The socio-geography of mining and hydro in Lao PDR

TECHNICAL NOTE - DRAFT

Analysis Combining GIS Information with Socioeconomic Data[1]

Introduction and motivation

1. Lao PDR is a poor landlocked country but it is rich in natural resources. Its mountainous geography gives rise to significant hydropower potential and the country is also rich in mineral deposits, particularly copper and gold. Exploiting these resources is an important dimension of the government's strategy to bring about economic growth and reduce poverty. **In line with government strategy, the pace of development in the hydro and mining sectors is accelerating and these projects are already bringing benefits, including increased revenues from royalties and taxes.**

2. **As well as significant potential benefits, mining and hydro development also implies risks for socioeconomic outcomes and the environment.**[2] This paper does not provide either a full assessment of these risks or benefits, or evidence about the impacts of previous mining and hydro projects. It just aims to analyze the spatial distribution of mining and hydro projects in Lao PDR. This information can then be used alongside other pieces of evidence, some of which are provided in other background papers to this report, in order to understand the ways in which risks and benefits are likely to arise.

3. **In order for policy to successfully maximize the benefits of development for poverty reduction, economic growth, and the environment, while minimizing risks, it is essential to understand the spatial distribution of mining and hydro projects in Lao.** There are several reasons why this is important, including:

    *   In order to assess the potential risks and benefits of a project, it is essential to estimate the number of persons affected. **Because the Lao population is unequally distributed geographically, the location of projects determines the numbers affected by mining and hydro projects.**

    *   The characteristics of the population vary between regions. For example, remote, upland areas tend to have higher poverty rates and a higher proportion of non Lao-Tai groups. **Different groups will be affected differently by mining and hydro projects and the location therefore determines the nature of risks and benefits that are likely to arise.**

    *   Because of the nature of hydropower, other natural resources such as forests tend to be located in areas with high exploitation potential. This can also be the case for mining. These resources have intrinsic values, but are also very important for the Lao economy and the livelihoods of the Lao people, especially the poor. **Understanding how current and planned projects overlap with other natural resources will help to plan developments and design**

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[2] See Fenton et al. (2010), and Gibson and Carlsson Rex (2010).

mitigation strategies with the aim of preserving these resources for current use and future generations.

- **While benefits often accrue mainly at the central level, risks tend to affect those living in the close vicinity of a mine or hydropower project.** Understanding the spatial distribution of projects is therefore central to designing appropriate benefit-sharing mechanisms, and to understanding some of the governance challenges facing natural resources in Lao PDR.

- Hydro and mining projects often overlap with each other or with other development projects, such as agro-business, or with farm land. Overlaps can magnify impacts on the environment and socioeconomic outcomes and imply an opportunity cost: lost income from other potential land uses. **Spatial data is essential to assess the extent of overlaps between mining, hydro and other land use, in order both to plan land use, and to design appropriate mitigation or benefit-sharing measures.**

- **Spatial information will also facilitate monitoring of the progress and impacts of projects** from a variety of perspectives (including revenue management, construction, environmental, social).

4. **Despite its importance, Lao PDR does not currently have a database that combines spatial information on mining and hydro.** The GIS work in this report draws on the most recent data from MEM and WREA to provide the most accurate picture currently available of the scale of mining and hydro in Lao PDR. It also links the geographic data with socioeconomic data from the Population census 2005 and the LECS survey to enhance our understanding of the nature of the populations it will affect. This note will provide a starting point for understanding some of the issues outlined above, and perhaps for development of a database that can be used in the future for integrated spatial land use planning.

5. **This note does not attempt to be comprehensive in estimating the number of people affected, but only to give a snapshot of geographical location and landscape in which future development of hydro and mining projects will take place.** This is a first step for future, more detailed, research.

Description of the data and methodology

6. The data used in this report comes from a variety of sources, the most important being data on the distribution and scale of mining and hydro projects from Ministry of Energy and Mines (MEM) and Water Resources and Environment Administration (WREA), and data on socioeconomic indicators from the 2005 Population Census and the 2002/3 Lao Expenditure and Consumption Survey (LECS). These data sources and the techniques used to estimate indicators such as poverty incidence and travel time are described in Table 1. The data described above is then combined to give estimates regarding the affected populations. For example, the number of affected villages is estimated by calculating the overlap of project areas with village locations. The affected population is then calculated using the village populations from the 2005 census. This information may differ from project-level estimates, as discussed below.

7. Although the data used are the most accurate currently available, it is important to note that the estimates in this paper rely on statistical methods that are, by nature, subject to some margin of error. Because of these technical issues, some of which are explained in more detail below, it is important to note that the results here are suitable for certain uses but not for others:

- **The results are intended to provide a "bigger picture", national-level overview** of the size of land that is likely to be affected by mining and hydropower, of the affected populations, and of their characteristics. Although the results will not be exact, they will give an idea of the magnitude of potential effects and an overview of the whole country that has not, so far, been available. This view will be used to inform higher-level strategic planning, so the margin of error implicit in the techniques is acceptable.

- **However, the results will not be sufficiently reliable to be useful at the project level**, and they are not intended for use at this level. For project-level needs such as compensation for land loss and the design of livelihood restoration programs it is essential to collect highly accurate, up-to-date information on affected populations, for which the data in this report cannot substitute.

Table 1: Data sources and methodology

Location and planning status of hydropower projects	Ministry of Energy and Mines (MEM), Dec 2009	

Inundated area of existing and planned Hydropower projects	MEM, and Water Resource and Environment Administration (WREA), Dec 2009	
Location, extent and status of mining concessions	MEM, Dec 2009	
Numbers of villages and people affected by mining and hydro projects	Obtained by combining information on location and extent of projects with information on village location and population	
Demographic information	Department of Statistics (DoS), Ministry of Planning and Investment (MPI) and Swiss National Centre of Competent in Research North-South (NCCR North-South). Information based on Population and Housing Census 2005.	**Citation:** Messerli et al. (2008)
Ethno-linguistic categories and families	DOS, MPI and NCCR North-South. Information based on Population and Housing Census 2005.	**Citation:** Messerli et al. (2008)
Poverty incidence and poverty density	DOS, MPI and NCCR North-South. Information based on Population and Housing Census 2005 and LECS III (2002/3).	Poverty incidence and density were estimated using small area estimation method combining LECS III and Census 2005 data by Epprecht et al. (2008). **Citation:** Epprecht et al. (2008)
District level accessibility	NCCR North-South. Based on cost-distance algorithms with various inputs data such as roads, topography, rivers etc.	**Citation:** Messerli et al. (2008)
Land cover 2002	Department of Forestry (DoF), Ministry of Agriculture (MAF).	
National Protected Area (NPA)	DOF, MAF	Status in fall 2009

Notes for interpretation of data

8.   **There are certain technical difficulties involved in calculating the impact of mining and hydro which mean that the estimates in this paper can be only an approximation**.

- **GIS information on the size of the reservoir is available for only 42 out of 90 current or planned hydro projects** in Lao and it is possible to analyze the affected population only for these projects.

- **Those living within the inundated areas or reservoirs are not the only households affected by hydropower projects.** Households downstream are often affected by changes in water flow and quality, for example. In order to give an approximation of the potential impacts, this report presents information on populations living within 1hour's walk of the reservoir, but this is a very rough estimate of potential effects.

- In addition to reservoirs already in operation, under construction, in planning or at the feasibility study stage, **MEM has information on 63 projects which currently have no MOU**. Because the status of these projects and the likelihood that they will ultimately be developed is unclear they are excluded from the analysis. But it is important to bear in mind that further potential for hydropower exists and, if exploited, the impacts could be even larger than estimated here.

- Because of the nature of the different sources of data used in the analysis, **care should be taken when interpreting areas of overlap generated using different data sources**. Because the data sources all contain some margin of error, the overlaps may be partly due to the "inaccuracy" of boundary delineation in the datasets used. This applies particularly to the overlay of inundated areas of reservoirs and National Protected Areas (NPA).

- **It is more difficult to estimate the area of land and the numbers affected by mining projects.** The area ultimately exploited is often a small fraction of the concession granted for general survey or exploration. Here we provide a rough estimate of the numbers affected by assuming that the numbers affected by future mining projects will be roughly similar to those affected by current projects that are in the exploitation stage. However, these estimates involve a large degree of inaccuracy and are based on untested assumptions. Further work is needed to better understand the impacts of mining on populations within the concessions.

- Lao PDR also has two petroleum exploration areas, which are not included in the analysis for this report.

Results: Socioeconomic characteristics of populations affected by current and planned hydropower and mining projects in Lao PDR

The estimated socioeconomic characteristics of affected populations are based on the maps presented in the next section. Part A presents information on populations living in the area that will be inundated by planned reservoirs. Part B presents information on populations living not inside the reservoir area itself, but within an hour's walk. Part C presents information on populations living inside mining concessions, plus estimates of the numbers that may be affected if the concessions under general survey or exploration status are eventually exploited. The central results of the analysis are as follows:

- The total inundated area of the hydropower projects for which the size of the reservoir is available will be **3,086 km^2**.

- **293 villages** will be inundated by these projects, affecting a total of around 100,000 people.

- If the projects for which information is unavailable are of a similar size, **around 280,000 people** will eventually need to resettle as a result of hydropower projects.

- **49,000 people** live within one hour's walk of a current or planned reservoir, some of whom be affected by direct effects downstream of the projects, or by indirect effects.

- It is more difficult to estimate the area of land and the numbers affected by mining projects. The eventual area exploited by a mine is usually very small- the results of this work show that it is around 38 km^2 on average. This means that the population physically resettled is usually very small- the estimates indicate that **fewer than 20,000 people** are located within concessions at the exploitation stage, and it is unclear what proportion of these people will need to be resettled.

- However, households who are not directly resettled may nonetheless be affected, either positively or negatively, for example through loss of agricultural land, possible contamination of water sources and soil, or through changes in the local economy, including new jobs. The numbers living in close proximity to a mining concession have not been estimated in the same way as for hydropower, because the difficulties mentioned above make this information particularly difficult to interpret.

- The results indicate that **around 600,000 people** live within mining concessions at the general survey or exploitation stage. Unlike households

located within the inundated area of a reservoir, these people may or may not be affected by the mining projects, depending on a number of factors, including where and how the company prospects for mineral resources.

- A rough estimate (based on the average exploitation area of the projects already under exploitation, and the estimated population density in the concessions in that category) suggests that, of the 600,000 located within general survey or exploration concessions, around **114,000** can be estimated to live in what will eventually become exploitation concessions. However, these estimates involve a large degree of inaccuracy and are based on untested assumptions.

- Further work is needed to better understand the impacts of mining on populations living within and close to mining concessions.

- In addition many mining concessions overlap with current or planned hydropower projects, so some households will be affected by both hydro and mining projects.

- Much of the land that will be affected is forest land, with some agricultural land also affected.

- The households that will be affected by future hydro and mining development are among the poorest households in Lao PDR. They are also disproportionately likely to be illiterate, and to belong to a non Lao-Tai ethnic group.

- The areas targeted are generally remote and lack access to health and education.

- Both mining and hydro projects are targeting increasingly remote and marginal areas over time.

Part A: Villages within the area inundated by hydropower reservoir

Note: The interpretation of all the following tables is affected by the fact that information on the size of the reservoir is available only for 61 of 153 hydropower projects.

Table 2: Overview of hydropower projects and projects for which sizes of reservoirs are available

	Projects	Projects with size of reservoir available	Projects with size of reservoir available (%)
Operational	9	4	44%
Under construction	9	6	67%
In planning	26	13	50%
Feasibility study	46	19	41%
Status unclear	63	19	30%
Total	**153**	**61**	**40%**

Note: Projects denoted "status unclear" are projects for which there is, as yet, no MOU. These projects are excluded from further analysis because it is difficult to judge the likelihood that they will go ahead.

Table 3: Basic socio-economic characteristics of villages within inundated areas for which size of reservoir is available

	No. Villages	Population	Poverty rate	Dependents per 100 non-dependents	Literacy rate
Under construction	31	12,583	41	86	68
In planning	86	27,438	45	88	61
Feasibility study	176	64,941	49	91	58
Total	**293**	**104,962**	**47**	**90**	**60**
National level			34.7	76	73

NB: Poverty rate based on poverty mapping by Epprecht et al, 2008, which is why it does not correspond exactly to the poverty rate based on LECS3 (2002/3) or LECS4 (2007/8) data.

Table 4: Mean travel time, minutes, villages within inundated areas

	District capital	Health centre	School grade 1-5	School grade 1-3
Under construction	66	34	18	207
In planning	240	185	91	87

Feasibility study	242	114	66	29
Status unclear	142	80	89	27

Table 5: National Protected Areas (km²), overlap with reservoirs

	Lao	Tai Thai	Khmuic	Palaungic	Katuic	Bahnaric Khmer	Vietic	Tibeto-Burman	Hmong	Mien
Under construction	43	6	29	0	17	1	0	0	1	0
In planning	9	18	20	0	16	8	1	18	11	0
Feasibility study	13	10	50	3	10	2	4	1	6	0
Total	16	12	40	2	12	3	3	5	7	0
National level	*44.4*	*20.6*	*11.8*	*0.5*	*7.0*	*3.1*	*0.2*	*2.8*	*8.0*	*0.5*

Stage	Km² in NPA
Under construction	109
In planning	200
Feasibility study	136
Status unclear	72
Total	**517**

Table 6: Ethno-linguistic families (%) of populations within inundated areas

	Lao-Tai	Mon-Khmer	Sino-Tibetan	Hmong-Mien
Under construction	34	52	0	14
In planning	35	42	11	12
Feasibility study	26	66	3	5
Total	**27**	**61**	**5**	**7**

Table 7: Ethno-linguistic categories (%) of populations within inundated areas

Table 8: Land cover of inundated areas, by status of hydropower project, km²

	Current Forest	Potential Forest	Other Wooded Area	Agriculture Land	Others	Total
Under construction	347.2	225.6	0.0	23.0	65.1	660.9
In planning	431.6	531.7	0.0	11.3	20.0	994.6
Feasibility study	289.8	517.7	5.1	13.2	67.3	893.1
Total	1068.6	1275.0	5.1	47.5	152.4	2548.6

Table 9: Land cover type of inundated areas, by status of hydropower project, %

	Current Forest	Potential Forest	Other Wooded Area	Agriculture Land	Others
Under construction	52.5	34.1	0.0	3.5	9.9
In planning	43.4	53.5	0.0	1.1	2.0
Feasibility study	32.4	58.0	0.6	1.5	7.5
Total	41.9	50.0	0.2	1.9	6.0
National level	*41.5*	*47.1*	*1.2*	*5.0*	*5.1*

	District capital	Health centre	School grade 1-5	School grade 1-3
Operational	67	44	5	40
Under construction	99	54	9	121
In planning	227	175	94	56
Feasibility study	149	65	40	28

Part B: Villages within approximately 1 hour walk from hydropower reservoirs

Note: The analysis excludes villages located within the inundated area, which are covered in Part A. The travel time estimates used to identify the villages within 1hour's walk are based on an accessibility model which takes topography, rivers and other geographical features into account.

Table 10: Basic socio-economic characteristics of villages within 1 hour walk from a reservoir

	No. Villages	Population	Poverty rate	Dependents per 100 indep	Literacy rate
Operational	30	18'774	28	86	80
Under construction	10	5'805	37	89	71
In planning	84	24'282	47	91	66
Feasibility study	131	63'395	44	87	66
Total	255	112'256	42	88	69
National level			34.7	76	73

Poverty rate based on poverty mapping by Epprecht et al, 2008, which explains why the estimates do not match exactly with estimates based on LECS3 (2002/3) or LECS4 (2007/8) data.

Table 11: Mean travel time in minutes, villages within 1 hour walk from a reservoir

Table 12: Ethno-linguistic families (%) of populations within 1 hour walk of a reservoir

	Lao-Tai	Mon-Khmer	Sino-Tibetan	Hmong-Mien
Operational	48	11	0	41
Under construction	34	51	0	14
In planning	35	40	11	12
Feasibility study	26	65	3	5
Total	32	50	5	13

Table 13: Ethno-linguistic categories (%) of populations within 1 hour walk of a reservoir

	Lao	Tai Thai	Khmuic	Palaungic	Katuic	Bahnaric Khmer	Vietic	Tibeto-Burman	Hmong	Mien
Operational	4	43	10	0	0	0	0	0	39	2
Under construction	23	12	15	0	17	19	0	0	14	0
In planning	5	30	19	1	10	6	4	11	12	0
Feasibility study	20	6	30	4	14	17	1	3	5	0
Total	14	18	23	3	11	13	1	4	13	0
National level	*44.4*	*20.6*	*11.8*	*0.5*	*7.0*	*3.1*	*0.2*	*2.8*	*8.0*	*0.5*

	District capital	Health centre	School grade 1-5
Exploitation	62	43	23
Exploration	68	50	25
General Survey	230	150	81

Part C: Villages within mining concessions, and estimates of villages affected

Table 14: Land, villages and population within current mining concessions and rough estimates of those to be potentially affected

	Projects for which information is available	Total land (km^2) covered by the current stage	Villages in the areas covered	Population in the villages covered
Exploitation	16	600 (38/project)	36	19,082
Exploration	57	11,164 (2,138)	672 (129)	374,748 (71,751)
General Survey	59	17,964 (2,213)	553 (68)	193,622 (23,847)
Total	**132**	**29,728 (4950)**	**1,261 (233)**	**587,452 (114,680)**

Note: Numbers in the brackets indicate very rough approximation of the potential affected areas and populations based on the average land take of the known projects in exploitation stage and the population density of the concessions at general survey and exploration stages.

Table 15: Basic socio-economic characteristics of villages within mining concessions

	Poverty rate	Dependents per 100 indep	Literacy rate
Exploitation	37	72	46
Exploration	31	71	49
General Survey	48	95	31
Total	**39**	**79**	**42**
National level	34.7	76	73

Note: estimates for concessions in exploration or general survey are based on entire concession, under the assumption that this will be roughly representative of villages in the eventual exploitation area. Poverty rate based on poverty mapping by Epprecht et al, 2008, which is why it does not correspond exactly to the poverty rate based on LECS3 (2002/3) or LECS4 (2007/8) data.

Table 16: Travel time, minutes, villages within mining concessions

Note: estimates for concessions in exploration or general survey are based on entire concession, under the assumption that this will be roughly representative of villages in the eventual exploitation area.

Table 17: National Protected Areas (km²), overlap with mining concessions

Stage	Km^2 in NPA
Exploitation	34
Exploration	216 (41)
General survey	1,478 (182)
Total	**1,728 (823)**

Note: Numbers in the brackets indicate very rough approximation of the potential affected areas based on the assumption that on average the percentage of concession land that overlaps with NPA will equal the percentage in the eventual exploitation area, and using the size of the exploitation area estimated in Table 14.

Table 18: Ethnic families (%) of populations within mining concessions

	Lao-Tai	Mon-Khmer	Sino-Tibetan	Hmong-Mien
Exploitation	75.4	20.7	1.4	5.0
Exploration	76.0	17.4	0.7	8.1
General Survey	45.2	35.7	3.5	15.7
Total	65.9	23.6	1.6	10.5

Note: estimates for concessions in exploration or general survey are based on entire concession, under the assumption that this will be roughly representative of villages in the eventual exploitation area.

Table 19: Ethno-linguistic categories (%) of populations within mining concessions

	Lao	Tai Thai	Khmuic	Palaungic	Katuic	Bahnaric Khmer	Vietic	Tibeto-Burman	Hmong	Mien
Exploitation	56.1	19.3	7.0	0.0	6.8	4.5	0.0	1.3	5.0	0.0
Exploration	46.2	29.9	5.8	0.3	5.5	3.6	0.1	0.5	7.7	0.4
General Survey	16.0	29.3	13.4	0.1	8.9	13.3	0.2	3.3	15.0	0.6
Total	36.5	29.3	8.4	0.2	6.6	6.8	0.1	1.5	10.0	0.4
National level	*44.4*	*20.6*	*11.8*	*0.5*	*7.0*	*3.1*	*0.2*	*2.8*	*8.0*	*0.5*

Note: estimates for concessions in exploration or general survey are based on entire concession, under the assumption that this will be roughly representative of villages in the eventual exploitation area.

Table 20: Land cover type by status of mining concession, km²

	Current forest	Potential forest	Other wooded Area	Agriculture land	Others	Total
Exploitation	198	236	3	72	91	600
Exploration	3919	4888	111	1444	802	11164
General Survey	8616	7996	174	481	697	17964
Total	12733	13121	288	1996	1590	29728

Table 21: Land cover type by status of mining concession, %

	Current forest	Potential forest	Other wooded Area	Agriculture land	Others	Total
Exploitation	33	39.3	0.5	12.1	15.1	100
Exploration	35.1	43.8	1	12.9	7.2	100
General Survey	48	44.5	1	2.7	3.8	100
Total	42.8	44.1	1	6.7	5.3	100
National Level	*41.5*	*47.1*	*1.2*	*5.0*	*5.1*	*100*

Results: Maps

The maps presented below describe the scale and distribution of mining and hydro in Lao PDR. Figure 1-Figure 3 show the distribution of projects and any overlap between them. Figure 4- Figure 8 overlay the location and size of reservoirs with information on village locations, population density, poverty incidence, the location of National Protected Areas and land cover. Figure 9- Figure 13 do the same for mines, and also display the location of important known mineral deposits and the DGEO mineral preservation zones, which are areas where future exploitation is particularly likely to occur.

Figure 1: Map of dam sites in Lao PDR, operational, under construction, in planning, feasibility study
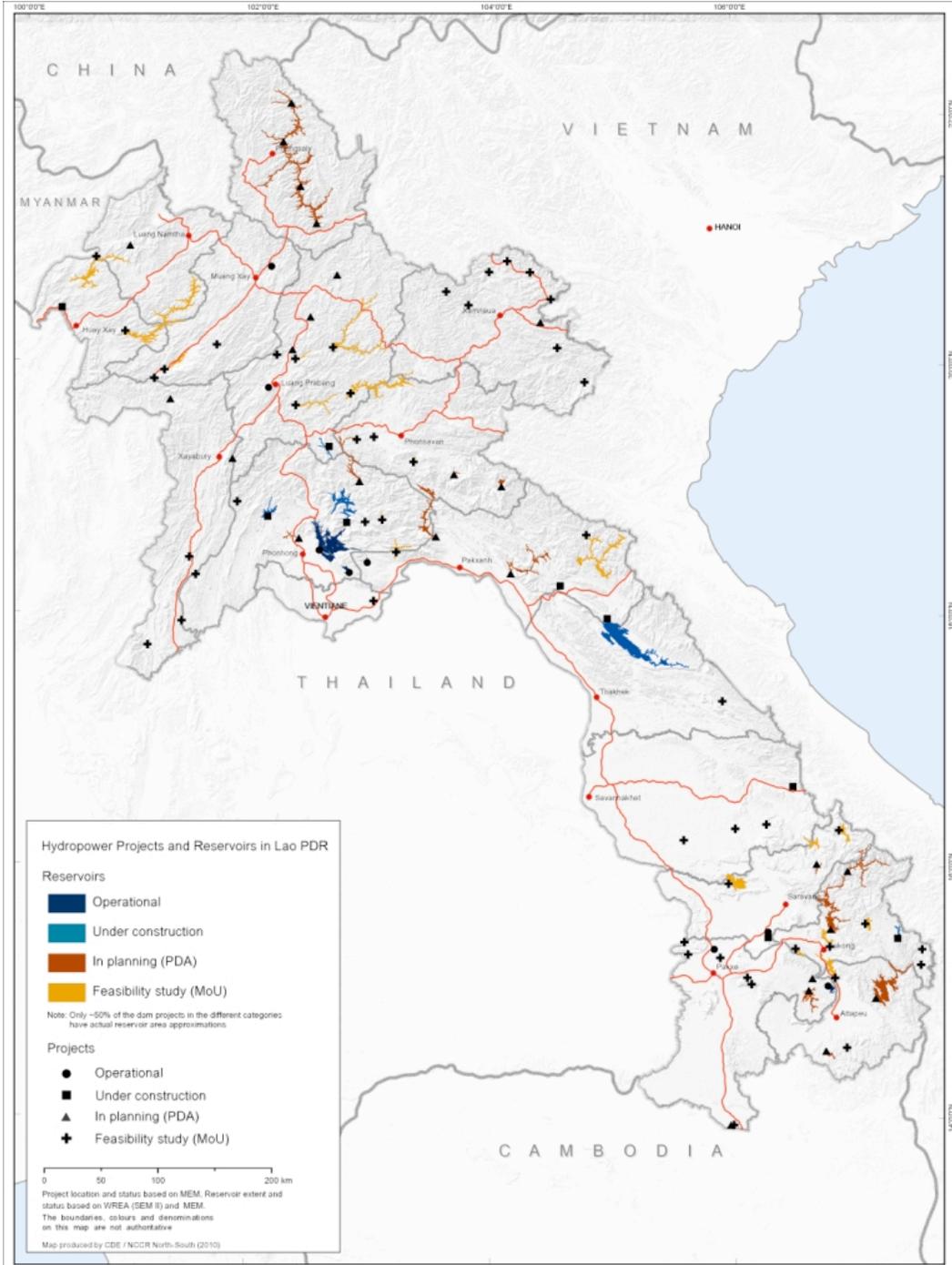
Figure 2: Map of mining concessions in Lao PDR, general survey, exploration, exploitation and petroleum exploration
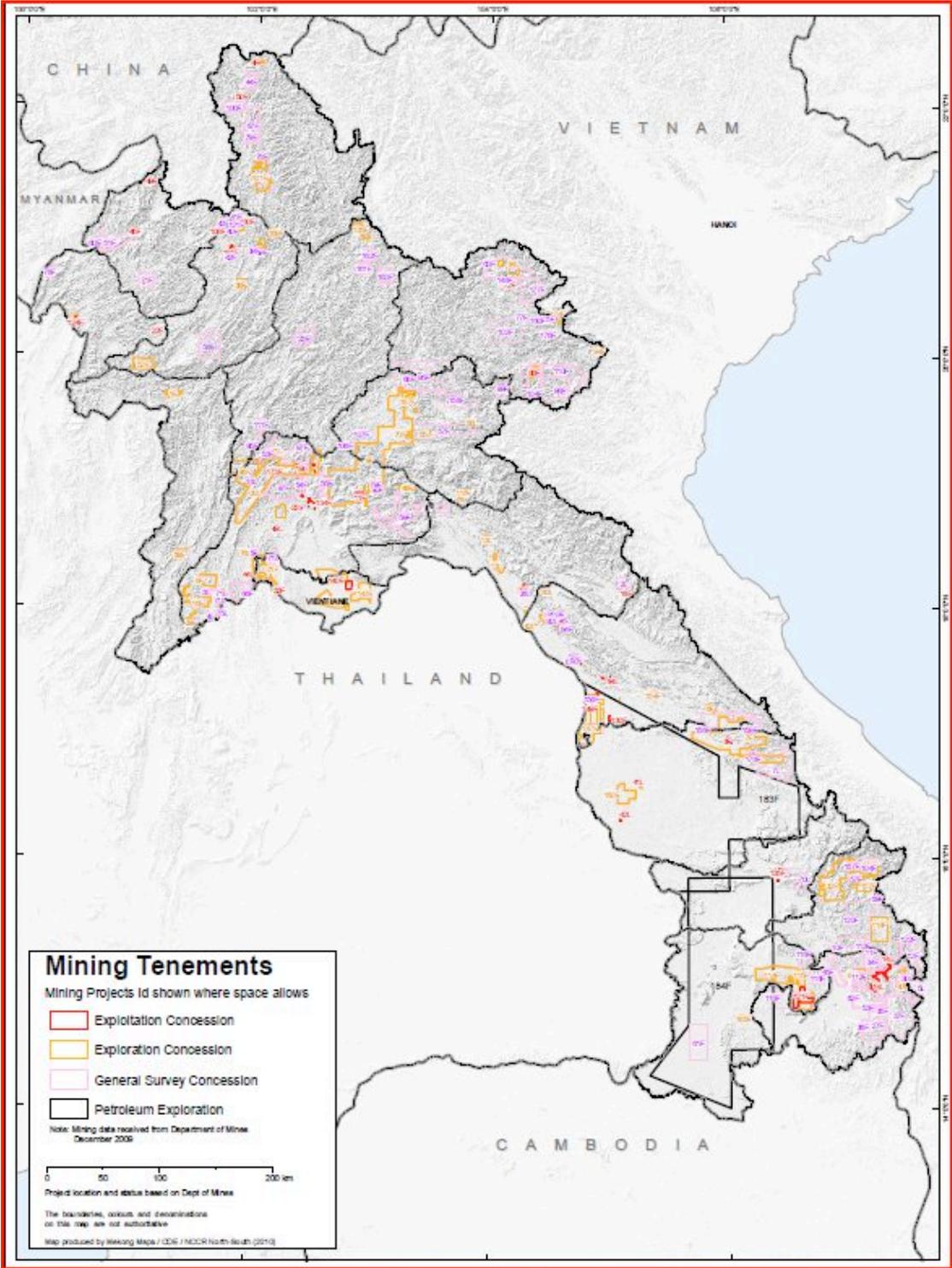
Figure 3: Map of mining and hydropower sites in Lao PDR, by stage
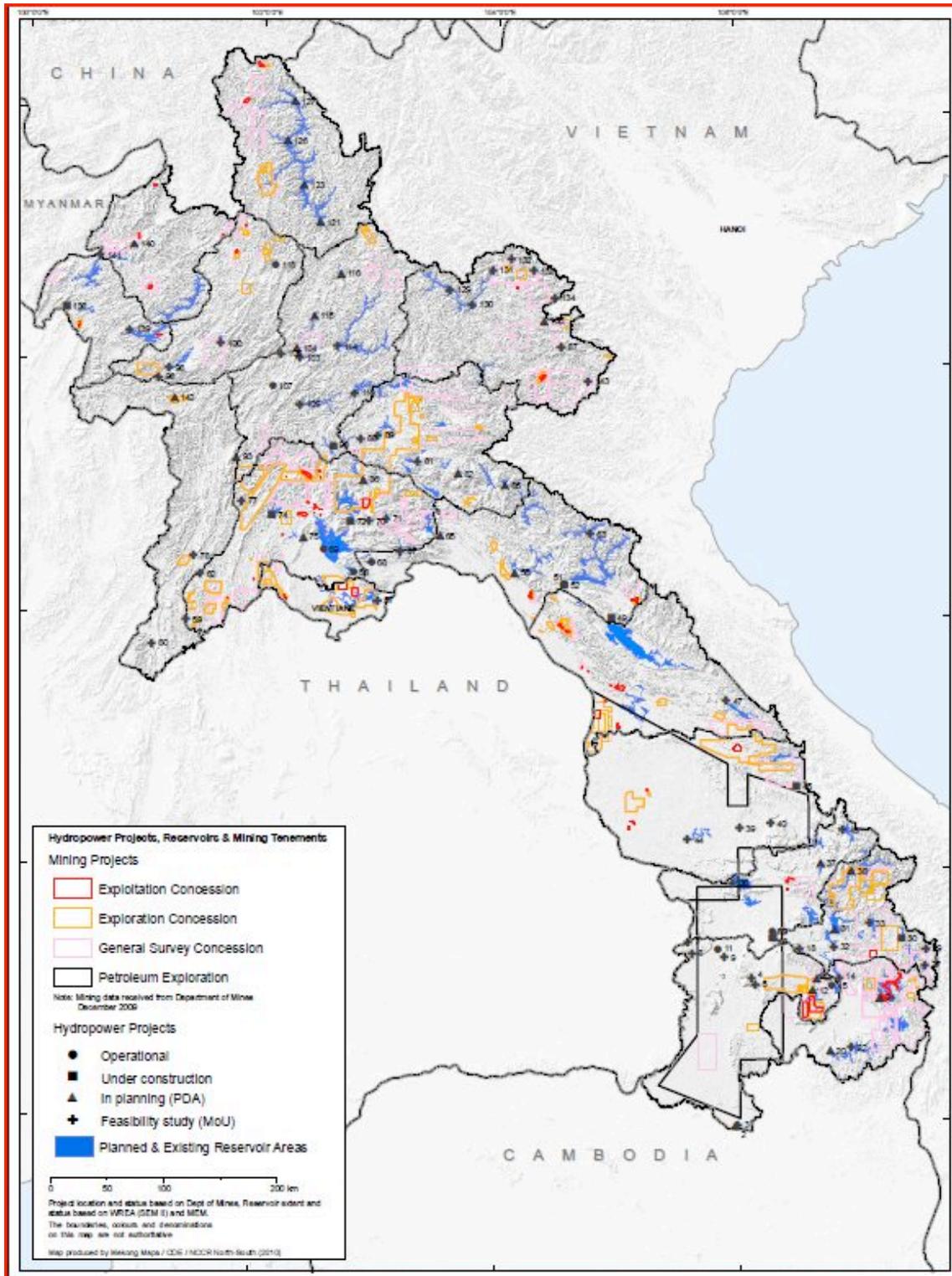
Figure 4: Map of current and planned hydropower plants, size of reservoirs and overlap with villages
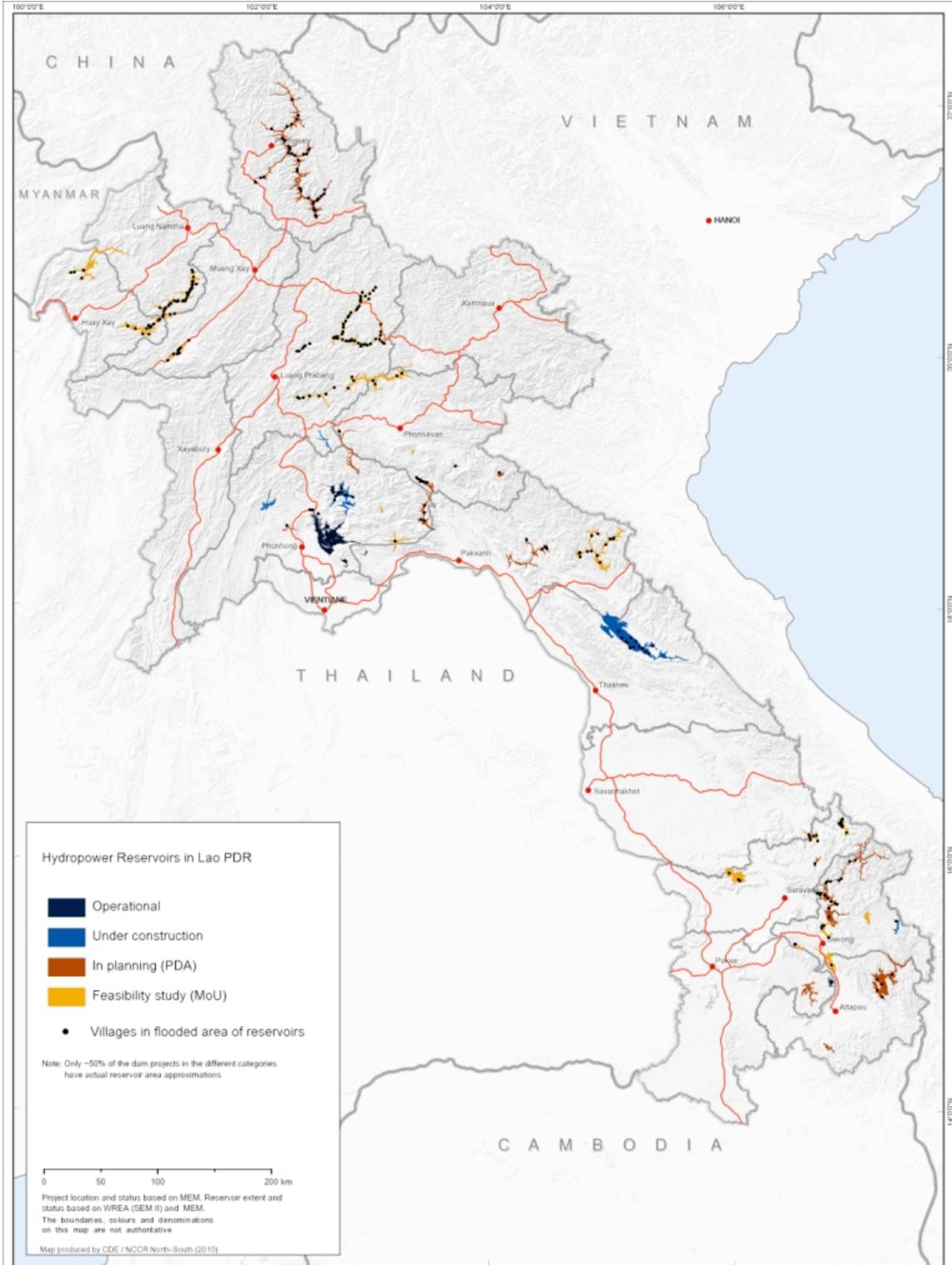
**Figure 5: Map of current and planned hydropower plants and population density**
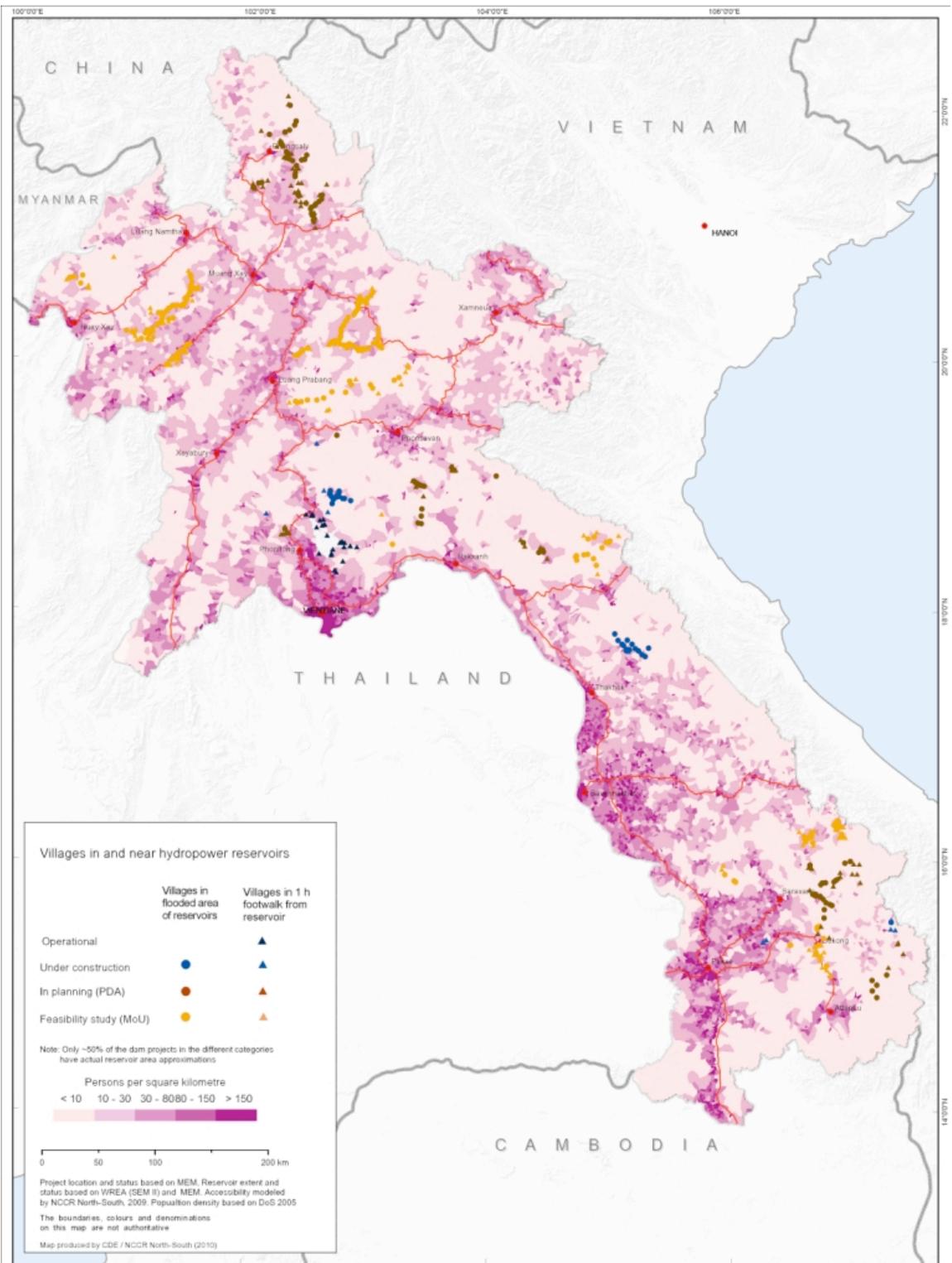
# Figure 6: Map of current and planned hydropower plants and poverty incidence
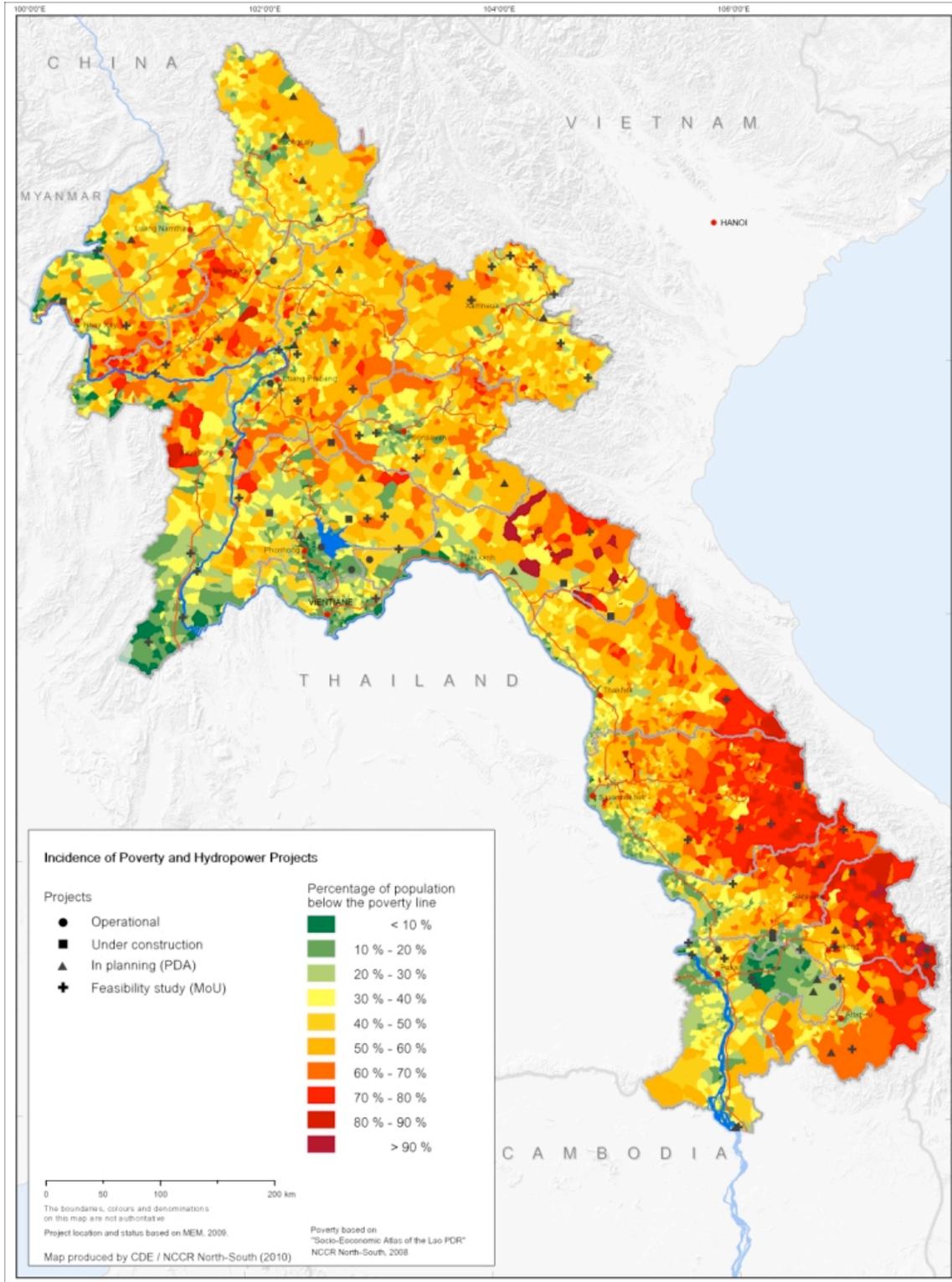
Figure 7: Map of current and planned hydropower plants and National Protected Areas
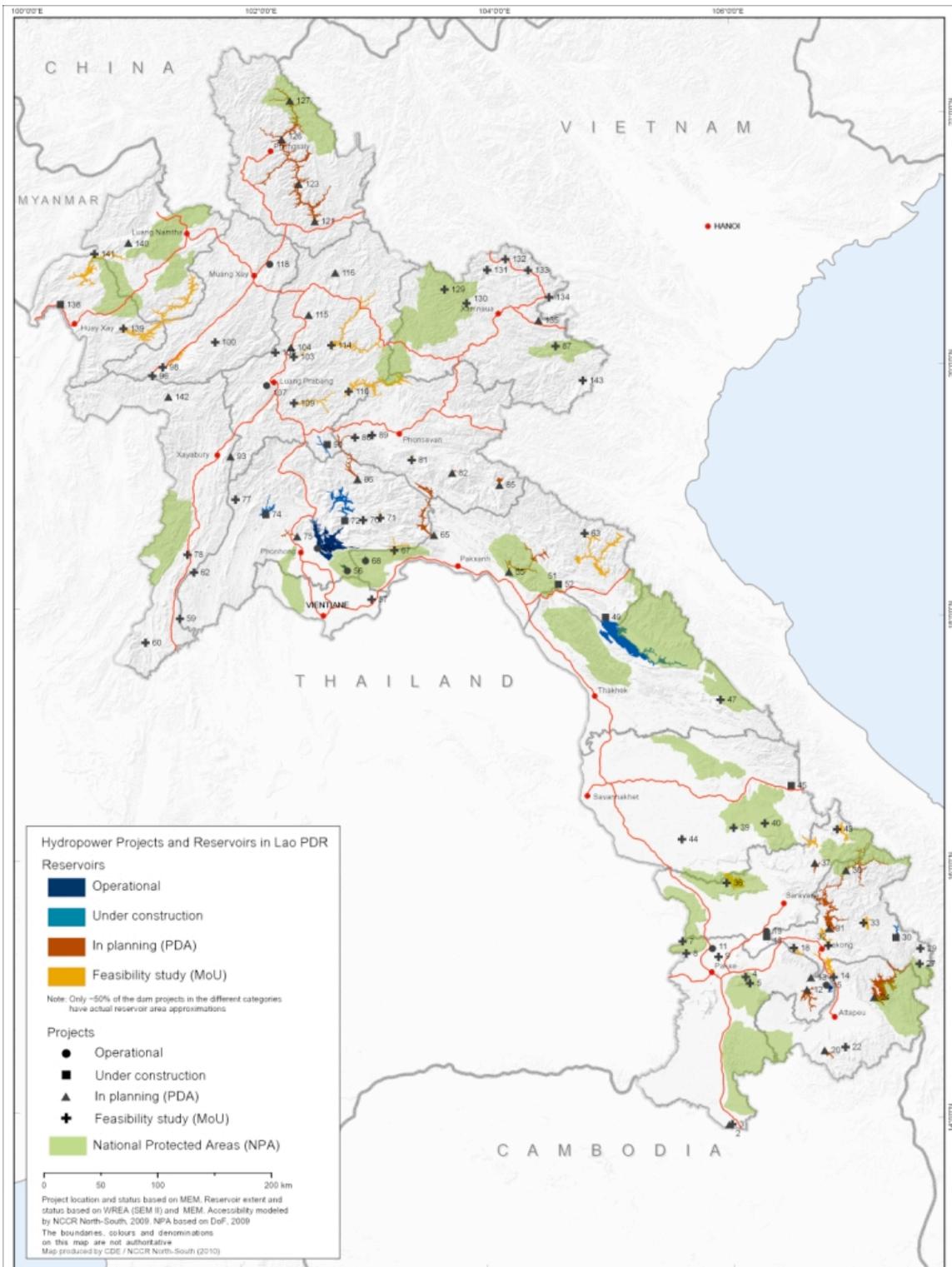
**Figure 8: Map of current and planned hydropower plants and land cover**

Land and Forest Cover Map 2002 and Hydropower Projects

Projects
- ● Operational
- ■ Under construction
- ▲ In planning (PDA)
- ✛ Feasibility study (MoU)

Land and Forest Cover
- Forest
- Unstocked Forest
- Scrub
- Ray
- Other agriculture lands
- Rice Paddy
- Other

0   50   100   200 km
The boundaries, colours and denominations
on this map are not authoritative
Hydropower project location and status based on MEM, 2009.   Land cover based on MAF, 2002

Map produced by CDE / NCCR North-South (2010)

Figure 9: Map of mining concessions and land cover

Mining Tenements &
Land Cover 2002

☐ Mining Concessions

Note: Mining data received from Department of Mines
December 2009

Land and Forest Cover Map 2002
- Forest
- Unstocked Forest
- Scrub
- Ray
- Other agriculture lands
- Rice Paddy
- Other

0   50   100   200 km

Project location and status based on Dept of Mines

The boundaries, colours and denominations
on this map are not authoritative

Map produced by Mekong Maps / CDE / NCCR North-South (2010)

Figure 10: Map of mining concessions, DGEO preservation areas and zones of metallic mineralization
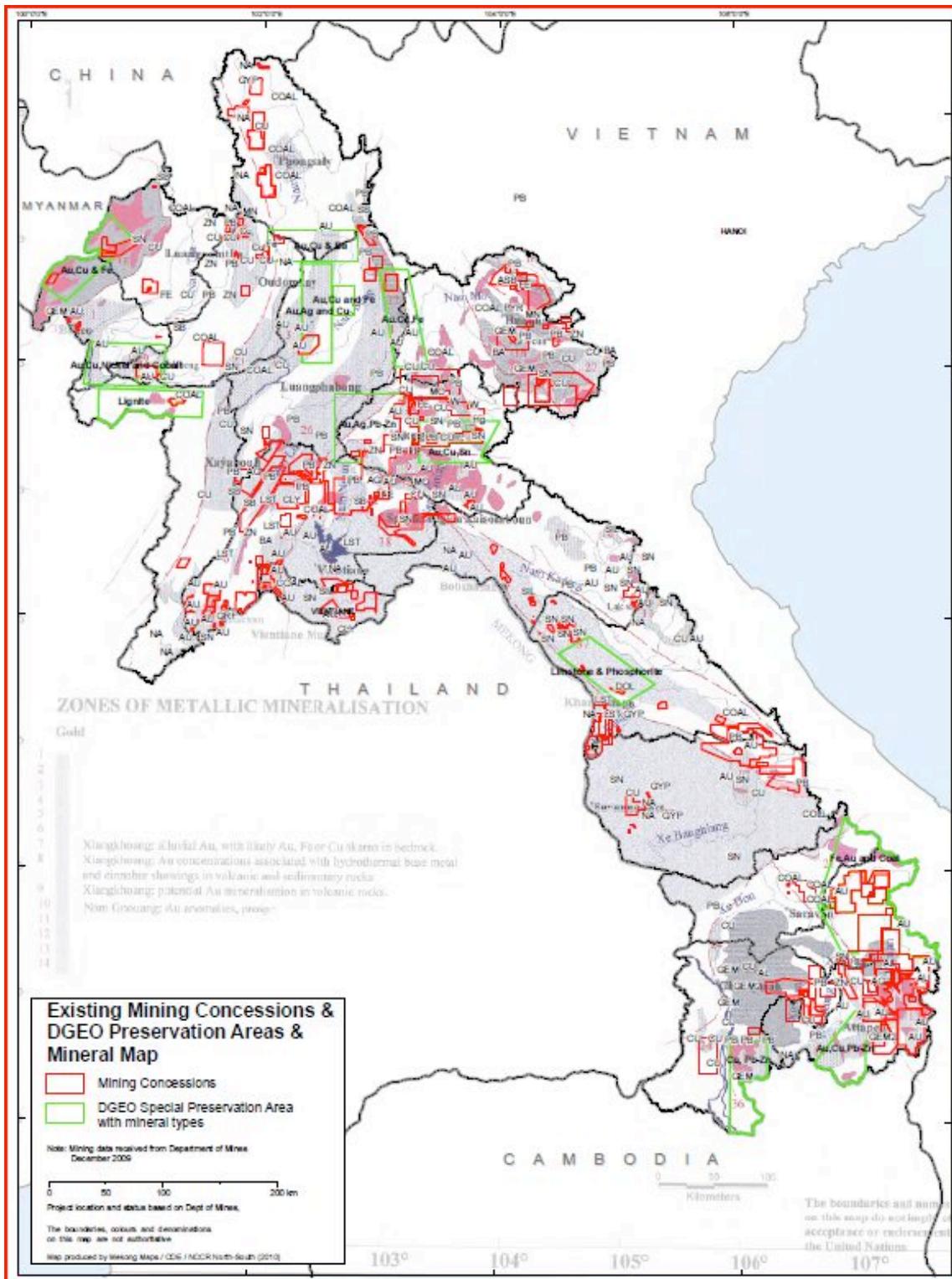
**Figure 11: Map of mining concessions and poverty incidence**
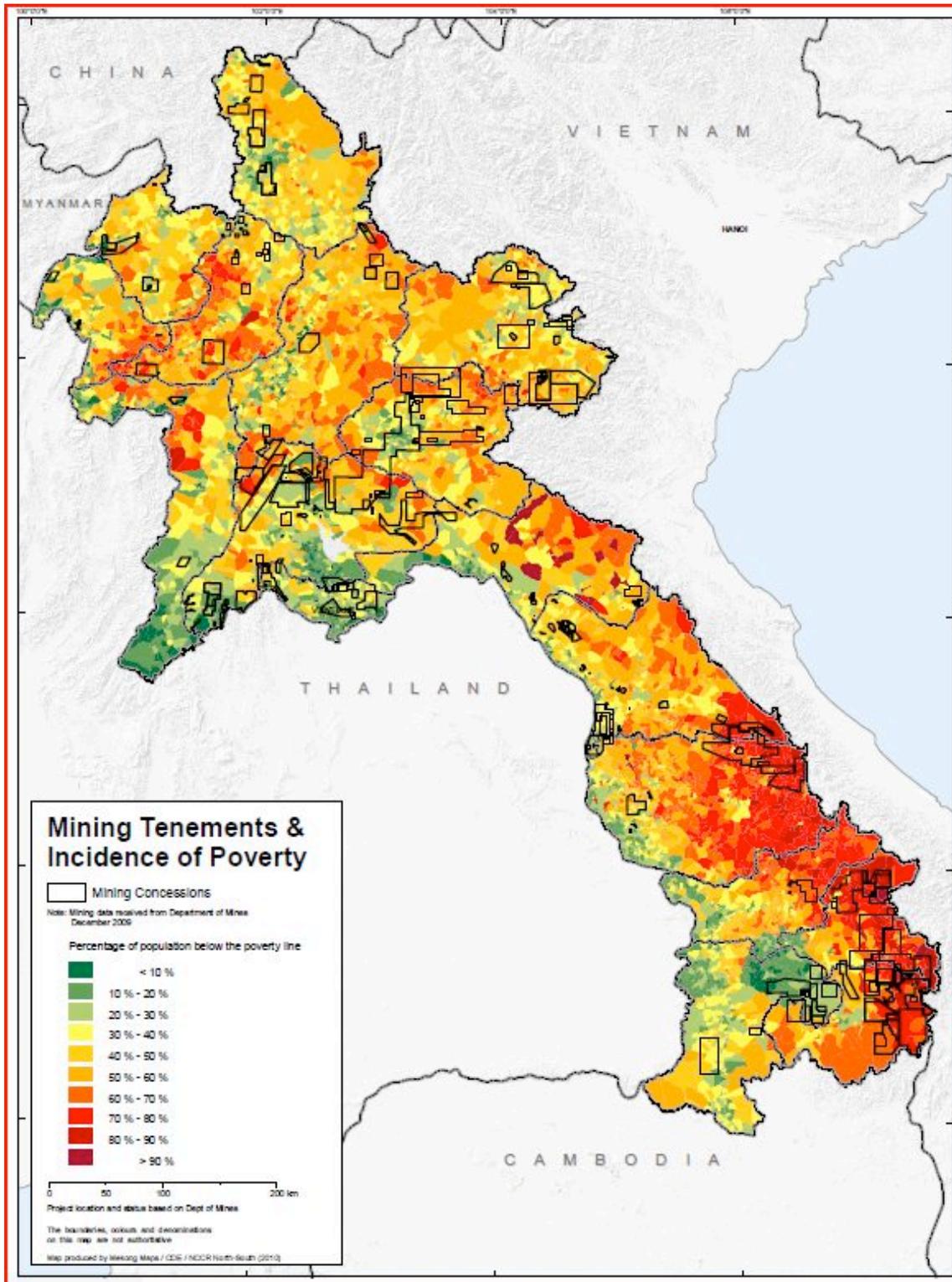
**Figure 12: Map of mining concessions and National Protected Areas**
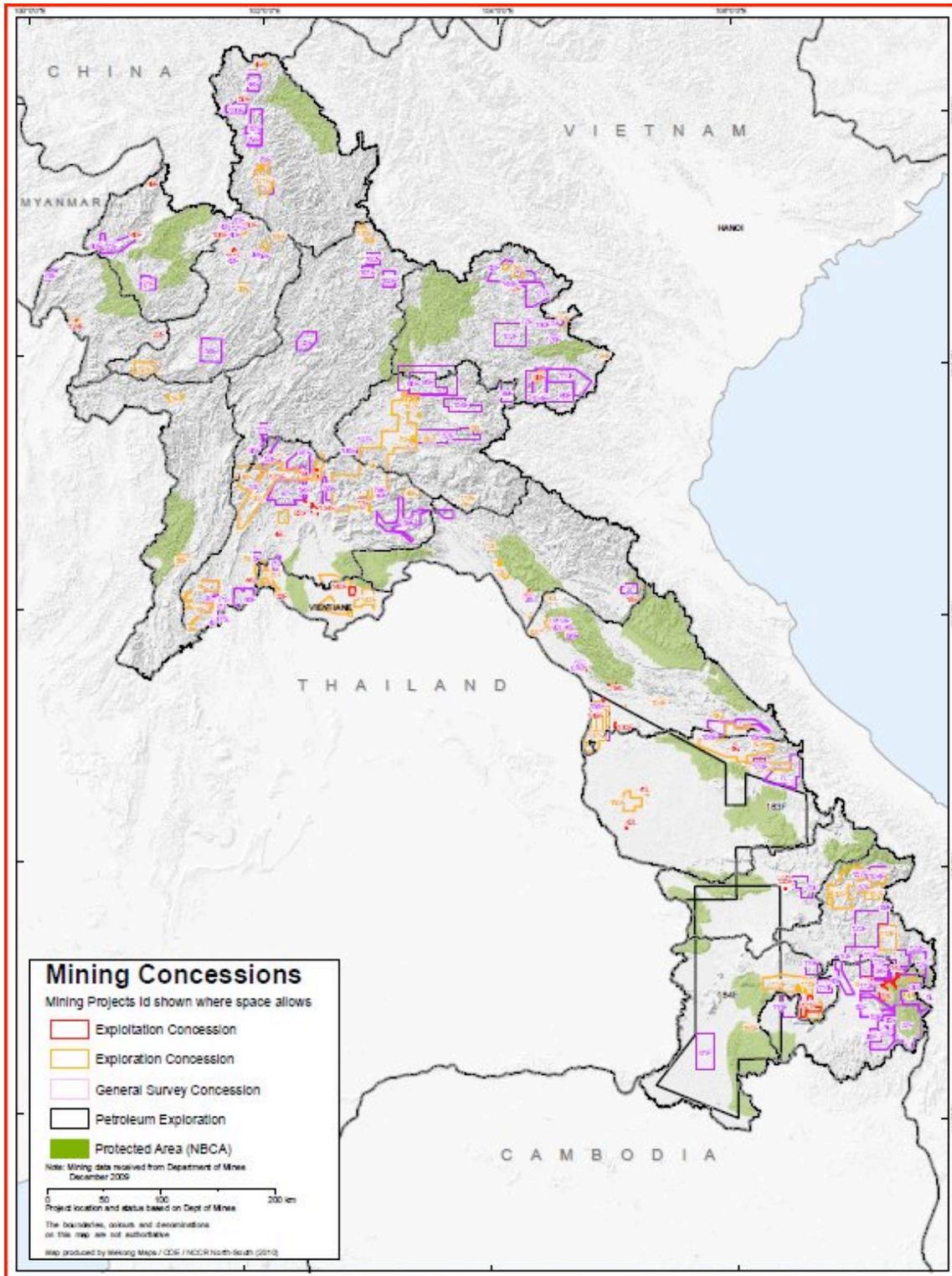
Figure 13: Map of military mining concessions, National Protected Areas and DGEO special preservation areas
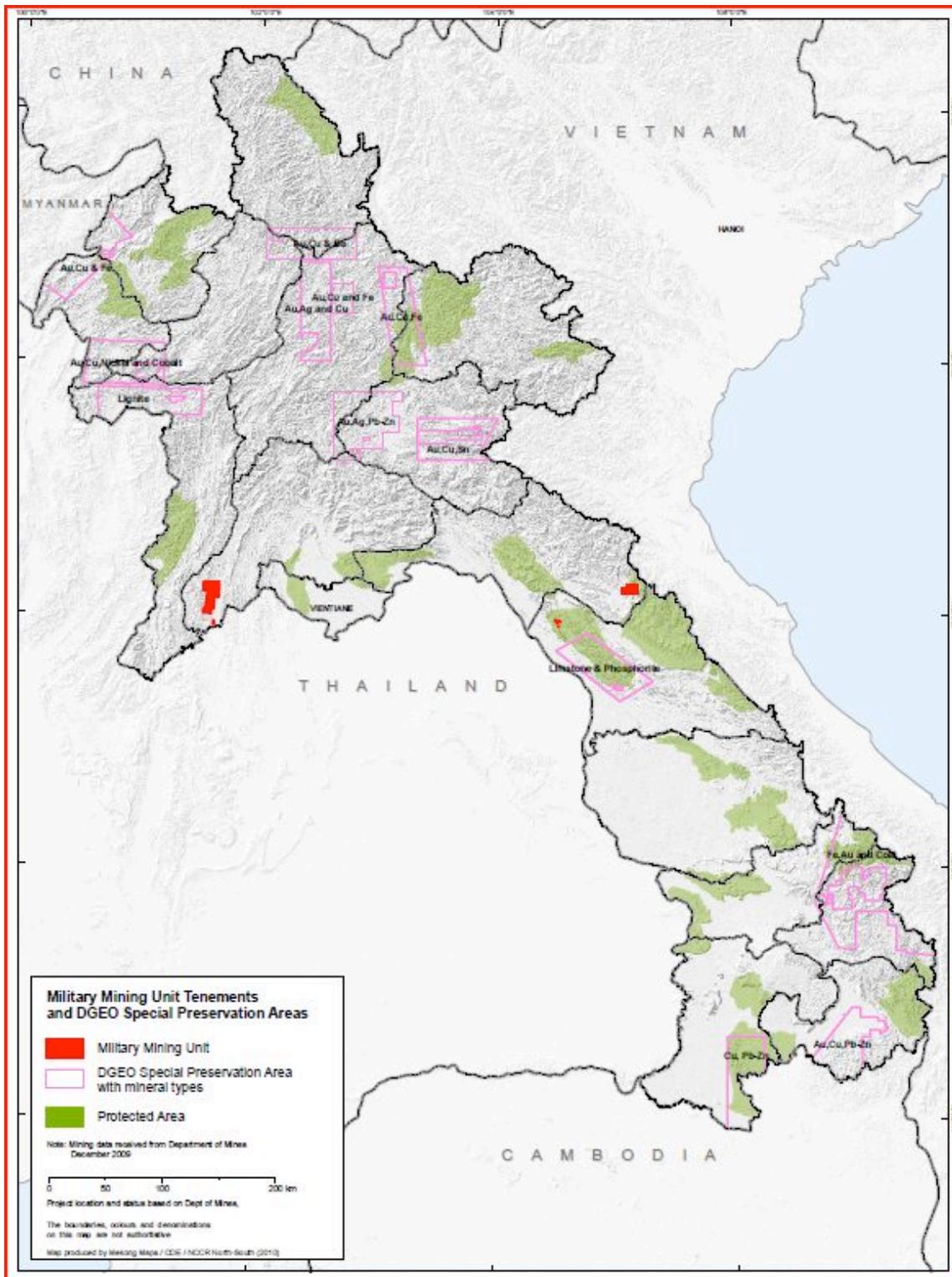
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