CHAPTER III

Climate and Vegetation
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Introduction - In general the climate is a dominant environmental factor influencing greatly not only processes operating in the terrain but also the agricultural prosperity of the Middle Mahanadi basin. It has also controlled the choice of farming systems through its influences on soil along with soil erosion and accelerated erosion. The area enjoys a seasonal rainfall under the monsoons encompassing the various climatic elements like the temperature, length of the day, moisture, precipitation which are of greatest significance in the agricultural pursuits particularly determining the crop combinations of the part of middle Mahanadi area. Discussions have also made on the occurrences of diversity of weather and climate mentioning their relationships in the soil moisture deficit budget in the study area. The present worker likes to stress on the climatic nature of the area and the surrounding areas with an object to correlate them with the development of the picturesque landscape as well as the variegated land use pattern of this area.

The rainfall pattern in the region is mostly controlled by the South West Monsoon and the retreating North East Monsoon wind system currents. The region shows low annual rainfall excepting the eastern hilly region. Sinha (1971) has correctly pointed out that though the State Orissa is located on the eastern coast of India, but it does not come under the direct path of S.W. monsoon with the result that monsoon rain is much lower than the West Bengal. To be more precise, the areas have not so remarkable hilly ranges in direction that would be the cause of heavy rainfall. Sometimes local depression is formed over Bay of Bengal, which move north west direction particular the region that are caused of cyclonic rainfall. The amount and distribution of rainfall are almost uniform in nature. The western part of the study region specially the areas of Daspalla, Ganis, Nayagarh Khendapara, Godagar, Narsingpur receive comparatively high rainfall due to high relief and also the areas of Athagarh, Banki and Tigar due to localational advantages. The rainfall varies from 1075 mm. to 1402 mm. of the area concerned. The rainfall in the areas has definite periodicity due to monsoonal control that the cause of seasonal rhythm of conditions influencing the pattern of land use.
The present rainfall analysis is based on the data of 8 to 12 years of different blocks which have been collected from District Agricultural office. The rainfall data of Banki P.S. is only available from the year of 1979.

Climatic Characteristics.

The Middle Mahanadi Basin is controlled by typical tropical monsoon climate associated with high temperature and medium to slightly high rainfall. The nature of its distribution in both cases is highly seasonal and the rainfall is highly concentrated in the month of June to September (Fig-3.1). The rainfall pattern is mildly modified by the relief variation on the eastern and extreme western part of this region. Its location in between the deltaic plains on the east and the highly rugged terrain on the middle west, manifests the transitional pattern of weather associated with many micro climatic characteristics. During pre-monsoon and post-monsoon period, the rainfall mostly is received in the region due to local depression formed over the Bay of Bengal.

The figure (3.1) shows the distributional pattern of rainfall of the study area. Depending upon the blockwise, 8 to 12 years (1973-84) rainfall data, isopleths and rainfall graph have been drawn. This map shows that the mean monthly and annual rainfall which varies from 1075 to 1482 mm, (Appendix-I). The rainfall is highly concentrated during the period from June to September, that varies from 64% to 92% of the area. The highest rainfall is recorded in the Athagarh P.S. where the climate is influenced mainly by maritime factors. The middle part of the study area, mainly the Shapur, Nagaon, Barabanda along the both sides of the Mahanadi valley which are characterised by gently undulating terrain, received comparatively to high rainfall is found to be located in the marginal hilly sectors of Desapalle, Nayagarh and Bolagarh, Ganja and Narsingpur block. Here the average rainfall varies from 1149 mm, to 1200 mm. Towards the east about 1234mm, of rainfall recorded. The distribution of such amount of rainfall seems to have resulted from two causes, firstly toward the coastal climate associated with local cyclonic storms, influenced the distribution of rainfall in the east. Secondly, the existence of hilly mountains mainly in the middle west portion of the area also affects it.
THE MIDDLE MAHANADI BASIN

Rainfall Distribution Map
(Mean annual & monthly)

FIG. 3.1
South-west Monsoon accounts for about 90% of the rainfall which is of prime importance as it directly controls the cropping pattern. Unfortunately this monsoon is fickle and capable of remarkable variation from normal. So the failure of and excessive monsoonal rainfall both bring in disaster to agriculture. To add to this, one finds that there are large number of local depressions over the Bay of Bengal having tendency towards land during the monsoonal season. The result is that the excessive rainfall is creating floods particularly in the south east part of Athagarh and Banki Block.

During the dry winter season the rainfall varies from 0 to 20 cm. Normally, the rainfall is very low during December and January. Winter rainfall is received from December to February. This rainfall helps the growth of a second crop in the non-irrigated tract of the region. But this rainfall is so low and uncertain that the growth of a second crop is limited to the small part of the study region. The rainfall pattern in this season is almost uniformly distributed excepting a few blocks like the Athagarh and Banki where the areas receive a comparatively higher rainfall. Generally, this dry winter season is followed by the pre-monsoon transitional period of a hot summer. This period some rainfall is received in the study area due to local depression formed over the northwest hilly region and also in the Bay of Bengal. In May the highest temperature recorded is about 35° C. With the arrival of South-west Monsoon in the month of June, the rainy season begins. During the rainy season, from July to September, the rainfall varies from 225 to 350 m.m. occurring in the western hilly areas which is 200 to 300 m.m. in the middle undulating terrain. From October the amount of rainfall gradually decreases upto February.

From the point of view of crop responses the whole year may be divided into two seasons-Kharif (May to October) and Rabi (Nov. to April) (Appendix - 14, 15). The rainfall is represented. About 90% of the total rainfall is adequate for any kharif crops whereas the rabi season receives only about 10% of annual rainfall. As rabi covers virtually the dry period, some short duration crops like pulses, millet, oilseeds may be grown which require less soil moisture. The rainfall pattern in the Kharif season is almost uniformly distributed in the
study region. But the eastern part of the region like the Athagarh and Banki, receives more than 1200 m.m. while the hilly areas of Basapalla, Nayagarh, Ganja, Narsingpur, Tigrir, receive 1100 to 1200 m.m. During the rabi season, however, the eastern part of the areas receive comparatively high rainfall whereas the western part of the hilly areas of the region record a very small amount of rainfall ranging between 90 to 110 m.m.

From this discussion, it has been observed that the region can be divided into four seasons in the whole area. These are (i) Dry winter (Dec to Feb), (ii) Hot summer (March to Mid June) with frequent thundershower or other severe local storms at the advent of (iii) The south west Monsoon (Mid June to Sept.) and lastly (iv) The Retreating South west Monsoon (October to Mid December).

The study of variability of rainfall is very important in the context of the use of agricultural land. Its variability in amount from season to season and year to year, can affect much of the crop agronomy. It is seen that variability is usually of the least magnitude over the area of high rainfall and greatest over those of low rainfall. But in the study region, there is very low direct relation with average rainfall (fig-3). This is because of the fact that the variation of rainfall of the area is very high, from year to year. In this region, isopleth and choropleth map (fig-3,2) have been drawn depending upon the coefficient of variability ($\sigma$) is actually the relation (in %) between the standard deviation and the mean. Standard deviation is a measure of the average amount of deviation is more than, the variability is high, similarly the low value of deviation corresponds to less amount of variability is high, similarly the low value of deviation corresponds to less amount of variability (Monk house, et al 1963). The rate variability of the region is very low which varies from 12 to 28% (Table-3). The moderate to high rainfall zone of Nayagarh, Basapalla, Ganja, Athagarh, Tigrir, Narsingpur and Banki have less than 20% coefficient of variability whereas the low rainfall zone of Bhopur, Beramba, Buegaon have more than 20% coefficient of variability (Table3). But in the areas of Golagarh and Khandopara the variability of rainfall is comparatively high, though the moderate to high rainfall is recorded. It is indicated that the nature of variation of annual rainfall is so much high that the mean annual rainfall recorded is moderate to high.
Table - 3.1

Coefficient of variabilities and relative variabilities of rainfall.

<table>
<thead>
<tr>
<th>Stations</th>
<th>Standard Mean deviation (X)</th>
<th>C.V. (%)</th>
<th>R.V. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolgarh</td>
<td>238.35</td>
<td>1108.66</td>
<td>21.54</td>
</tr>
<tr>
<td>Nayagarh</td>
<td>217.88</td>
<td>1181.59</td>
<td>26.44</td>
</tr>
<tr>
<td>Shepur</td>
<td>300.22</td>
<td>1091.73</td>
<td>31.49</td>
</tr>
<tr>
<td>Khandapara</td>
<td>252.60</td>
<td>1074.89</td>
<td>47.52</td>
</tr>
<tr>
<td>Nuagaon</td>
<td>198.85</td>
<td>1025.09</td>
<td>19.44</td>
</tr>
<tr>
<td>Desapalla</td>
<td>198.53</td>
<td>1248.63</td>
<td>31.97</td>
</tr>
<tr>
<td>Ganja</td>
<td>191.47</td>
<td>1109.36</td>
<td>17.26</td>
</tr>
<tr>
<td>Athgarh</td>
<td>236.36</td>
<td>1392.80</td>
<td>16.97</td>
</tr>
<tr>
<td>Tigiria</td>
<td>205.74</td>
<td>1149.40</td>
<td>17.90</td>
</tr>
<tr>
<td>Baramba</td>
<td>220.99</td>
<td>1066.57</td>
<td>26.72</td>
</tr>
<tr>
<td>Narsingpur</td>
<td>234.24</td>
<td>1171.22</td>
<td>20.00</td>
</tr>
<tr>
<td>Banki</td>
<td>149.79</td>
<td>1179.50</td>
<td>12.74</td>
</tr>
</tbody>
</table>

*C.V. = Coefficient of variability, R.V. = Relative variability.

Normally, the variability of a region depicts the corresponding degree of reliability of rainfall. In general, the variability is less than 20% in the areas of Nayagarh, Banki, Athgarh, Desapalla, Ganja, Tigiria and more than 20% in the areas of Bolgarh, Nuagaon, Baramba and Khandapara which indicate more reliability in the former than the later. The worker has also calculated the relative variability (R.V., %) on an annual basis (Table-3.1). The relative variability (R.V.) is actually the relation (in %) between the summation of mean deviation and the mean. The nature of co-efficient variability depends on relative variability. If relative variability shows high then c.v. must also be high. The figure 3.3 indicates that the direct positive correlation. The worker has also found out the correlation between annual rainfall and co-efficient of variability. The distribution of scatter point and nature of regression lines shows the low negative correlation as usual.
**Rainfall vs Coefficient Variability (C.V.)**

\[ Y_C = -0.95x + 48.93 \]

**Relative Variability vs C.V.**

\[ Y_C = 101x + 1.98 \]
The straight line of the best fit obtained by the method of least square is $Y = 0.012x + 33.30$ which indicates the negative correlation ($x = 0.21$). The result of correlation of co-efficient on pearsonian product moment formula is 

$$r = \frac{\sum XY - (\sum X)(\sum Y)}{\sqrt{\sum X^2 - (\sum X)^2} \sqrt{\sum Y^2 - (\sum Y)^2}}$$

which in cases the lower degree of association of annual rainfall with co-efficient variability. From the point of view of agronomy, it is indicated that the areas of high variability can be on normal crop production.

It may be mentioned that the temperature condition remains more or less same throughout the region. But the variation of mean annual temperature is comparatively high in the west on wards. Mean annual temperature varies from $27^0$ to $28.30^0 C$. The temperature is maximum in May of about $35^0 C$ in the areas of Nagpur where as the temperature during the winter is about $20^0$.

The study region enjoys the tropical savannah type climate as per koppens classification (B.N.Sinha - 1971). The worker also formulated the water Budget graph indicating the dry subhumid climate which is discussed in the next chapter. The worker has divided the micro zones mentioning the salient features of weather and climate of the study area to project a clear picture. In the present study, the rainfall variation has been considered as the basis of demarcation of following zones.

The present study area can be classified into the four micro-rainfall zones (Fig-3,4).

1. Low rainfall zone (less than 1100 m.m.) - This zone covers the areas of Sarama, Bhapur and Nuagaon that lies between the western hilly region and the flat alluvial plain in the east. The amount of rainfall is below 1100 m.m. and is noted for the higher degree of rainfall reliability and uncertainty. The factors like comparatively lower latitude that the adjacent areas its location far way from the Bay of Bengal, and clearance of forest etc. have mainly caused the occurrences of its lesser amount of rainfall in respect of the western parts of the region.

II. Moderately low rainfall zones (1100-1200) - This zone comprising the mid western hilly tract and adjoining plain areas on the s
Plate 9 Part of the right bank sector of the Mahanadi at Kantilo with stunted and thorny bushes (xerophytes group) indicating the scarcity of rainfall under dry subhumid climatic condition in the area.

Plate 10 Parts of the deciduous bamboo forest cover on the gneissic quartzite land (back) along with scattered 'mahul' trees (front) in Ghantuliberi area, Daspalla block.
east as shown in the map. The amount of rainfall varies from 1100-4200 m.m. The zone shows relatively higher amount of rain found to correspond to the higher degree of dissection in terms of rills, gullies etc. thus resulting in the occurrence of accelerated soil erosion and other environmental hazards hindering the agricultural practices. Besides soil erosion the denudation of forest belt has also caused some socio-economic problems which have far-reaching effects in the rural cultural status of the area.

III. Moderate rainfall zone (1200-1300 m.m.).

This zone covers the areas of small parts of Tigitir, Benki and eastern part of Dasspalla block which is dominated by flat alluvial terrain, meander scar etc. Here the amount of rainfall varies from 1200-1300 m.m. which increases towards east downstreams (Fig. 3-4). The soil of these areas is highly productive and it best suited for agriculture.

IV. Humid with high rainfall zone (more than 1300 m.m.).

To the eastern part of Athagarh and Banki block, the highest rainfall is found to be accompanied with severe local storms which formed over the Bay of Bengal. The occasional patches of smaller depression land or low lying area contain backswamps, large-scale deposition of silt and clay etc. which are believed to have developed by the process of accretion and fillings in the valley areas especially during the high monsoonal period. As the region is affected by the occurrences of local storms, frequently coming from the sea, the agricultural and other economic activities are influenced at that time.

In this text, the present researcher likes to discuss in short the characteristic features along with general distribution of vegetation as its types, species and growth rate are mostly controlled by the climatic factors which comprises temperature and moisture and their combinations. On the other hand, forest vegetation is an important determinant of land use pattern as presented in chapter IX in details.

Vegetation.

Forest vegetation is an outcome of natural processes where various components of the ecosystems like climate, soil, biotic factors etc. interacted to manifest themselves in the form of forest cover on the middle Mahanadi basin area. Forest vegetations which now occupy about
Plate 11 Sal forest is seen in the hillside slope areas in the background, Nayagarh town with Shree Munna Nayak, caretaker of Janata Lodge of Nayagarh is also present.
33.44 percent to the total study area, as against the states average about 39 percent. According to Champion’s classification of forest in the middle and middle eastern sector of the Middle Mahanadi basin as tropical dry deciduous zones and in the south, west and northern sector it is dry deciduous zones.

The forest vegetation of the Middle Mahanadi basin (Fig-3.5) is highly concentrated in the dissected hilly areas, foot hills zones while the elevation varies from 50 metres along the bedia of the Mahanadi river to above 300 metres in Balimunda parbat (Pahar) regions, with a view to better exploitation and protection against indiscriminate destruction. The vegetation of the part of Middle Mahanadi basin has been classified into three subcategories such as (i) Reserved Forest, (ii) Protected forest and (iii) Unclassed forest. The first two types of valuable timber and bamboo account for about 75 percent of the total forest area. They are under the strict control of the Forest Department, Govt. of Orissa. On the other, the unclassed forest (Plate 14) is largely open to public for getting fuel wood, grazing their cattle in the part of Middle Mahanadi basin area.

In the study area, vegetation is divided in two divisions in administrative point of view namely Nayagarh division and Athagarh divisions in the Puri and Cuttack districts respectively which jointly cover about 172,554 hectares area of the total study area. Nayagarh subdivision includes Dasapalle, Gania, Nuagaon Nayagarh, Khanda, Oday forest area in the southern valley of the Mahanadi river whereas Athagarh division comprises Narsingpur Beramba, Tigiria and Athagarh in the northern valley of the Mahanadi river. But, the forest area of Kikli - I and Banki-II are under the Khurda division covering about 101.89 hectares area.

The forest area of Nayagarh division consists of about 114,875 hectares area classified as moist deciduous forest being developed in the central and eastern hilly Zones and dry deciduous forest are in middle east and eastern low elevated zones. Generally, the forest of Nayagarh division is characterised by dense mixed jungle in which sal and bamboo are most common species. Other species are pine, sal, kanha, mahul, arjun, asan, harida etc. in association with mixed jungles. Towards middle to the west in the Puri district, mixed with
Plate 12 View of natural and cultural vegetation types both natural (back) and planted (front) in Dasapalla area.

Plate 13  Scrub and bushes jungles common type of vegetations are developed in the subdued conical hill of undulating terrain in Sonamukhi Village area, Khendapara block.
Plate 14. Development of the unclassed open forest set in the dissected hilly terrain in the Sabarjani pahar beyond the Satkosia upstream.
eal forest mixed with other evergreen species merging to dry mixed forest. In the southern Mahanadi valley area forest in highly concentrated to the dissected hilly, greater undulating terrain associated hilly, greater undulating terrain associated hilly, greater undulating terrain associated with valley sides regions. It may be mentioned here that mostly forest areas converted into jungles in association with shrub and grasses, the forest areas of Belagarh, Bhopur, eastern part of Khandapara and Nayagarh are characterised by thinly mixed jungles associated with Khaira Kusum, gohira etc. Species being developed in the subdued elevated areas (50 meter to 150 meter a.s.l.) classified as dry deciduous zones due to climatic factors.

The forest areas of Athagarh division, are restricted to the north and north west hilly area and hill side slope area comprising Narsingpur Baramba, Tigiria, Athagarh block which cover about 57,670 hectares area. The percentage of forest area of Narsingpur is high which is about 59 percent of the total block area and then followed by Athagarh about 20 percent Baramba 10 percent and Tigira 6 percent to the total block area. The sal is a common species both the month west and north east tract of this region Bamboo and salia bamboo are common species in the south central area of this region. The Banki forest area is mainly restricted to the extreme eastern hilly areas being developed on the upper Gondwana rocks of the part of Middle Mahanadi basin area. Although the mixed jungles occur in this area, the growth of the species are very poor and open.

Concluding Remarks.

Climate and vegetation are two important physical components which control not only the major economy of the people, but are also important in the determination of the evolution of landform suites as well as channel patterns of the part of Middle Mahanadi basin. The varying geomorphic processes associated with the fluctuation of the volume, planations of banks scourage and filling during floods, excess of evaporation under arid condition causing drought and subsequently crop failure relating to agricultural activities, for example are largely dependent on the climate.

The Middle Mahanadi basin enjoys a typical tropical monsoonal climate which is controlled by South West Monsoon and the retreating
North East Monsoon wind systems with mean annual rainfall 1625 m.m. to about 1400. The Middle Mahanadi basin area, the amount and distribution of rainfall are mildly modified by the relief variation as well as its locational advantage in between the deltaic plains in the east and the highly rugged terrain in the middle west, manifest the transitional pattern of weather associated with micro climatic characteristics.

The area has been divided into four rainfall zones mainly based on the rainfall and temperature variation from upper to the lower stretches of the part of Middle Mahanadi basin. The highest rainfall (more than 1300 m.m.) is found to be accompanied with local severe storms in Athagarh and Banka area while the lowest rainfall (less than 1100 m.m.) is noted in the gently undulating terrain of Bhopur, Bolagarh, Barameru area and low to moderate rainfall (1100 to 1200 m.m.) occur in the adjoining areas of the eastern and western hilly areas of the Middle Mahanadi basin. The occurrences of variability and uncertainty of rainfall are common especially over the gentle undulating terrain in the middle and extreme eastern tract of the area where the environmental hazards of water scarcity or drought and the catastrophic climatic event in terms of severe local storms and floods are found to have posed serious problems to agriculture and related socio economic activities as illustrated in a later chapter.

The distribution and types of vegetation of the part of Middle Mahanadi basin area are closely related to the rainfall distribution. For example, dry deciduous types of vegetation in low rainfall and moist deciduous vegetation are found to have developed in high rainfall zones.
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