Chapter 4
Geo-Economic Features of the Growth Corridor

CHAPTER 4 GEO-ECONOMIC FEATURES OF THE GROWTH CORRIDOR

This Study focuses on the "Growth Corridor Area", which encompasses the municipalities of Phnom Penh and Sihanoukville and the five surrounding provinces[1]. The population of the Growth Corridor Area is 4.8 million people over a total area of 31,000 km^2. This chapter describes the geo-economical features of the Growth Corridor area from the various sectoral perspectives, and summarize the issues to be addressed in the Master Plan.

The Growth Corridor Area contains three distinctive sub-areas with different characteristics: the Greater Capital Area (Phnom Penh and the surrounding Kandal Province), where the nation's administrative and economic functions concentrate; the Sihanoukville Area where the nation's only deep seaport is located, and the remaining "Intermediate Area", which is predominantly rural.

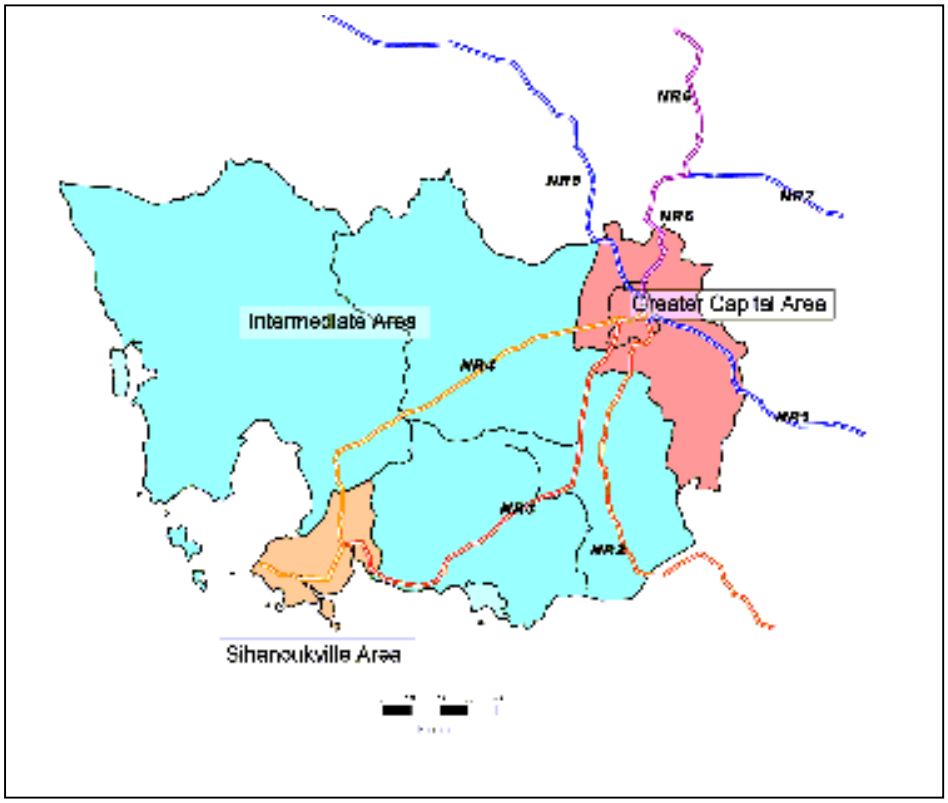


Figure 4-1 Location Map of Growth Corridor area

[1] Five provinces are Provinces of Kandal, Kampong Spueu, Takev, Kampot and Kaoh Kong.

4.1 NATURAL SETTING

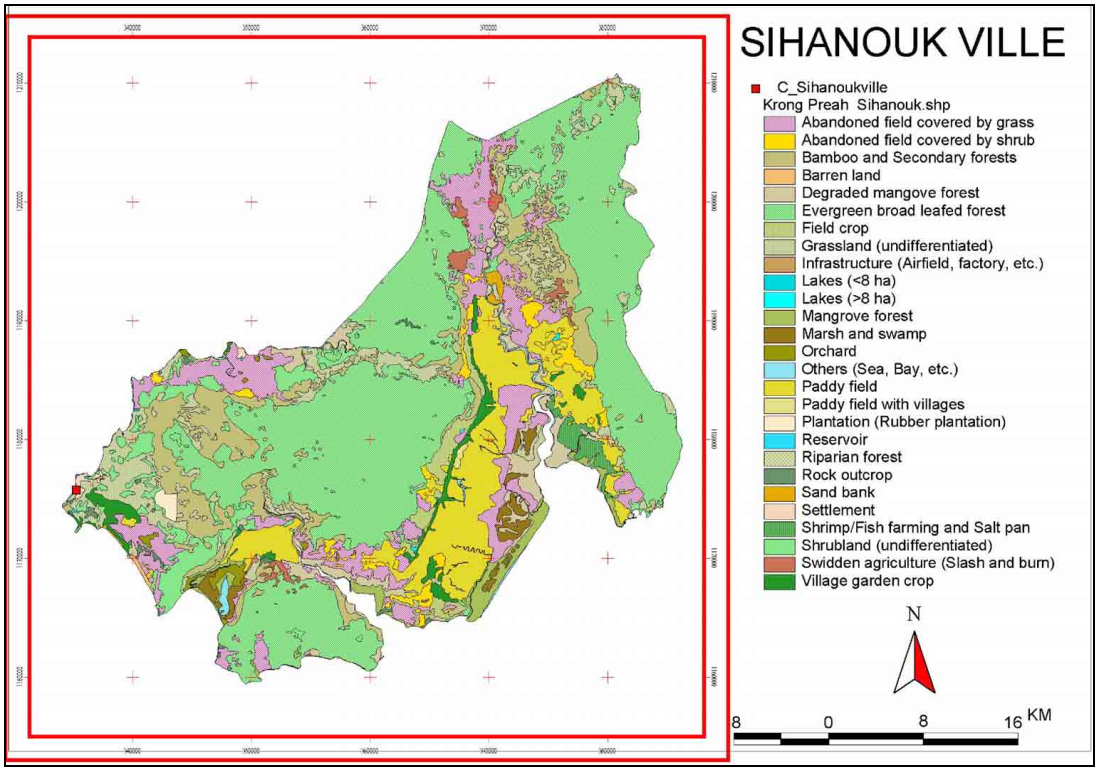
4.1.1 Geographical Features of the Study Area

(1) Sihanoukville

Sihanoukville is located 224 km southwest of Phnom Penh on the coast of the Gulf of Thailand and covers an area of 868 km^2 of which about two-thirds are classified as mountain or hilly land with the highest peak of 327 m (Phnom Mousna Mountain) and one-third is flatland including wetlands and 24 islands. The topography of Sihanoukville changes from east to west: outskirts of sandstone massif of the Elephant Mountains in the east to mud flat/sandy bottom in the west with the plain area in its center. The coastline of Sihanoukville is 119.5 km long, about a quarter of national total, of which 35 km is sand beach and the remaining 84.5 km is rock, mud and mangrove forest. Sihanoukville has a deep-water port, the only national deep-water port in Cambodia.

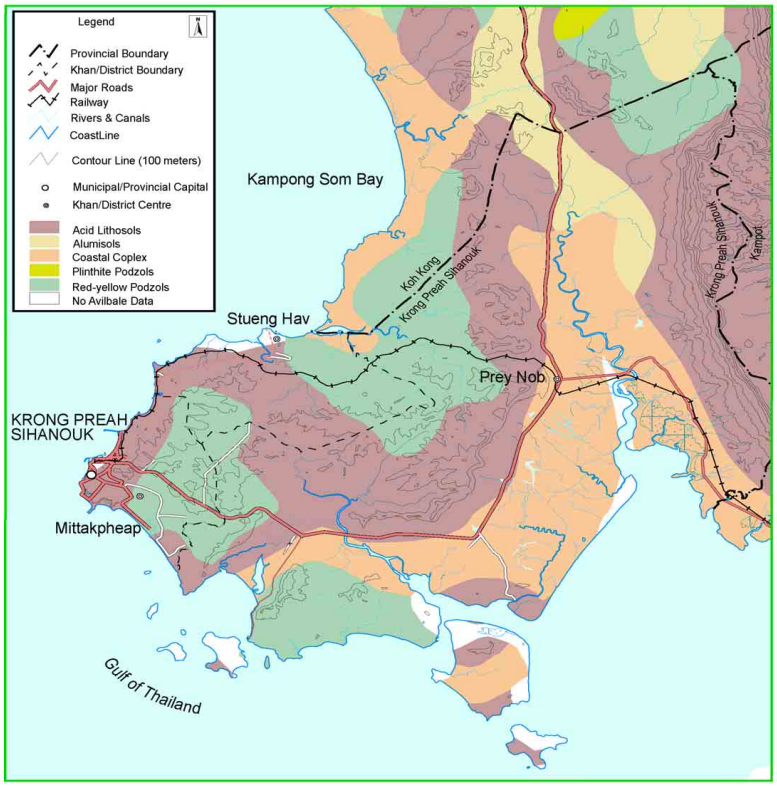
Figure 4-2 shows the current land use of Sihanoukville. The land of Sihanoukville was originally covered by a large forest area. However, the pattern of land use has been changing because of the expansion of urban area since the early 1960s. According to the study conducted by Danida, the current ratio by land use categories is as follows; forest land 65.05%, agricultural land 27.49%, inundated land 3.42%, housing land 3.42%, and vacant land 0.54%[2]. Soils mainly consist of acid lithosols, coastal ponzols and red-yellow podzols, as shown in **Figure 4-3**.

[2] Ministry of Environment and Danida, Physical Framework Plan-Sihanoukville, April 2002, p7



Source: Department of Public Works Research Center

Figure 4-2 Current Land Use of Sihanoukville



Source: JICA Study Team (Original Source: Physical Framework Plan-Sihanoukville, MOE & Danida, 2002)

Figure 4-3 Soil and Topography of Sihanoukville

The municipal center of Sihanoukville is on the headland of the peninsula and surrounded by beaches on three sides. The topography of the municipal center is moderately hilly and about 10 m above sea level with the highest point 130 m. The center covers an area of 88.92 km^2 and the current ratio by land use categories is as follows; residential/commercial area is 16.8 km^2 or 19% of the total area, industrial area 10 km^2 or 11%, tourist area 6.5 km^2 or 6.3%, recreational area 3.5 km^2 or 4%, port area 1.5 km^2 or 1.7%, and protected area and others 51.5 km^2 or 57%[3].

The climate of Sihanoukville comes under tropical monsoon. **Table 4-1** shows the average monthly temperature in Sihanoukville. As shown in **Table 4-1**, the average maximum temperature is above 32 Celsius from March to July, while the average minimum temperature is below 24 Celsius from January to February and in December. The highest average maximum temperature is 32.6 Celsius recorded in April and May, while the lowest average minimum temperature is 21.5 Celsius recorded in January in the period from 1997 to 2001. Judging from the average mean temperature, April and May are the hottest months in the year, but the temperatures of this season in Sihanoukville are lower than the temperatures of the Greater Capital Area.

Table 4-1 Average Temperature in Sihanoukville (average of year 1997 to 2001)

(Unit: Celsius)

Province \ Month		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Sihanoukville	Average Minimum	22.4	23.9	24.2	25.5	25.6	24.9	24.2	24.1	24.4	24.1	24.0	23.2
	Average Mean	26.3	27.3	28.2	28.7	28.8	28.3	28.0	27.1	27.1	26.9	27.0	26.6
	Average Maximum	30.3	31.5	33.1	32.6	32.6	32.5	32.5	31.2	30.2	30.5	30.5	30.2

Source: Department of Meteorology, Ministry of Water Resource and Meteorology

Sihanoukville receives the highest volume of rainfall in the study area. The annual rainfall in Sihanoukville was 3097.7 mm in 2002 and 3112.3 mm on the five-year average. As **Table 4-2** shows, the annual precipitation varies every year, but the volumes were above 2,000 mm throughout past six years. The rainy season is from May to November. As shown in **Table 4-3**, the precipitation is especially high from June to September. The highest monthly rainfall volume in the past six years was 962.8 mm recorded in Aug. 2000. On the other hand, the period from January to April and December is the dry season. The average monthly precipitation is lower from January to March and in December. Localized torrential downpours during the rainy season sometimes cause floods. The monsoon flows from the southwest during the rainy season and from the northwest during the dry season[4].

[3] The calculation is based on the study conducted by the Fraser Thomas.

[4] According to the record of the meteorological station in the Sihanoukville airport, strong wind had been rarely observed during the period from 1863 to 1979. The strongest wind observed is 9 m/s.

Table 4-2 Change of Annual Rainfall volume in Sihanoukville (1997-2002)

(Unit: mm)

1997	1998	1999	2000	2001	2002	Average (1997-2002)
2291.1	2749.4	3734.0	3476.5	3324.8	3097.7	3112.3

Source: Department of Meteorology, Ministry of Water Resource and Meteorology

Table 4-3 Average Monthly Rainfall Volume in Sihanoukville*

(Unit: mm)

Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
30.9	38.9	96.3	169.9	281.6	442.5	564.7	651.9	370.2	284.6	152.6	28.1

*Average of 1997 to 2002 monthly rainfall volumes

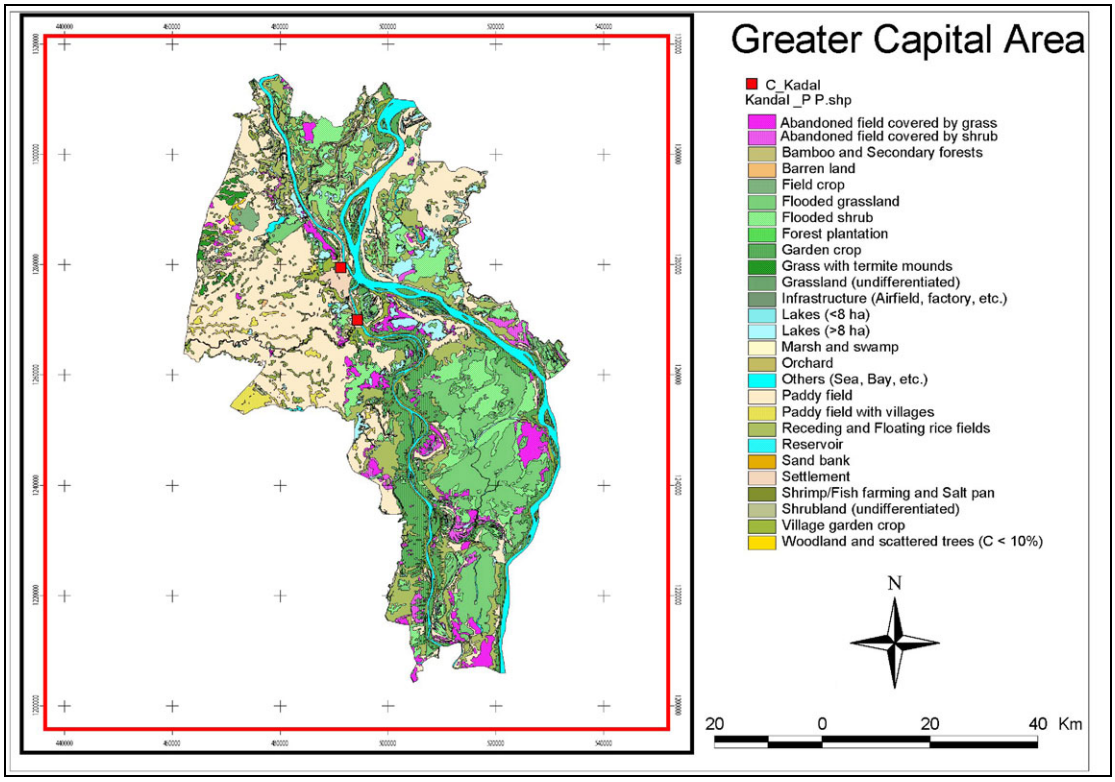
Source: Department of Meteorology, Ministry of Water Resource and Meteorology

Sihanoukville has 32 small rivers and streams that flow into the Gulf of Thailand with the water levels increasing and decreasing depending on the volume of rainfall. The Prek Teouksap and Prek Kampong Smach are relatively big among these rivers. Domestic waste and wastewater from the factories are discharged to the rivers with no treatment and the effluent affects the marine ecosystem.

(2) Greater Capital Area

The Greater Capital Area consisting of Phnom Penh Municipality and Kadal Province is located on the delta of four large rivers, Tonle Sap River, Upper and Lower Tonle Mekong Rivers, and Tonle Bassac River, and the south of Kandal borders on Vietnam. The Upper Tonle Mekong River branches off the other three rivers at Phnom Penh. The Tonle Sap River flows backward to the Tonle Sap Lake from the middle of June to October because the high water level that stems from the high volume of rain and melt-water.

Figure 4-4 shows the current land use of the Greater Capital Area. The Greater Capital Area covers an area of 3,929 km^2 (Phnom Penh 375 km^2 and Kandal 3,553 km^2) of which about 37% is used for agriculture and 10.5% is residential area. The topography of the Area moderately slopes down from west to east and from north to south with the highest terrain zone in the northwest (the highest point is 283 m). The Area is flood prone and flooding tends to occur from July to October. The urbanized area in the Greater Capital Area is 27.08 km^2 and the total of residential and commercial use accounts for almost 80% of the land use as shown in **Table 4-4**. The Greater Capital Area lies on Holocene and Old alluvium mainly consisting of unconsolidated silt and clay with some sand covers. The alluvium overlays weathered rock and clay at the depth of 30 to 50 m with hard crystalline rock on its base. It is estimated that there is no artesian aquifers in the Greater Capital Area.



Source: Department of Public Works Research Center

Figure 4-4 Current Land Use of the Greater Capital Area

Table 4-4 Land Use of the Urbanized Area in the Greater Capital Area

Land Use Category	area (ha)	%
Residential Area	1,314	48.5%
Commercial Area	792	29.2%
Industrial Area	80	3.0%
Public Facilities	192	7.1%
Agricultural Land	14	0.5%
Parks & Open Space	36	1.3%
Wetland	—	—
Water Surface	280	10.3%
Total	2,708	100.0%

Source: the Transport Master Plan of the Phnom Penh Metropolitan Area, JICA and Municipality of PHN, 2001

The temperature and rainfall volume of the Greater Capital Area fluctuate affected by the tropical monsoon climate. **Table 4-5** shows the average monthly temperature in Phnom Penh (data of temperature in Kandal is not available). As shown in **Table 4-5**, the average maximum temperature exceeds 34 Celsius from March to May, while the average minimum temperature is below 23 Celsius from January to February and in December. The disparity between minimum and maximum temperature in the Greater Capital Area is bigger than in Sihanoukville. The highest average maximum temperature is 36.3 Celsius recorded in March,

while the lowest average minimum temperature is 20.0 Celsius recorded in December in the period from 1997 to 2001.

Table 4-5 Average Temperature in Phnom Penh (average of year 1997 to 2001)

(Unit: Celsius)

Province \ Month		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Phnom Penh	Average Minimum	22.1	22.9	24.4	25.2	25.4	24.9	24.7	24.7	24.4	24.1	23.1	21.7
	Average Mean	26.8	27.8	29.6	30.1	29.8	29.2	28.6	28.6	28.3	27.4	26.5	25.9
	Average Maximum	31.5	32.8	34.8	34.9	34.3	33.5	32.5	32.5	32.3	30.9	29.9	30.0

Source: Department of Meteorology, Ministry of Water Resource and Meteorology

Table 4-6 shows the change of annual rainfall volume in the Greater Capital Area in the past six years. The annual rainfalls in Phnom Penh and Kandal were 1,230.6 mm and 1,190.3 mm in 2002 respectively, and average annual rainfalls of the past six years were 1,568.1 mm and 1385.8 mm respectively. As shown in **Table 4-6**, the annual precipitation fluctuates from year to year. The maximum precipitation was 2095.9 mm recorded in Phnom Penh in 2000 and the minimum was 1190.3 mm recorded in Kandal in 2002. The monthly precipitation also varies as shown in **Table 4-7**. The rainfall volume is relatively low from January to April and in December, and then, it increases from May. The precipitation is especially high from September to October.

Table 4-6 Change of Annual Rainfall volume in the Greater Capital Area (1997-2002)

(Unit: mm)

Province \ Year	1997	1998	1999	2000	2001	2002	Average (1997-2002)
Kandal	1195.3	1204.3	1639.7	1780.3	1304.7	1190.3	1385.8
Phnom Penh	1400.2	1484.5	1593.1	2095.9	1604.4	1230.6	1568.1

Source: Department of Meteorology, Ministry of Water Resources and Meteorology

Table 4-7 Average Monthly Rainfall Volume in the Greater Capital Area*

(Unit: mm)

Province \ Month	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Kandal	20.3	6.0	32.1	86.8	113.5	137.1	134.2	180.5	166.6	328.5	127.7	74.6
Phnom Penh	31.9	11.5	58.8	87.6	106.1	168.8	178.2	172.5	246.4	312.7	139.3	76.7

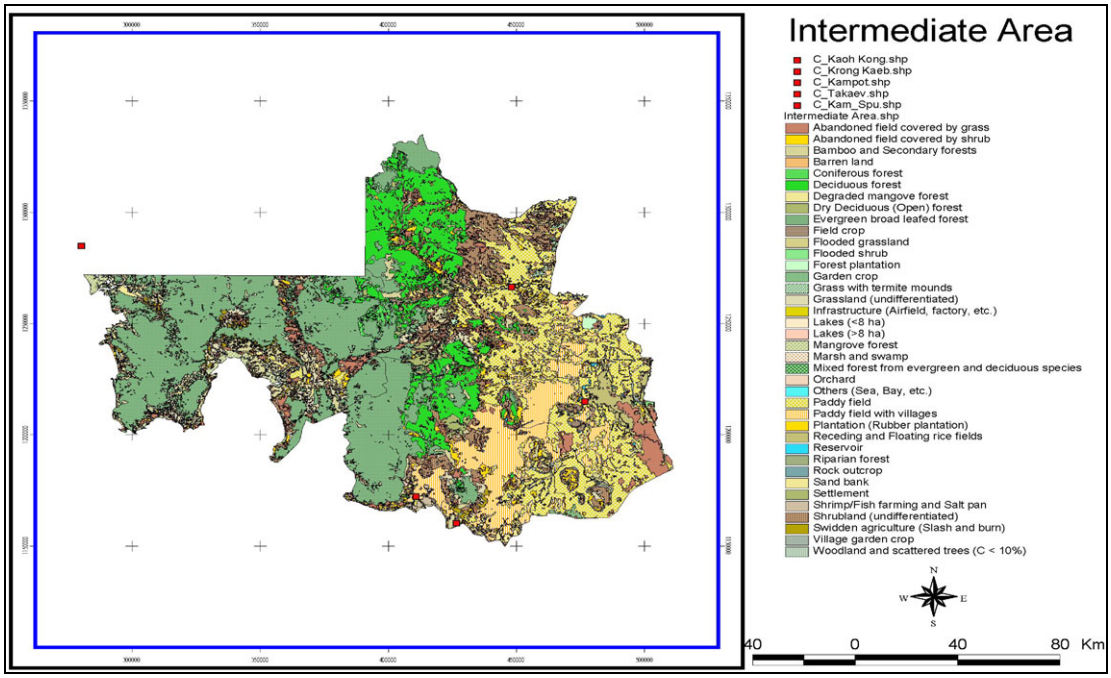
*Average of the 1997 to 2002 monthly rainfall volumes

Source: Department of Meteorology, Ministry of Water Resources and Meteorology

(3) Intermediate Area

The Intermediate Area consists of four provinces; Takaev, Kampong Spueu, Kampot, and Kaoh Kong (from east to west) with an area of 26,949 km^2 which accounts for about 85% of the total study area. Plateaus or mountainous areas occupy about 61% of the Intermediate Area, and the remaining 28% is categorized as plain and 9% is coastal zone. Most of the area in Takaev, and the areas in the eastern halves of Kampong Spueu and Kampot are plain (32% of the area in Kampong Spueu and 38% of the area in Kampot are plain). The Cardamom Mountains and the Elephant Mountains cover most of the area in

Kaoh Kong, and the areas in the western halves of Kampong Spueu and Kampot. Plateau and mountainous areas occupy 83% of Kaoh Kong, 68% of Kampong Spueu, and 52% of Kampot. The current land use of the Intermediate Area is shown in **Figure 4-5**.



Source: Department of Public Works Research Center

Figure 4-5 Current Land Use of the Intermediate Area (there is no data for a part of Kaoh Kong)

Soils of the eastern part of plain in the Intermediate Area (mainly the eastern part of Takaev) are black cracking clay with high organic matter benefiting from the annual flooding of the Tonle Bassac River. The higher land in the western part of the plain in the Intermediate Area (western half of Takaev, eastern halves of Kampong Spueu and Kampot) has red soils with low organic matter. Soils of the plateau and mountainous areas mainly consist of acid lithosols and red-yellow podzols.

Table 4-8 shows the average monthly temperature in Kampot (data on temperature in another provinces in the Intermediate Area is not available). As shown in **Table 4-8**, the average maximum temperature is above 32 Celsius from March to May. Judging from the fact that the average minimum temperature rarely exceeds 24 Celsius all year round, it is relatively cool in the night and early morning. The highest average maximum temperature is 33.5 Celsius recorded in April and May, while the lowest average minimum temperature is 23.0 Celsius recorded in January in the period from 1997 to 2001. The change of temperatures in the Intermediate Area varies. Therefore, the above description on the temperature of Kampot cannot apply to the Intermediate Area as a whole.

Table 4-8 Average Temperature in Kampot (average of year 1997 to 2001)

(Unit: Celsius)

Province \ Month		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Kampot	Average Minimum	21.9	22.5	23.0	23.9	24.0	23.7	23.7	24.2	23.9	23.9	23.3	22.9
	Average Mean	26.5	27.1	27.6	28.4	28.3	27.8	27.4	27.7	27.8	27.7	27.2	27.0
	Average Maximum	31.1	31.8	32.2	32.9	32.7	31.9	31.1	31.2	31.7	31.6	31.2	31.1

Source: Department of Meteorology, Ministry of Water Resources and Meteorology

As shown in **Table 4-9**, the annual rainfalls in the Intermediate Area vary by year and province. Kampot province, which faces the Gulf of Thailand, has a higher volume of rainfall than Takaev and Kampong Spueu, which are located in the eastern part of the area. The minimum precipitation in the past six years was 734.9 mm recorded in Kampong Spueu in 2002 and the maximum was 2,532.9 mm recorded in Kampot in 1999. The monthly precipitation also varies by province as shown in **Table 4-10**. There is hardly any rain from January to February and in December, but the volume of rainfall begins to increase from March in Kampot, and from April in Takaev and Kampong Spueu. The precipitation is especially high from June to October in Kampot, and from August to October in Takaev and Kampong Spueu.

Table 4-9 Change of Annual Precipitation in the Intermediate Area (1997-2002)

(Unit: mm)

Year / Province	1997	1998	1999	2000	2001	2002	Average (1997-2002)
Takaev	904.1	1228.9	1533.9	1599.3	1521.0	1248.7	1339.3
Kampot	1919.8	1255.1	2532.9	2337.0	2316.8	1626.1	1998.0
Kampong Spueu	1020.0	1281.5	1668.8	1877.4	1650.8	734.9	1372.2
Kaoh Kong	no data	no data	no data	no data	no data	no data	—

Source: Department of Meteorology, Ministry of Water Resource and Meteorology

Table 4-10 Average Monthly Rainfall Volume in the Intermediate Area*

(Unit: mm)

Province \ Month	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Takaev	20.0	5.1	42.0	115.3	105.1	89.3	125.8	160.7	176.0	368.5	135.0	45.6
Kampot	26.8	17.2	128.0	132.4	176.7	203.8	282.2	411.7	206.8	243.6	190.2	41.4
Kampong Spueu	36.8	6.5	78.6	117.1	123.6	96.3	101.4	214.7	232.3	245.2	108.4	31.8
Kaoh Kong	—	—	—	—	—	—	—	—	—	—	—	—

*Average of the 1997 to 2002 monthly rainfall volumes

Source: Department of Meteorology, Ministry of Water Resource and Meteorology

The canal network in Takaev is the densest of all the provinces in Cambodia, comprising 3,450 km of principal canals of which about 20 to 25% have been in use[5]. The direction of water flow in the eastern part of plain in the Intermediate Area changes with the annual flooding of the Tonle Mekong Rivers, and the Tonle Bassac River. Along the coastline in the Intermediate Area, the rivers run

[5] As canals interlink many reservoirs, there are few discrete irrigation systems.

westwards from the Cardamom Mountains and have catchments of about 15% of the land area. The rivers flowing into the Gulf of Thailand are relatively short and small, and their water levels fluctuate drastically with the volume of rainfall. Nine rivers running in Kampot and six rivers running in Kaoh Kong are relatively large[6].

4.1.2 Soil Condition

The soils in the study area are not as well endowed as in the other parts of Cambodia. Three types of soils are dominant:

- The eastern part of the plains, part of Kandal and Takaev, has relatively good soil for cultivation. Nonetheless the land productivity remains low because of the regular occurrence of floods.
- In the western plains, in the eastern half of Kampong Spueu and Kampot, soils are not fertile. Land productivity is relatively low due to this, together with the limited water supply.
- In the mountains, rainfall is plenty but flooding does not occur. The soil is generally sandy, thin, and not fertile. This kind of soil is not suitable, to intensive cultivation.

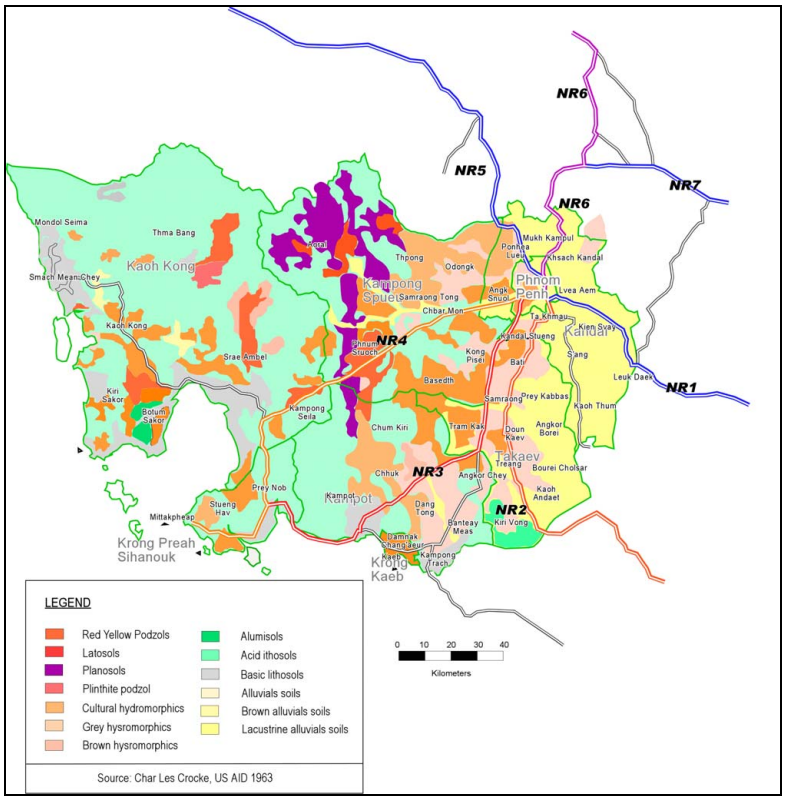


Figure 4-6 Soil Map of Study Area

6 The nine rivers in Kampot are the Kampong Krognoung, Kbal Romeas, Kampong Bay River, B.G.I, Koh Toch, Kdart, Smach, Thnaut and Trapeng Ampov. The six rivers in Kaoh Kong from north to south are the Stung Meteouk, Stung Russei Chrum, Stung Sala Munthun, Stung Chhay Areng, Prek Piphot and Prek Kampong Som.