Trans. Inst. Indian Geographers
Vol. 7, No. 2 July 1985

BASIN ENVIRONMENT AND MANAGEMENT -THE CASE OF THE SUBARNAREKHA SYSTEM

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ABSTRACT : The paper examines the case of Subarnarekha river as a socio-economic unit, developed in response to morphological characteristics and terrain properties of the basin. The man-nature relationship is so vital that its recognition and adoption as a basic factor in planning efforts is inescapable. Any move that deeply interferes with the established ecological processes may irreparably disturb the conditions. The authors show, giving the example of Subarnarekha basin, how the long established harmonious man-environment relationships could form the basis for promoting future development.

THE CONCEPT

River basins have often been regarded as convenient units of study related to resource management, planning and development. The starting point of the concept of "basin as a planning unit" is the appreciation of a basin as an ecological system. By basin ecology we mean those elements of the basin environment which through their mutual interactions create the necessary and sufficient conditions for a river basin to maintain its own dynamics of change, harmonious with time. In other words the biotic and the abiotic forces within the basin environment co-exist in a manner so that the normal functioning of running water is not disrupted, producing irreversible effects and the basin evolves and manifests itself in its ultimate form. On the other hand human beings tend to fashion their activities on the surface of the earth in accordance with the natural systems operating within a region. It should not be; however, misconceived that by adapting themselves with natural systems human beings subject themselves only to the dictates of their environment. Adaptation includes not only adjustments but also alterations of the environment in order to achieve the social purpose of labour of a given community. It also does not mean that human beings constitute a counter-force of nature; in fact, the control, regulation and alteration of environment are done by human beings who are as much a part of nature as are other elements of their environment. Thus human community occupying the space within a river basin tend to produce a spatial order which runs roughly parallel to the morphological manifestations of the natural system comprising landforms and associated terrain conditions produced by running water. A drainage basin, therefore, may also be looked upon as a social and economic unit.

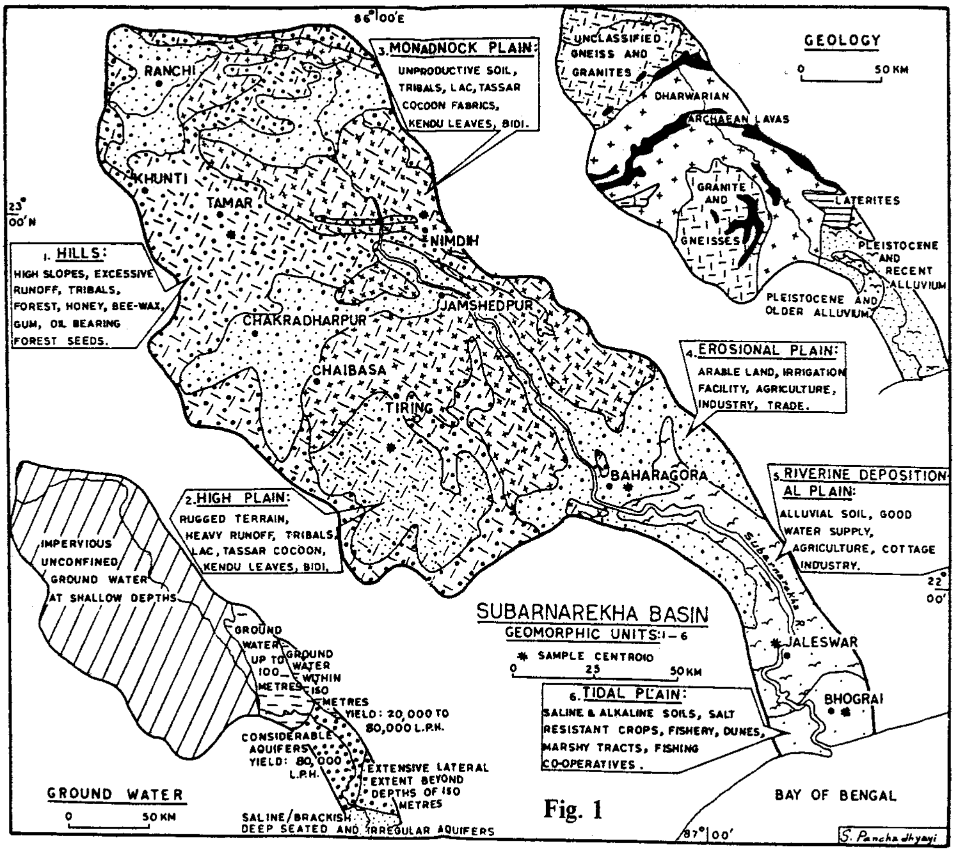


Fig. 1

It is essential for decision makers to recognise the need for understanding the principles on which the man nature relationships are based so that the interventions in the natural system do not interfere with the dynamic balance obtaining between natural forces and human aspiration towards development. It is also needless to point out that the relationship varies from region to region or for that matter, from basin to basin. It is necessary, therefore, to probe deeply into the intrinsic attributes of the ecology of the basin in question and also into the layout of the social, economic and cultural activities of the community living in the basin. These only can provide the basis for substantial appreciation of the future course of management of the resources of the basin and their utilisation for the social, economic and cultural objectives set by the community itself.

SUBARNAREKHA BASIN

With the above perspective in mind, we now pass on to a more down to earth discussion relating to the basin of the Subarnarekha which forms the unit of our investigation. This basin occupies an extensive area (19,236 square kilometres) in the states of Bihar, Orissa and West Bengal (Fig. 1) and is an area of diverse physical and social characteristics. This diversity will be evident as we deliberate upon the various aspects of man-nature interrelation in the basin in different sections of this paper.

THE COURSE

It is probably wise to begin with a pedantic description of the course of the river itself. This river rises in Bihar, north-west of Ranchi and flows in a south-easterly direction for about 400 kilometres and finally pours out its water into the Bay of Bengal a little west of the Bengal-Orissa Border. The main tributaries of the Subarnarekha are the Raru, Kanchi, Karkari, Kharkai on the right bank and the Dulung on the left bank. The maximum area of the basin, about 70 per cent, falls in the state of Bihar while only a 10th or so is within Orissa. The rest, about 20 per cent, lies in the south-western part of the state of West Bengal.

WATER RESOURCES

The principle resource of the basin, *from our stand point* is its water potential, because the basin is primarily shaped by the surface flow of this water and its consequent processes. The maximum discharge of the river is around 14,000 cumecs while the minimum is about 3 cumecs only. This is a sufficient measure of a enormous amount of fluctuation that takes place in the volume of flow and availability of water through different periods of the solar year. Notwithstanding the fluctuation, the total annual run off of the basin is in the vicinity of 13,000 million cubic metres, with great variations in different reaches of the river.

In the districts of Hazaribagh, Ranchi, Singhbhum, Mayurbhanj and Purulia ground water resources are rather poor and can be found only in weathered regolith of the hard rock formations. The small area which lies in the district of Midnapore in West Bengal (Fig. 1 b) offers a somewhat better groundwater prospect with aquifers composed mostly of course and fine sands. The most prospective aquifer conditions occur in the lower reaches in the districts of Balasore in Orissa where affluent ground water conditions are suitable for maximum utilisation for purposes of agriculture. But in the coastal regions saline aquifers are intercalated with fresh water aquifers in the more surficial layer but fresh water prospects increase considerably with depth.

This enormous water potential, surface and sub-surface, has not been utilised to any convincing extent either through development of irrigation or through generation of hydro electricity. Not more than 122,000 hectares of cultivated land receive the supply of irrigation water from projects like, Roro, Kanchi and Kobro, etc. The only sizeable enterprise at power generation is the Subarnarekha project near Ranchi with an initial capacity of 130 kilo watts only. It is to be noted that an optimum utilisation of the water resource of the basin is needed not only for giving a permanent relief to uncertain agricultural economy of the basin but also to make possible the use of variety of other mineral and forest resources in an increasing degree and to create a diversified and self-provisioning economy. The need for such an economy will be evident from the discussion of social and economic aspects of the basin ecology in the subsequent part of this paper. But before we do that it may be necessary to indulge into a systematic study of the physical environmental features that constitute the spatial expression of the system of running water responsible for the evolution of the basin itself.

GEOMORPHIC UNITS

Fundamental to the discussion of the features produced by the water-system of the Subarnarekha, are the geomorphic provinces appearing within the basin with distinctive boundaries and characteristics of their own (Fig. 1). We shall enter into these distinctive provinces by describing in some detail the methods adopted for their identification.

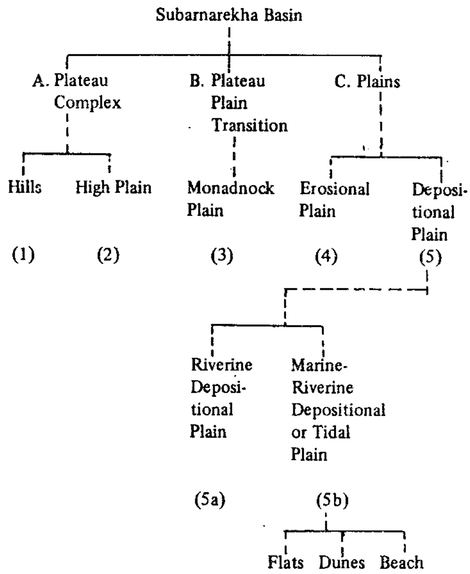
REGIONALISATION TECHNIQUE

The basic data for geomorphic regionalisation of the basin are derived from the topographical maps published by the Survey of India on the scale of one inch to a mile. Each topo-sheet has been divided into nine equal grids and within each grid a topographical section has been drawn by joining the highest and lowest points. The section has then been divided into segments according to the slope characteristics with boundaries located at distinctive breaks of slope or kinks. The corresponding breaks have then been joined through smooth lines across the grids and across the sheets covering the entire basin to depict well-defined geomorphic units. The boundaries of these units do not necessarily follow contours and often cut the contours obliquely. The units, thus, delineated, therefore, are not mere altitudinal zones. They are rather morphological units whose properties generally depend largely on the slope characteristics of the terrain.

It is to be noted that while some of units are discernible from the profiles, others cannot be identified in the same manner. The problem crops up particularly in the plains section where the demarcation between the erosional plain and the depositional plain may not be indicated any topographic break at all. The erosional plain therefore has to be separated by means the lowermost extensions of signs of erosion as gullies, bare rocks, stream initiation and the like. Below this the plain has obviously been shaped by deposition of purely riverine origin. But as we reach further down, integration of drainage lines takes place because of two-way flows in rivers which are influenced by both riverine and marine forces. The plain thus formed bears the properties of a true deltaic tract which is bordered on the sea margin by dunes and benches made of mud and sand.

CLASSIFICATORY SCHEME

The geomorphic units identified in the above manner may be represented tabular taxonomic order as below:



A. PLATEAU COMPLEX

The plateau forms a segment of the Chhotanagpur Plateau of India. It covers an area of about 8,000 square kilometres roughly 42 per cent of the total basin area. It ranges from 914 metres to 300 metres in elevation. The plateau complex combines within itself the plateau of Ranchi, Singhbhum, Mayurbhanj and Purulia. The major part of the plateau is shared by the Ranchi Plateau which is bounded on all sides by steep scarps. It has a rolling surface with residual hills composed of resistant rocks like granite-gneiss, schists and continuous belt of Dharwars. The plateau presents basically an undulated surface occasionally interrupted by flatish tracts. This complex, according to the variations in surface topography can be conveniently divided into two units, namely Hills and High Plains.

1. HILLS

The hills of the plateau complex are distributed widely in different parts of the basin but a keen examination of the map of the geomorphic units will make it evident that there is a definit pattern in their occurrence. In most cases the hills occupy the central most positions of the major interfluves and are bordered by surfaces of lower elevations curved out by the process of erosion. The maximum extension of he hills occurs in the south-central portion of the basin between the Karkari and the Sanjay rivers, from where the extent in a narrow bend eastward along the southern boundary of the basin. The most notable exception to this pattern is provided by the Dalma hills through which the Subarnarekha makes its way in the form of a gorge.

2. HIGH PLAIN

In the south-eastern part of the basin, in the catchment of the Kharkai the hills have given away to a surface which relief variations are much less compared to that of a hilly area. This surface lies more or less in the middle reach of the river Kharkai. The surface is relatively free from isolated heights but at the same time retains an altitude much higher than the plains of the basin. This area has therefore been called a high plain.

B. PLATEAU PLAIN TRANSITION

3. MONADNOCK PLAIN

Bordering the hills in most parts of the area except the Sanjay basin, are scattered plains which sometimes cover quite extensive contiquous tracts having attitudes of 300–400 metres on an average. These plainish rolling lands are strewn with scattered and isolated monadnocks. Their surfaces are mostly barren with frequent rocky wastes.

C. PLAINS

The plains are distinguished from the plateau on the basis of the smoothness of slopes. They share a large part of the basin covering an area of about 12,000 square kilometres or 58 per cent of the basin area. It covers a portion of Singhbhum, Midnapore and Balasore districts in a large extent and small portions of Ranchi, Purulia and Mayurbhanj districts. The plains are further sub-divided according to the scheme already mentioned.

4. EROSIONAL PLAIN

The Erosional Plains cover an area of roughly 5,340 square kilometres approximately 28 per cent of the basin area. It is a rolling plain having an elevation between 150 and 300 metres. A major part of these plains is occupied by the Chaibasa Plain in Singhbhum district of Bihar. These plains are also visible quite extensively in the West Bengal portion of the basin. The erosional plains are generally covered by reasonably thick veneer of soil which increases gradually as the depositional plains are approached.

5. DEPOSITIONAL PLAINS

The depositional plains lie generally below 150 metres and cover an area of 6,000 square kilometres or 32 per cent of the basin area. The sub-divisions of the depositional plains are discussed briefly below.

5a. RIVERINE DEPOSITIONAL PLAIN

The tract which is formed as a plain without any significant relief variation principally by the depositional forces of system of upland water flow has been named the riverine depositional plain. These depositional forces include those associated with the floods of the river Subarnarekha. The extent of the depositional plain within the basin is restricted to the lower reaches of the river and involves a small area compared to the total size of the basin. This peculiarity is due to the fact that the basin of the Subarnarekha tapers down considerably towards its lower part because of structural controls. The depositional plain is characterised by almost absolute flatness of the terrain covered by thick alluvial soils through which the Subarnarekha flows in a highly meandering course.

5b. MARINE – RIVERINE DEPOSITIONAL OR TIDAL PLAIN

The tidal plain covers a much less area in the lower extrimity of the basin and is distinguished from the riverine depositional plain by the fact that in this tract, both the marine and the riverine processes are actively operative in creating a dead flat plain within which tides are as much important factors as are rivers. Towards the seaward margins, the tidal plain is characterised by coastal dunes, mud flats and beaches composed of both mud and sand.

GEOMORPHIC UNITS AS ENVIRONMENTAL UNITS

The above descriptions, particularly the sequence of landforms associated with the volume of surface flow in the river from the source to the mouth reveals that there is a system involved in the evolution of the different geomorphic units of the basin. The look of the terrain changes systematically in consonance with the changes in the volume and direction of water flow in the basin. It is now our turn to examine whether and how far these systematic variations also correspond to other natural elements of the basin environment.

NATURAL ENVIRONMENTAL RELATIONSHIPS

If we look at the distribution of the forest in the basin it may be difficult at the first glance to discern any definite pattern in their distribution. This is primarily because of the fact that due to human interventions through centuries the original configuration of forests has undergone significant changes. The forests now appear as a scattered lot of small stands interspersed with clearings which are widely used for both habitation and cultivation. But if you permit ourselves to apply our imagination and construct a generalised outline of what the forests possibly looked like in the past or what they should look like normally, then we are certain to establish some kind of a relationship between geomorphic and natural vegetal contours of the basin. We shall find that the thickest and the highest vegetative covers are generally to bé found in the innermost parts of the interfluves which we have called the hills in our geomorphic terminology. On the Monadnock and High plains flanking the hills the intensity of forests decrease considerably while major portions of erosional plains are described as arable. As we enter the depositional plains forests are practically absent, except in traces and the whole area is most intensively used for the purpose of the agriculture. It is clear that the dendrite in the river pattern has expressed itself into a system of landforms which ultimately reflects itself into the pattern of its natural vegetational canopy. Even the exception in the landform development, the case of the Dalma Range to be specific, is confirmed by a stretch of the forest extending transversely across the Subarnarekha near Jamshedpur. The pattern of human intervention on the other hand, only replicates the dendritic river pattern in general.

We have already seen that the underlying geological structure (Fig. 1) has acted as independent factor in shaping the basin. It seems that it has also some cognisable influence in the distribution of soil over which normally develops in accordance with the given climatic, biotic and also geomorphic processes. On a very generalised scale the soils of the basin appear as a number of bends stretching north-south across the direc-

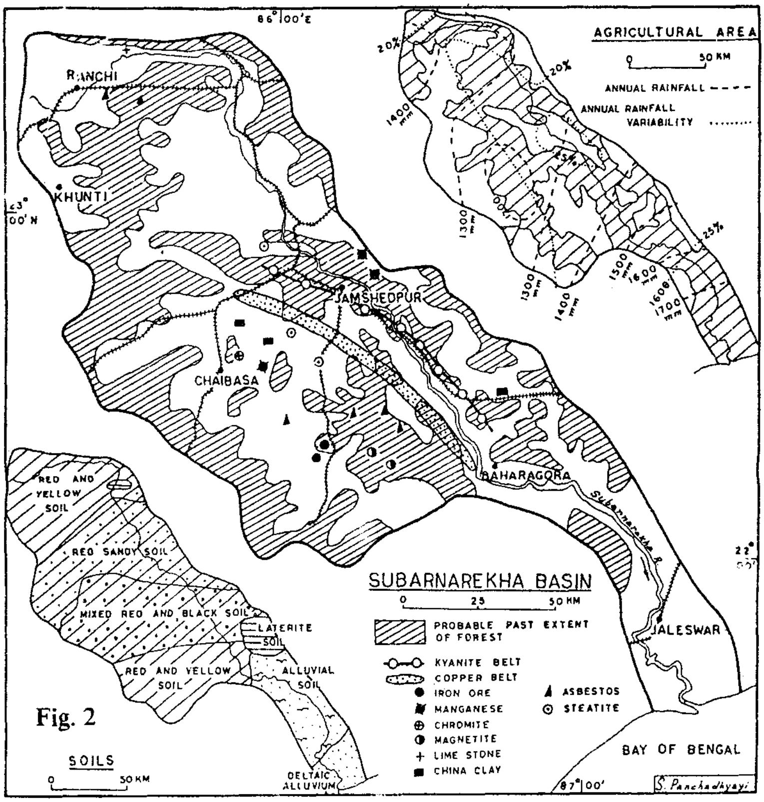


Fig. 2

tion of the main drainage line. This may at first sight look line a mis-match with the physical and floral layout of the basin. But in detail one should note that the discordance cannot be taken as a departure from the normal rule of the basin system. The major features of concordance in this respect are at least three. First, the entire area which is dominated principally by the forces of erosion is covered by a complex of lateritic soils (Fig. 2) which include true laterites, red and yellow soils, red sandy soils and red and black soils. Secondly, the riverine plain is wholly composed of alluvial soils of relatively recent origin. Thirdly, the deltaic plain coincides with the zone of saline and alkaline soils developed under the combined influences of riverine and marine agencies of land formation within the domain of erosion, it is possible to reckon that the red and yellow soils have developed primarily on the archaian granitegneiss basement complex. On the Dharwars, red soils are found to be frequently mixed with black soils. In all probability the red soils represent those developed from the Dharwarian parent materials while the black soils are derived from the archean lavas and basic intrusives subsequently redistributed. The true laterites, however, are supposed to be low level laterites developed in the presence of a high ground water table and are located on the outer margins of the depositional plains. Thus, when observed in detail, the relationships among geology, drainage, landforms, natural vegetation and soils (Figs. 1 & 2) are established more or less satisfactory. This rediscovery lends adequate support towards starting hypothesis that the attributes of terrain are acquired in conformative with the basic processes which are responsible for depecting a natural territory, in our case the basin of the river Subarnarekha.

HUMAN RESPONSES

We shall now pass to the human aspects of the problem under study. It has to be admitted at the outset that the desires and activities of man, as a tool investing and tool absorbing being, manifest themselves in a far more complex manner than do natural elements. As we have examined the natural system as an integral of several components, we shall also try to examine man as expressed by some of his qualities in social, economic, demographic and cultural terms. It is necessary to point out further that we are dealing not with the primitive individual man but with man as a social being.

As it has often been pointed out by Human Geographers, human societies choose to locate their field of activities with the primary consideration of water available for their use. The primary indicator of man-nature interaction, therefore, is the incidence of population in a place. When we look at the map of density of population in the Subarnarekha basin the fact that unfolds itself unmistakably is that there is a very significant correlation between water and population.

Near the head sections of the main stream and the upper tributaries like the Karkari there are some blocks and or police stations where the density of population per square kilometre is in the vicinity of only a hundred persons. From those areas the population density increases steadily towards the lower parts of the valley until it reaches more than 450 persons per square kilometre in the flat deltaic portions. This increase does not take place in any constant rate, but it varies almost concomitantly in response to the constancy or abruptness of changes in terrain condition. For example the occupation opportunities provided by the terrain do not vary greatly from the high plain through the monadnock plain to the erosional plain. In all these three units the scope for agricultural development and other economic activities are more or less similar. The density of population also through these plains does not show appreciable variation from an average of 200 to 225 per square kilometre.

A definite pattern is also visible in the distribution of villages in the basin. In the sparsely inhabited areas of the hills, high plain and the monadnock plain the number of villages per 100 square kilometre is only 30 or 40 but as we approach the plains the number increases to a 100 or so. The maximum number of villages are found over the erosional plains but as the nature of the terrain does not permit the availability of large contiguous arable patches, the village size becomes small compared to that in other tracts. Here the villages are generally located over small convey swells devoid of any significant soil cover surrounded by good cultivable areas. As these patches of cultivable lands are small they cannot support a big population in a single cluster. The villages are therefore small but large in number and distributed more or less uniformly in the erosional plain. The village size increases considerably in the riverine and the deltaic plains for obvious reasons. However, the most interesting aspect in this regard is the fact that the biggest villages are to be found in the rather unproductive monadnock plains. Large villages are also characteristic of the high plain and the hilly areas. The large clusters of population along with their small numbers in the upland tracts can possibly be explained by the small number of places in which can offer adequate supply of drinking water. Thus the density of villages and their size have developed a bimodal character in response to the habitational and agricultural opportunities provided by the terrain.

It is understandable that the opportunities of utilising environment for economic purposes are maximum towards the riverine and deltaic plains and highly restricted in the rough and hilly tracts of the upper catchment areas. This is the reason why the percentage of workers in the population decreases in a very distinctive manner as we move along the river from its head water regions to its out fall at the sea. This implies that the more resistant environment in the upper areas necessitates the involvement of a larger proportion of the total potential work force of the population to be engaged in the pursuit of livelihood. This proportion may be so high as to include larger number of female members of the family as well as minors. The dependency ratio of the population living in a different terrain is apt to be low compared to environmentally better endowed areas. This rules seems to hold good in the Subarnarekha basin also where the work participation rate of population rate of population decreases from more than 40 per cent in the hilly areas steadily to about 25 per cent in the deltaic plain.

The above observation brings us into the realm of ethnicity and culture. There is no reason to believe that a resistant environment will be associated with a high work – participation rate in every cultural situation. It is almost universally noted that the involvement in economic layout is generally higher in the case of tribal populations as well as many the lower castes of our traditional social hierarchy. This is corroborated by the distribution of scheduled tribes and castes within the Subarnarekha basin also. In the higher margins nearly 90 per cent of the population belong to the categories of scheduled castes and tribes of which the tribes have an overwhelming share. The tribal population is only nominally present in the lower margins where the incidence of scheduled castes is sizeable although they do not account for more than 25 per cent of the total population. What emerges from the discussion is that the inferior lands are occupied by the conventional social out castes while the superior are under the command of the higher-ups of our socio-cultural order.

It is also interesting to see that the people belonging to the lower rung of the socio-cultural hierarchy try to cultivate their own holdings, however small and infertile they may be. The hills, therefore, show the maximum incidence of owner-cultivators and the minimum of agricultural labours. On the other extrimity of the basin in the tracts facing frequent problems of salinity and alkalinity, incidence of owner-cultivators is again very high. In the intervening areas morphological quality of terrain, soil productivity and the relative presence of tribes and caste maintain a most logical relationship with the relative percentages of owner cultivators and agricultural labourers. It should also be mentioned that purely tertiary workers who, in a way can be thought of as the parasites of the society are practically absent in the hills, the high plains and the monadnock plains; but are present significantly in the agriculturally more productive plains of the basin.

We have been able to show that a systematic relationship obtains between the natural and human developments in the basin of the Subarnarekha. The summary of these relationship can be presented in a brief but articulate manner. In the form of a table in which six administrative units are taken as representative samples of the different geomorphic units. The natural and the socio-cultural characteristics of these administrative units are shown in the table. It should be noted that the table is only a simplified version of the complex relationships between man and nature obtaining within the basin under study.

DESIRABLE RE-ALLOCATION PATTERN

The above table after providing for sufficient understanding of the prevalent mode of human adaptation to environment, also indicates the desirable pattern of adjustment of economic and cultural activities that should strengthen the productive base of the economy of the basin as a whole. We shall now discuss the problems and prospects towards attaining such desirable patterns of interaction between man and nature in the six geomorphic units that fall within the basin of our enquiry.

REGIONAL IMPERATIVES

The hills, obviously do not offer much scope for a total reliance on agricultural activities for the sustenance of the people of this region. In the present state of things, agriculture is by far the most important category so far as the pattern of landuse and the occupational structure are concerned. But we have no other alternative to conclude that the high slopes coupled with excessive runoff do not offer a good prospect for agricultural developments on which the people can rely for a successful adaptation with the given environment. Agriculture, in these hills, must be considered as an occupation which can guarantee only the minimum sustenance of the people living in the tracts but it is unlikely that these people, mainly the tribals will be able to join the mainstream of the national life with agriculture as their sole occupation. There are, however, sufficient opportunities for the forest being harnessed for such activities as collection of tassar cocoons, collection of *kendu* leaves required for manufacturing of *bidi*, rearing of *lac*, gathering of honey, bee-wax, gum, oil-bearing forest seeds and allied activities which can constitute gainful secondary occupations for the tribal agriculturists. It should also be remembered that a great deal of the agricultural techniques of these tribal people is derived from shifting agricultural habits which are seen extensively over the hill-forests of Mayurbhanj, Singhbhum and Ranchi districts. It may also be wise and necessary to introduce the elements of sedentary farming among the tribals through a better supply of general inputs of agriculture by a well-conceived plan of connecting the scattered villages by means of better roadways. The supply centres of agricultural inputs can also serve as centres of marketing in which the state may be required to exert itself more in direct purchase and price regulation of articles like *kendu* leaves, *lac*, and tassar cocoons in an effective manner. This should also be matched with a desirable development of cooperatives which can take full advantage of the principles of local self-government in matters of finance and management of their own structures and can also reduce the distance between small producers and large organised markets.

Over the high plain of the Kharkai, the prospects have been utilised to their minimum till now because of the practically non-existent infrastructure for a proper agricultural development. But it is possible to conceive a series of dams and reservoirs, both small in size, to stagger the water that runs off the terrain and produces the aridity of tract in question. The emphasis on agricultural development of this tract should be higher than that in the hills, but augmentation of the local waters for irrigational purposes is of prime importance in this regard.

The monadnock plain present a picture in which a small population can be maintained in a few centres of concentration. Here the necessity for a diversification of the economy is of utmost significance. But in order to give a viability to the few but large centres of population in this tract, it is necessary that an occupational diversification has to be achieved through the introduction of those crafts in which considerable value addition can take place. In other words, the emphasis should be on the development of manufacturing activities within the centres of population. For example, the lac and the *tassar* cocoons which are gathered from the hill-forests, the *kendu* leaves derived from the jungles of the catchment areas can be manufactured into stickloc, and shellac, tassar fabrics and *bidi* in the major centres of population within the monadnock plain. These centres can also be the focii for exchange of agricultural and manufactured products between neighbouring regions, provided an integrated policy of development is designed by the public bodies for economic upliftment of the basin itself.

Coming to the erosional plain it has to be admitted that the nature of the topography is admirably suitable for the development of a gravity flow irrigation system which requires the presence of a minimum gradient between the interfluves and valley bottoms for smooth transfer of water. The erosional plain is supposed to be rich in the basic soil nutrients because the top soil, relatively devoid of basic nutrient have been washed off the surface, while the lower layers contain adequate basic materials on which agriculture thrives in its maximum extent. The problem of water has to be solved largely by construction of dams and reservoirs helping gravity flow irrigation in which international experts have placed a strong reliance. The larger settlements on the boundary between the agriculturally surplus regions of the southeast and the potentially rich industrial environment of the northeast. The locations of the centres of exchange may, however, depend on the organisational structure and the size of markets of the products concerned.

The depositional plain, by its definition, is an area where agriculture should necessarily form the major activity. The water supply for agriculture in this section is not really a problem because the additional income of water by surface run off from the upland areas, over and above the normal rainfall should be considered as sufficient to meet the needs of agriculture and domestic uses. It has to be seen, however, that a stable fertility status be maintained through manuring, fertilization, crop rotation and other improved techniques of farming. The constraint that may stand in the way of maximum utilisation of the agricultural resource potential of this alluvial plain is the possibility of excessive supply of water both from surface accumulation and a high ground water table. If the surface runoff in the upper area is staggered through construction of dams and reservoirs, then it may actually aggravate the possibility of water logging. A proximate solution to the problem may be sought by increasing the intensity of irrigation through repeated use of the land by multiple cropping and drawing out the water from the sub-surface level by means of tube wells.

In the deltaic section the main problems are drainage and salinity. Here, the emphasis must be placed on raising of salt resistant crops, fishery, stabilisation of the dunes by vegetation and also on the development of such artisan crafts which can use the ruds and grasses growing in the marshy tracts. This has to be supported adequately by the development of water transport facilities to be availed of by country boats of moderate size. Since fishing can constitute one of the major occupations of the people of this tract, it may be also necessary to create fishing co-operatives and primary collection centres for transporting the fish to inland areas.

It is needless to say that the details regarding the appropriate measures commensurate with micro-level environmental situations will go on increasing as one probes deeper and deeper into the attributes of specific units and sub-units of lower and lower orders. But it may be also necessary to highlight some of the macro aspects of the planning of the basin we shall discuss these items in the next section.

SOME MACRO CONSIDERATIONS

The major two production sectors of any economy are agriculture and industry. A proper balancing between the two sectors with regard to allocation of resources including manpower is of vital important to the growth of the economy. It will be seen that the lands of the Subarnarekha basin and the resources contained therein provide the opportunities for such a balanced allocation from several angles. First, the basin is rich in a combination of forest and mineral resources. The most economically valuable forest trees, chiefly sal, sishoo, khair and others constitute one of the main resources of this basin. The geological wealth of the Subarnarekha basin includes iron ore, bauxite, manganise, China clay, asbestos, apatite, limestone, steatite, kianite, not to speak of copper whose concentration in the lower valley of the Subarnarekha is most significant in India. So far as the industrial significance of the basin is concerned, the only deficiency seems to be the absence of fossil fuels. Alongside this industrial potential the rainfall of the basin, varying from 1200 to 1700 millimetres with only a moderate variability (Fig. 2) and with desirable temperature conditions, constitutes another very important resource for both agriculture and industry. The soils also are reasonably thick and productive whenever the relative relief is moderate or low. The physical resource base, therefore, should not inhibit either the rural or the urban sectors of the economy.

Secondly, the spatial pattern of distribution of the physical resources is such that their utilisation can be made harmonious with the geomorphic shaping of the basin. The forests, minerals, uplands and hard soils are present together in a combination towards the western half of the basin from which water drains off. On the other hand plain lands, thick soils, good sub-soil water reserves (Fig. 1), all suitable for crop and animal husbandry are present in the eastern half of the basin which drains in water from the western half. This arrangement makes the spatial resource re-allocation pattern rather simple.

Thirdly, the two most agriculturally unproductive extremes of the basin are the water scarce upper catchment areas and the water covered deltaic margins. These two are dominated respectively by the tribals and the lower castes of the basin population. Their command over agricultural (and superior farming techniques is small in comparison to the higher and the middle castes who have firmly occupied the best areas in the middle section of the valley. These people specially the the tribals of the west can derive their livelihood much more conveniently provided the forests and the minerals are utilised in a manner in which they can participate more effectively. The same applies to a possible expansion of the marine resource horizon in the extreme east.

All economic questions obviously cannot be solved within the purview of basin management which has to be conceived as only an act on the stage of regional planning drama performed by planners at different levels and abstracted in consonence with the ethos of national planning. The geographers' role is only to suggest how the stage has to be arranged for the particular act. It has to be noted that planning is essentially a political game and the task of intigrating the welfare of a particular bunch of people and to find out the appropriate political part for doing so lies finally in the hands of the policy makers of the country.

TABLE I

S. No.	Sample Administrative Unit	Geomorphic Unit	General Slope Characteristics (Rank Order)	Drainage Density	Erosional Intensity (Rank Order)	Depositional Intensity (Rank Order)	Natural Vegetation	Soil	Temperature
1	2	3	4	5	6	7	8	9	10
1.	Tamar II	Hills	1 (Highest – Slope)	Very High	1	6	Densest forest mainly *sal*	Red & Yellow sandy	Coldest month : 17.5 – 20.0°C Hotest month : 27.5°C
2.	Tiring	High Plain	2	High	2	5	Degraded *sal* forest	Mixed red-yellow and black	Coldest month : 20°C Hottest month : 27°C
3.	Nimdih	Monadnock Plain	3	Very High to High	3	4	Same with extensive blanks	Red Sandy	Same
4.	Baharagora	Erosional Plain	4	High	4	3	Isolated stands of mahua, palash, etc.	Red-yellow and alluvial	Same
5.	Jaleswar	Riverine Depositional Plain	5	Low	5	2	Deforested with grassy vegetation	Recent alluvial	Same
6.	Bhograi	Marine-Riverine Delta	6	Low to very Low	6	1	Casurina on dunes, traces of mangrove	Deltaic alluvial	Same

TABLE I (Contd....)

S. No.	Rainfall	Ground Water	Population Density /km^2	Workers as % of Total Population	Agricultural Labourer	Owner Cultivator	Mining Forestry etc.	Household & Manufacturing Industry	Rest	Scheduled Cast	Schaduled Tribes	No. of Villages per 100 km^2	Average Village Size
	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	Annual Av. 1350 mm variability 19%	Impervians unconfined groundwater at shallow depths in fractures, joints, weathered zones – very limited	104	41	19	76	0.5%	2.0%	2.5%	7%	83%	30	418
2.	Same 24%	Same	191	35	26	59	3.0%	4.0%	8.0%	8%	69%	40	454
3.	1250 mm 18%	Same	214	34	34	59	0.3%	1.6%	5.1%	4%	34%	30	744
4.	1550 mm <20%	Marginal areas of ground-water basins with restricted lenticular acquifers in phreatic zones upto 100 meters	229	33	49	39	1.0%	0.3%	10.7%	5%	37%	120	195
5.	1700 mm 26%	Areas with considerable acquifers confined and unconfined yield 80.000 l.p.h.	341	27	36	49	0.8%	3.0%	11.2%	14%	9%	90	377
6.	1700 mm 27%	Areas with saline 1 brackish deep seated and irregular aquifers	462	26	28	61	1.5%	2.0%	7.5%	14%	2%	100	455

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