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CORONA Satellite Photographs – A New (Old) Tool for Earth Scientists

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CORONA satellite photographs are a welcome source of data for the earth science community, especially in countries like India. CORONA was a code name for the series of photo-reconnaissance satellites launched by U.S.A. during 1959-1972 meant for surveillance of the Soviet block of countries in the cold war era (Wikipedia, 2008). These orbiting satellites used conventional photographic techniques by employing cameras loaded with film to capture the earth surface details. This was before the invention of the digital technology, which is currently used in all the polar orbiting remote sensing satellites. The recovery of the film exposed by the CORONA satellites was very interesting. The reentry of the canister of the exposed film ejected from the CORONA satellites was the first man-made object to return from the earth orbit (David, 2004). This was designed to withstand the atmospheric conditions at 150 to 200 km above the earth surface with a heat shield that could be jettisoned and a parachute that could be deployed when the canister reenters the atmosphere (Galiatsatos, 2004). The telemetry signal and strobe lights would also turn on after its reentry so that the U.S. Air Force carriers that were deployed for such precise recovery job could locate it, snatch it in the midair by its chute cords and haul it onboard (Galiastatos, 2004; Schmidt et al. 2001). This recovery task was always carried out over the oceans. Of course, this mid-air acrobatics failed number of times, but the film capsules were designed to be in tact even if they fall into water so that they could be recovered by the U.S. Navy ships on patrol, or, after floating briefly would sink into ocean to prevent its recovery by others (Galiatsatos, 2004). It is heartening to note that these photographs are made available for civilian use since 1995.

The CORONA satellite photographs are of very high spatial resolution of ~3 m (Bayram et al. 2004). The system parameters and types of cameras and films used in the CORONA series of satellites were detailed by Dashora et al. (2007). These photographs are available at a very low-cost. A film strip covering an area of about 2600 km^2 costs about 18 American dollars. Since such a large area is covered in a single frame, the CORONA photographs provide a synoptic view of the terrain like the modern satellite images. This will help in understanding the regional landscape features (Fig. 1). Scanning the negative film strips of these photographs gives better positive digital outputs compatible to computer processing for the creation of vector data layers and comparing with other datasets. Even at 600 dpi, the photographs stand enlargement to their full spatial resolution showing the surface details very clearly (Fig.2).

Nageswara Rao et al. (2003) found the CORONA photographs useful for accurate mapping of the beach ridges in the Godavari delta area, which could not be deciphered from the modern remote sensing images as these coastal sandy linear features representing the former shoreline positions are mostly obliterated due to the recent intensive land use practices (Fig.3). There is another advantage of the CORONA photographs. They are excellent record of the conditions prevailing more than four decades ago. Nageswara Rao (2006) identified the coastal landform changes on decadal scale by GIS analysis of the scanned CORONA photographs and the recent satellite data products, which in turn helped in understanding the shoreline dynamics in the Godavari delta (Fig. 4). The stereo coverages of CORONA, wherever available, were also found useful in conjunction with field surveys through differential global positioning systems (DGPS) for creating digital elevation models and to generate fairly accurate contour maps through digital photogrammetric techniques (Schmidt et al. 2001; Galiatsatos et al. 2005).

The inexpensive and high-resolution CORONA photographs have become a good mapping source for the international scientists (Kumahara and Nakata, 2001) who

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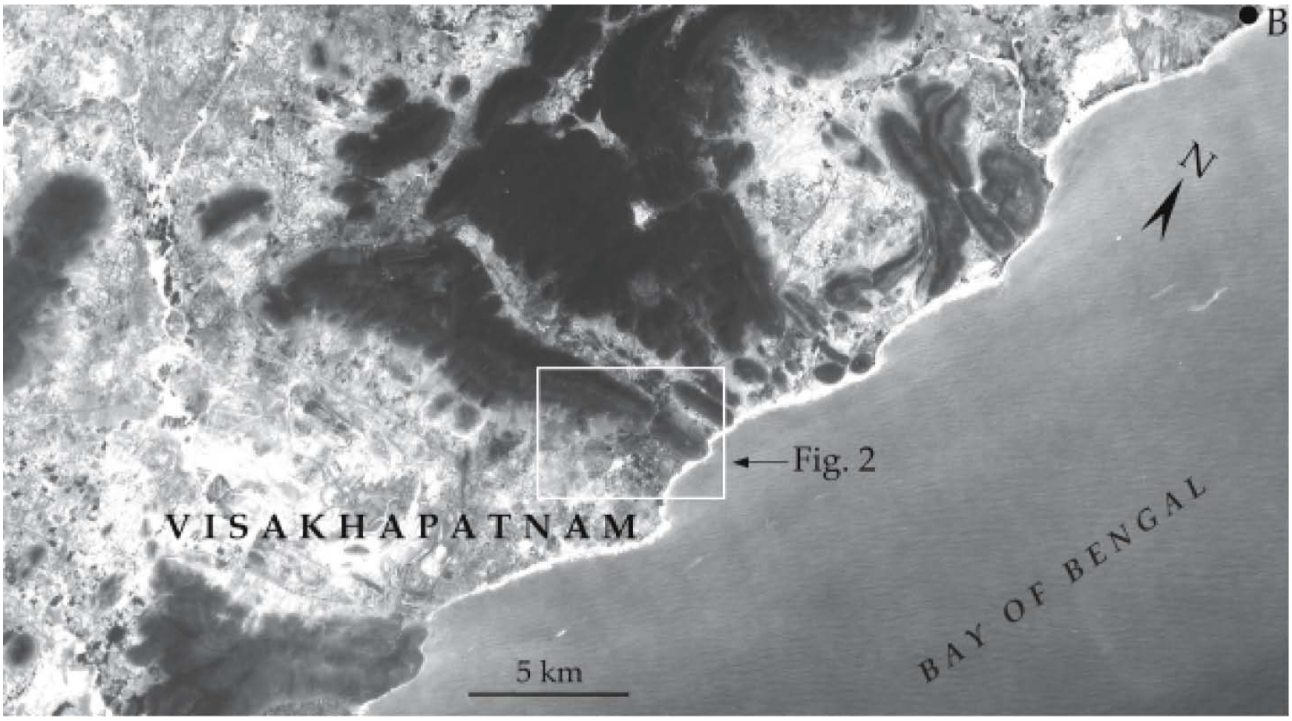

Fig.1. Scanned image of a part of the CORONA satellite photograph showing the coastal region between Visakhapatnam and Bhimunipatnam ('B', in the extreme top right) in Andhra Pradesh. This picture, covering a 38 km x 21 km area, reveals the regional trend in the structural hills in the region. The area in white coloured box is enlarged in Fig.2.

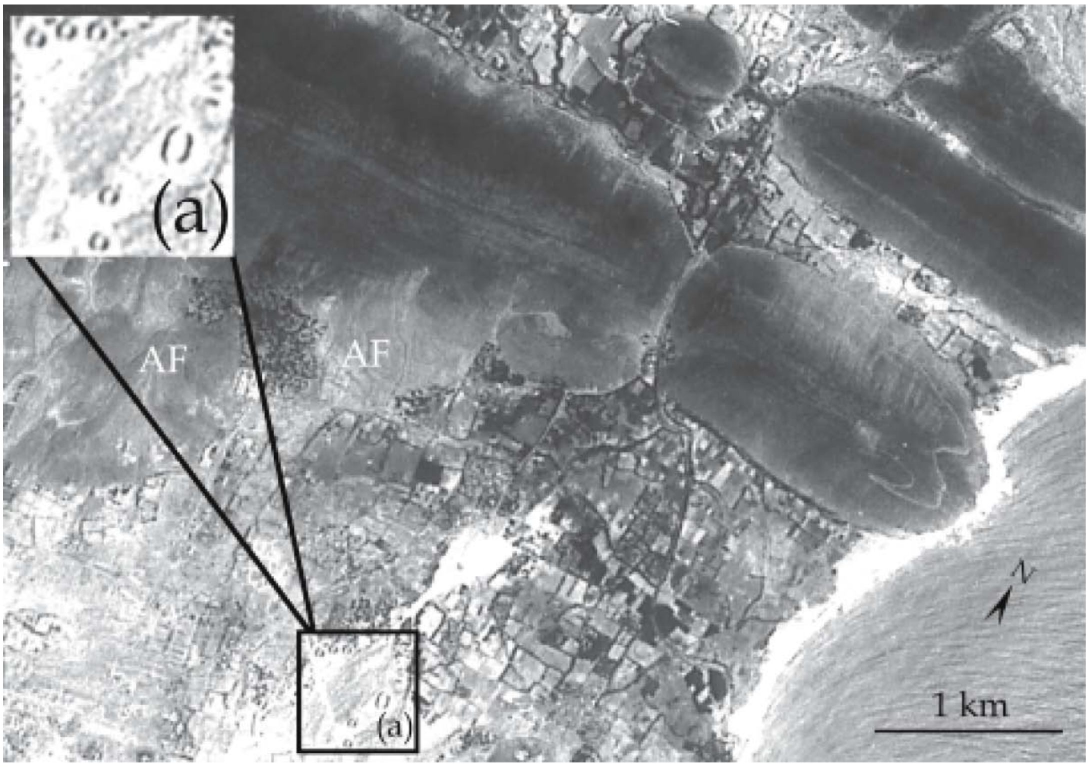

Fig.2. A small portion of the area to the northeast of Visakhapatnam city showing details of the strike and dip of the rocks, alluvial fans (AF), wave-refraction patterns, beaches, and cultural features like roads, farm boundaries, etc. The inset (a) is a further enlargement of a part of the Andhra University Engineering College campus with the six circular hostel buildings clearly visible.

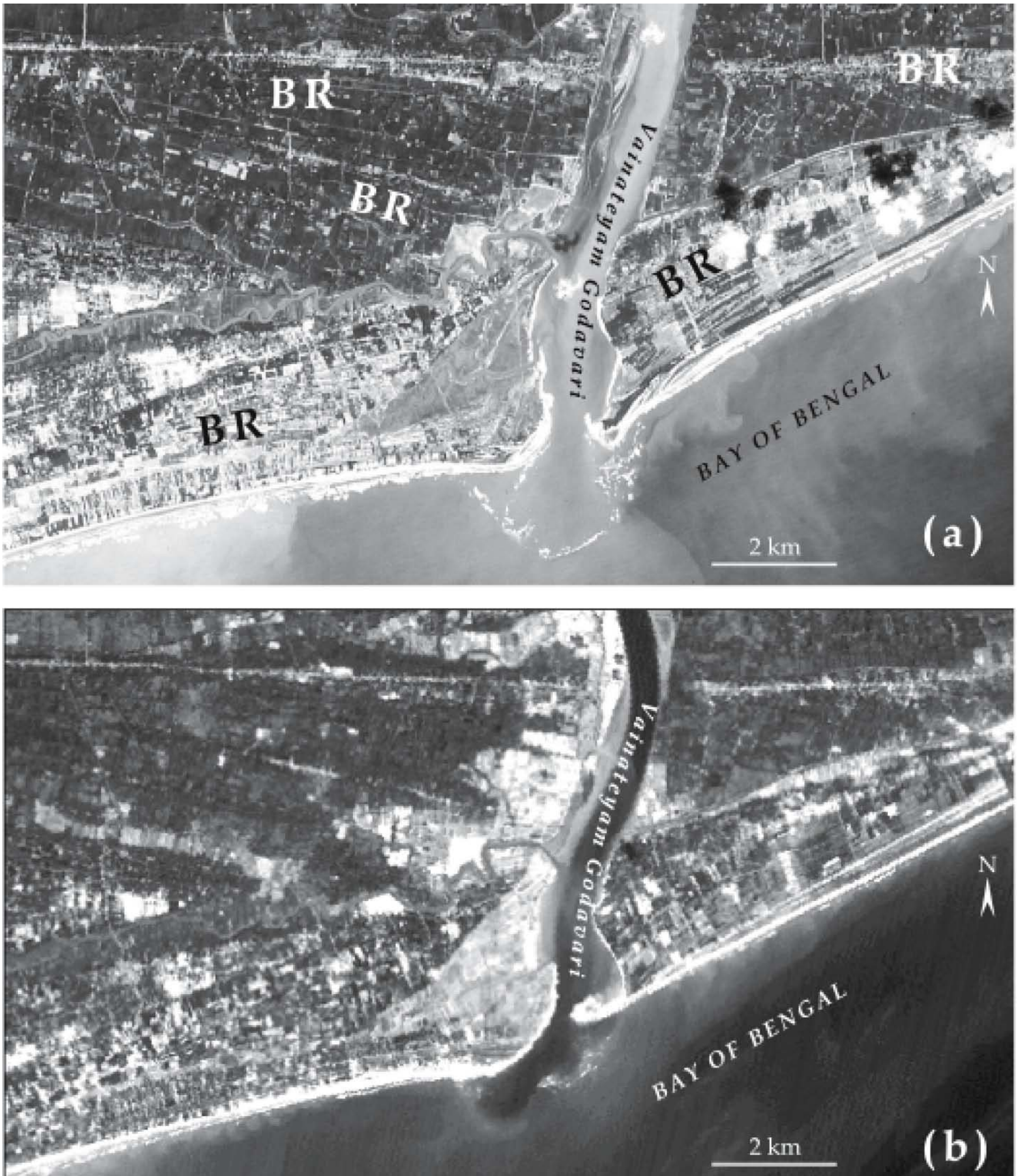

Fig.3. The CORONA photograph from 5 October 1965 (**a**) showing the estuarine zone of the Vainateyam, one of the four distributary branches of the Godavari River. The beach ridges (BR) on both sides of the Vainateyam are more clearly visible as series of thin white lines in this photograph than in the recent (15 February 2004) IRS LISS III Band 2 image of the area (**b**). It may be noted that the CORONA image can be enlarged several times more than what is shown in print here.

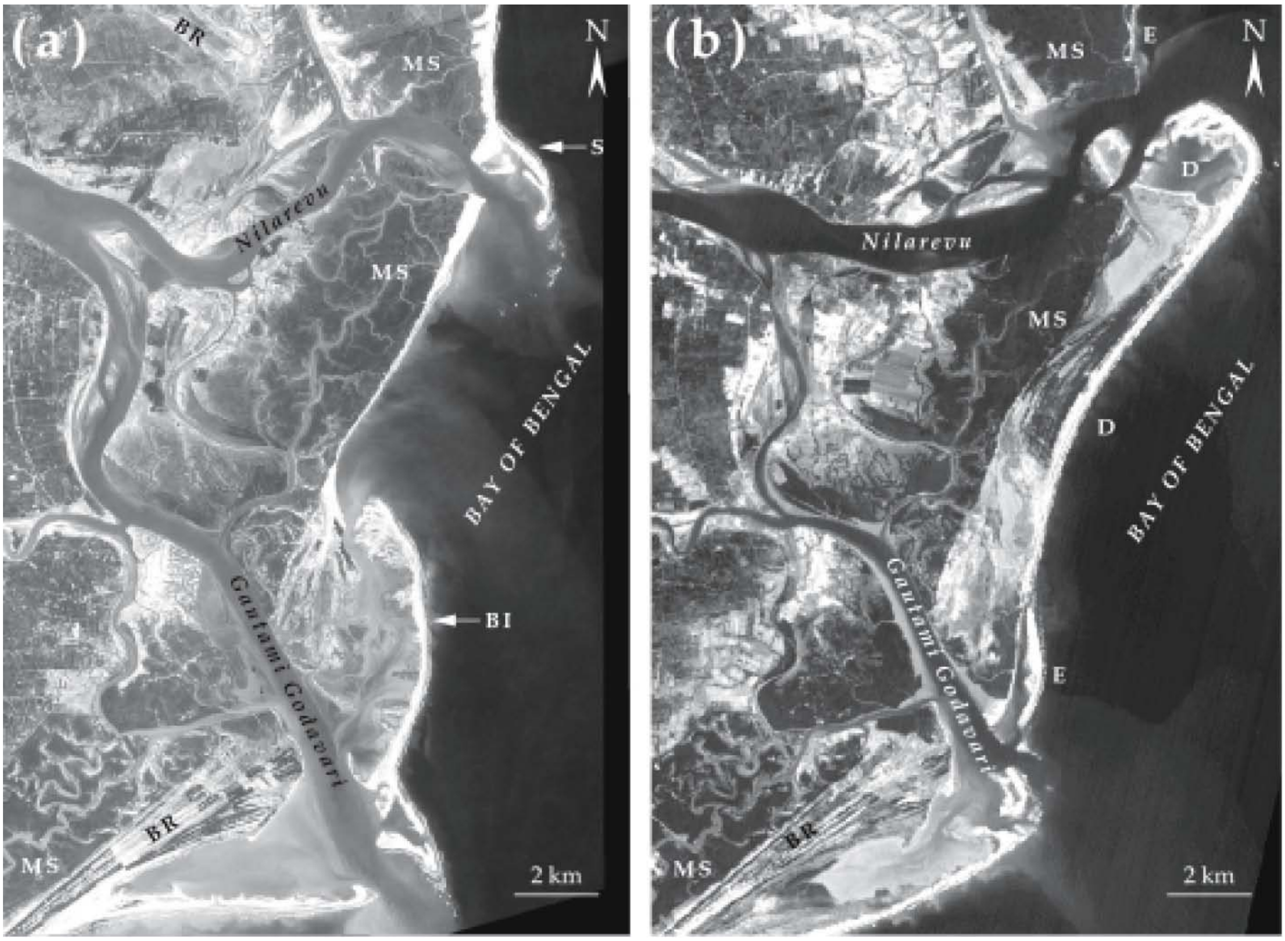

Fig.4. CORONA photograph from 5 October 1965 (**a**), and IRS LISS III Band 2 image from 15 February 2004 (**b**) showing the area close to the Gautami and Nilarevu distributary mouths in the Godavari delta region. Distinct changes in the shoreline configuration due to erosion (E) of spits (S) and barrier islands (BI), and deposition (D) along different coastal sections are noticeable in the right panel (b) when compared to the left panel (a). The beach ridges (BR) are clearly visible in the CORONA photograph (left panel), while they are more or less obliterated in the recent LISS III image. The course of Nilarevu has widened and that of Gautami had shrunk in width during the last four decades indicating a shift in the direction of river discharge. Reduction in the extent of the mangrove swamp (MS) due to coastal erosion and encroachments for aquaculture are also noticeable, especially on both sides of Nilarevu.

have research interests in developing nations where either the data sources like maps, aerial photographs, etc. are not available or are restricted. The earth science community in India would benefit by using the easily available, high-resolution CORONA data for geomorphological mapping, and change-detection studies on decadal scale.

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