Chapter 7
The Controlled Lower Damodar River: A Product of Hydro-Geomorphic and Anthropogenic Processes

Abstract The Lower Damodar should be culturally defined. Forms, processes and materials in the controlled section are generically quasi-natural in character. Social space of Bengali refugees has played a significant role in riverbed colonization and in subsequent land use practices. There is a strong linkage between changing geomorphic space and perceived environment. Land ownership rights are crucial factors in riverbed land utilization. The modified concept of human ecology helps in explaining land uses. There can be no a priori model for human-environment interactions. Human interaction with the environment depends on personal experience. The controlled Lower Damodar is a product of twin processes; quasi-natural hydro-geomorphic processes on the one hand and anthropogenic land-utilization processes on the other.

Keywords Anthropogenic · Flood · Flood control measures · Human ecology · Human-environment interactions · Hydro-geomorphic · Land use · Social space

7.1 The Lower Damodar, a Product of Human Activity

In the preceding chapters applied geomorphological issues, ranging from floods, flood control measures and their impacts on selected hydro-geomorphological parameters to river-bed land use in the Lower Damodar River, were discussed in separate sections. The purpose of this segmented discussion was to highlight individual issues. In Chapter 2 several concepts were discussed as heuristic assumptions. Now, these segmented issues must be unified and the validity of heuristic assumptions established.

Our first assertion is that the Lower Damodar, as it is today, is clearly a product of human activity. The natural east-west trend of the river, southward deflection below Barsul-Chanchai, and the deferred junction with the Hooghly, are conditioned by regional slope and sub-surface lineaments. The riverbank was the natural boundary of the river and its flood propensity was inherited from hydromorphological and meteorological conditions prevailing in the entire Damodar basin. The Lower

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Damodar River used to adjust with excess discharge through a well-defined distributary system on the left and spill channels, or hanas, on the right, failing which extensive areas in the present Barddhaman, Hooghly, and Howrah districts used to be flooded. It started losing its identity as a natural river in the later half of the eighteenth century due to human intervention in the form of embankments. The near gradation of the river was disturbed in different phases by artificial base levels created by the Jujuti sluice, the Rhondia weir, the Durgapur Barrage, the Panchet and Maithon reservoirs, and finally, by the Ulughata sluice. Since the completion of the Maithon and Panchet reservoirs, the river has been transformed into a "reservoir channel" or a "reserved controlled channel". The Lower Damodar is now identified by control structures, cultural features, and human made indicators.

7.2 Forms, Processes, and Materials in Controlled Section Are Quasi-Natural in Character

From the notion that the Lower Damodar needs to be culturally defined has emerged the second assertion of this research: that forms, processes and materials in the controlled sector are quasi-natural in character because of human intervention with the natural fluvial system by means of control structures. It is not to be denied that the emergence, migration, and stabilization of bars are products of fluvial processes, but stabilization of bars has become more significant due to sediment trapping by roots of cultivated vegetation. Even the inundation-prone peripheral zones of settled bars do not remain fallow. Either grasses are grown or crops of low value and quick-maturing crops are grown as additional crops in bars such as Bara Mana and Kasba Mana. Decaying channels with clay deposits are also used for wet rice at Ramkrishnapalli, Pallishri, Bara Mana, Rangamatia, and Fatehpur (Bhattacharyya 1998, 1999, 2008b). In Paikpara, the bed of the Damodar is intensively cultivated in the non-monsoon period. Furthermore, domesticated vegetation and the addition of artificial fertilizers have changed the very composition of the soil. All these cultural practices have helped in stabilization and extension of riverine bars and in developing human-induced modified soil profiles (Bhattacharyya 1998).

The above statements do not necessarily imply that the stabilization of bars and changing soil composition due to land use practices should be interpreted as anthropogenic processes. Man may be a geologic agent, a concept supported by Sherlock (1922), Thomas (1956), Brown (1970), and others. Although the role of humans as geologic agents in shaping the earth's surface depends on the level of technological expertise, sedimentation and pedogenic processes are governed by universal physical laws. In contrast, land utilization, an anthropogenic process, is governed in the truest sense by location-specific socio-cultural and politico-economic factors. Comparing observations and assessments from several case studies on the river-bed land utilization in the Lower Damodar, we can justifiably conclude that simultaneous operation of fluvial and pedogenic processes on the one hand and anthropogenic processes in form of land utilization on the other have resulted in forms, processes and materials in the Lower Damodar that are "quasi–natural" in

character. This claim was introduced in Chapter 4 while examining the hydromorphological consequences of control structures and was again re-examined while assessing river-bed land utilization. To differentiate it from a physical environment where everything is natural, it is proposed that, for a historical environment, the term "quasi-natural" be adopted as an adjective for geomorphic forms, processes and materials (Bhattacharyya 1998).

7.3 Concept of Culture in Resource Appraisal

In the analysis of riverbed land use and settlements, less emphasis was placed on origin and more on adjustment patterns in a physical and socio-cultural milieu. The riverbed was assumed to be a resource base and not a resource in itself. In the sections of the river studied, potential resources of the riverbed are fairly uniform. Sandy loam, for example, is found almost everywhere. Use of these undifferentiated bed-materials, however, has been spatially and temporarily differentiated based on the cultural proclivities of the settlers. The riverbed users are mostly Bangladeshi refugees but there are a few families of Biharis in places like Gangtikali and Gaitanpur. Since Bengalis are rice eaters, paddy is the main crop in Bengali-dominated settlements, whereas wheat is the crop of choice in sand bars dominated by the Biharis who primarily eat a type of bread. Bangladeshi refugees have introduced jute as a cash crop as they were used to jute culture in their previous habitat in Bangladesh whereas potato culture was introduced in Rangamatia, Fatehpur and Kasba Mana by locals who migrated from the Hooghly district, noted for potato cultivation, after the 1978 floods. Imprints of acquired local culture are evident in Bara Mana and Majher Mana where mulberry plantations have become significant components of the cultural landscape after 1978. The linkage between mulberry plantations and the silk culture of Bankura-Bishnupur does not require any further explanation. Floriculture in Bara Mana, Gaitanpur as well as in Chhayani Gujrat and Panchani Gujrat is no doubt governed by strong economic factors i.e., market facilities in Durgapur, Barddhaman and Howrah but selection of flowers such as marigold, hibiscus and rose is motivated by religious demand. Betel leaf chewing is a widely prevalent habit in India. Apart from market facilities in Howrah, this national cultural trait has played a decisive role in the growth of betel leaf plantations in the river-bed of the Amta channel (Bhattacharyya 1998). Admission of the concept of culture in resource appraisal is not new in applied geomorphological or human environmental research. This concept is used here to explain functional relations between the riverbed resource base and its users.

7.4 Significance of Social Space in Colonization Processes and Land Use Practices

Apart from cultural variations and preferences, the other major social/psychological factor influencing riverbed land use is the fact that most of the Bengali settlers are refugees, a status with legal, social and economic connotations (Kuper and Kuper

1995). In the Lower Damodar riverbed, they are not majority-identified refugees, but self-alienated refugees. This very definition and status have played a crucial role in sequential occupation of the riverbed by refugees and in land utilization. It is a global experience that refugees are not fully accepted by host communities, particularly when the same economic sector has to be shared. The riverbed occupiers were from the farm sector in erstwhile East Pakistan or present Bangladesh, a sector already saturated in West Bengal when millions of Bengalis crossed the border. So, from the very beginning, host communities perceived these migrants as parasites. The refugees themselves were keenly aware of their outsider status. The newcomers were not differentiated from the Bengalis of West Bengal in terms of language spoken or religion. In fact, prior to partition, their social structure and organization was conditioned by similar ecological and cultural factors. But their newly acquired refugee status created a distance from the locals. This distance was a perceived distance. Although they were forced to share the same physical space or geometric space in West Bengal, their position in the sociological space was different. This perceived space is the social space as advocated by Durkheim in 1933 and also by Sorokin (1928, 1959), Theodorson and Theodorson (1969), Chombert de Lauwe (1952, 1956), Buttimer (1969, 1980) and Bhattacharyya (1998, 1999, 2009). A section of the refugees' deserted government-sponsored colonies and camps. Thus from "majority-identified refugees," they became "self-alienated refugees." At this juncture the riverbeds of West Bengal became their new addresses or "niche." In the Lower Damodar sand bars, locations with disadvantages were selected so that their self-alienation could be retained and they could avoid resistance from the locals. In the plantation history of the world it has always been observed that newly arrived groups at the initial stage try to avoid clashes with locals and start plantations in terrains perceived as less fertile by locals. Examples of this phenomenon include the rubber plantations in Malaysia as well as tea and coffee plantations in India and Sri Lanka. This is a common feature of the colonization process. So when the barren sand bars with grass jungles, away from main transport routes, were occupied by refugees, the locals did not raise any protest because to them the sand bars were just fundamental entities.

Colonizing ab initio in a totally different environment, the refugees in the Lower Damodar riverbed assessed the controlled riverbed not as it was but as it was perceived by them, a perception conditioned by their felt position in society, i.e. social space. Since their social mobility was restricted, they adopted a "self-help" policy. They cleared the jungles and built their own huts. To reach a minimum level of self-support in food production, they started growing essential food crops. Apart from paddy, an inferior species of bottlegourd (*Legenaria Siceraria*) locally known as "khero" was introduced in fresh sands of low nutrient status. The falling of leaves and animal droppings enhanced the fertility of sandbars. In later stages they tried to sell part of their crops grown for additional income to attain a level of self-reliance (Bhattacharyya 1999–2000b, 2008b). The granting of land deeds to the refugees has given them a further measure of self-sufficiency and parity with the locals. This is the experience in almost all refugee-settled sandbars. Rogge (1987) has observed these sequential changes in refugee settlements in Sudan but has not used the term

"social space." Verstappen is eloquent about socio-economic controls on rural land use (Verstappen 1983). Applying these ideas in the context of the Lower Damodar, it can be stated that one's perceived position in society, perceived relations with others, and perceived social distance or mobility are *sine qua non* in developing a functional relation with a given resource base (Bhattacharyya 1998).

7.5 Strong Linkages Between Changing Geomorphic Space and Perceived Environment

A question that naturally arises from the previous discussion is the following: is there any relationship between changes in perceived environment and changes in real environment? Craik (1970), Clayton (1971), Cooke and Doornkamp (1974, 1990), Basu (1988), Verstappen (1983), Hart (1991), Bhattacharyya (1998, 2009), and Gregory (2006) realized the need for applying perception concepts in applied geomorphological research but there is a lack of empirical study in this area. Saarinen (1966), Correia et al. (1998), Bhattacharyya (1991, 1997, 1998), Ladson and Tilleard (1999), Darby and Thorne (2000); Downs and Gregory (2004), Piegay et al. (2005), Chin and Gregory (2005), and Gregory (2006) in research on hazard, river management and on humans' role in changing fluvial regime have emphasized the concept of perception and perceived environment.

In this study of the Lower Damodar, the concept of perceived environment in examining the functional relations between the riverbed and its occupiers is utilized. Changes in real environment are recorded on the geographic space. Different types of control structures, changing boundaries of sand bars, the opening of spill channels, the deterioration of distributaries, and other similar changes leave their cognizable imprints on the surface. Perceived environment is reflected in land use practices as it is shown below through the examples of Gangtikali, Paikpara and other parts of the Damodar riverbed. Just as there is an overt expression of social space, the perceived environment has its overt expression through selection of settlement sites, crops to be grown, and so on.

In Gangtikali, there was a change in real environment when coal mines on the west were flooded in 1959. Prior to this event, the islanders did not perceive the agricultural resource potential of the east side. In fact, their interaction with their environment had been essentially dictated by the coal mining company which saw Gangtikali only as a geological resource. After the 1959 floods, however, the islanders, driven by the need to look beyond coal mining, began to realize the agricultural resource potential of the eastern part of the island. The settlement sites shifted from west to east (Fig. 6.1). Since Gangtikali is located at a higher elevation, release of water from the reservoirs turned out to be a boon for lift irrigation.

There were a series of changes in geomorphic space and geomorphic resources in Paikpara with the opening of the Muchi-Begua hanas and the Kanki-Mundeswari. The main flow of the Damodar shifted to the Kanki-Mundeswari and the old Damodar deteriorated to such an extent that its bed became agricultural land during

non-monsoon periods. The bed of the old Damodar is now perceived more as a fund resource and less as a flow resource. Moreover, people view the Muchi-Begua hana side as vulnerable due to bank erosion. In accordance with this there is an out-migration from Paikpara and the main settlement site is shifting towards the east (Fig. 6.23). Observable changes in real geomorphic environments have occurred below the Ulughata sluice. The Lower Amta channel has almost become a defunct channel and has been unofficially declared defunct by the executive engineer, Irrigation and Waterways Department, Government of West Bengal. Environ-sensitive betel leaf plantations are located here as the area is perceived to be safe for these plantations.

When the first group of settlers arrived in the riverine bars, the Durgapur barrage, Maithon, and Panchet reservoirs were yet to be constructed. There was a rapid change in real environment when these three emerged as major transverse control structures. Monsoon flow decreased, peak flow reduced, and there was a shift of peak flow from July–August to September (Figs. 4.2, 4.3, 4.6a, 4.6b, 4.7; Tables 3.3 and 4.5). There is no doubt that perceived environment constructed by the refugees changed just as rapidly. They quickly discerned the effect of the water release from the reservoirs and barrage and the inundation patterns of their land. All these examples indicate that perceived environment changes with changes in the real environment, though not always at an equal pace. Sometimes perceived environment changes faster than the changes to be observed in the real environment and vice versa. For instance, when refugees sought out remote and barren sandbars as desirable locations, their perception of the advantages of their environment were not conditioned by any actual changes to the real environment. On the other hand, the 1978 floods caused remarkable changes in the real environment, severely damaging several riverine bars. There was, however, no consequent change in the perceived environment of the refugees due to their restricted social mobility and economic constraints. It can be concluded, therefore, that there is a close link between changing geomorphic space and perceived environment, and that perceived environment is conditioned by social space (Bhattacharyya 1998).

7.6 Public Policy and Land Ownership Rights

A discussion of the factors that influence perceived environment would not be complete without touching on issues of law and public policy. A cardinal change in perceived environment has occurred after the refugees were granted land deeds. This legal step has given refugees a level of self-sufficiency beyond the level of self-help they attained in the initial stages. Environmental perception was embedded in the decision to build embankments on the flood-prone Lower Damodar, in removing the right bank embankment in places, and in constructing modern control structures. But execution or realization of decisions was made possible only by government policy. This is true, though not as much, for agricultural practices. After the partition of India in 1947, cultivation of jute in West Bengal was encouraged

by the government as major jute-growing areas were in erstwhile East Pakistan (presently Bangladesh) and jute mills were in the Hooghly industrial belt. This illustrates the vital concept that legal issues, however sensitive they may be, need to be incorporated in applied geomorphological as well as human-environmental research. Geomorphological expertise can only be used to solve practical problems if it is supported by public policy. Pitty (1982) has drawn attention to the importance of public policy in the application of geomorphology in flood control measures while commenting on Hails's remark that most geomorphologists are interested in individual academic pursuits and not in solving practical problems (Hails 1977; Pitty 1982). Since colonization, refugees have struggled to fortify their forcibly occupied resource base in self-sought settlements. It is only after gaining land ownership rights have they begun to view the riverbed as their own. A kind of allegiance or topophilia has developed among refugees (Bhattacharyya 1999).

7.7 A Modified Concept of Human Ecology Helps to Explain Land Use

At a particular historical juncture, the riverbed of the Lower Damodar became the second habitat of Bangladeshi refugees and alluvial bars their new addresses/niches/micro-habitats. The functional relations that have developed between riverbeds and refugees exemplify the concept of human ecology as proposed by Park and Burgess in 1921 (Theodorson 1961). In the present study these concepts have been modified taking a socialistic view-point. Refugees have extended their resource base right up to the inundation-prone peripheral zones of sand bars by growing crops of low value as additional crops. Decaying channel beds have been used for paddy crops. In the bank erosion-prone areas they take immense care to grow grasses. Wherever horizontal extension of the existing resource base is not possible they use the land for multiple cropping, thus expanding the resource base vertically. Initially they were treated as parasites by host communities. That parasitic relationship has now been replaced by a relation of competitive cooperation and this relationship has evolved through interactions such as the exchange of commodities and extension of market facilities. The Bara Mana is a good example of all human ecological issues in an alluvial bar. From growing inferior crops in nutrient-poor fresh sands, they have gone through several serial stages in agriculture and now have almost reached a productive peak by growing plantation crops such as mulberry (Bhattacharyya 1999–2000b). This has been possible due to increased accessibility to markets and enhanced social and economic mobility of the community. A deviation from the classical position of human ecology is possible by resolving that survival potentialities of communities are not genetically transmitted but acquired through personal experience. The concept of "survival of the fittest" as proposed by Darwin and later followed by conventional human ecologists has been applied in this human-environmental research, but in

this argument the "fittest" refers to technological fitness. Fitness is acquired cultural fitness as well. The people of Rangamatia are fighting against bank erosion by constructing a series of dykes (Bhattacharyya 1998, 1999, 2008b). Based on these observations, it can be asserted that the concept of human ecology in a modified form is clearly relevant to applied geomorphological and human-environmental research.

7.8 Human-Environment Interactions Depending on Personal Experience

The importance of personal experience in enhancing survival fitness ensues from the fact that the river-bed dwellers had no a priori model to guide them in their new habitat. Most of them come from deltaic Bangladesh where rivers are perennial, flood slope is gentle, speed of on set is slow and riverbed materials are clayey. In the former East Pakistan or in Bangladesh they were not used to living in a riverbed. Moreover, the rivers in Bangladesh have not yet become reservoir channels. Physical characteristics of the Damodar are different in terms of flood-slope, flood-speed and bed materials. Thus, the riverbed dwellers had no a priori model before them. Their decisions regarding selection or change of settlement sites have been conditioned by their personal experiences which have changed over time. Similarly, their personal experiences have helped in selecting crops from cereals to high-value cash crops. From personal experience, the riverbed users of Paikpara have come to know that the old Damodar is drying up and that the Muchi-Begua is posing a problem for them. So there is a flight of population in face of an anticipated calamity. In contrast, a mulberry plantation has been introduced in the refugee-dominated Bara Mana and Majher Mana. Riverbed dwellers have learned through experience that if water is released from the reservoirs, the highest part of the bar remains above inundation level. Western philosophers like Hume, Burkley, and Indian philosophers belonging to the school of Carvac have always advocated for empiricism or sense experience in explaining human behavior. Through personal experience, the islanders of Gangtikali have come to know that the release of water from the Panchet/Maithon reservoirs has no inundation risks for them, whereas in Damodar Char Mohana, release from the reservoirs and backrush from the barrage becomes hazardous. This stretch between Durgapur barrage and Majher Char has become safer for the settlers due to controlled flow from the reservoirs. The riverbed users know which parts of their settlements will be inundated and to what extent they will be inundated. Through personal experience they have learnt the hydromorphological consequences of several control structures and changes in overall socio-economic and political environments. Therefore, it is ultimately personal experience that has played a decisive role in developing a functional relation between the riverbed of the Lower Damodar and its users (Bhattacharyya 1998).

7.9 The Reservoired Lower Damodar, a Product of Hydro-Geomorphic and Anthropogenic Processes

The Lower Damodar shares many of its hydro-geomorphic characteristics with other controlled rivers in India and elsewhere. No other regulated river, however, has such a high density of riverbed population. Embankments, weirs, barrages and reservoirs have become familiar components of the landscape in the Lower Damodar. Similarly, settlements, agricultural fields, and rural roads are now viable elements of the riverbed between the Maithon and Panchet reservoirs and Falta outfall. The landscape that has emerged is thus quasi-natural and human-modified in character. In fact, almost all major rivers in the world are generically quasi-natural. The foregoing discussion on observations and explanation of floods, flood control measures, consequent changes in selected hydro-geomorphic phenomena, and land use practices in the Lower Damodar, leads us to several broad conclusions. It is clear that the controlled Lower Damodar should be culturally defined. Forms, processes and materials in the controlled section are generically quasi-natural in character. The social space of Bengali refugees has also played a significant role in colonization in the riverbed and in subsequent land use practices. There is a strong linkage between changing geomorphic space and perceived environment. Land ownership rights have turned out to be crucial factors in riverbed land utilization. Since no a priori model exists for river bed colonization, human-environment interaction under these conditions depends entirely on personal experience. A modified concept of human ecology has proved to be useful in explaining land use practices. The controlled Lower Damodar is a product of twin processes; quasi-natural hydro-geomorphic processes on the one hand and anthropogenic land-utilization process on the other.

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