CLIMATE AND GEOMORPHIC PROCESSES

Climate studies of any region entails the detailed analysis of temperature, precipitation, humidity, atmospheric pressure and wind. The Kalyani River Basin has an unique climatic disposition given its location as well as topography. Surrounded by high mountains and hills on three sides and the plateau of Meghalaya on the east, the south west monsoon winds are deflected and compressed through its narrow valley.

The factors affecting the climate of the Kalyani River Basin can be summarized as follows:

1. The situation and alignment of the hills and the narrow valley of the Kalyani River.

2. The seasonal change in the pressure condition of the Bay of Bengal to the south of the landmass of the northeastern part of the subcontinent and the northwestern landmass of India.

3. The tropical oceanic (south west) airmasses that blow over this region.

4. The influence of the occasional westerly disturbances in winter.

5. Presence of local valley winds.

6. Presence of vast waterbodies (oxbow lakes at the lower course) and forest cover leading to development of local cyclonic conditions before the summer months.

The Kalyani River Basin falls broadly under the humid tropics given its latitudinal position (26° 13' 47" N - 26° 40' 38" N). Though the geomorphic processes are partly guided by the underlying physical structure of the region, climatic influence in the form of gradational processes have a major role to play.
CLIMATIC ATTRIBUTES OF BASIN

Climate directly influences the natural vegetation of any region through precipitation, evaporation, daily range of temperature, wind velocities and direction while atmospheric pressure, relative humidity have an indirect impact.

The Kalyani River Basin is part of a raised portion of landmass (Mikir Plateau) adjoining the Meghalaya Plateau. The Himalayan mountain range to the north and the Naga Patkai ranges to the east prevents the escape of the moisture laden south west monsoon winds. The Meghalaya Plateau cause the orographic rise and the collision of these winds.

This leads to copious amount of rainfall in the nearby hills of Mawsynram and Cherrapunji, yet the Kalyani River Basin aligned to the flow direction of these winds do not receive such heavy rainfall. These can be attributed to the terrain configuration of the basin, which is a rainshadow region.

With the northwards migration of the sun during the summer season, landmasses heat up and a low pressure system develops. This leads to a steep pressure gradient with that of the sea to the south. Occasional thundersqualls and rainfall is common during the months of March–April in the Kaliani River Basin. They are locally known as Bardoichila and move with a speed of 50 - 65 km/hr. Dust storms are common during springs, while summers are hot and dry with winters usually accompanied by haze, mist and fog.

Here both the areal variations as well as the seasonal conditions have been discussed meanwhile keeping in mind the availability of climatic data from nearest district headquarters at Diphu. The study are has no meteorological stations monitored by the government. (Fig. 4.1).

RAINFALL

The rainfall regime of the Kalyani River Basin is shown in Fig 3.1. It is noted that rainfall varies from a minimum of 920 mm at Diphu situated 160 km south of the study area to a maximum of 3190 mm at Bhitor Kaliani located to the north east of the basin. The meteorological station of Diphu lies about 160
km to the south of the river basin. The region receives a mean annual rainfall of 974.83 mm only. The variation in rainfall is chiefly due to changes in elevation, disposition and alignment of the minor river valleys and the scarps and ridges of different orders. The central part of the river basin falls in the rainshadow zone and receives light and scanty rainfall.

The five rainfall zones identified are:

i) less than 50 cm ii) 50 cm - 100 cm iii) 100 cm – 150 cm iv) 150 cm - 200 cm v) more than 200 cm. The highest rainfall is over 200 cm in the northwestern part of the basin where the Kalyani River originates as a waterfall and enters the narrow valley on the northwestern portion of the basin as the Langkangtang Langso (Ref. Table 4.1)

Since the Kalyani River Basin is elevated more along the southern periphery, the gap created by the minor channel of Langlakso Nadi leads to free entry of the moisture laden south west monsoon winds in alignment with the channel course. The northern limits of the basin are elevated thus leading to copious amounts of rainfall as high as 250 cm within the Kalyani River Basin.

The amount of rainfall decreases as one proceeds east within the basin reaching a lowest of 35 cm at Khelan Terrangaon which lies in the rainshadow zone of the southern uplands. The uplands have elevations of over 1100 m and is responsible for minimal precipitation as they inhibit the moisture laden south west monsoon winds from reaching over to the leeward sides. The rainfall here is chiefly orographic in nature with clyonic disturbances occurring for a brief period (5 – 7 days) during the month of April.

The eastern part of the Kalyani River Basin which shares its physiographic boundary with the flat expanse of the Golaghat plains is fed by the retreating northeast monsoons during the months of October - December. The Daigurung water divide facilitates shedding of some moisture on its windward side.
### TABLE 4.1: DISTRIBUTION OF MEAN ANNUAL RAINFALL WITHIN THE BASIN

<table>
<thead>
<tr>
<th>Station</th>
<th>Elevation above M.S.L (in metres)</th>
<th>Location in the Kaliani River Basin</th>
<th>Rainfall (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Kaja Kramchcha</td>
<td>293</td>
<td>South west on the right bank of Langlakso Nadi</td>
<td>203</td>
</tr>
<tr>
<td>2. Shikari Ranghänger</td>
<td>280</td>
<td>On the left bank of Langlakso Nadi.</td>
<td>218</td>
</tr>
<tr>
<td>3. Chaprasi Rangpahar</td>
<td>283</td>
<td>On the left bank of Dukhia Langso before it joins the Phang Langso</td>
<td>177</td>
</tr>
<tr>
<td>4. Dikru Timmangaon</td>
<td>290</td>
<td>Left bank of Nihang Langso</td>
<td>76</td>
</tr>
<tr>
<td>5. Bepar Terrangaon</td>
<td>320</td>
<td>On the right bank of Tarapung Nadi flowing west and then south to the north of the basin.</td>
<td>115</td>
</tr>
<tr>
<td>6. Lãntuk Terrangaon</td>
<td>290</td>
<td>On the right bank of Tarapung Nadi flowing south to the north of the basin.</td>
<td>106</td>
</tr>
<tr>
<td>7. Sikari basti</td>
<td>192</td>
<td>On the right bank of the Kaliani River – central part of the valley.</td>
<td>128</td>
</tr>
<tr>
<td>8. Tuchchagaon</td>
<td>160</td>
<td>On the left bank of the Kaliani River – central part of the valley.</td>
<td>107</td>
</tr>
<tr>
<td>9. Charikuthi</td>
<td>140</td>
<td>On the right bank of the Kaliani River – eastern part of the valley.</td>
<td>100</td>
</tr>
<tr>
<td>10. Sanghpi Dinphigaon</td>
<td>130</td>
<td>Flat alluvial plains on the eastern part of the basin on the right bank</td>
<td>200</td>
</tr>
</tbody>
</table>
The rainfall zones of the Kalyani River Basin follow the alignment of the ridges and the scarps aligned south west to north east chiefly. The moisture laden winds which enter the Kalyani River valley from the south west are obstructed by the waterdivide of the Nihang Langso, and they veer north east after shedding moisture on the windward side. Thus mostly dry winds enter the valley from the west and barring local pockets which receive some precipitation ranging from 50 cm - 150 cm. The heaviest rainfall is received during the months of August and September with October being nearly dry, followed by minor showers during November and December.

**Long Term Variation in Rainfall**

Long term variation in rainfall in the region in the same place has been noted at Sarthe Terrangaon. The mean annual rainfall at this location varied from a maximum of 142.6 cm in 2003 to a minimum of 100 cm in 2007. During the month of December in 2008 the rainfall varied from 40 cm to a maximum of 104 cm.

**TEMPERATURE**

The distribution of temperature is affected by the inclination, duration and intensity of the sun’s rays, altitudinal variations, amount of cloud cover and humidity conditions. Since the major portion of the Kaliani River Valley lies in the rain shadow region, the summer climate is dry due to minimal presence of moisture in the air. Broadly the latitudinal position (26° 13' 47" N - 26° 40' 38" N) of the Kalyani River Basin imparts to it a humid tropical type of climate. Coupled with its local influence of elevated highlands to the southern margin of the basin, the rainshadow effect within the basin is crucial, to impart it a humid subtropical type of climate. October is the driest month of the Kalyani River Basin with the cold north east winds bringing down temperatures during the months of November, December and January. With the end of February temperatures begin to rise within the basin and March, April, May and June are considerably hot with temperatures ranging from 23.4° Celsius to 35° Celsius.
The diurnal range of temperature is high with nights being cool and afternoons being hot. The mean daily temperature at Kaja Kramchcha varies 8.4º Celsius in January to 33.4º Celsius in June. The maximum and minimum temperatures for the Kalyani River Valley has been recorded at 23.4º Celsius to 8.4º Celsius respectively during January and rises to a range of 33.9º Celsius to 23.8º Celsius respectively during June.

**ATMOSPHERIC PRESSURE**

Atmospheric pressure is a significant indicator of climatic variables like wind and rainfall. Regions of low pressure zones create a pressure gradient with that of a nearby high pressure zone to suck in winds and vice versa.

The Kalyani River Basin falls under the system of Asiatic Low which encompasses areas central Asia and south west Asia and are responsible for the summer monsoon rains of Asia. During winters an intense high pressure system develops in the region with the sea to south maintaining a low pressure system. The cold northeast winds enter the Kalyani River Valley from the eastern margin and flows through the narrow valley bringing down temperatures to as low as 8.4º Celsius. Day time heating results in upvalley winds but cold heavy air moving down the valley sides lead to cold nights.

**WIND CONDITION**

The wind pattern is south westerly to northeasterly during the summer months and reversed during the winter months. The winds from the valley sides move down during nighttime due to high pressure on the slopes and they flow up the valley sides during daytime. The wind velocity recorded at Kaja Kramchcha is 16 km/hr, Shikaribasti is 20 km/hr and at Sanghpi Dinphigaon 17 km/hr during the late summer month of June. The number of calm days are highest January and February and least during the months of March, April and May.

**RELATIVE HUMIDITY**

Relative humidity is the amount of moisture in the air compared to the amount the air can hold at a particular temperature. When the air is unable to hold the available moisture it condenses to form dew. Since the Kalyani River...
Basin is covered by dense cover of moist mixed deciduous forests the humidity in the region ranges from 78% to 52% in the mornings and evenings respectively at Kaja Kramchcha. Daytime humidity is higher compared to the evenings. The months of August and September have the maximum humidity at 80% while it is least during January 50%. The daily range of humidity is maximum during the winter season and least during the rainy season.

SEASONAL VARIATIONS

The following four seasons are noted in the Kaliani River Basin:

1) Winter Season (December - February): With the southward migration of the sun, winter sets in during November and continues till the end of February. The weather during this period is influenced by the high pressure system of central Asia, the subtropical jet stream and the high pressure system to the east.

The winters are cold with temperatures falling to 7º C in January. The daily range of temperature during this season varies from 8º C in December to about 10º C in February. Winter showers are recorded during the months of January to February. About 48.5 cm of rainfall is received during these months. December is the driest month of the year. This attracts incursion of moisture from the Mediterranean region leading to short spells of cloudy and drizzly weather. The cold northeast trade winds bring down temperatures further leading to presence of thick fog over the entire valley. The valley bottoms have thick fog early morning while the upper reaches have foggy conditions as afternoon gives way to evenings. The total number of foggy days range from 60 to 100. (Ref. Fig.4.1)

2) The Hot Weather Season (March - June): The month of late March signifies the coming of local weather disturbances in the form of cyclonic circulations called Bardoichilla and temperatures rising progressively to form the hot summer months.

These months can be called as a transitional phase from the cool winters to the wet monsoons. The chief character of these months are the rapidly increasing temperatures, disappearance of fog and frequent occurrences of thundershowers. With the northward migration of the sun temperatures rise.
over the valley floors rapidly compared to the elevated areas creating steep pressure gradients. The temperature ranges from a maximum of 38.5º C to a minimum of 10.9º C. The diurnal range of temperature is very high with cool nights and hot afternoons.

At the beginning of the season i.e. in March low level sweeping winds blow over the valley culminating in dust storms bringing down visibility and causing hazards. Of late it has been noticed that monsoons are delayed with the increase in amount of rainfall probably due to clearing of slopes for shifting cultivation. The June temperatures for 2007 was 23.6ºC, for 2009 was 32.3º C and for 2010 was 33.4ºC. This signifies the rise in valley temperatures and inability of the land to contain the heat due to depleting natural vegetation cover.

3) The Rainy Season (July - October): The low pressure conditions prevailing within the valley allow the incursion of south west monsoon winds from the south west. As these winds are less than 5 kms from the surface, they bifurcate and one arm strikes against the southern slopes of the water divide of the Nihang Langso shedding moisture while the other arm enters the Kaliani River Valley through its opening at the south western portion. The whole of the region is covered by the monsoon rains by the 20th of June.

The leeward sides of the Kalyani River Basin receive less rainfall. For example Shikari Ranghbang receives 218 cm of rainfall while Dikru Terrangaon receives only 76 cm of rainfall lying in the rainshadow zone of the southern slopes. The number of cloudy days are maximum during this season ranging from 18 to 23 days. In August and September the relative humidity is as high as 93% to 94% and the diurnal range of temperature is lowest at 5ºC to 7ºC.

4) The Transitional Period of November: This season is characterized by negligible rainfall in the initial days measuring 35.7 cm gradually leading to 7.3 cm as the days progress. There is gradual lowering of temperature and the nights become colder. The diurnal range of temperature is 5ºC to 7ºC relative humidity varies from 52% to 54%. The days are dry and the skies are clear with no cloud cover.
GEOMORPHIC PROCESSES OPERATING WITHIN THE BASIN

Those natural processes whether physical or chemical which help to bring about a gradual change in the morphology of landforms are called as geomorphic processes. The Kalyani River Basin experiences geomorphic processes of the physical type and very few pockets are influenced by chemical degeneration of rock masses. Since the predominant rock types are granite and gneisses, penetration and percolation of rainwater is minimal.

WEATHERING

Chemical weathering is noted along the deposits of limestone and removal of forest cover has resulted in slope wash, sheet erosion and decaying of rocks through action of rainwater. Physical weathering is dominant on the dissected and sparsely covered slopes.

Exfoliation is evident pointing to high range of diurnal temperatures. Block disintegration and exposure of columns sandstones are evident along the river banks.

Physical weathering is especially noted in regions which are not covered by vegetation or have a thin soil cover. Such examples can be found at Dikru Timmangaon, Bepar Terrangaon and Baliram Terrangaon.

Physical weathering in the form of exfoliation has been noted within the basin, and most rock masses have been reduced through spheroidal exfoliation. Cracks along zones of weakness within the has been noted upon platform like rock outcrops and points to the operation of alternate heating and cooling of these rock masses. (Plate 3.6)

MASS MOVEMENT

Mass movement is the movement of loosened earth debris along a slope to the lowest possible point. Mass movement in the Kalyani River Basin is noted within the subwatershed of the Jhanganri Nadi (right bank) and the BarPung Langso (left bank). Landslides due to loosening of underlying soil along with slumping is noted along the tributary valley of the Tarapung Nadi (left bank). Deposition of loosened materials is noticed on gentler slopes of the along both banks of the Kalyani River but in small pockets.
Shifting agriculture in the region leads to loosening of soils on the slopes and when the rains come creep downslope to be deposited in the channel, leading to risks of flooding.

**CLIMATIC INFLUENCE UPON LANDFORMS**

Climate plays a significant role in initiating geomorphic processes which lead to alteration in their surficial forms. It should be noted that climate provides the agents for denudation, degradation and erosion. They are, temperature, precipitation and wind, to carve out varied landforms shaped by endogenetic processes such as plate movements, lava ejection, block movements or faulting. Any landform on the surface of the earth is a combined function and result of both physical as well as climatic processes taking gradual time to evolve and still be under the influence of the changing process.

As there are different climatic regions on the earth’s surface the intensity, type and nature of influence of the different climatic agents vary from region to region due to thermal gradients caused by latitudinal, seasonal, land and water spread variations. Vegetation faces the direct impact of climatic influence and grows in response to the scope of moisture availability, wind direction, temperature, amount of insolation received, evaporation and nature of soil as rendered by the climate of the region. The combined impact leads to varied geomorphic processes in different climatic regions.

Thus an arid climatic will have different geomorphic processes operating within its region in contrast to those operating in humid climates.

The physical features within the Kalyani River Basin are a result of both endogenetic as well as exogenetic processes. As exogenetic processes are climate influenced, they are directly related to the intensity and variability of rainfall, temperature, atmospheric pressure, wind, cloud cover etc. Frost action in cold moist climates results in the physical weathering of rocks. In humid tropics, high temperatures and plentiful supply of moisture lead to chemical weathering. Both physical and chemical weathering are important agents of rock decay in the humid region of the Karbi Anglong Plateau. Ruggedness of terrain leads to local climatic variations which determine the intensity of operation of various geomorphic processes. Besides the physical properties of
the waste mantle as well as the nature of vegetal cover and run off characteristics also help to shape these landforms.

Geomorphic processes produce landforms which reflect the climatic influence under which particular landforms developed. Budel (1944), suggested that the morphogenetic regions that develop are due to a certain set of climatic conditions where particular geomorphic conditions will predominate and give rise to landscape characteristics which will differ from landscapes developed under different climatic conditions.

Peltier (1950) has suggested a tentative list of morphogenetic regions and attempted quantitative definitions of them in terms of temperature and moisture conditions and has suggested likely dominant geomorphic processes in each region. According to Peltier’s model for possible mean annual rainfall (0 – 90 inches) and mean annual temperature (10° - 80° F), the boundaries suggested of morphogenetic regions are: glacial, periglacial, boreal, savanna, arid, maritime moderate and selva.

Following Louis Peltier (1950) and the mean annual temperature and rainfall of the basin is considered as 18.6º C and 120cm respectively suggesting a moderate morphogenetic region.

Among the denudational processes, running water and mass-movement is noted chiefly. Block failure of rock masses is noticed near the banks of the Kalyani River at Tuchchagaon. Since the southern western part of the basin is elevated compared to the northern part, the southern part encounter the rainbearing cloud foremost and hence receive more rainfall and are intensely dissected and steeper.

Decomposed rock mantle when in prolonged contact with rain water easily loosen them selves along the slopes on the banks of the Barpung Langso and Tarapung Nadi to result in frequent landslides. Foliated rocks like slates and quartzites lead to steeply downward dipping slopes in some parts of the Kalyani River Basin.

The Kalyani River Basin falls under moderate morphogenetic region and experiences maximum impact of fluvial erosion.