using legal, economic and educational means.	Examples of actual or possible problems resulting from lower dry season flow levels and polluted discharge.
Soil Water and Groundwater				
Level and flow rise in soil and rocks due to change in evapo-transpiration in watershed and global warming	Easier well access to groundwater	Can cause water-logging (and salinization where groundwater is saline) and exacerbate bank erosion.	Monitor groundwater levels. Train riverbank gardeners in diverse cultivation including deep rooted permanent crops.	Examples of actual or predicted water-logging due to forest clearing. Sample surveys of likely areas on stream flats. Examples of bank erosion promoted by high groundwater levels. Sample surveys.

POSSIBLE CHANGES/ TRENDS/ INTERVENTIONS	LIKELY BENEFITS	POSSIBLE ISSUES, PROBLEMS	MITIGATION	INFORMATION NEEDED
Sediment				
Forest clearing increases erosion.		Dams store sediment so limit their lifetime. Suspended load reduces domestic amenity.	As above	Studies from other basins, eg Ganges Sample study of the movement of soil/sediment down catchment/basin
Sediment Eroded from Banks		Land loss devastating to owner. River widened. Sediment deposited downstream causing shallowing. River may slow and deposit more Flooding may increase.		Map of bank erosion sites. Monitoring data on river cross section and flow height and velocity
Sediment dredging	Supply of sand and gravel	River flow height and rate may be altered and deposition or erosion changed.		Monitoring data of river heights and flow rates and erosion and sedimentation nearby.
Chemicals Discharge	'Cheap' disposal if no fee	Reduces drinkability. Kills animal kingdom NO3 PO4 pollution promotes cyano-bacteria which use O2 when die and thus kill fish		Monitoring data from discharge pipe or drain, and river water downstream from effluent discharge. Monitoring of pesticide and fertilizer shop sales in catchment
Tourism and Recreation and Trade				
Tourism booms Trade booms	Jobs/income	Detrimental cultural/social change	Education, regulation	Proposals on method of maintaining culture
Flat land Development				
Infilling wetlands	Other growth	Loss of fish habitat	Minimize	Study
Urban landfill and building	Urban growth	Change in flood flow pattern	Plan land development to minimize problems.	

Part E: Time-Series Data Needed to Prepare Better Scenarios for Mekong Basin Sub-Areas

(Note that since the preparation of these proformas in December 2003 some further time-series data was obtained from the line agencies, in particular the Irrigation Department.)

Although the data collected and collated for Analysis and Scenario formulation for Sub-Area 1L in Northern Lao PDR is substantial it tends to either focus on one date or is general for the Northern region or even the nation as a whole. In order to say anything useful about the future it is necessary in most cases to know something about past trends. Unfortunately in agriculture and some other water related activities the figures tend to rise and fall with the weather. This means that many years are needed to establish a trend. This thus means that we are seeking additional data on the sub-area provinces. Where provinces, such as Luang Phabang, are divided between several major tributary catchments it will be very useful to have data by district, especially where districts more or less fall within one catchment.

Proformas prepared cover the following:

	Topic	Sub-topic	Proposed Source of Data
1	Land cover/ land use		Remote sensing DOF
2	Land and forest Village Survey Data		MAF
3	Hydro-power	Dams on tributaries	Electricity Department
4		Irrigation	Electricity plus Irrigation Department
5		Other consequences	Electricity plus STEA?
6		Run-of-river dams	Electricity
7	Irrigation	Area	Provinces
8		Production	“
9		Planning	“
10		Non-area	“
11	Fisheries	Wild fisheries	“
12		Managed fisheries	“
13	Rainfed crops		“
14	Water supply		“
15	Pollution	Mining discharge	“
16		Factory discharge	“
17		Human waste discharge	“
18		Agricultural chemicals and livestock	“
19	Mass movement		“
20	Bank erosion		“
21	Sand bars and quarrying		“
22	Navigation	Weight or type of boat	“
23		Other	“
24		Plans or projections	“
25	Floods		“

Land Cover Data from Remote Sensing

(Please include the years for which you have data).

Land cover/use	Area of Land Cover/Use for Sub-Area 1L (square kilometres)					Comment
Year						
Cover etc						
Satellite name						
Name of Organization doing analysis						
Name of Scientist that did or is doing analysis						
Steep Lands						
Well established Forest						
Logged forest						
Substantial regrowth						
Scrub						
Bamboo						
Grassland						
Shifting cultivation (only cropping area)						
Flatland						
Rainfed rice						
Irrigated (state the season)						

Make larger table and add categories if necessary/available

Land and Forest Village Survey Data

Province.....District.....??

Total Population.....Number of Villages.....

Sources of Data.....

(Please include the years for which you have data. Enlarge table if appropriate)

Attribute	Year Unit	Actual				Planned		
		2005	2010	2020	2005	2010	2020	
Population	People							
Land allocation	Sq Km							
Forest allocation	Sq Km							
Total land and forest allocation	Sq Km							
Land use planning	Sq Km							
Logging Concession areas	Sq Km							
Proportion that is forest	Percent							
Conservation Areas	Sq Km							
Proportion that is forest	Percent							
Protection Areas	Sq Km							
Proportion that is forest	Percent							
Production forest	Sq Km							
Timber plantations	Sq Km							

Dams on Tributaries in Sub-Area 1L

Actual and Planned Hydro-power Dams on Mekong Tributaries

River	Project	Actual or Expected Date of Completion	Progress to Date (end of 2003)	Electricity Generation Capacity (MW)	Annual Energy Generation (GWh)	Active Storage Capacity (Mm3)	Mean flow (m3/sec)	Min flow {m3/sec}	Average Generating Cost (USc/kWh)	Expected Electricity Markets
Nam Ko		1970?		1.5						
Nam Dong				1.0						
Nam Long				11	53		4			Lao
Nam Sim				7	24		2.6		4.57	Lao
Nam Pha	Nampha			100/150	350					Lao
Nam Tha	Namtha 3	200		1.25						
	Namtha 1	2001??		230-272		2000				
	Namtha 4A	2015		54	250					
	Namtha 5	2010		100	430					
Nam Beng	Nam Beng	2008		30	175	101	38		5.17	Lao
Nam Ou	Nam Ou 2	2010		630-950		66,100				
Nam Khan	Nam Khan 2	2005??		145		480				
Nam Khan	Nam Khan 3			47	222				3.47	Lao

Data from Diagnostic Study 1997. MIH List of Electric Power Projects, and Power Sector study and Lao Sector studies

Irrigation Expected from Hydro-power Dam Construction on Mekong Tributaries

River	Project	Actual or Expected Date of Completion		Irrigation area in wet season (ha)	Irrigation area in dry season (ha)
Nam Ko		1970?			
Nam Dong					
Nam Long					
Nam Sim					
Nam Pha	Nampha				
Nam Tha	Namtha 3	200			
	Namtha 1	2001??			
	Namtha 4A	2015			
	Namtha 5	2010			
Nam Beng	Nam Beng	2008			
Nam Ou	Nam Ou 2	2010			
Nam Khan	Nam Khan 2	2005??			
Nam Khan	Nam Khan 3				

Other Consequences of Dam Construction on Mekong Tributaries

River	Project	Actual or Expected Date of Completion	Expected lifetime of Dam Structure	Expected lifetime of Reservoir volume	Population whose Houses are sub-merged	Flat agricultural land sub-merged (ha)	Forest area sub-merged	Minimum Dry Season Flow (Mm3)	Mean Percent change in dry season flow +/-	Percent of Fish Migration Hindered
Nam Ko		1970?								
Nam Dong										
Nam Long										
Nam Sim										
Nam Pha	Nampha									
Nam Tha	Namtha 3	200								
	Namtha 1	2001??								
	Namtha 4A	2015								
	Namtha 5	2010								
Nam Beng	Nam Beng	2008								
Nam Ou	Nam Ou 2	2010								
Nam Khan	Nam Khan 2	2005??								
Nam Khan	Nam Khan 3									

Run-of-River Hydro-Power Dams in Sub-Area 1L

Run-of-River Hydropower Proposed in 1994 *Mainstream* in SA1L

	Electricity Generating Capacity MW	Annual Energy Generated (GWh)	Storage Capacity (Mm3)	Population whose Houses are sub-merged	Flat agricultural land sub- merged	Forest area sub- merged	Mean Percent change in dry season flow +/-	Percent of Fish Migration Hindered
Pak Beng	1230 (1000-1,800)							
Luang Phabang	970 (1300-2600)							
Xayabouli	1260 (600-1200)							
Pak Lay	1010 (1200-2,000)							

Run-of-River Hydropower Proposed on *Tributaries* in SA1L

Tributary Name	Province/ District	Electricity Generating Capacity (MW)	Annual Energy Generated (GWh)	Storage Capacity (Mm3)	Population whose Houses are sub-merged	Flat agricultural land sub- merged	Forest area sub- merged	Mean Percent change in dry season flow +/-	Percent of Fish Migration Hindered

Irrigation Cropping Area and Production

Province.....District.....???

Total Population.....Number of Villages.....

Sources of Data.....

(Please include the latest five years for which you have data. Add extra years if data is available) Include details of area for each irrigation type if you have data, otherwise just the total for each season. Max means the area possible in a very good year.

		Area (Hectares)									
		Max	Actual	Max	Actual	Max	Actual	Max	Actual	Max	Actual
Year											
Wet Season Rice	Total Wet season rice										
	gravity fed from weir across stream										
	pumped from stream										
	pumped from pond or small reservoir										
Dry season Rice	Total Dry season rice										
	gravity fed from weir across stream										
	pumped from stream										
	pumped from pond or small reservoir										
Wet season 'Upland Crops'	Total Wet season 'upland crops'										
	wet season Gravity Riverfed										
	wet season – Pumped from stream										
Dry season 'Upland Crops'	Total Dry season 'upland crops'										
	dry season - Gravity fed from stream										
	dry season Pumped from stream										
	dry season Pumped from bore or well										

Make larger table if necessary

Any evidence of sedimentation behind weirs either as mud blanket across the storage area or as courser material at the upstream end?

Irrigation Production

Province.....District.....???

Sources of Data.....

(Please include the latest five years for which you have data. Add extra years if data is available) Include details of production for each irrigation type if you have data, otherwise just the total for each season. *Max* means the production possible in a very good year.

		Production(Unit:.....)									
		Max	Actual	Max	Actual	Max	Actual	Max	Actual	Max	Actual
		Year									
Wet Season Rice	Total Wet season rice										
	gravity fed from weir across stream										
	pumped from stream										
	pumped from pond or small reservoir										
Dry season Rice	Total Dry season rice										
	gravity fed from weir across stream										
	pumped from stream										
	pumped from pond or small reservoir										
Wet season 'Upland Crops'	Total Wet season 'upland crops'										
	wet season Gravity Riverfed										
	wet season – Pumped from stream										
Dry season 'Upland Crops'	Total Dry season 'upland crops'										
	dry season - Gravity fed from stream										
	dry season Pumped from stream										
	dry season Pumped from bore or well										

Irrigation Planning

Province.....District.....???

Way in which plan was written.....

		Area Planned for completion (Unit:.....)		
		2005	2010	2020
Wet Season Rice	Total Wet season rice			
	gravity fed from weir across stream			
	pumped from stream			
	pumped from pond or small reservoir			
Dry season Rice	Total Dry season rice			
	gravity fed from weir across stream			
	pumped from stream			
	pumped from pond or small reservoir			
Wet season ‘Upland Crops’	Total Wet season ‘upland crops’			
	wet season Gravity Riverfed			
	wet season – Pumped from stream			
Dry season ‘Upland Crops’	Total Dry season ‘upland crops’			
	dry season - Gravity fed from stream			
	dry season Pumped from stream			
	dry season Pumped from bore or well			

Non-Area Irrigation Data

Province.....District.....??

Sources of Data.....

(Please include the latest five years for which you have data if possible)

	Year Unit	Past Years					Comment	Planned for Completion by		
								2005	2010	2020
Traditional Weirs	Number									
Concrete weirs	Number									
Irrigation Pumps	Number									
Ponds for Irrigation	Number									
Small reservoirs	Number									
*										
*										
Average Depth of Irrigation in Dry Season	Metres									
Average Depth of Irrigation in Wet Season	Metres									

*** insert any other type of irrigation source**

Note that the depth of irrigation in the wet season is only the amount of water delivered to the fields {calculated by the scheme manager}not including rainfall.

Make larger table if necessary

Fisheries

Wild Fisheries

Fish are the key product of surface water bodies that are used by millions of people at the present time. The concern is with production trends that may be affected by over-fishing, or deterioration in the environment due to introduced species, built structures, reduced water quality, changed flow regimes or substrate changes.

Province.....District.....???

Total Population.....Number of Villages.....

Sources of Data.....

.....

(Please include the latest five years for which you have data. Add extra years if data is available)

	Year						Comment
	Unit						
Wild Fisheries							
Fish production from Streams and lakes including small dams	kilograms						
Main months of catch	Months						
Three main species caught	Species name						
Approximate total stream length that important species of fish can easily pass for their life cycle*	kilometers						
Approximate total stream length that important species of fish cannot easily pass for their life cycle**	kilometers						

Make larger table if necessary

Please comment on habitat degradation.....

.....

.....

***, ** Please total for all streams in province. Give separate figure for each important species if that is significant and known.**

Managed Fisheries

	Year						
	Unit						
<i>Rice fields</i>							
Weight of fingerlings introduced	Kilograms						
Fish harvest	Kilograms						
Main months of harvest	Months						
Three main species caught	Species names						
<i>Dug ponds</i>							
Weight of fingerlings introduced	Kilograms						
Fish harvest	Kilograms						
Main months of harvest	Months						
Three main species raised	Species names						
<i>Reservoirs</i>							
Weight of fingerlings introduced	Kilograms						
Fish harvest	Kilograms						
Main months of harvest	Months						
Three main species raised	Species names						

Rainfed Crops

Rainfed crops are necessarily wet season crops. The area is relevant to IWRP as the cropped area has replaced other land covers/uses and crops and soil 'evapo-transpire' water that otherwise may become stream flow. Crop production is relevant in that it indicates something of the material standard of living and health of the people in the area.

Province..... District.....???

Total Population.....Number of Villages.....

Sources of Data.....

(Please include the latest five years for which you have data. Add extra years if data is available. Add major tree and field (upland/row) crops for which data is available)

	Area Growing / Harvested (ha)					Production (tonnes)				
Year										
Crops										
Teak										
*										
*										
Rainfed Wet Rice										
Sloping-land rice										
Other Major Crops										
Maize (corn)										
Starchy roots										
Peanuts										
^										
^										

* other timber species. ^ major fruit species. Make larger table if necessary

Water Supply

Under this heading is almost all non-agricultural and non-power 'consumptive' use of water

Province.....District.....???

Total Population.....Number of Villages.....

Sources of Data.....

.....

(Please include the latest five years for which you have data)

	Year Unit	Past Years				To be Completed by		
						2005	2010	2020
Clean water	Percent supplied							
Piped Town Water Supply	Number of People using							
	Million Cubic metres							
Piped Business and Industrial	Number of business/ industrial Units							
	Million Cubic metres							
Mining Companies	Number of Mines							
	Million Cubic metres							
Hand pumps	Number of People using							
Bucketed wells	Number of People using							
Gravity Fed Systems	Number of People using							
Springs	Number of People using							
Streams for domestic water	Number of People using							
Ponds for Domestic water	Number of People							

Make larger table/add other categories if necessary

Water Pollution

Mining Discharge

Mining is fairly new in Northern Laos so little is known about mining discharge to streams or groundwater. 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. Sediment is often called tailings and should be properly maintained behind constructed dams, but dams may break. Do Provincial/District staff have any evidence of mining discharge to water bodies?

Province.....District.....???

Total Population.....Number of Villages.....

Sources of Data.....

(Please include years for which you have data even if rough. Indicate how accurate it is.)

Make a separate table for different tributary catchments if relevant)

	Years						Comment
	Units						
Mineral							
Mine Name							
Date mine established							
Any Evidence of Chemical Discharge to water bodies							
Any Evidence of Sediment Discharge to water bodies							
Any remedial action?							

Factory Discharge

Factories for processing or manufacturing are fairly new in Northern Laos so little is known about their discharge to streams or groundwater. Chemical discharge or Waste dumping can effect surface or sub-surface water bodies. Do Provincial/District staff have any evidence from survey or anecdote of factory discharge to water bodies?

Province.....District.....???

Total Population.....Number of Villages.....

Sources of Data.....

.....
 (Please include years for which you have data even if rough. Indicate how accurate it is.)

Type of Factory	Year Established	Catchment	Evidence of Discharge to or dumping in water bodies					Any remedial action?
			Years Units					

Human Waste Discharge

Sewage systems may not be present in Northern Laos but septic tanks and pour flush latrines may be contaminating the groundwater and even surface water bodies directly or by groundwater discharge to the surface water bodies. Pollution may be most likely where a set of latrines serves a large building where many work or live. Do Provincial/District staff have any evidence from survey or anecdote of human waste discharge to or seepage into water bodies? Evidence may be from observed flow from a latrine area, a biochemical test, changed colour or smell of the receiving water body, or ill health of the users.

Province.....District.....???

Total Population.....Number of Villages.....

Sources of Data.....

.....
 (Please include years for which you have data even if rough. Indicate how accurate it is.)

Type of Latrine system	Year Built	Type of water body polluted	Evidence of Discharge to (pollution of) water bodies					Any remedial action?
			Years					
			Units					

Agricultural Chemicals (Pesticide/fertilizer)

Province.....District.....???

Total Population.....Number of Villages.....

Sources of Data.....

.....

(Please include years for which you have data even if rough. Indicate how accurate it is.)

Type of Chemical	Sale Price or Volume of Agricultural Chemicals						Comment
	Year Unit						

Please enlarge table if necessary

Livestock Waste Discharge

Livestock faecal waste is not usually considered a problem except where large livestock congregate in large numbers or are penned for intensive feeding. Such problems may be rare in Northern Laos but it is worth considering the potential problem in order to take preventive action at least. In a few places such as intensive pig raising livestock waste may even now be contaminating the groundwater and thus domestic water supplies and even surface water bodies directly or by groundwater discharge to the surface water bodies. Do Provincial/District staff have any evidence from survey or anecdote of livestock waste discharge to or seepage into water bodies? Evidence may be from a biochemical test, changed colour or smell of the receiving water body, or ill health of the users.

Province.....District.....???

Total Population.....Number of Villages.....

Sources of Data.....

.....
 (Please include years for which you have data even if rough. Indicate how accurate it is.)

Type of Livestock	Type of Stock Concentration	Type of water body polluted	Evidence of Discharge to (pollution of) water bodies					Any remedial action?
			Years					
			Units					

Enlarge table if necessary.

Has any preventive action been taken?.....

.....

Bank Erosion

Province.....District.....???

Total Population.....Number of Villages.....

River/Catchment Name.....

Sources of Data.....

(Please include the years for which you have data, even if very rough. Indicate how accurate it is.)

	Year						Comment
	Unit						
Width	Metres						
Length	Metres						
Concurrent or Preceding events that may be cause							
Length of Protection works undertaken	Metres						

		2005	2010	2020	Comment
Length	Metres				
Budget available	Kip				

Make larger tables if necessary

New or Enlarged Sand Bars and Quarrying

Sand bars may enlarge or emerge due to bank or watershed erosion of sand that is then transported by quick moving streams to be deposited where the stream cross section increases or the gradient decreases and the water velocity slows. This can affect navigation and may temporarily exacerbate flooding.

Province.....District.....???

Total Population.....Number of Villages.....

Sources of Data.....

(Please include the years for which you have data even if very rough. Indicate how accurate it is) Make a separate table for different tributary catchments if relevant

	Year						Comment
	Unit						
Approximate Width of obviously changing sand bars	Metres						
Approximate Length	Metres						
Concurrent or Preceding events that may be cause							
Suspended load	Appearance						
Large visible Mud deposition	Square metres						
Sand and Gravel quarried from Streams	Tonnes						

Make larger table if necessary

Mass Movement: Landslides and Mudflows

Mass movement that can be characterized as landslides, mudslides, rock fall and soil creep are an often forgotten form of sediment movement to streams three of which that can also block them quickly creating a temporary dam and reservoir, perhaps suddenly giving way to create a muddy flood or mud flow that can engulf nearby downstream villages. Landslides come in two types: deep and shallow. Shallow ones are usually due to the action of water on subsoil weakened by the removal of deep rooted vegetation i.e. trees. Deep landslides are due to earthquakes and thus rock and perhaps deep soil failure often in permanently saturated ground, and so occur beneath all types of land cover on slopes. Landslides become mud flows if containing a high proportion of clay, are highly saturated and very poorly cohesive. Mudflows can move many kilometres. Northern Laos is subject to earthquakes but data on landslides and mudflows is poor. We would like to know if provincial/district staff have any knowledge of landslides and mudflows in their area. If you do could you please fill in the table below or make your own table.

Landslides and Mudflows

Province.....

Catchment	District	Type of Mass Movement	Magnitude {km or km ² }	Previous land covers/uses	Date (approx)	Immediately preceding events that may be cause

Navigation 1: Boat Weight/type

Province.....

Sources of Data.....

(Please include years for which you have data even if rough. Indicate how accurate it is.)

Tributary Name or Mainstream	District or Reach	Weight or Type of Boat in Wet Season (Years for which you have data)			Weight or Type of Boat in Dry Season (Years for which you have data)		

Navigation 2

Tributary or Mainstream	District or Reach	Physical Changes such as blasting and quarrying affecting Navigation (Years for which you have data)			Navigation Aids Now	Percent of Lao Boats by Weight (Years for which you have data)		

Navigation 3 (plans or projections)

Tributary or Mainstream	District or Reach	Physical Changes Planned such as blasting affecting Navigation			Navigation Aids Planned (Number of locations)			Projections of Percent of Lao Boats by Weight		
		by 2005	by 2010	by 2020	by 2005	by 2010	by 2020	by 2005	by 2010	by 2020

Flood Survey Data

Province Name.....District??

Sources of Data.....

(Please include the latest five years for which you have data).

	Year							Comment
	Unit							
Flood Area	Square Km							
Approximate Flood Duration	Days							
Flood Depth (average)	Metres							
Damaged area	km ²							
Cost of Crop Damage	Million kip							
Cost of Infrastructure Damage	Million kip							
Total Damage Cost	Million kip							

Make larger table if necessary

Plans for Flood Mitigation

	2005	2010	2020
Estimated Reduced Maximum Flood Area			
Estimated Reduced Maximum Depth of flood			
Financial cost			
Budget that will be available			

Make larger table if necessary

Part E: References

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- MRC State of Basin Report
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