

**SECOND NORTHERN MOUNTAINS POVERTY REDUCTION PROJECT**

**DISASTER RISK ASSESSMENT FOR THE  
NORTHERN MOUNTAINS PROVINCES**

**Report for the World Bank  
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The northern mountains provinces including Dien Bien, Hoa Binh, Lao Cai, Lai Chau, Son La, and Yen Bai are the provinces that have complicated natural and topographical conditions and thus are prone to natural disasters. The provinces are among the Vietnam's poorest provinces (Vietnam Development Report 2008). Damage caused by natural disasters has undermined numerous development achievements of these provinces, preventing people from escaping from vicious circle of poverty. Thus, it is necessary to assess disaster risks in the six provinces in order to establish crucial information for poverty reduction projects as well as development projects.

## **Dien Bien Province**

### **Geographical Location**

Dien Bien is a mountainous province in the North-West of Vietnam, bordering Lai Chau to the North, Son La to the East and the North-East, Yunnan Province of China to the North-West, and Lao People's Democratic Republic to the West and South-West.

### **Topographical Features**

Dien Bien has complicated topography with more than 90% of the area are high mountains of 25<sup>0</sup> slope alternating with narrow and sloping valleys and streams. The province is located in the upstream area of three main river systems: Da River, Ma River, and Mekong River with over 10,000 rivers and streams that have more than 1 km length. There is Muong Thanh valley with plane surface forming the Muong Thanh extensive field.

### **Climate**

Dien Bien has mountainous tropical monsoon climate with quite cold and dry winter, hot and rainy summer together with irregular and diversified features. The climate is influenced little by typhoon but by dry and hot wind with the annual temperature of 21-23<sup>0</sup>C, the rainfall of 1,700-2,500mm, and the humidity of 83-85<sup>0</sup> averagely.

Due to extensive natural area and faulted topography, the climate here can be divided into 3 distinctive climatic sub-regions: Muong Nhe, Muong Lay and Son La Plateau and Ma River upstream.

### **Administration and Population**

Dien Bien province includes Dien Bien Phu city, Muong Lay town and 7 districts: Muong Thanh, Dien Bien Dong, Muong Ang, Muong Cha, Muong Nhe, Tua Chua, and Tuan Giao. The total natural area of Dien Bien is 9,562.9 sq.km with the population of 499,899 (Provincial People's Committee, 2008), and the population density of 46 people per sq km. There are several ethnic groups living in this province such as Thai, H'Mong, Kinh, Dao, Tay, Ha Nhi, Lao, Cong, Si La.

## Land use

**Table. 1: Ratio of Land-use in Dien Bien province**

No.	Type of Land	Area (ha)	Percentage
1	Agricultural land	108,158 ha	11.32%
2	Forestry land	309,765 ha	32.42%
	Forest cover rate		37%
3	Specialized land	6,053 ha	0.68%
4	Residential land	3,064 ha	0.28%
5	Untapped land	528,370 ha	55.3%
	<i>Total</i>	<i>956,290 ha</i>	<i>100%</i>

*Source: Provincial People' Committee, Ministry of Planning and Investment, 2008*

## Disaster

Disasters in Dien Bien consist of flash flood, landslide, whirlwind, hailstone and earthquake

**Table. 2: Statistics of remarkable damage caused by disaster in Dien Bien in recent years**

	Damage	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Typhoon	Human										
	House and construction works										
	Land (ha)*										
	Economy (Mil. VND)										
Flood	Human										
	House and construction works										
	Land (ha)										
	Economy (Mil. VND)										
Flash flood, landslide	Human				17	6	1		3		1
	House and construction works				1134	393	920		-		21
	Land (ha)				1025	453	251		439		214
	Economy (Mil. VND)				5154	1083	900		-		1726
					7	3					0
Whirlwind	Human		41								
	House and construction works		24				940				
	Land (ha)		15				6600				

	Economy (Mil. VND)	2100	3600
Earthquake	Human	-	
	House and construction works	2120	1
	Land (ha)	-	
	Economy (Mil. VND)	-	

(\*): Area of land for agriculture and aquaculture

*Source: Provincial People' Committee and NDMP, 2008*

## Hoa Binh Province

### Geographical Location

Hoa Binh is a North-Western mountainous province, bordered by Phu Tho province in the North, by Ha Nam province and Ninh Binh province in the South, by Hanoi in the East, and by Son La and Thanh Hoa provinces in the West.

### Topographical Features

Hoa Binh has complexly divided topography with high mountains but no extensive field which exist in Lai Chau and Son La. It is greatly sloping in the Northern West - Southern East direction and divided in to 2 obvious regions:

- High mountain region (in the Northwest) with the mean altitude of 600-700m, and mean slope of 30-35<sup>0</sup> and 40<sup>0</sup> in some places. The topography here is full of obstacles and difficult of access. This region has an area of 2,127.4 sq km making up 46% of the whole province's area.
- Midland region (in the Southeast) with the mean altitude of 100-200m, and mean slope of 20-25<sup>0</sup>. The topography includes low mountain ranges and is divided very little. The area of this region is 2,535.1 sq km which accounts for 54% of the whole province's natural area.

Hoa Binh has relatively dense and even system of rivers and streams distributed in all of its districts. The biggest river running through the province is Da River, which has 15,000 sq km basin with 151 sq km flowing across some districts such as Mai Chau, Da Bac, Tan Lac, Ky Son, and Hoa Binh city. Hoa Binh hydroelectric dam separates Da River forming a big reservoir with the area of about 10,000 ha, and the capacity of 9.5 billion m<sup>3</sup>. Boi River which originates from Thuong Tien Commune, Tan Lac district is 55 km long. Bui River which rises from Lam Son commune-Luong Son district spreads 32 km. And Lang River takes it source from Bao Hieu commune-Yen Thuy district with the length of 30 km.

## Climate

Climate in Hoa Binh is humid and hot with much rain seasonally, the average temperature is 22.9<sup>0</sup>C-25<sup>0</sup>C. The highest temperature is recorded in June, July, and August at average of 27<sup>0</sup>C-29<sup>0</sup>C, and the lowest temperature is reported in January and February in the range of 15.5-16.5<sup>0</sup>C. The annual rainfall is 1,500mm – 2,200mm and rainy season is from April to September.

## Administration and Population

Hoa Binh province comprises Hoa Binh city and 10 districts: Luong Son, Cao Phong, Da Bac, Kim Boi, Ky Son, Lac Son, Lac Thu, Mai Chau, Tan Lac, Yen Thuy, and Hang Tram. The province area is 4,662.5 sq km with the population of 803,300 and population density of 172 people per sq km. The ethnic groups living here include Muong, Kinh, Thai, Tay, Dao, Mong.

## Land use

**Table 3: Ratio of Land-use in Hoa Binh**

No.	Type of Land	Area (ha)	Percentage
1	Agricultural land	66,759 ha	14.32%
2	Forestry land	194,308 ha	41.67%
3	Specialized land	27,364 ha	5.87%
4	Residential land	5,807 ha	1.25%
5	Untapped land	172,015 ha	36.89%
	<i>Total</i>	<i>466,252.86 ha</i>	<i>100%</i>

*Source: Provincial People's Committee, Ministry of Planning and Investment, 2008.*

## Disaster

Disasters in Hoa Binh consist of flash flood, flood (Hung Thi and Mai Chau districts), hailstone, whirlwind (from June to September annually), drought, hoarfrost.

**Table 4: Statistics of damage caused by remarkable disaster in Hoa Binh in recent years**

	Damage	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Typhoon	Human									3	
	House and construction works									50	
	Land (ha)*									2,417	
	Economy (Mil. VND)									-	
Flood	Human		-					-	2	14	5
	House and construction works		10					65	-	1,954	1,138
	Land (ha)		648					261	400	210	246



isolated mountain ranges and valleys. Mountainous topography together with sub-climate creates a diversified natural environment.

The main provincial river system consists of Red River originating from Yunnan province of China, passing 120 km through Yen Bai province, and Chay River rising from Tay Con Linh mountainous region (China) running 124 km across the province.

### **Climate**

Lao Cai has tropical monsoon climate due to complex topography and great stratification of the altitude, thus there exists the alternation of subtropical sub-regions and temperate sub-regions. The annual mean temperature is 22 – 24<sup>0</sup>C; highest at 36<sup>0</sup>C, and lowest at 10<sup>0</sup>C (0<sup>0</sup>C in some places such as Sa Pa); the annual mean humidity is over 80%, the highest level is 90% and lowest one is 75%. There is difference in humidity among regions: the high regions are more humid than the low ones. The annual average rainfall is over 1,700 mm, reaching the highest level in Sapa at 3,400 mm, and the lowest level in Lao Cai city at 1,320 mm. Mist occurs regularly in the whole province, and densely in some particular place. Hoarfrost appears in the very cold periods. In the region having altitude more than 1,000 m (Sa Pa, Bat Xat) snow falls annually.

### **Administration and Population**

Lao Cai consists of Lao Cai City and 8 districts: Bao Thang, Bao Yen, Bat Xat, Bac Ha, Muong Khuong, Sa Pa, Si Ma Cai, Van Ban. The natural area of the whole province is 8,057.08 sq km with the population of 593,600 (2007), and the population density of 89 people per sq km. The ethnic groups living in Lao Cai include Kinh, H'Mong, Tay, Dao, Thai.

### **Land-use**

*Table. 5: Ratio of Land-use in Lao Cai province*

No.	Type of Land	Area (ha)	Percentage
1	Agricultural land	76,203 ha	9.57%
2	Forestry land	178,192 ha	22.11%
3	Specialized land	150,113 ha	18.63%
4	Residential land	7,100 ha	0.9%
5	Untapped land	393,500 ha	48.83%
	<i>Total</i>	<i>805,708 ha</i>	<i>100%</i>

*Source: Provincial People' Committee, Ministry of Planning and Investment, 2008.*

### **Disaster:**

Disasters in Lao Cai consist of flash flood, flood, landslide, whirlwind, drought, forest fire, hoarfrost, damaging cold.

*Table. 6: Statistics of remarkable damage caused by disaster in Lao Cai in recent years*

	Damage	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Typhoon	Human										1
	House and construction works										35
	Land (ha)*										-
	Economy (Mil. VND)										-
Flood	Human			4				3	4		
	House and construction works			1,033				3	12		
	Land (ha)			1,247				7	558		
	Economy (Mil. VND)			35,500				2,000	20,000		
Flash flood, landslide	Human		20		8	3	23	7		14	79
	House and construction works		60		446	61	3	1		55	2,902
	Land (ha)		457		1,537	122	3	-		-	6,027
	Economy (Mil. VND)		24,100		25,000	8,000	680	-		5,000	879
Whirlwind	Human		1				2				2
	House and construction works		74				615				-
	Land (ha)		51				3				-
	Economy (Mil. VND)		1,000				500				-
Damaging cold	Livestock										19,471
	Land (ha)										-
	Economy (Mil. VND)										145

(\*): Area of land for agriculture and aquaculture

## Lai Chau Province

### Geographical Location

Lai Chau is a Northwestern mountainous province in Vietnam. It borders Yunnan province of China to the north, Dien Bien province to the West and South-West, Lao Cai province to the East, Yen Bai province to the South-East, and Son La province to the South.

## Topographical Features

Lai Chau has high mountainous topography. Its land, in which 60% is over 1,000m high, and 90% is over 25<sup>0</sup> sloping, is profusely divided by mountain ranges running along the direction of Northern West - Southern East. There are high and sloping mountains and hills alternated by narrow and deep valleys, and also many plateaus, rivers, and streams. The Lai Chau's topography is very complex with many distinctive features that are formed from different strongly tectonic periods including many faults, wrinkles, and much depression.

The river and stream system here is relatively dense and sloping. The rivers with many waterfalls and rapid flow are potentiality for the hydroelectric development.

## Climate

Lai Chau has typical climate of Northwestern high mountainous tropical zone (i.e, hot day and cold night) and is slightly affected by typhoon. The climate is divided into two obvious seasons: rainy season and dry season, the rainy season with high temperature and humidity lasts from May to September; dry season, which is cold with low rainfall and humidity is from November to March. April and October are the transitional periods between two seasons. The annual mean temperature is 22-25°C. The annual mean rainfall is 2,500 – 2,700 mm which distributes unevenly, and concentrates in June, July, and August making up 80% of the total amount of rainfall. Droughty months start from December to March. Lai Chau is influenced much by the Western and Southeastern wind, and little by Northeastern monsoon wind.

## Administration and Population

Lai Chau has 1 town namely Lai Chau and 6 districts: Muong Te, Phong Tho, Sin Ho, Tam Duong, Than Uyen, Tan Uyen.

With the total area of 9,065.123 sq km, the province has the population of 308,000 (2008), and the population density of 34 people per sq km and it consist of several ethnic groups such as Thai (35.75%), H'Mong (25.13%), Kinh (19.36%), Dao (6.92%), Khomu (2.65%), Ha Nhi (2.32%), Giay (1.64%), La Hu (1.21%), Lao (1.20%); and other ethnic groups: Lu, Hoa, Khang, Mang, Cong, Tay, Sinh Mun, Si La, Tho, Nung, Lo Lo, Muong, Phu La, Co, etc. accounting for less than 1% of the provincial population.

## Land-use

*Table. 7: Ratio of Land-use in Lai Chau province*

No.	Type of Land	Area (ha)	Percentage
1	Agricultural land	64,299.9 ha	7.09%
2	Forestry land	283,667 ha	26.32%
	Forest cover rate		31.3%
3	Specialized land	4,489.61 ha	0.49%
4	Housing land	1,918.44 ha	0.21%
5	Untapped land	524,118.87 ha	58%

	<i>Total</i>		906,512.3 ha		100%
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Source: Provincial People' Committee, Ministry of Planning and Investment, 2008

## Disaster

Disasters in Lai Chau consist of flash flood, earthquake, hailstone, whirlwind (average occurrence frequency of 1.3-1.5 days per year)

**Table. 8: Statistics of remarkable damage caused by disaster in Lai Chau in recent years**

I	Damage	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Typhoon	Human										6
	House and construction works										75
	Land (ha)*										-
	Economy (Mil. VND)										-
Flood	Human										
	House and construction works										
	Land (ha)										
	Economy (Mil. VND)										
Flash flood, landslide	Human				5	5			6		1
	House and construction works				231	-			43		4
	Land (ha)				485	35.5			-		-
	Economy (Mil. VND)				5,00	700			-		-
Whirlwind	Human				1						
	House and construction works				563						
	Land (ha)				2,70	8					
	Economy (Mil. VND)				3,41	0					
Earthquake	Human										
	House and construction works										
	Land (ha)										
	Economy (Mil. VND)										

(\*): Area of land for agriculture and aquaculture

# Son La Province

## Geographical Location

Son La is a mountainous province located in the North-Western Vietnam, bordering Yen Bai province and Lao Cai province to the North, Vinh Phu province and Hoa Binh province to the East, Thanh Hoa province and Lao People's Democratic Republic to the South, and Lai Chau province to the West.

## Topographical Features

Son La's topography is complex and sharply divided by high mountain ranges, valleys, rivers and the surfaces of two plateaus which all run in the Northwestern-Southeastern direction. There are many small mountain ranges standing nearly perpendicularly to the major mountain ranges, which make this province become more divided. These features give Son La the distinctive strength in creating various product categories of many climatic zones. The average altitude from 600m to 700m and mountain accounts for 85% of the province's area.

Plateaus: Son La and Moc Chau are two serial plateaus running along the province, and they are also the separating line between Da River and the Ma River. Son La Plateau is 100km long – spreading from Thuan Chau district to Yen Chau district, 25km wide with average altitude about 500m-700m. While Moc Chau plateau has the length of 80km, stretching from Yen Chau district to Rut Stream of Hoa Binh province, the width of 25km with average altitude of 800m - 1000m. The two plateaus' surfaces are relatively even and flat. Despite the strong division, the soil layer is quite thick, well absorbent with fair rate of protein, high rate of phosphorous, and includes many types of soil that are appropriate to a number of crop plants.

Rivers and stream: Da River system and the Ma River system both run parallel with the province's length. Da River flows 239km through the province together with 32 large and small estuaries; the Ma River runs in the province with the length of 93km along with 17 estuaries. These two systems make up a relatively dense network of rivers and streams (the river/ stream density is 1.8 km per sq km), which combines with the great slope to create high potential for hydroelectric development.

## Climate

Being affected by the geographical location and topographical altitude, Son La has relatively various climate with both its typical features and properties of tropical monsoon climate. Annual temperature is 21<sup>0</sup>C on average, the highest at 27<sup>0</sup>C, and the lowest at 16.7<sup>0</sup>C. The rainfall is 1,410mm on average, 1,829mm in the year of highest level (1907), and 998mm in the lowest year (1964), number of rainy days is 118 days per year on average. Annually relative humidity is 81% on average. Climate of Son La is clearly divided into two seasons: Winter is cold, dry with little rain, the rainfall is less than 10% of the total amount of the year, the air humidity falls down at 75-76%, hoarfrost appears in December and January. Summer is hot, early coming with much rain, lasting from May to September, the rainfall accounts for up to 90% of total amount of the whole

year, and no typhoon. Generally, climate of Son La makes favorable conditions for developing some production forms typical in subtropical and temperate regions beside the forms which are common in tropical regions.

## Administration and Population

Son La includes Son La city and 10 districts: Quynh Nhai, Muong La, Thuan Chau, Phu Yen, Bac Yen, Mai Son, Song Ma (Ma River), Yen Chau, Moc Chau, Sop Cop. The province's area is 14,055 sq km with the population of 972,800 people equal to the density of 69 people per sq km.

## Land-use

*Table 9: Ratio of land-use in Son La province*

No.	Type of Land	Area (ha)	Percentage
1	Agricultural land	190,070 ha	13.52%
2	Forestry land	331,120 ha	23.55%
	Forest cover rate		22.1%
3	Specialized land	22,327 ha	1.53%
4	Housing land	5,756 ha	0.39%
5	Untapped land	856,227 ha	59.02%
	<i>Total</i>	1,405,500 ha	100%

Source: Provincial People's Committee, Ministry of Planning and Investment, 2008

## Disaster

Disasters in Son La consist of flash flood, earthquake, thunderstorm, hailstone, forest fires and hoarfrost (usually appears in December and January).

*Table.10: Statistics of remarkable damage caused by disaster in Son La in recent years*

I	Damage	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Typhoon	Human										19
	House and construction works										640
	Land (ha)*										3,994
	Economy (Mil. VND)										201,556
Flood	Human							-	2	11	
	House and construction works							3	-	2,388	
	Land (ha)							1	-	10,492	
	Economy (Mil. VND)							-	-	14,268	
Flash flood,	Human						10		1		

landslide	House and construction works					4,953	1,488				
	Land (ha)					3,138	461				
	Economy (Mil. VND)					4,794	1936				
Whirlwind	Human	2				1	4				
	House and construction works	197				1,915	-				
	Land (ha)	3685				154.3	-				
	Economy (Mil. VND)	-				6,600	-				
Earthquake	Human										
	House and construction works										
	Land (ha)										
	Economy (Mil. VND)										

(\*): Area of land for agriculture and aquaculture

## Yen Bai Province

### Geographical Location

Yen Bai is one of thirteen mountainous provinces in the North, lying between the Northeastern and Northwestern regions, bordering Lao Cai, Phu Tho, Ha Giang, Tuyen Quang and Son La. Yen Bai is the clue of road lines, railway, water-way from Hai Phong, Ha Noi to Lao Cai border gate.

### Topographical Features

Yen Bai is characterized by the topography that is increasingly high in the direction of South East to North West and formed by three huge mountain ranges which are in Northwestern – Southeastern direction: In the West, Hoang Lien Son mountain range lies between Red River and Da River, the next is the antique mountain range namely Con Voi lying between Red River and Chay River, in the East there exists the limestone mountain range lying between Chay River and Lo River. The topography is complex and can be divided into two big regions: the low and the high regions. The former is more than 600m at average altitude, accounting for 67.56% of total province's area. The population of this area is scattered and the potential in land, forestry, mineral and can be mobilized for socio-economic development. The latter is less than 600 m at average altitude, including mainly low mountains and hills, pan valleys, accounting for 32.44 % of province's area.

### Climate

Yen Bai located in the tropical monsoon climate, the temperature is 22 - 23<sup>0</sup>C on average; and 37.03<sup>0</sup>C at highest level and, 1<sup>0</sup>C at the lowest level; the months from December to February are coldest ones with the appearance of the hoarfrost sometimes; sunshine hours of the whole year are 1,577 hours; the average humidity accounts for 84.06 %. The occurrence of rain and typhoon is common from June to August, with the average amount

ranging among 1,500mm- 2,200mm. Based on climatic and topographical features, Yen Bai can be sub-divided into five climatic sub-regions:

- The Mu Cang Chai sub-region has altitude of 900m on average and average temperature is about 18 – 20<sup>0</sup>C, down to 0<sup>0</sup>C sometimes in winter.
- The Van Chan – Southern Van Chan sub-region has average altitude of 800 m, average temperature among 18 – 20<sup>0</sup>C, the North is much rainy while the South is the least rainy region of the province.
- The Van Chan – Tu Le sub-region has average altitude about 200m – 400m and average temperature ranges about 21 – 32<sup>0</sup>C.
- Sub-regions of the South of Tran Yen, Van Yen, Yen Bai city, Ba Khe, with the altitude of 70m, and average temperature ranging among 23 – 24<sup>0</sup>C, is the drizzly rainy region in the province.
- In Luc Yen sub-region, the altitude of Yen Binh is less than 300 m with average temperature ranging about 20 – 23<sup>0</sup>C, is the region with largest area of water surface (Thac Ba lake is 19.050 ha).

### Administration and Population

Yen Bai has 9 administrative units: Yen Bai city, Nghia Lo town and 7 districts: Luc Yen, Mu Cang Chai, Tram Tau, Tran Yen, Van Chan, Van Yen and Yen Binh, with total 180 communes, wards, small town.

Yen Bai covers an area of 6,882.92 sq km with the population of 723,500 and population density of 105.1 people sq km including ethnic groups: Kinh, Tay, Dao and H'Mong.

### Land use

*Table 11: Ratio of Land-use in Yen Bai province*

No.	Type of Land	Area (ha)	Percentage
1	Agricultural land	69,315.12 ha	10.07%
2	Forestry land	282,241.86 ha	41%
3	Specialized land	29,199.78 ha	4.25%
4	Housing land	3,804.54 ha	0.55%
5	Untapped land	303,730.7 ha	44.13%
	<i>Total</i>	<i>688,292 ha</i>	<i>100%</i>

Source: Provincial People's Committee, Ministry of Planning and Investment, 2008

### Disaster

Disasters in Yen Bai consist of flash-flood, landslide, flood, whirlwind

*Table 12: Statistics of remarkable damage caused by disaster in Yen Bai in recent years*

I	Damage	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	Typhoon										
	Human										-

	House and construction works								9
	Land (ha)*								809
	Economy (Mil. VND)								-
Flood	Human		4	2				6	2
	House and construction works		206	474				354	41
	Land (ha)		361	2323				369	1425
	Economy (Mil. VND)		4000	-				-	9332
Flash flood, landslide	Human			3		-	5		4 41
	House and construction works			564		55	4.052		- 1068 7
	Land (ha)			1286		450,8	196		- 3854
	Economy (Mil. VND)			8000		-	2000		- 438
							0		
Whirlwind	Human							8	
	House and construction works							357	
	Land (ha)						1227,5		
	Economy (Mil. VND)						8500		
Damaging cold	Livestock								-
	Land (ha)								-
	Economy (Mil. VND)								-

(\*): Area of land for agriculture and aquaculture

## Disaster Reduction in the Six Provinces

### Current situation of disaster

Compared to the year 1975, the population in northern mountainous area of Vietnam has increased by 25-30%. The rising of population brings about the rising in consumption demand, natural resources exploitation and environment degradation. The formation of many more towns, villages along Red, Da Rivers and many localities of the six provinces with the expansion of land which is covered by concrete has decreased amount of rainfall water infiltrating into the ground and increased the water amount discharged into river branches resulting in flood (e.g. flood in 1990 in Lai Chau town).

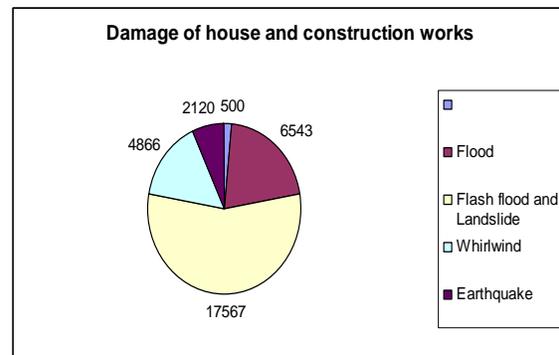
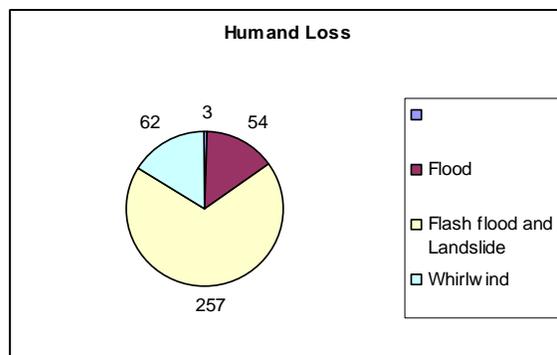
The increase of population in the six provinces combines with shifting cultivation of wandering hill tribes, uncontrolled forest exploitation and forest fire has narrowed down forest area and thin down the forest floor. The speed of deforestation is much faster than that of afforestation. The degradation in qualification of vegetation cover has made clear effect, in many cases, directly affected the formation of flash-flood. For the same period of time and rainfall, flash flood shall not happen or happen with less damage in the thick-forest- floor area and vice versa. According to the survey conducted in Nam Than stream,

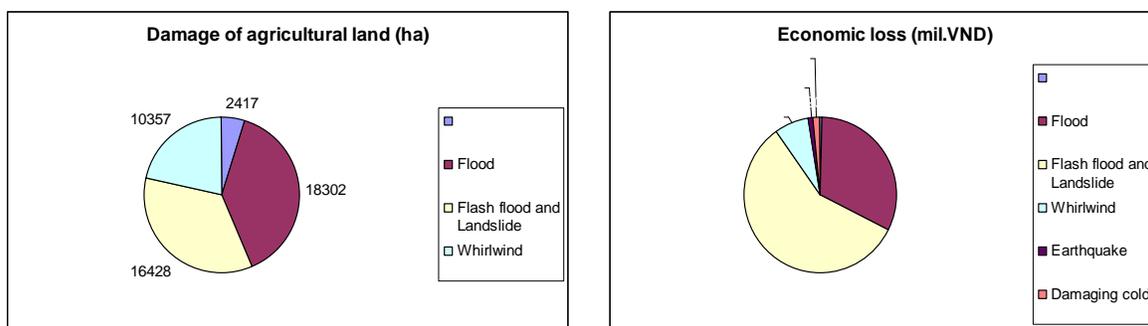
Than Uyen, Lao Cai, with the same amount and time of rainfall, the flood level of 1960 is lower than that of 1990 and 1991 (DMU, 2002).

The six provinces – Dien Bien, Hoa Binh, Lao Cai, Lai Chau, Son La and Yen Bai have abnormal hydrometeorology and weather conditions. Data of hydrometeorology obtained in the past years and remarks of local meteorologists show that rain in the provinces tends to occur in narrow area with high intensity. Damage data of the six mountainous provinces show that natural disasters appearing frequently include: flash flood, flood, landslide, whirlwind, hailstone, damaging cold and earthquake. Among these disasters, flash flood, landslide, and whirlwind are more common in all of six provinces, regularly appearing and causing the most human and property damages (NDMP, 2008).

**Table. 13: General information of six provinces**

Region	Province	Area (Sq.km)	Average population	Population density (people per sq.km)	Type of disaster
North East	Lao Cai	6,357	593,600	89	Flash flood, flood, landslide, whirlwind, drought, forest fire, hoarfrost, chilly cold
	Yen Bai	6,882.92	723,500	105.1	Flash flood, flood, whirlwind, landslide
North West	Dien Bien	9,554.097	499,899	46	Flash flood, earthquake, landslide, whirlwind
	Hoa Binh	4,662.5	803,300	172	Flash flood, flood (Hung Thi, Mai Chau), hailstone, storm, drought, hoarfrost.
	Lai Chau	9,065.123	308,000	34	Flash flood, landslide, earthquake, hail, whirlwind, hoarfrost
	Son La	14,055	972,800	69	Flash flood, flood (Moc Chau, Yen Chau, Sop Cop), earthquake, whirlwind, hailstone, hoarfrost





**Figure 1: Statistics of Damage caused by Disaster in the six provinces from 1999 to 2008**

**Box 1: Whirl wind**

A whirlwind is a weather phenomenon in which a vortex of wind, a vertically oriented rotating column of air, forms, due to instabilities and turbulence created by heating and flow (current) gradients. In a whirlwind, the wind often blows in the counterclockwise direction, and the wind force can reach level 11, 12 or over level 12 followed by heavy rain, thunder, hail sometime mixing with dust.

It is difficult to forecast a whirlwind, meteorologists can only warn about the appearance of whirlwind before some tens of minutes or some hours by such modern devices as radar and meteorological satellites. Thus, the prevention for houses and evacuation for human is often sudden and passive.

*Allocation of whirlwind according to territory and time 1999-2008*

Location	Month												Entire year	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
	Times of whirlwind occurrence (n)													
Dien Bien				1	1									2
Lai Chau				1	1									2
Son La			6	3	3									12
Lao Cai			2	2										4
Yen Bai			2	2	1									5

A flash flood is a rapid flooding of geomorphic low-lying areas - washes, rivers and streams. It is caused by heavy rain associated with tropical typhoon. This is natural phenomenon formed by the combination of factors: basin, intensive rainfall, sloping topography and thin vegetation cover. Flash flood occurs suddenly in short time (less than six hours), the strong flow sweeping away anything within its course (mud or soil, rock flow). The formation and damage caused by flash flood has close relation to rainfall, climatic condition, topographical features, human activities, and flood discharging capacity of each region.

#### ***Properties of flash flood***

- Flash flood caused by sloping topography: formed by the combination between high rainfall on the sloping topography of over 20-30% and the thin vegetation cover of 30-40%. Flash flood of this type occurs in leaf-shape basin, with the area of less than 2000sq.km. When there is occurrence of heavy rain in a large area of the basin, water level in river and stream branches raises quickly. The water then flows into the main river of the whole topography forming flash flood.

- Flash flood caused by obstacles: occurring along the riverside where the landslide regularly occurs. This is unstable land area, river bed slides sharply with V-shape section such as belt in Phong Tho (Lai Chau), Muong Lay (Dien Bien), etc. In faulted belt, the land surface is unstable making it prone to landslide. After heavy rain, water amount underground on sloping side and basin becomes saturated sliding to the river at high speed and create mud or rock flow.

#### ***Zoning areas prone to flash flood***

In Northern mountainous provinces, flash flood often occurs from July to October annually. In the last three years 2006, 2007, 2008, flash flood, however, tends to appears even before July and after October.

*Area of high flash flood possibility:* Basin of Nam Po-Muong Te River and Nam Muc-Muong Lay (Dien Bien); Basin of Nam Pan, Nam La(Son La) River; upstream of Chay River – Muong Khuong, Bao Thang, Bao Yen; Ngoi Phat, Bo Canal, Bat Xat(Lao Cai)

*Area of flash flood possibility:* A large area of Nam Mu River – Muong La (Son La), Than Uyen, Sa Pa (Lao Cai), Phong Tho (Lai Chau) and Mu Cang Chai, upstream of Thia canal, Tran Yen, Van Yen, Tram Tau, (Yen Bai) and basin of medium and small-size rivers, and streams in Hoa Binh.

*Source: DMU, 2002, NDMP, 2008*

**Table 13: Summary of damage caused by some typical flash floods in the six provinces (1958 -2008)**

TT	Date	Affected area	Number of the dead	Destroyed construction (TL, Roads, house )	Damaged agricultural area (ha)	Damage in money (billion VND)
1	06/22/1958	Nam Cum, Lai Chau		40		
2	9/2/1975	Dien Bien, Lai Chau	-	-	-	
3	7/7/1976	Nam Na, Lai Chau	-	-	-	
4	9/12/1976	Nam Nhe, Lai Chau	-	-	-	
5	6/22/1977	Mu Cang Chai, Yen Bai	-	-	-	
6	6/30/1988	Bao Thang, Lao Cai	8		100	
7	6/27/1990	Lai Chao Town, Lai Chau	75	300	300	22
8	7/27/1991	Lai Chao Town, Lai Chau				
9	7/27/1991	Son La Town, Son La	32	862	5100	
10	5/15/1992	Bao Yên, Lao Cai	3		200	
11	7/2/1992	Phong Tho, Lai Chau			185	
12	8/16/1993	Lao Chai, Ta Giang Phin, Sa Pa, Lao Cai	7	5		
13	7/7/1994	Dien Bien Town	9	95	565	15
14	7/23/1994	Muong Lay, Lai Chau	17	18		
15	8/9/1998	Ma River, Thuan Chau, Muong La, Yen Chau, Moc Chau and Son La Town, Son La	4	300	390	2.791
16	7/2000	7 communes of Sapa district	20	60	-	-
17	7/2002	Than Uyen, Lao Cai	7	188	505	15
18	9/2004	Phin Ngan, Bat Xat	23	3	-	0.68
19	7/12/2005	Yen Bai	5	237	196	20
20	7/25-8/9/2008	Bat Xat, Sa Pa, Bao Thang, Bao Yen	79	500	4,888	879

Source: DMU, 200 ;, NDMP, 2008

### **Disaster reduction and the linkage with development project**

The analysis of secondary data of 6 provinces as well as field trips in communes: Van Hoi – Tran Yen district, Yen Bai; Trinh Tuong commune, Bat Xat district, Lao Cai; and Xuan Lao commune, Muong Ang district, Dien Bien on disaster reduction and implementation of development projects reflect some common issues in the province as follows:

1. Among macro solutions, afforestation is crucial solution which helps minimize the formation and damage caused by flood and flash flood. As the provinces' reports, area of forest work has been increasing year after year. However, situation of forest floor quality - thickness of vegetation cover – and area of recovered natural forest particularly in riverhead are not mentioned.
2. Yen Bai and Lao Cai are the first provinces to forecast flash flood by rainfall measuring devices and flood mark, however, it is not very effective. According to staffs of Yen Bai provincial Committee for flood and typhoon control: the

locations of rain measuring devices are not logical (not in upstream but often in lower locations), there hasn't been any connection between the devices, so the warning effect is not very high.

3. Most of disaster prone communes in the six provinces haven't had disaster map, except for 4 communes in Lao Cai province ( Sang Ma Sao and Phin Ngan communes in Bat Xat district, Ban Ho and Trung Trai communes in Sa Pa district) (Hung, 2009).
4. In mountainous communes and districts, the 4 on-the-spot motto has not been well articulated with prompt assistance and provision, in case disaster exceeds capacities of the communes and districts, from their respective district and province. The disaster reduction action plans of localities and the actual investigation show that:
  - Facilities and materials for disaster response and rescue have been insufficient, could not meet the requirements for such a complex disaster;
  - Available local rescuing team has been insufficient;
  - Communication with and support from higher administrative levels (i.e. District People's Committee and Provincial People's Committee) have not been well organized.

Therefore, in case of sudden flood in short time, the communes were being isolated and assistance of district and province has been in passive situation.

5. Construction planning for the six provinces has not well undertaken: there have been lack of development plans for inter-district and rural residential areas. The construction planning in the six provinces still remains some following insufficiency:
  - The cultivation and settlement methods of people in the communes have been dispersed. Therefore, construction of basic infrastructure (roads, electric and water system) is not cost-effective.
  - In the context of shortage of capital, priorities for construction of infrastructure have yet been done.
6. The socio-economic, sectional and construction development plans have not been integrated with disaster reduction solutions: The report on socio-economic development's achievement of previous year and plan for socio-economic development for the next year does not either indicated the loss caused by disaster to development goal or show which advantages can be achieved from implementation of disaster reduction plan.
7. Disaster awareness and knowledge among community people is still not high and passive in the effort to reduce the effect of natural disasters: even after the occurrence of severe damaging cold in 2008, ratio of households carried out works to cover livestock-house for protecting livestock from getting cold is still very low; number of human loss due to unbelievable reason like collecting firewood in flood or watching flood; when the disaster happened number of people rely on police and army forces to response to the disaster **(Hung, 2009)**.

8. Measures making infrastructure become disaster-proof are not fully applied. The reasons, as explained by the project owners, were lack of experts and materials as well as the increase of construction expense if these measures are being applied:

- In several infrastructure projects, the selection of site has often been made on the basis of cheap land cost and land availability rather than from consideration of the possibility that the construction works may affect the natural environment or being affected potential natural hazards. Therefore, these constructions had interfered much into the natural environment razing to the ground too much and blocking stream or river flow: number of welfare works (medical stations, schools, markets..) have been built in the valleys blocking the flow and thus causing higher damage when flash flood occur; infrastructure works (i.e. road, small bridge) have been built without considering the possibility of flash flood causing obstruction of flows or isolating residential areas when flood happened (Bat Xat, Van Chan..).

- The project owners often hire local labour to undertake construction works. Problem arises when the local labour do not has adequate skill. Besides, due to the deficiency in regulations and inspecting staffs, the local practice of construction rarely incorporate the use of Vietnam building codes. Even when building codes applied, the correct application requires skilled labour that is lack in the locations. This forces the sponsors to carry out more researches and provide training courses for local staffs and labour.

- Infrastructure projects have always not completed in term of required items and components (e.g. several roads have been built without water drainage gullies along two sides of or across the road, small irrigation canal without cover...), lack of consideration of making disaster-proof infrastructure and lack of expense for maintenance or repair. After being damaged by disasters, most of the construction works have been rebuilt applying to the same previous methods and standards.

- Some irrigation construction projects do not base on updated data in terms of flood frequency and magnitude that can cause disaster when they are breakdown: Huoi Phan irrigation work in Muong Lay, Dien Bien had been designed based on the data collected in 1959-1962 with water discharge of 3,000 m<sup>3</sup>/s. Thus, the work was broken down in flood in July 17, 1999 which has water discharge of 4,090 m<sup>3</sup>/s.

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