CHAPTER III

STUDY AREA

Physical, biological, and socio-economic conditions are jointly related to the extreme seriousness and rapid enlargement of soil erosion in PARC area, Ba Be. Physical and biological characteristics naturally affect to the rate of erosion while the social and economic factors are known as indirectly erosion-caused factors. These factors are the driving forces of the accelerated erosion within the PARC area.

3.1 Physical Characteristics

The very steep land, rapid decline in vegetation cover degree, and strong rainfall events, robustly affect to the accelerated erosion in the region.

3.1.1 Geographical location and administrative setting

The study area is located in the Southeastern part of Ba Be District, Bac Kan province, Viet Nam between 105^{o} 34' – 104^{o} 49' West longitude and between 22 ^{o} 14'- 22 ^{o} 30' Noth latitude. It consists of seven communes, namely Cao Thuong, Cao Tri, Dong Phuc, Hoang Tri, Quang Khe, Nam Mau and Khang Ninh (Figure 3-1).

The total land area of seven communes (Table 3-1) in the study area is about 32,000 ha. Three communes, namely Nam Mau, Dong Phuc, Quang Khe cover larger areas of 5,835.44, 5,765.33 and 5,498.36 ha corresponding 19, 18 and 17 percent respectively. The smallest commune is Cao Tri.

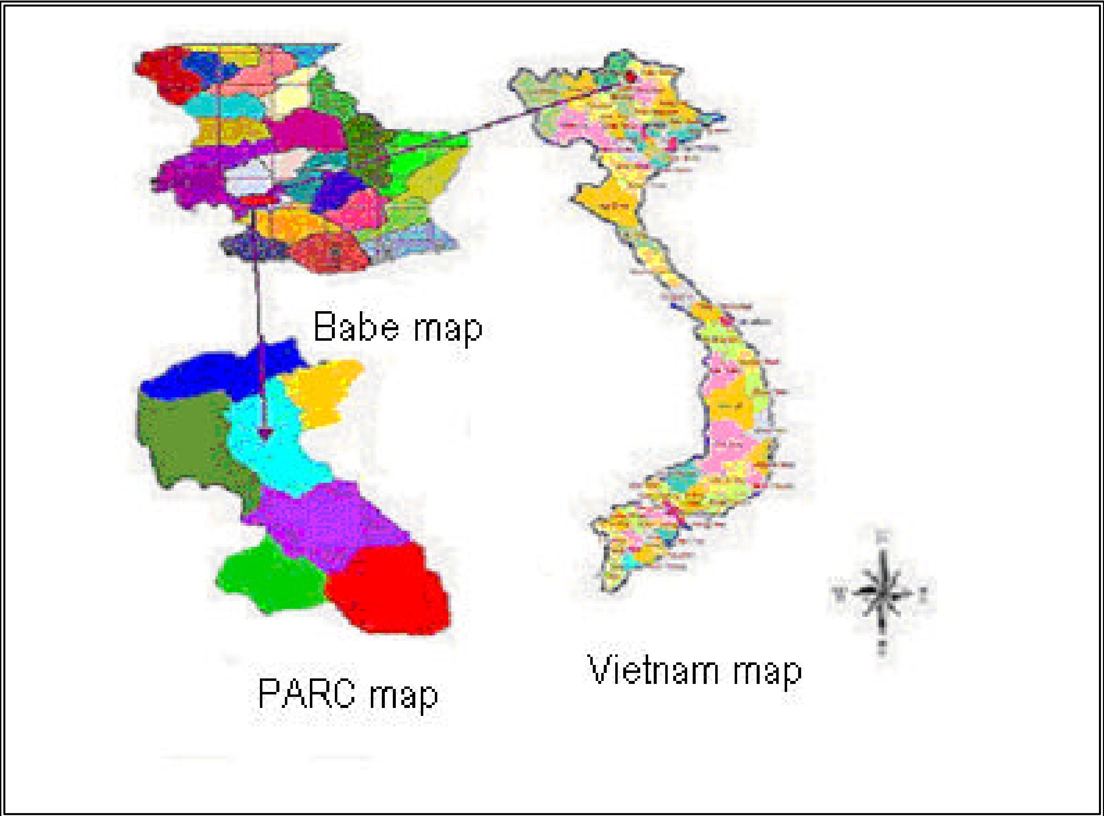

Figure 3-1 The geographical location of the study area

Table 3-1 Distribution of the land in PARC area

Name of commune	Area (ha)	Percentage (%)
Cao Thuong	3,940.7	13.0
Cao tri	2,443.2	0.8
Dong Phuc	5,765.3	18.0
Hoang Tri	3,517.8	11.0
Quamg Khe	5,498.3	17.0
Nam Mau	5,835.4	19.0
Khang Ninh	4,479.9	14.0
Total	31,480.9	100.0

Source: PARC project, 2000

3.1.2 Topographic conditions

The elevation in the study area is a considerable spatial variation from 120 to 1540 meter above mean sea level (Figure 3-2).

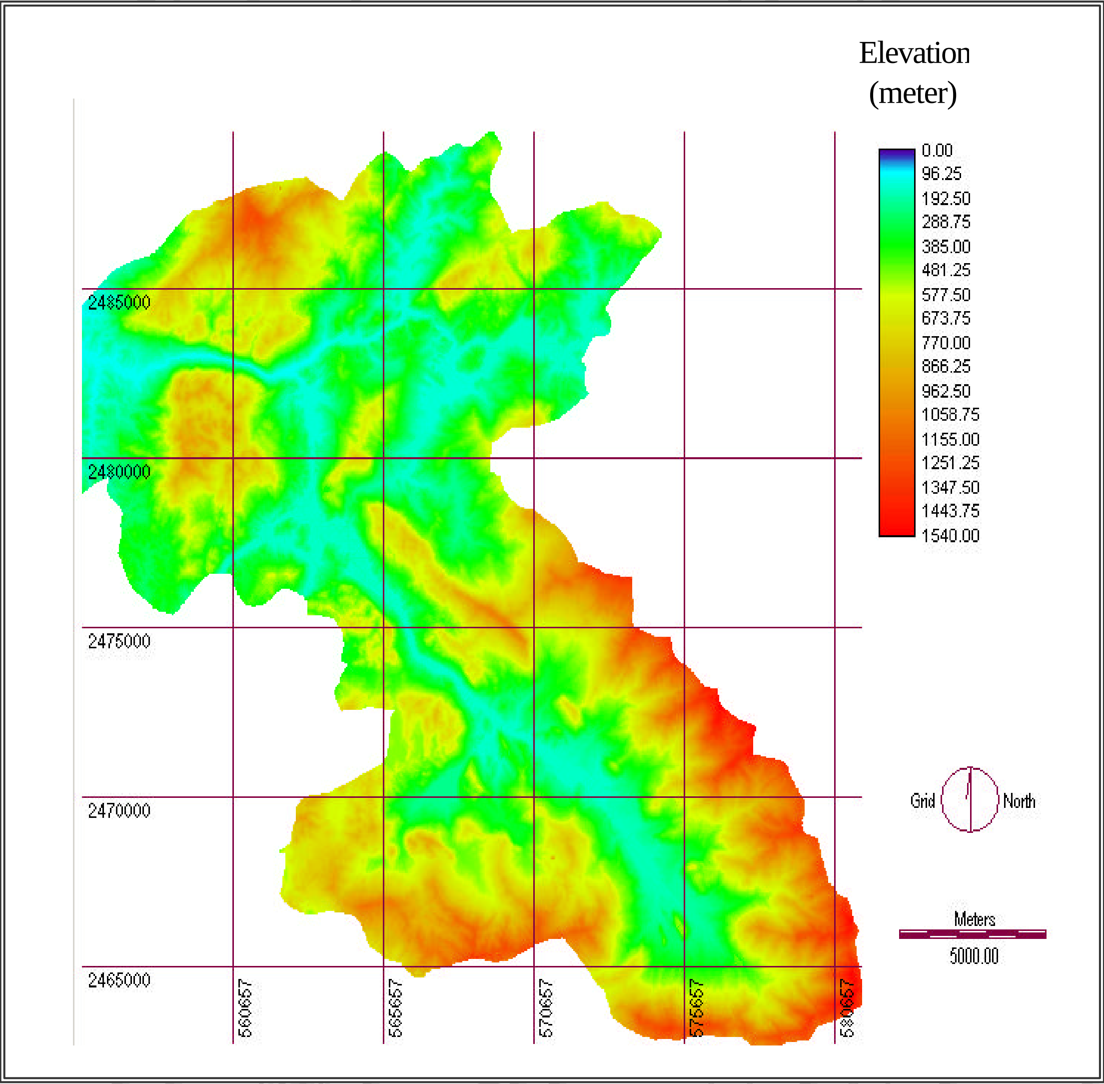

Figure 3-2 The elevation map in the study area

The topographic characteristics closely associates with the magnitude of the soil erosion at areas where vegetation is sparsely scattered. The topography of a landscape represented by its elevation and slope affect the surface runoff volume and velocity of overland flow. Soil erosion is increased as a result of respective increases in velocity and volume of surface runoff. Steeper slopes produce higher overland flow velocity and longer slopes accumulate runoff from larger areas result in higher flow velocity. Consequently, both lead to the increase in the potentially accelerated erosion across the landscape.

It is indicated that most of elevation in this area falls within the range of 380 to 1540 meter above mean sea level. Therefore, potentially accelerated erosion probably becomes an extreme threat if the soil conservation practices and forest protection are not considerable.

The spatial distribution of slope varies from 0 to 86 percent throughout the study area (Figure 3-3). It is showed that slope in the range of 45 to 86 percent covers a larger part in the study area and it spreads throughout the landscape while low slope occupies a smaller part in the area. The slope of the study area varies from 0 to 86 percent, which is grouped into five classes of <7, >7 to <15, >15 to <20, >20 to <25, >25 to <30 and > 30 percent (Morgan, 1995). Most of the area located in the slope higher than 30 percent which is occupied nearly 71.44 percent of the total area and only 1.48 percent of area is occupied by the slope of less than 7 percent that has less effect on soil erosion.

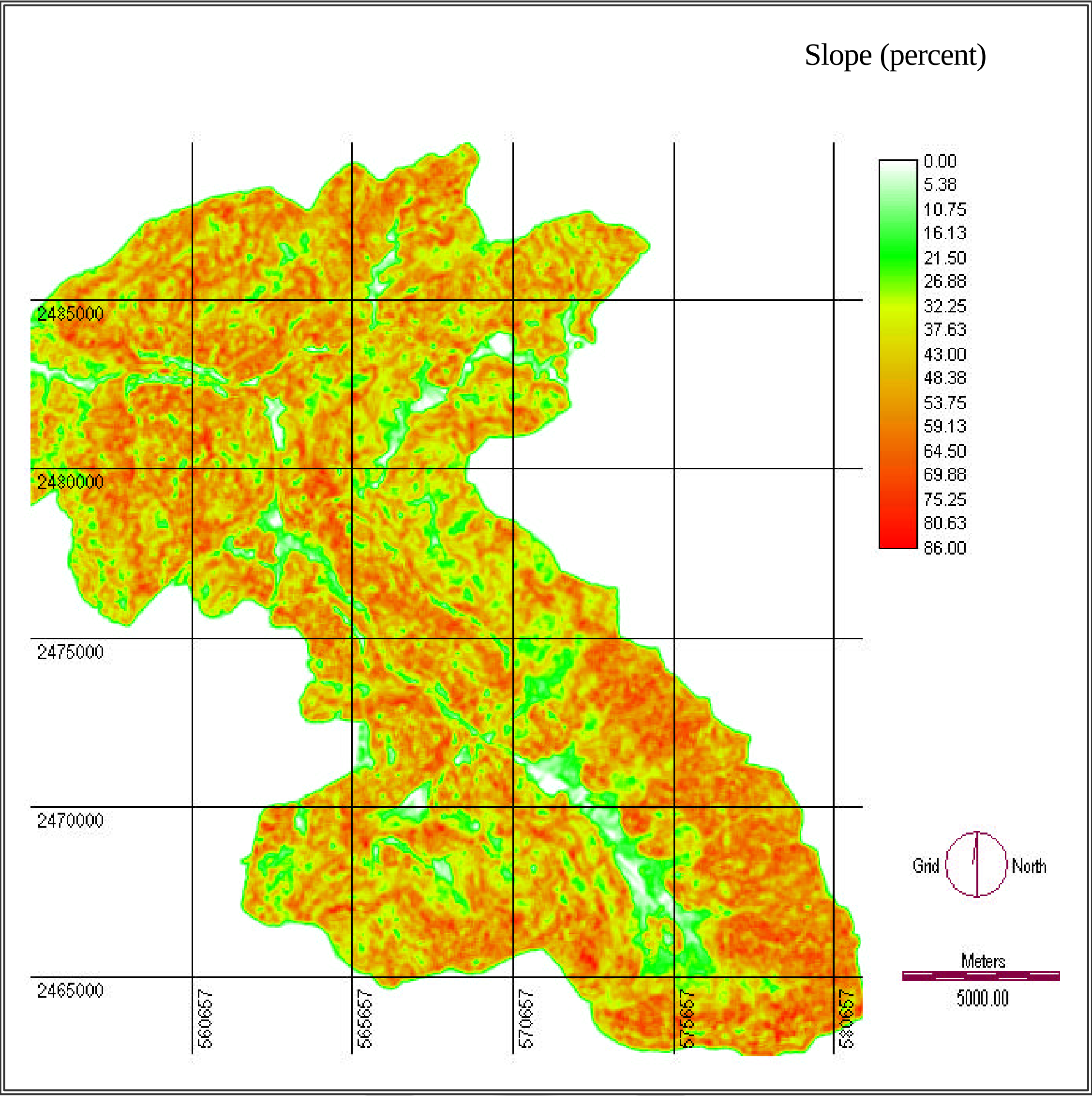

Figure 3-3 The slope map in the study area

3.1.3 Land use characteristics

Land use cover plays a very important part in controlling the accelerated erosion. It refers as a protective layer on the aboveground because it absorbs some of energy of falling raindrops and running water. The effectiveness of a plant cover in reducing the erosion by the raindrop impact depends on its height, continuity and density. The intercropping, crop rotation, diversity preservation of land covers, protective strips of tree on uplands are all significant for weakening direct raindrops and overland runoff velocity. The recent land use in year 2000 in PARC area was classified into 13 types that derived from remote sensing interpretation (Figure 3-4).

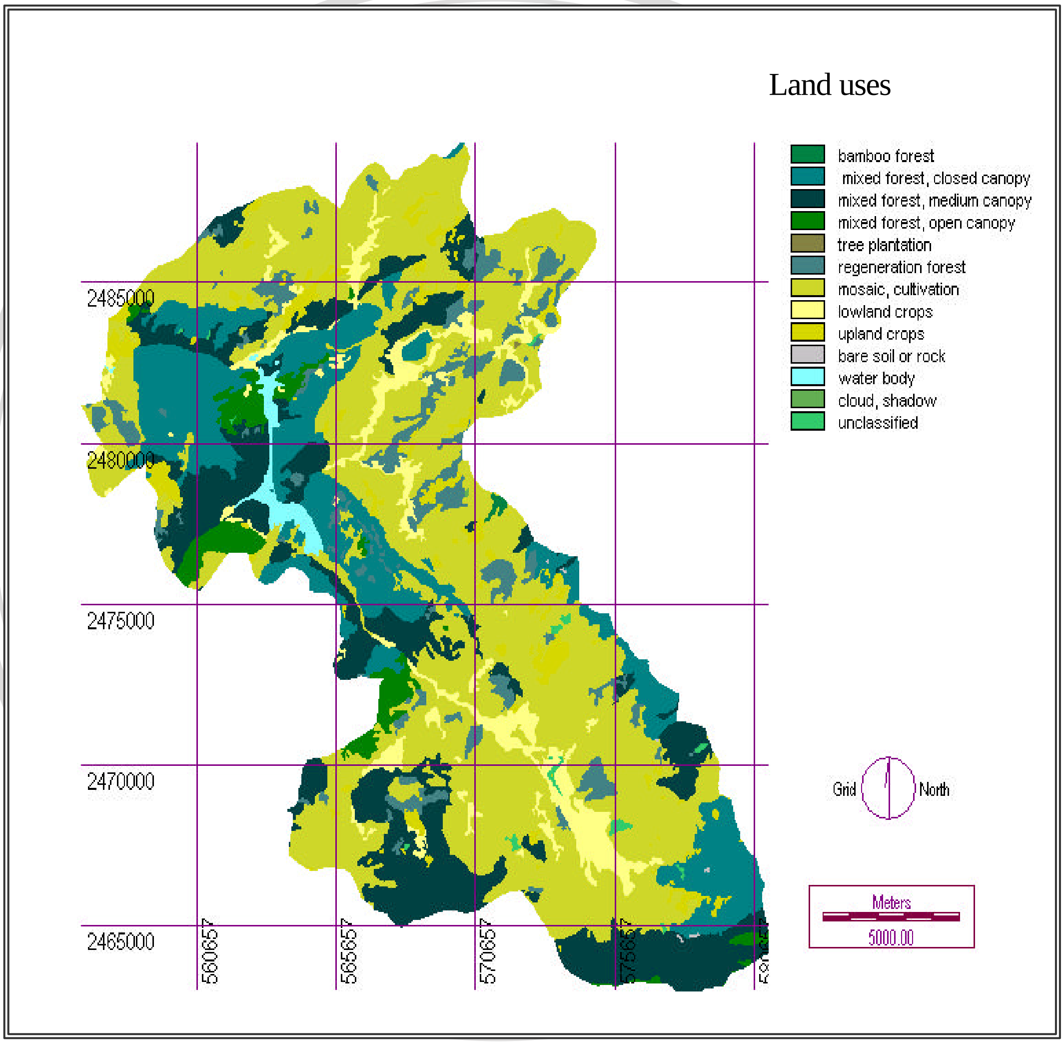

Figure 3-4 The map of the land uses in the study area

The area and its proportion in the Table 3-2 showed that the mosaic shrub, cultivated land with grassland covers an largest area of 46.53 %; the mixed forest, medium canopy and mature mixed forest, closed canopy are ranked as the second and third that cover areas of 17.55 and 15.51%, respectively. However, the mixed forest, medium canopy and mature mixed forest, closed canopy are mostly concentrated in the protected area. The cropping lowland and cultivation upland distributed through the landscape, so it probably lead to the fragmentation of the landscape and the soil erosion enlargement.

Table 3-2 Types of land use in the PARC area

Class	Types of land use	Area (ha)	Percentage (%)
1	Mosaic shrub, cultivation and grassland	14893.9	46.53
2	Mixed forest, medium canopy	5617.1	17.55
3	Mature mixed forest, closed canopy	4965.4	15.51
4	Lowland crops	1994.5	6.23
5	Shrub and regeneration forest	1968.3	6.15
6	Upland crops	1151.1	3.60
7	Mixed forest, open canopy	941.4	3.94
8	Water body	317.3	0.99
9	Unclassified	107.7	0.34
10	Mature bamboo forest	29.7	0.09
11	Bare-soil or rock	11.8	0.04
12	Tree plantation	4.2	0.01
13	Cloud, shadow	3.4	0.01

Source: PARC project, 2000

3.1.4 Soil types

Soil characteristics relate to resistance to both soil detachment and transportation when a rainfall event occurs. The resistance of a soil to erosion mostly depends on its basis properties that mostly consist of the soil texture, the soil structure, the soil permeability and the percentage organic matter. These soil properties are considerably affected to soil erosion acceleration due to the susceptibility of the soil and the surface runoff.

The recent soil types in PARC area was classified into18 classes (Figure 3-5) according to type of original rock (parent rock) and soil color. Among soil types in the study area, the feralit based bright yellow soil occupies a largest area of 8,836.6 ha. Acid macma based yellow soil and carbonate based high hill dark-red soil were ranked as the second and third that cover areas of 6,793.86 and 6,099.2 ha and their proportion of 21.83 and 19.60 % respectively. The sediment soil without yearly filling-up covers an area of 3,853.67 ha and the other soils cover a smaller percentage in the region (Table 3-3).

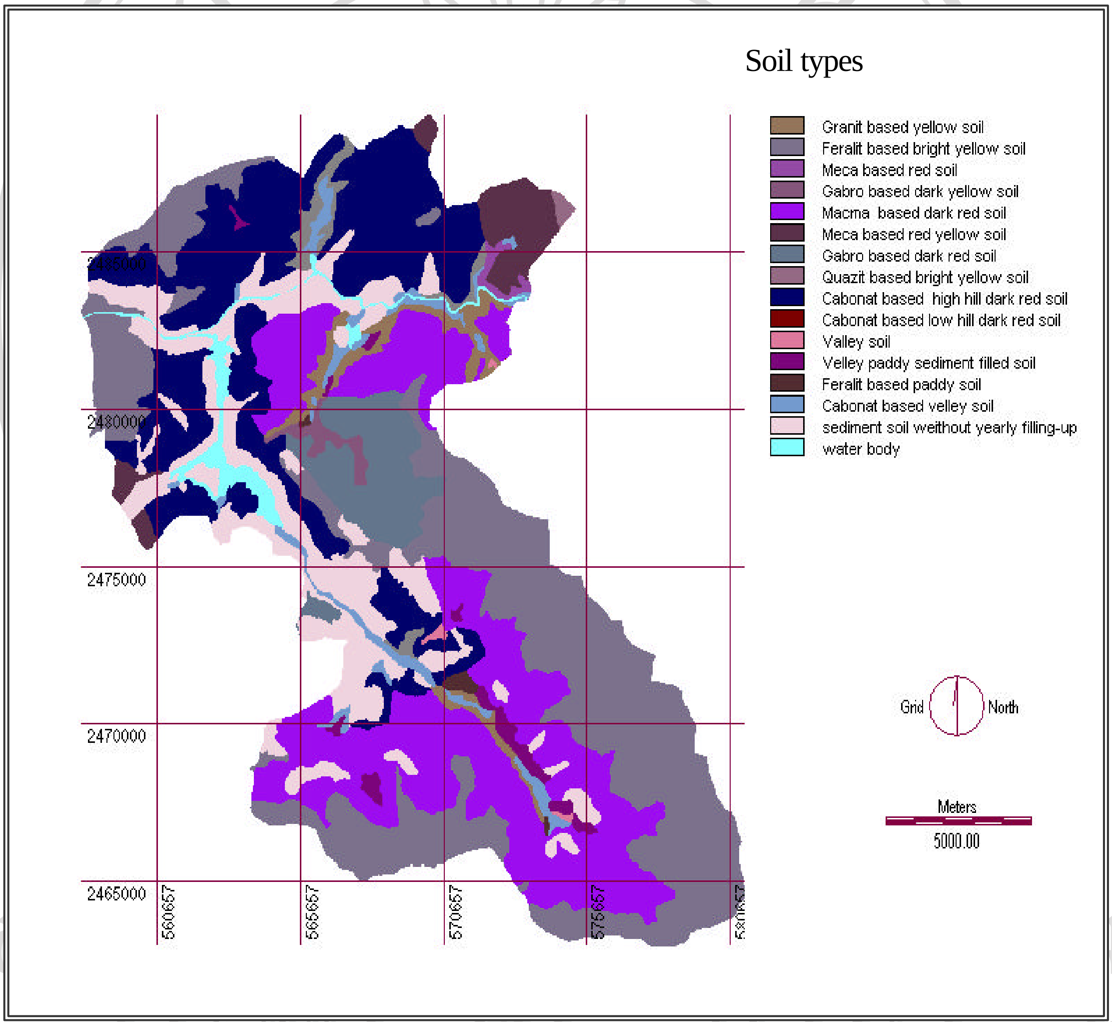

Figure 3-5 The map of soil types in the study area

Table 3-3 Soil types area and its proportion in the PARC area

Class	Soil types	Area (ha)	Percentage (%)
1	Feralit based bright yellow soil	8916.7	28.32
2	Acid Macma based yellow soil	6892.9	21.90
3	Carbonate based high hill dark-red soil	6099.3	19.38
4	Sediment soil without yearly filling-up	3852.7	12.24
5	Neutral/Bazic based macma dark-red soil	1524.6	4.84
6	Mica/Philit based red-yellow soil	876.1	2.78
7	Carbonate based valley soil	683.0	2.17
8	Granit/Liparit based yellow soil	657.3	2.09
9	Soil mixing with rock	583.1	1.85
10	Fallow soil	462.9	1.47
11	Valley paddy sediment filled-up soil	348.6	1.11
12	Macro/Bazic Gabro based dark-red soil	209.5	0.67
13	Meca/Philit based red soil	106.1	0.34
14	Feralit based paddy soil	80.9	0.26
15	Quazit based bright-yellow soil	51.2	0.16
16	Valley soil	43.5	0.14
17	Carbonate based low hill dark-red soil	2.2	0.01

Source: Backan Department of Agriculture and Rural Development, 2000

3.1.5 Rainfall regime

Amount of rainfall and its intensity cause soil loss because detaching power of raindrops strikes the soil surface. The average annual rainfall (1990 – 2001) is mostly concentrated from May to September, which is accounted for about 75% of total annual rainfall in the study area and the number of rain-days also has a same trend on this period (Figure 3-6).

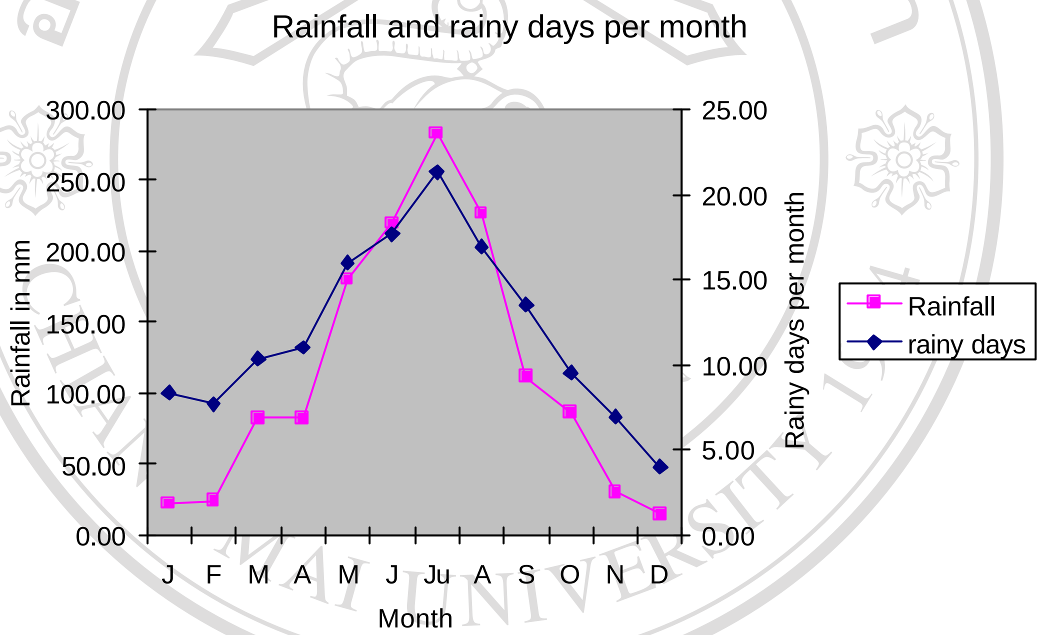

Figure 3-6 The dynamic of the rainfall in the study area

3.1.6 Direction of the surface runoff

Surface runoff can carry the amount of the soil that contains available nutrients such as nitrogen and phosphorus into streams, lakes and ground-water supply. The losses of these nutrients have led to the severely degraded soil and reduction in crop yield. Module RUNOFF was used to generate the surface direction of flow in study area. The direction of the surface runoff map derived from DEM (Figure 3 -7) showed that the surface runoff in PARC come outside this watershed at outlet in the northern of watershed; therefore, a large volume of runoff may come out of the watershed and its accompanying mass of the soil loss in this area.

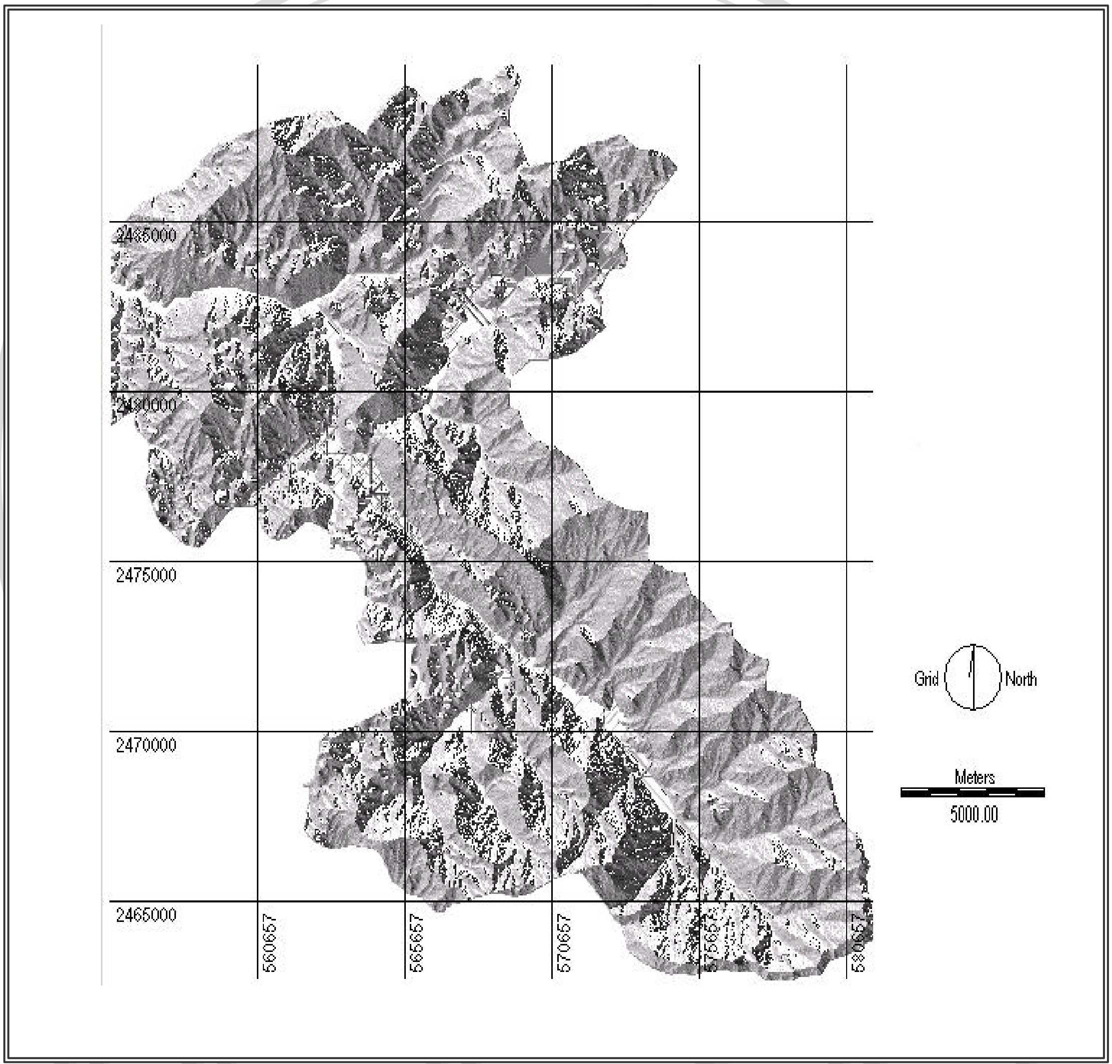

Figure 3-7 The direction of the surface flow in the study area

3.2 Socio-economic conditions

The social-economic conditions are jointly related to soil erosion thorough maintaining the economic return of the farmers who controls and manages their uplands in this area. The rapid population growth in last two decades in this region led to an expansion of shifting cultivation and consequently put a heavy pressure to dramatic reduction in natural forest cover, uplands degradation, and crop productivity.

3.2.1 Population growth

Population growth brings to expansion of shifting cultivation cross the landscape that consequently led to the soil erosion and degradation. The average land area for one person was about 3.05 ha (Table 3-4). Five of seven communes in this area have land area per person ranged from 1.41 to 5.62 ha.

Table 3-4 Population density and land allocation in PARC area

Commune	Population (person)	Land area (ha/commune)	Land holding (ha/person)
Cao Thuong	2,396	3,940.7	1.64
Cao Tri	120	2,443.3	20.36
Dong Phuc	1,025	5,765.3	5.62
Hoang Tri	1,229	3,517.9	3.86
Quang Khe	252	5,498.4	21.81
Nam Mau	2,109	5,835.4	3.76
Khang Ninh	3,171	4,479.9	1.41
Total	10,302	31,480.9	
Mean			3.05

Source: PARC Project, 2002

Only two communes, namely CaoTri and Quang Khe commune, land area per person were 20.36 and 21.81 ha, respectively. Khang Ninh commune had highest population of 3,171 people; therefore, land area per person was at lowest land area of 1.41 ha. Cao Thuong was also a commune that has high population of 2,396 people and land area per person was about 1.64 ha. These two communes were facing with a big challenge for increasing demand while soil degradation is still extremely serious.

3.2.2 Shifting cultivation and agriculture

The efforts of the central government to control the deforestation could not be enforced against the strong local needs for subsistence and their income generation. Both central and local government spent a considerable effort to settle shifting cultivators. However, a share of forestland in this area still remains such cultivation practices (PARC project, 2000).

As a consequence of shifting cultivation, a part of agricultural lands became very seriously exhausted. The main crop yield in 1995 such as paddy rice, upland rice, maize, cassava, soybean and green bean was very low (Table 3-5).

Table 3-5 Area, yield and productivity of main crops in PARC in 1995

Kind of crop	Area (ha)	Productivity (ton $year^{-1}$)	Average yield (ton ha^{-1} $year^{-1}$)
Irrigated rice	290.0	659.6	3.48
Rainfed rice	674.9	1,956.3	3.89
Upland rice	67.4	1,067.0	1.65
Maize	143.8	2,397.6	1.65
Cassava	253.0	2,530.0	10.00
Soybean	75.0	30.0	0.40
Green bean	123.9	77.3	0.60
Total	1,628		

The paddy rice, both irrigated rice and rainfed rice, covered a large area of 964.9 ha. Soybean and green bean covered an area of 198.9 ha. The crop yield in 1995 was generally achieved at low rate. Yield of spring and autumn paddy rice reached at 3.89 and 3.48 ton ha^{-1}, respectively. While yield of upland rice, maize, cassava, soybean and green bean was about 1.65, 1.65, 10, 0.4, and 0.6 ton ha^{-1} respectively.