CHAPTER - 9

CONCLUSION

9.1 MAIN FINDINGS AND OBSERVATIONS : The Sali River Basin (914.5 sq.km.) is a small but conspicuous geomorphic unit with variegated landscape patterns of physical and economic significance in the Chotanagpur plateau fringe of Bankura district, West Bengal. Appraisal of the major parameters of the geo-environment like geological base, climatic conditions, fluvial environment and landforms, pedological variations, source of water for irrigation, and the land use pattern has unravelled many of the problems so far as the development of the agricultural land use of the Basin is concerned. The main findings and observations of the geo-environmental appraisal in this thesis have been briefly discussed as follows :

The geological background of the area is characterized by the rocks ranging in age from Archaean crystalline to Recent Alluvium (Table 2.1). The area is covered by the quaternary sediments which can be classified into four litho-statigraphical units (Fig. 2.1). These are in order of decreasing antiquity : (a) Lalgarh Formation (Laterite), (b) Sijua Formation (older Alluvium), (c) Chuncura Formation (Silt with fine sand), and Hugli Formation (Silt and Clay). The corresponding morpho-units are : (a) Lalgarh (Upland), (b) Sijua (Terrace), (c) Chunchura (Rolling Plain) and (d) Hugli (Flood Plain). The geological history of the terrain reveals that Lalgarh Formation is the product of extreme exidation of the pre-quaternary sediments. The sediments of other formations are deposited in fluvial environment. Lalgarh Formation, the maximum covered area, adversely affects the agricultural land use because of its lateritic hummocks. Chunchura and Hugli Surfaces are moderately favourable for agriculture, but they are very small in area and susceptible to flash flood that frequently damages the standing crop particularly in the lower sector of the Basin off Sonamukhi town. Only the Sijua Formation, covering about 35 per cent of the total area in the Basin, is best suited to agricultural land use so far as the relief, soil and water availability are concerned (Table 2.2).

The climatic base of the Sali Basin reveals that the area enjoys a typical tropical humid monsoonal climate which is mainly controlled by rain bearing south-west monsoon wind system and characterized by two marked bi-zeric conditions. Rainfall is attended by pre-and post-monsoon dry periods (Fig. 3.2). About 80 per cent of the total mean annual rainfall (1350 mm) occur during the south-west monsoon season from June through September (Table 3.3). The area also experiences oppressive heat due to high temperature mainly in the months of May through August (Table 3.1). May is the hottest month and the temperature may rise even above 40°C. Duration of dry spell within the south-west monsoon season is significant (Table-3.4) and it affects adversely the successful cultivation of aman paddy (main crop). It has been also observed that the normal annual rainfall gradually decreases from 1329 mm (1915-55) to 1293.4 (1956-90) during the period of 60 years (from 1915-90) for which data are available. Number of years in which rainfall is below 75 per cent of the normal is 4 (Table 3.5) i.e. 6.9 per cent and number of years in which rainfall is below 25 per cent is 30 i.e. 50 per cent. This is clearly indicative of a marked swing towards drought in the area.

The soils of the Sali Basin as a whole are moderately deep and coarse in texture. Average percentage of sand is 55 (Table 4.2). Out of the total seven types of soils recognised in the Basin, Joyrambati, Hatikheda and Mrigindihi soil types are significantly productive and cultivation of paddy and other crops is more or less satisfactory (Fig. 4.2). Other soil types are poor in water holding capacity and extremely deficient in NPK (Table 4.4). Soil erosion which has assummed the greater proportion at present due to large scale felling of forest trees in the loose coarse grained lateritic soils and heavy leaching during the rains is a serious problem which has to be tackled with the assistance of the government.

Studies on fluvial environment and landforms reveal that prior to the inception of the valleys, the toprography was represented by the laterite capped table-land comprising denudational hills, pediments and pediplains of the earlier cycle of erosion. Thus the initiation of the rivers on this erosional surface marked the beginning of deposition in

the quaternary period with the appearance of successive depositional terraces and flood plains (Fig. 5.1). Broad geomorphological divisions of the Basin (Table 5.3) reveal that Gangajalghati Upland and Kora Upper plain surfaces have duricrusts (laterite) and alluvial terraces. The Sali river flowing through the area is actively engaged in eroding the older surfaces and building up the down stream area by the process of deposiion. Sonamukhi Rolling Plain and Bodai Low Flat Plain Surfaces have developed a number of depositional features. The average slope of the Basin is easterly which is very well reflected in the unidirectional easterly flow of the rivers. The terrain of the Basin being more or less undulating, there is usually no active flood plain. But occasional flash flood is not ruled out due to sudden heavy rainfall during the monsoon season. Out of the total four geomorphic surfaces, the surface-IV (Table 3.3) experiences almost regular annual flood, the waters of which are spilled out from the voluminous Damodar river in the immediate north. The general drainage pattern of the Basin is Dendritic and Rectangular which are controlled by the relief and structure at micro-level (Fig. 5.2). Being fed by the monsoonal rainfall, most of the rivers go dry during the hot weather season. Morphometrically, this fourth order basin (Strahler's method) has developed a very high number of first order system, highly variable bifurcation ratio, low sinuosity index, low drainage density, and low circulatory ratio. Spatial variation of relative relief and average slope is also not high. Roughness index and hypsometric integral have also been calculated and found lying in the lower side. All these parameters support the Sali Basin having usual relief features of an undulating plain.

The optimal utilization of water for irrigation (both surface and ground water) is singularly vital for the development of agriculture in the Sali Basin, Bankura. The use of surface water for agriculture is from the (i) flow of the main river and its tributaries, (ii) tanks and *jhor-bunds* and (iii) canals of the Sali Reservoir Project within the Basin and (iv) the canals of the DVC right bank which carry water from outside the Basin. Field investigations reveal that the surface water is not only inadequate, but also hindered by (a) quick run-off

due to undulating topography followed by (b) high evaporation due to larger duration and greater intensity of insolation besides (c) rapid percolation in the N.En. part between Sali and Damodar where the top soil is coarse sandy. Water in the Sali Reservoir at Gangajalghati becomes so low during lean period that it fails to combat the problem of drought in the area. With distinct four seasonal conditions viz., (i) Nor'wester ridden pre-monsoon (March-May), (ii) Humid warm South West Monsoon (June-Sept.), (iii) Humid Warm Retreating Monsoon (Oct.-Dec.), and (iv) Short Cool winter (Jan.-Feb.) with occassional arrival of western disturbances. The primary source of surface water in the Sali Basin is rainfall. In the nor'wester season the uncertain fall of rain with dust storm does not sustain any crop while the S.W. Monsoon is the main source of rainwater (Table 3.2). In the summer (*kharif*) season, because of the undulating terrain, greater part of this valuable water resource is lost due to high run-off in the Sali Basin. The tropical cyclone during the Retreating monsoon, though supplying very heavy quantity of surface water because of incessant rainfall within a couple of days associated with cyclonic conditions, destroys the heavy headed grain bearing standing *aman* paddy (the main crop) rather than sustaining it. Again, because of the lateritic surface soil not much of the surface water supply is held in the soil. The Western part of the Basin has thin veneer of soil cover because of faster ascending slope with sparse vegetation and accordingly, recharge is low. Ground water occurs in the shallow weathered zone of the hard rocks and circulates through the cracks, fissures and joints within them. Ground water occurs in the aquifers comprising laterite, lithomerge and sands of various grades in the middle sector of the Basin. The dug wells which end in the laterite usually dry up in summer but those which have penetrated through the laterite upto lithomerge are found to contain some water during the summer months. The eastern most sector in between Sali and Damodar is almost a flat country covered by thick alluvium and a good prospective of ground water source.

Appraisal of the broad land use pattern of the Sali Basin (Fig. 7.1) reveals that a considerable portion of the area is not suitable for

agriculture. About 35 per cent of the total area of the Basin are *tora* lands (Table 7.4) which are usually covered by coarse grained sandy soils having very poor water holding capacity and rocky out crops often remain as degraded forests or fallow. About 8 per cent of the area are not cultivated every year due to the shortage of rain water and remain as current fallow. Inspite of that nearly 60 per cent of the area have been brought under plough. The percentage of area as wasteland, however, is not very high, being hardly 6. This means that due to the increase of population, people have brought more and more land under plough although they could not improve their farming because of the unfavourable terrain and paucity of water resources. Regarding the technological know-how for agricultural development, the inhabitants of the Sali Basin, as observed, stand no where and financial constraints have been a handicap. Land under forests in the area has shrunk to hardly 14 per cent of the total area (Table 7.1) although the forest including cultural forests is the second important block next to agriculture in the land use of the Basin. Large scale cutting of trees by the contractors continued even after independence in 1947 since the demand for wood and wood-based industry particularly pulp and paper has increased. On the other hand, the land capability classification of the Sali Basin (Fig. 7.5) shows that the soil condition as a whole is such that the greater part of the area is more suitable for natural growth of forest. It helps the resource-poor dryland farmers to cope up with the loss of crops due to drought, reduces soil and water loss, utilizes off-season rainfall and meets the requirement of fuel wood, timber, fruits and fodder.

Statistically, the impact of landforms (1. Relative relief, 2. Average slope, 3. Drainage density, 4. Roughness index) on land use pattern (5. Area under forests, 6. Area under paddy, 7. Area under other crops, 8. Area not available for cultivation) has been proved significant among the Geomorphic Surfaces (I Gangajalghati Upland, II Kora Upper Plain, III Sonamukhi Rolling Plain, and IV Bodai Low Flat Plain) in the Sali Basin. Area under paddy (main crop) and area under other crops in surface III and IV are much more variable when compared to surface II and I. Surface-wise variability of

roughness index and its influence on the other parameters is also significant. Variation between surface II and IV, and II and III is statistically significant in the case of all the characters except drainage density (Table 8.3). Variation of the relationship among different characters between pairs of surfaces I and II reveals that the surface II has better terrain condition and water availability for profitable agricultural land use (Table 8.2).

9.2 SUGGESTIONS : After careful observations of the main findings in the present research work on geo-environmental appraisal of the Sali River Basin, Bankura district, West Bengal, some of the following suggestions can be made for the development of the socio-economic conditions of the area.

Lalgarh surface that has covered up 46 per cent of the total area in the Basin has coarse sandy soil, faster run-off and poor ground water potentials. Originally forested, this vast tract of land has mostly been converted to farmland to feed the increasing population. Now the problem is that the forests have gone, but agriculture is not developed mainly due to water scarcity. Therefore, it has been suggested that the areas which have better potentials for agriculture should be developed for croplands and the other areas be brought back to the forestry. This is to be done for better economic as well as ecological considerations. It should be noted that land under forests has already been shrunk to hardly 14 per cent of the total area. This has considerably enhanced laterization since the shade giving forest cover has been removed through reckless deforestation.

It transpires from the agro-climatic conditions of the Sali Basin that the *aman* paddy (main crop) of shorter growing period is suitable because of the fact that the rainfall in the first half of the monsoon (June-July) is always lower than its requirement in the entire area. Besides, irrigation is to be extended to meet the shortfall even in the second half (August-September) of the monsoon season. In the upper sector of the Basin (Gangajalghati - Barjora P.S.) although the annual rainfall is even more than the crop requirement, the actual water available from the rain for crop plants is much lower because of the

huge loss of water due to run-off. The scope of irrigation is also very limited since the storage capacity of water in the existing tanks and *jhor-bunds* is not sufficient, and the ground water potential is also very low. Therefore, it has been suggested that cultivation of *aman* paddy should better be replaced by other crops consuming lower amount of water particularly in the higher plots of land.

Soil conservation which is used to be equated with erosion control can be achieved by two means : barrier approach and cover approach. The former referred to the use of physical barriers to check run-off and down-slope soil movement and the latter one is checking erosion by maintenance of a ground surface cover throughout the period of erosive rains. The appraisal of the pedological base of the Sali Basin reveals that the soil conservation measures may be suggested for different land capability sub-classes. Land capability sub-class IIs needs field terracing, contour tillage, crop rotations, strip cropping, stubble mulching, application of fertilisers, manures and soil amendments according to requirement. Land capability sub-class IIw is good except for excessive water during the second half of the monsoon season (August-September). Disposal of water is necessary by drainage system followed by field terracing, contour bunding and crop rotations. Land capability sub-class IIIe comprises moderately good land but susceptible to erosion. Intensive soil conservation measures viz., contour bunding, bench terracing, field terracing, safe water disposal and agronomical practices are necessary. Land capability sub-classes IIIs and IVs comprise moderately good land with severe limitations of soil texture and soil depth. The soils are subjected to past erosion and needs intensive soil conservation measures, viz., narrow based bench terracing, contour trenching, safe disposal draining etc. Stabilization of terraces and inter trenched areas may be done by contour planting, mulching and other vegetative methods. Mechanical structures may be selected depending upon the type of crops/forestry. Land capability sub-class IVe needs very intensive soil conservation measures to protect soils from further erosion. Some of the measures suggested are bench terracing (broad based) provided soil depth is favourable. Areas of low effective soil depth may be provided with

narrow based terraces, contour trenches etc. Safe disposal drains for excess run-off may be provided for the elimination of excess rain water, while Land capability sub-class VIe has very severe limitations and may be kept under permanent vegetation viz., forests/social forestry, contour trenching/diversion of channels may be provided whenever needed.

As a part of the mechanical soil conservation practices, construction of earthen embankments of composite type across the gully courses at suitable locations may be taken up to collect the run-off for multipurpose benefits to the people viz., crop production, fisheries and homestead use. Besides, these water storage tanks will function as infiltration tank to maintain the sub-surface moisture storage capacity.

To tackle the problems of water utilization, the main effort should be to hold back the run-off water in the upper sector of the Sali Basin and to maintain sufficient drainage system to prevent water logging in the lower sector. Deficiency of water for crop cultivation is compensated for by such measures as construction of reservoirs and canals and limited utilization of ground water through dug-wells, shallow tube-wells and deep tube-wells. Therefore, in order to meet the needs of the rising population more intensive multiple farming methods and steps for the regulation of run-off and utilization of ground water must be initiated and implemented. Efforts have also to be made to utilize at least a part of the run-off in dug-out tanks. To check the seepage losses from the tanks, several sealing materials may be used.

For mitigation of flood hazard in the lower part of the Sali Basin, first it requires the correct delineation of flood way, flood fringe way and flash flood areas. Since the flood is due to the occasional higher discharge conditions of the Damodar, traditional protective measures like maintenance of embankment and construction of diversion channel within the Sali Basin are not adequate. Measures of a flood abatement (i.e., water-shed management, afforstation etc.) and flood protection (i.e., embankment, reservoirs, by-pass channel etc.) should be taken up in the main Damodar valley with great sincerity. However, a more detailed geomorphological study is necessary for

evaluation of the terrain at micro-level. Emphasis should be given on accurate assessment of the run-off in a systematic way so far as agricultural development is concerned.

It has been observed that because of the increase of population and subsequent absence of agricultural modernization, arable farmings in the Sali Basin have already extended quite far at the expense of forests. It would not be possible or ecologically desirable to enlarge the net area sown to any great extent in future. Rather, serious attempts should be taken up to improve upon the cropping intensity even to the extent of 150 per cent by the turn of the present century from the existing 122 per cent and adequate infrastructure including irrigation facilities is to be ensured to the maximum extent possible. Identification of short duration drought tolerant high yielding variety should receive priority. Alternate food crops like short duration millets and maize that require much less water than paddy, particularly in the uppermost land situations need be explored. Double croppings with short duration varieties of these crops as well as paddy-millets or paddy-pulses (like cowpea, soyabean) may be cultivated.

The land capability classification of the Sali Basin shows that the greater part of the area is more suitable for natural growth of forests of dry deciduous trees. It is absolutely necessary that all the existing degraded forests are to be restored immediately and turned into dense forests. Massive afforestation and forest protection programme should be taken up and the local people be involved. Further, there is a large chunk of land given to various non-agricultural uses as per official figures. Detailed break-up of these built up areas is not available. But that as much as 12.92 per cent of the total area go for various non-agricultural uses in the Sali Basin, particularly in Barjora where the percentage is 20, is surprising. A much deeper probe is needed to identify which of the non-agricultural uses has consumed so much of space in the region.

9.3 CONCLUDING REMARKS : The Sali Basin of Bankura district - a noted backward area in West Bengal presents a variegated geo-environ-

ment which is characterized by a significant diversity of geological back ground, climatic base, soil conditions, landforms and fluvial environment, source of water for irrigation, and a general land use pattern. Quaternary geology of the Sali Basin reveals that the Lalgarh Formation has covered maximum area but adversely affects the agricultural land use because of its lateritic hummocks and loose coarse sandy soils having poor water holding capacity. Chunchura and Hugli surfaces are moderately favourable, while the Sijua Surface, covering about 35 per cent of the total area is best suited for cropping.

The typical tropical humid monsoonal climate of the area is characterized by two marked bi-zeric conditions of the Monsoon. Rainfall is attended by pre- and post-monsoon dry periods. Duration of inter-dry-spell within the monsoon season affects agriculture adversely. The area experiences oppressive heat due to high temperature mainly in the months of May through August. Incidence of drought is also not less important. Soils in general are coarse in texture and poor in nutrients. Out of the total seven types of local soils in the Basin, Joyrambati soil is most suitable for agriculture. Soil erosion in the area is also very high particularly due to heavy leaching during rain. Rills and gullies have developed and patches of bad lands are in progress on the lateritic uplands after the trees in the forests have been felled recklessly.

The topography of the Sali Basin is highly matured as revealed in the presence of the pediplain along with the top cover of laterite, highly graded nature of the river valley, overall gentle slope and low relief, and monotonously extensive nature of plains, the only exception being the river valleys where slope varies. Of the total four geomorphic divisions, Gangajalghati Upland and Kora Upper Plain have duricrusts and low terraces while Sonamukhi Rolling Plain and Bodai Low Flat Plain surfaces are characterized by depositional features. The altitude in general, varies from 140 m to 40 m above m.s.l. The general drainage pattern of the Basin is dendritic and rectangular which are controlled by the relief and structure at micro-level. Being fed by the monsoonal rainfall, most of the rivers go dry during the hot weather season.

Regarding the source of water for agriculture the deficiency of surface water exists every where in the Basin since the monsoon is seasonally variable, uncertain and unreliable. Much of the surface waters are also lost because of the faster run-off in the undulating terrain in the areas under Gangajalghati and Barjora P.S. and rapid percolation in the interfluvial sandy stretches between the Sali and the Damodar. On the other hand, the unfavourable geological conditions highly restrict the source of ground water in most of the areas within the Basin. No tube-well has been sunk successfully in Gangajalghati area as bed rock is encountered at a shallow depth just below the weathered residium. In the middle sector, the dug wells which end in the laterite usually dry up in summer but those which have penetrated through the laterite upto lithomerge are found to contain some water during the summer months. In the eastern most portion of the Basin, however, the situation is slightly better.

The appraisal of the broad geo-environment of the Sali Basin also reveals that in the land use about 35 per cent of the total area are *tora* lands which are usually covered by coarse sandy soils and rocky out crops and often remain as fallow lands particularly after deforestation. Inspite of that, about 60 per cent of the area have been brought under plough. Land under forests on the other hand has shrunk to hardly 14 per cent, although it is the second important block next to agriculture. Therefore, forests need immediate development through massive afforestation programme. Land not suitable for farming should better be brought back to the forestry. While planning for the desirable optimum land use in the area for the year 2001 A.D., the target should be to raise the cropping intensity to about 150 per cent from the existing level of 122 per cent after carefully tackling the problem of water shortage for agricultural land use. Current fallows that have taken away about 8 per cent of the total area in the Basin should be brought under regular farming. In the years of low rainfall, new variety of *kharif* season oil seed, 'til' which requires low amount of water and much less care than paddy can be grown.