CHAPTER 2: GEOMORPHOLOGY

2.1 Regional Geomorphology

The Lower Reaches of Narmada Valley (LrNV) (downstream of Kevadia Dam) forms a small window within Lower Narmada Valley. The LrNV comprises similar geomorphic units those broadly categorized for the whole of lower Narmada Valley. Geomorphologically, the LrNV is grouped into three geomorphic units: the Higher Erosional Surfaces, the Lower Erosional Surfaces and the Alluvial Plain surfaces (Figure 2-). Each of these surfaces exhibit different characteristics in terms of altitude, erosional pattern and geology.

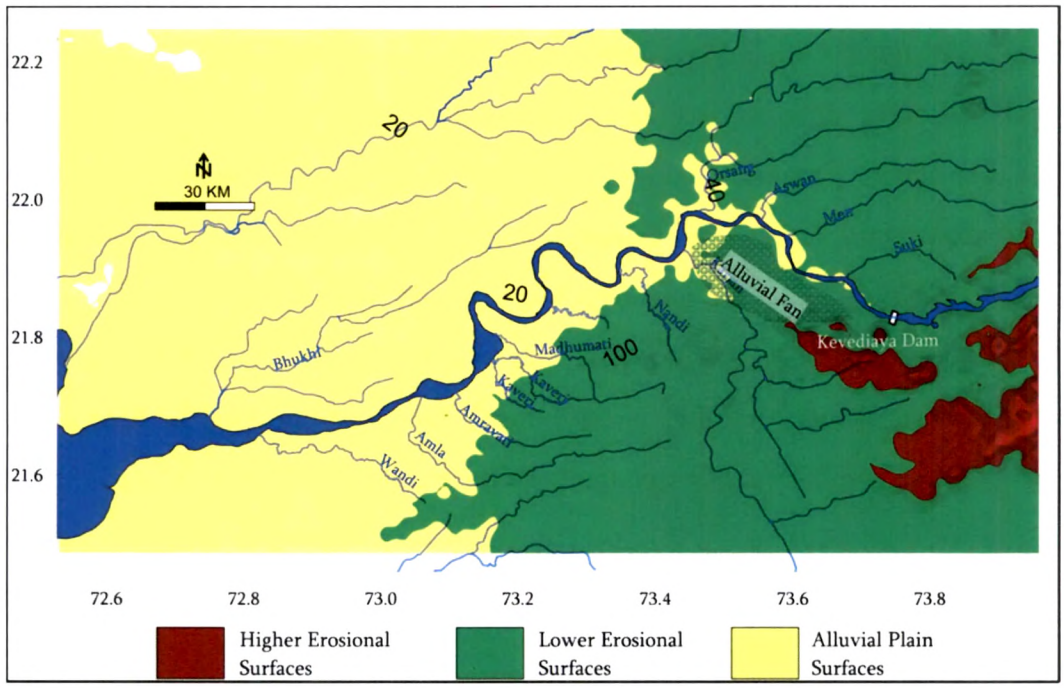

Figure 2-: Geomorphological map of Lower Reaches of Narmada Valley.

2.1.1 Higher Erosional Surfaces

The higher erosional surfaces range in elevation from 400 m to 840 m a.s.l. Geographically it occurs in two distinct areas viz. North and South of the present Narmada channel and is referred to as Northern Higher erosional Surface (NHeS) and Southern Higher erosional Surface (SHeS) respectively. NHeS is developed mainly over Precambrian metasedimentary rocks and granites. It forms the southern extension of Aravalli mountain range. The overall landscape of the NHeS

shows degraded domal hills that are devoid of regolith. The tributaries drains over this surface follow structural trends of large fold or limb of anticlinorium/ synclinorium and shows differential erosion in its way. The NHeS forms catchment for major northern tributary of the Narmada is the Orsang that is having a drainage area of 4079 sq. km.

The SHeS are well exposed in the South of the present Narmada channel, represents surface above 400 m. The SHeS attains maximum height of about 840 m along Rajpipla hills. The SHeS forms an extension of Satpura Hill Range in Gujarat. The SHeS features a number of basalt flows and associated intrusive. The SHeS has, on an average, about 1 m to 2 m thick regolith capping the hill top. The lower order and higher order stream within the SHeS flow through steep and deep valleys. The River Karjan (1489 sq. km drainage area), a tributary of Narmada has catchment over the SHeS. The SHeS is bounded by Rajpipla escarpment that extends from Kevadia dam in the west to Rajpardi in the east. The escarpment is defined as a regional fault (RF_2: Sant and Karanth 1993) and has been further understood to have played a significant role in defining Cambay basin blocks (southern Ankleshwar block and northern Jambusar-Bharuch block). Kaila (1981) further identified extension of these regional fault (RF_2) into subsurface displacing Mohorovicic.

2.1.2 Lower Erosional Surfaces

Lower erosional surfaces are developed in forefront of high erosional surface and thus occur in both north and south of Narmada channel. The lower erosional surfaces are 50 m to 300 m in elevation. The Northern Lower Erosional Surface (NLeS) has developed over Deccan basalt and discontinuous patches of Bagh Beds, sandstone, limestone and shale. Precambrian granites and quartzite hills occur as regional high. The contact between Precambrians and Bagh beds show angular unconformity whereas the contact between Bagh beds and Deccan

basalt is faulted (Sant and Karanth, 1988). The NLeS is drained by the Rivers Orsang, Aswan, Men and Suki. These Rivers have, at places, incised deep through the Bagh Beds and Deccan basalt like Gorge at Suki River near Kevadia.

The Southern Lower Erosional Surface (SLeS) is well developed on the western margin of the study area over Deccan basalt and Tertiary sediments whereas SLeS forms a narrow strip between Narmada channel and SHeS escarpment over alluvial fans (Sant and Karanth, 1993; Chamyal et al., 1994; Chamyal et al., 1997; Bhandari et al., 2001; Bhandari, 2004a). The Tertiary sediments are deformed resulting into several domes (Agarwal, 1984) which standout as regional high like Babaguru hill. The major tributaries drain the west of SLeS are Madhumati, Kaveri, Amravati, Karjan and Nandi Khadi.

2.1.3 Alluvial Plains

Alluvial plains are developed on the west and the north of the NLeS and the SLeS. The River Narmada flows along the southern margin of this vast alluvial plain. The River Narmada has incised about 30 m exposing various sediment facies belonging to Quaternary period. Quaternary sediments overlie directly over the Precambrian rocks, Bagh beds, Deccan basalt and Tertiary sediments. The variability in sediment facies suggests the role of different processes during Quaternary period.

2.2 Geomorphology of the Study Area

The Quaternary landscape of the study area can be distinctly divided into three geomorphic surfaces, based on the denudational pattern, elevation and linear to curvilinear erosional boundary. These three surfaces are: Quaternary Surface 1 (QS_1) Quaternary Surface 2 (QS_2) and Quaternary Surface 3 (QS_3) (Figure 2-).

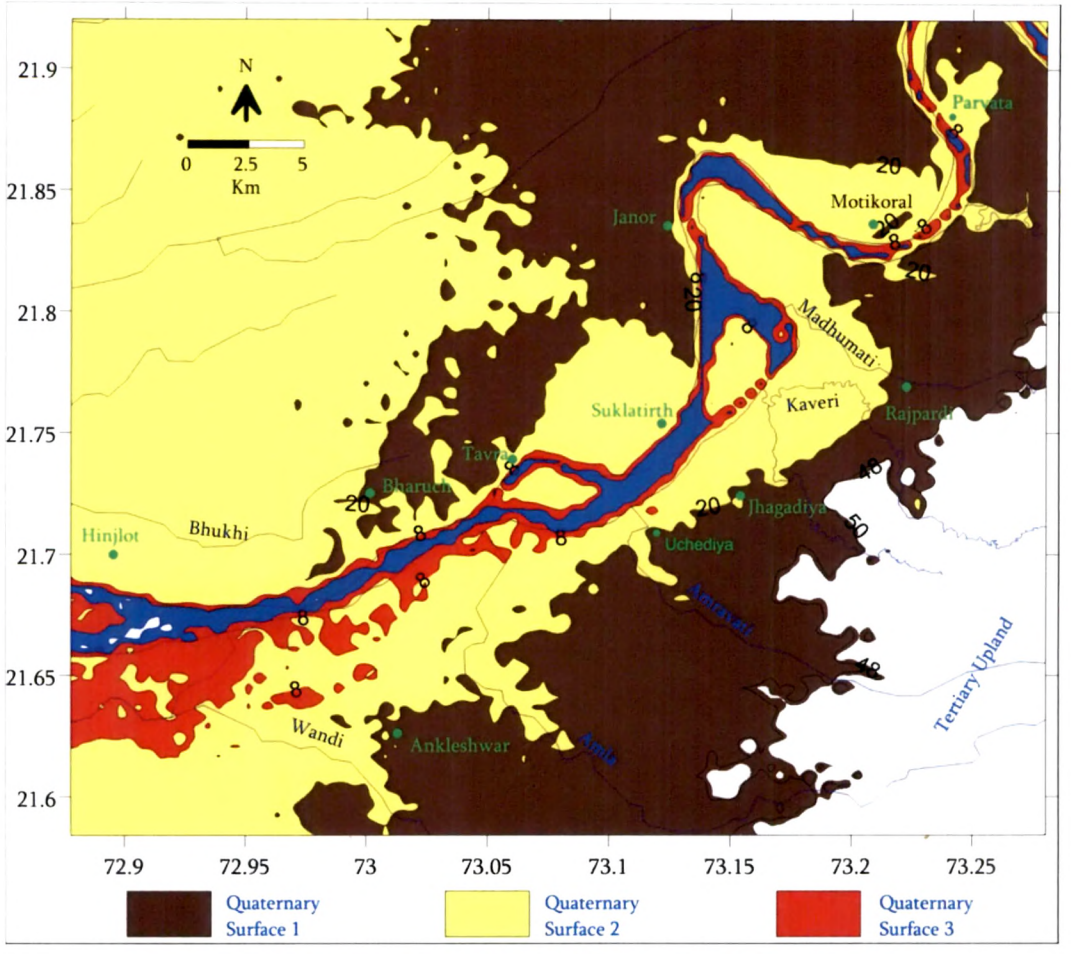

Figure 2-: Geomorphology of the area under study

2.2.1 Quaternary Surface 1

QS_1 forms a widely developed regional surface with flat to rolling ground. QS_1 lies between 22 m to 46 m a.s.l. The widely developed QS_1 is a result of coalescing sediment brought by various rivers from the east and the south. QS_1 is bounded by NLeS in the east and SLeS developed over Tertiary sedimentaries in the south. QS_1 hosts the flood plain of River Narmada. River Narmada has incised within QS_1 by about 30 meters. When compared to wide northern QS_1, the QS_1 developed in the south, between the Tertiary SLeS and the Narmada channel follows a narrow linear landform. QS_1 in the southern part comprises of gravelly-sandy facies overlaid by muddy facies that together overlying the sediments of Tertiary age (Figure 2- and Figure 2-). The margin of QS_1 is identified as 'Palaeobank' along both northern and southern bank of River Narmada.

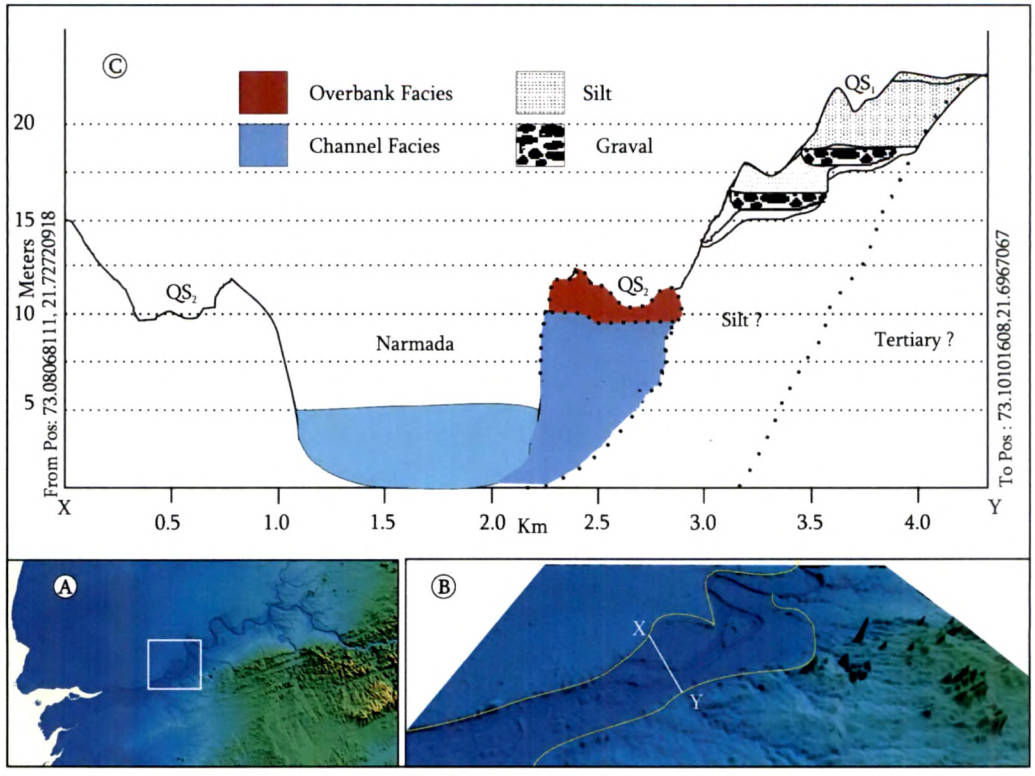

Figure 2-: Cross-section of Narmada channel at Uchediya Sequence. A: Lower reaches of Narmada valley, B: 3D surface of the study area, C: Cross section across Narmada.

Figure 2-: Field photograph showing the contact between gravel and silt in QS_1

Along the northern bank of the River Narmada, palaeobank is well exposed, which follows a curvilinear pattern whereas along the southern bank, the most prominent landform extending as a linear track running for 65 km is formed. The palaeobank appears from Rajpardi town, extends towards Ankleshwar and further west, where it merges with estuary zone. The palaeobank marks lateral heterogeneity exposing Tertiary rocks closer to Jhagadiya followed by sequence with gravels at base overlaid by silt. The palaeobanks trends parallel to Cambay basin marginal fault (RF2, Sant and Karanth, 1993) and several ENE-WSW trending Plio-Pleistocene anticlines further south (Agrawal, 1984).

2.2.2 Quaternary Surface 2

QS_2 represents flood plain of River Narmada. QS_2 is bound by palaeobank along both the northern and the southern bank of the River Narmada. QS_2 are relatively stable but are seasonally active during floods. The elevation of QS_2 varies from 8m to 18m a.s.l. Several tributaries of the River Narmada incised in the SLeS as well as QS_1 get defunct after they flow into QS_2, crossing over the palaeobank. The present Narmada flows on an average 8 m below the QS_2 surface, distinguishing a 'Neobank' (Figure 2-).

Figure 2-: Field photograph of Neobank showing sandy and muddy sequence

The neobank developed adjacent to the present Narmada channel, along both the northern and the southern bank extends for about 45 to 50 km. The QS_2 to the north of the present Narmada channel hashave developed in three discontinuous patches namely, Motikoral Surface, Shuklatirth Surface and Bhukhi Surface whereas to the south of Narmada QS_2 has developed along two patches namely Uchediya Surface and Parvata Surface. The Uchediya surface forms a linear, continues and single landform extending for about 35 km aerial distance with varying width from 0.5 to 6.0 km.

The present study is focused on investigating a very significant landform developed along the southern bank of the present Narmada River referred to as Uchediya Surface. Smith et al. (2009), while studying the Peace River of Canada argued that the geometry of the various Holocene surfaces are the consequence of accretion and growth of point bars gradually with increase in amplitude of a meander as well as simultaneous acretion along Counter point bars. However, the parallel nature of QS_1 and QS_2 along the southern bank of Narmada show intricate relationship of landform aggradation.

2.2.3 Quaternary Surface 3

QS_3 comprises of active landforms within the channel bounded by neobanks. The elevation of this landform varies from 2 m to 6 m a.s.l. In the present study area, QS_3 are developed with discontinuity within the channel as bars (Figure 2-).

The Narmada channel, in the present study area, exposes two significant channel bars namely Kabirvad bar and Tavara bar developed upstream and downstream of the village Uchediya respectively. Mapping of bars was carried out from topographic sheet on 1: 50,000 scales published in 1972 and Satellite image frame of 2009 incorporated in Google earth. The field observations were supplemented for updated interpretations. Topographic sheet of 1972 shows, flow of river water from both the side of the Tavara and Kabirvad bars (Figure 2-)

whereas the recent observation in field as well 2009 satellite image frame shows river flows along a single channel (southern in case of Tavara bar and northern in case of Kabirvad bar).

Figure 2-: Field photograph showing the develepment of QS_3 at downstream of Uchediya surface.

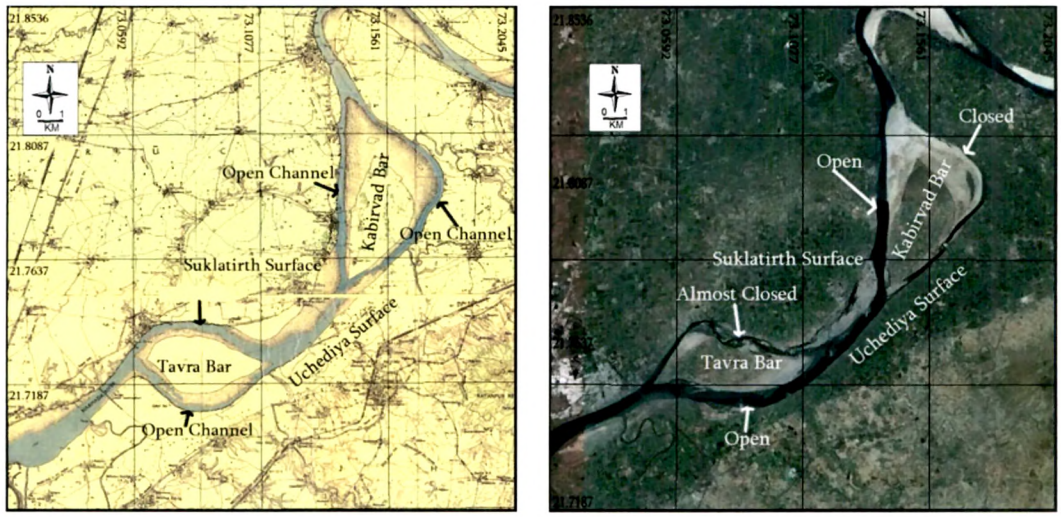

Figure 2-: Historic modification of Tavra bar and Kabirvad bar between 1972 and 2009

The second channel that once existed is almost blocked by sediment. This has caused major changes in the thalweg line, initiated erosion along the northern bank between the Golden Bridge and the National Highway no. 8 Bridge, erosion along southern bank, near Barbhata village, located opposite to Bharuch city. The 1972 record shows aggradation along the southern bank near Barbhata village. The

shift in thalweg line has further initiated development of lateral point bar in downstream of Golden Bridge (Figure 2-).

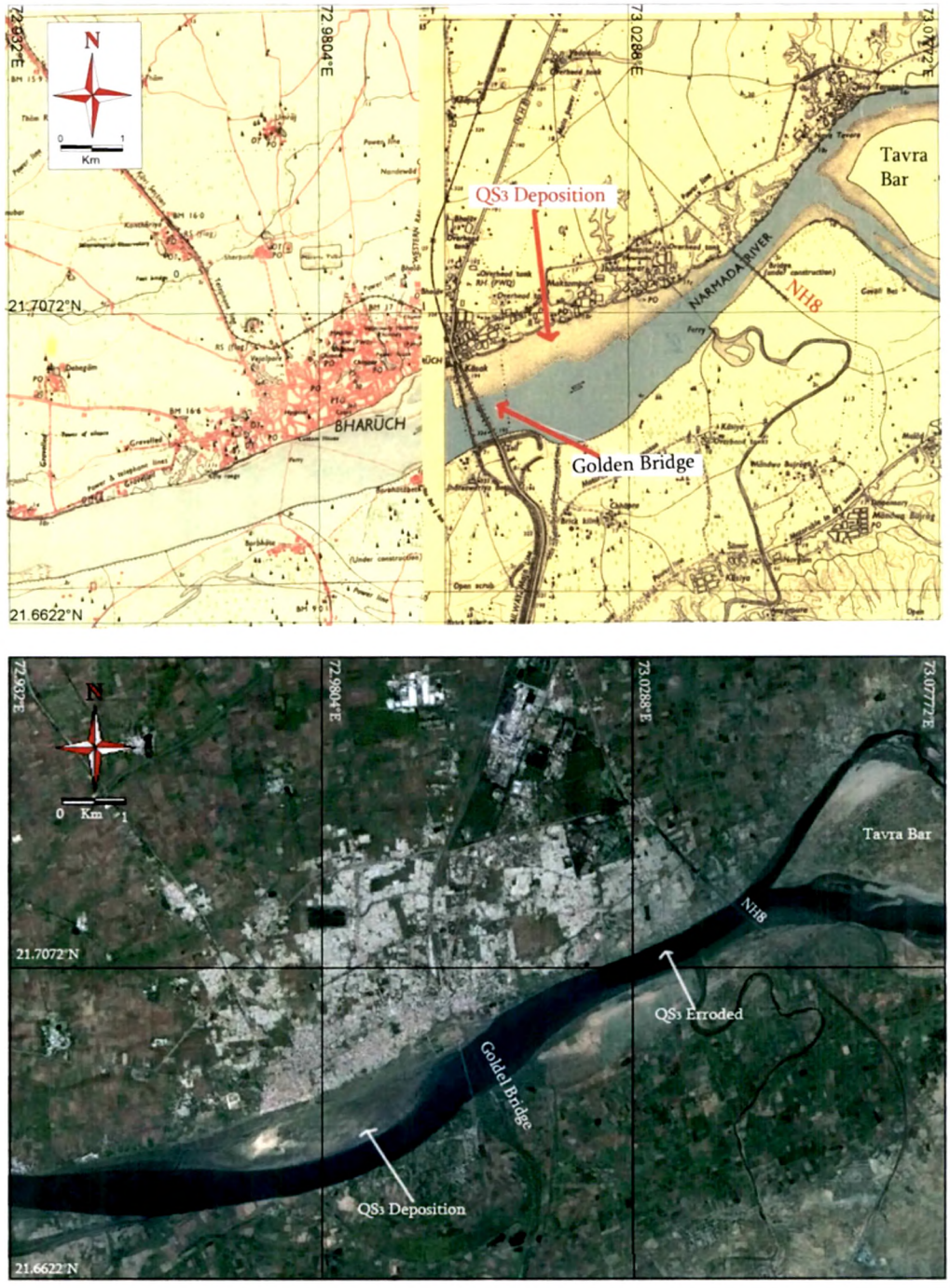

Figure 2-: Historic development in QS3 near Bharuch during 1972 to 2009