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RESTORATION OF DEGRADED SAND DUNES ON FLATTENED BEACHES OF GOA: IMPLICATION FOR COASTAL MANAGEMENT

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Extensive use of beaches for tourism and recreation has resulted in dramatic modifications of the morphology of geomorphic features along the sea front of Goa. Of the entire coast, Miramar beach (west of Panjim), and Colva beach (central coast) are amongst the most frequented. It is at these sites where large volumes of sand are blown inland, creating hazardous conditions for public in general and beach users in particular (Fig. 1). Aeolian transport of beach sand was noticed since 1977, but this aspect has rarely been studied. This paper describes how an environment friendly technique can curtail loss of beach sand due to wind, and proposes how damaged sand dunes can be regenerated.

The first ever experiment to regenerate sand dunes were conducted in April 2007 at Miramar beach, Goa (Fig. 2). The critical area constitutes a 160m long N-S frontal beach strip, which is flat, bare, devoid of vegetation, and hence degraded. Damage due to uprooting and loss of vegetation are attributed to continuous trampling by humans. Since the binding capacity of dune vegetation is lost, the dune sand is left exposed. Bare and flattened dunes are created resulting in the production of free sand.

During windy days, large quantities of loose beach sand are blown from the beach and subsequently accumulate on the adjacent roads (Fig. 1). Driven by highest wind speeds during June - August (36 km/h in 2004 and even 60 km/h in 2007), this episode is most intense during this period every year. As much as 25 cubic meters of wind blown sand were deposited on the Miramar traffic island in a single day. A recurring phenomenon, sand deposits on the roundabout creates nuisance to beach users and to circulating traffic.

The most environment friendly method to recuperate damaged dunes is to erect sand fences. Installation of 1 m high slats is an effective way

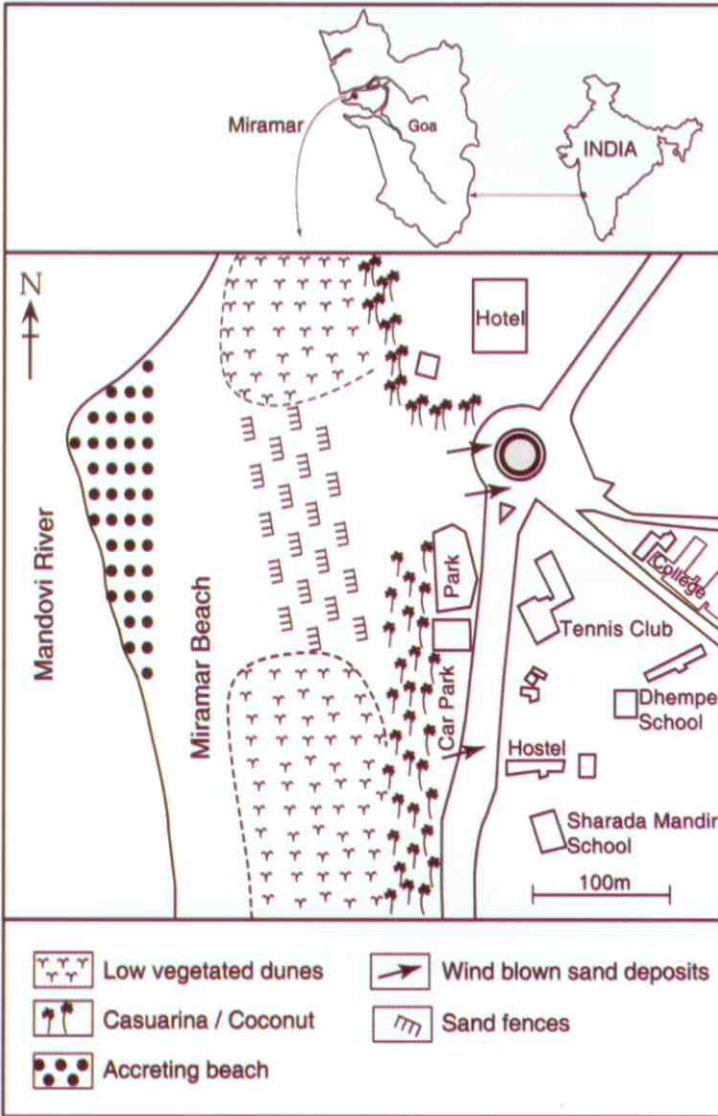


Fig. 1: Map showing the area of concern on Miramar beach where a 160m long dune link is missing due to trampling. Arrows indicate dominant wind direction, and also sites where aeolian sand deposition is most pronounced. Fences are erected on the flattened strip so as to trap moving sand. The (length of) fences are not to scale.

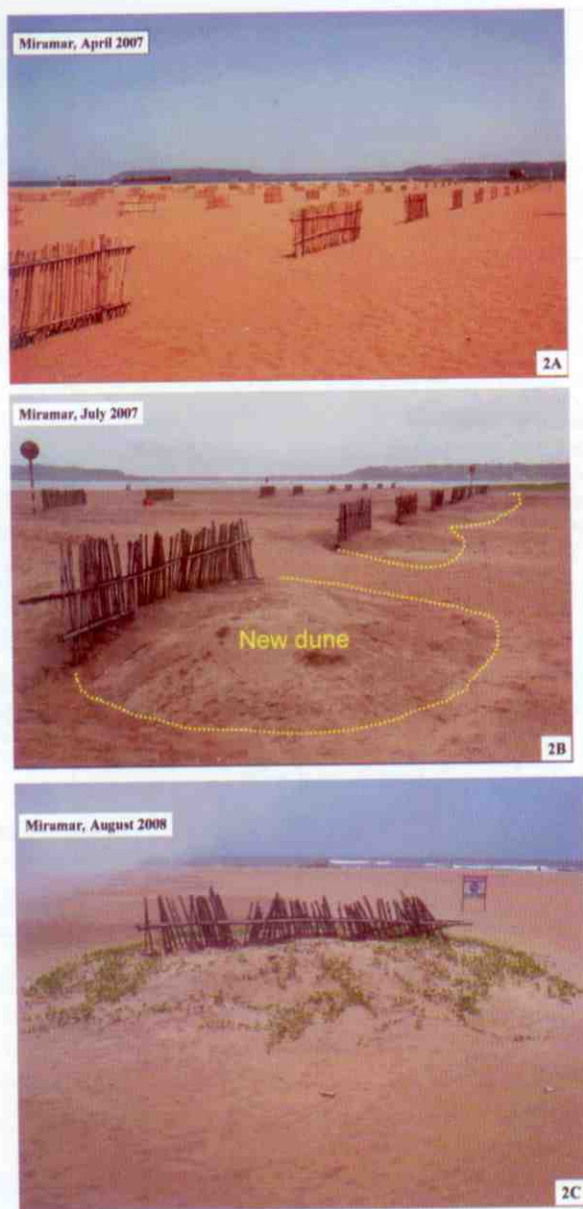


Fig. 2: Various stages of a dune building project. 2A: Installation of rows of coast parallel sand fences; 2B: Gradual accretion of wind blown sand behind each fence; 2C: An example of a stable vegetated dune formed naturally.

that traps moving sand and provokes prevailing winds to deposit their sand content. Fences are made of 1 m high wire mesh, vertical wooden strips or bamboo and fixed perpendicular to the direction of prevailing winds (Fig. 2A). This technique was recommended as a remedial measure to: (1) curtail loss of beach sand, (2) recreate new sand dunes, and (3) re-establish the pre-existing vegetation / dune line. In collaboration with the Corporation of the City of Panjim (CCP), a series of coast parallel 1 m high sand fences were installed in March 2007.

Three months later, in July 2007, results obtained were encouraging. Whereas several truckloads of sand were removed from the traffic circle every year, only a negligible amount of sand found its way on the road (in 2007 and 2008), after the fences were installed (Fig. 2B). Regeneration of dunes is evidenced by 'ipomoea' vegetation that has rooted itself on the accumulated sand, behind several fences. By August 2008, a series of well formed dunes, with a maximum height of 70 cm, and with a carpet of 'ipomoea' creepers, were observed (Fig. 2C). These field measurements were conducted using a Smart Station. Sand fences offer an easy way of inducing accretion of sand by impeding wind velocity. Therefore, it is possible to stop the movement of sand by trapping it on the beach itself, the area that is presently flat and devoid of vegetation.

Although the success of the dune building experiment was endorsed by the CCP, the project lacked an appropriate mechanism to ensure the safety and sustainability of the wooden fences. As a result, continuous interference with the fences, crushing of newly accreted sand mounds, and fading enthusiasm in this experiment, lead to a virtual collapse of the dune building project. The sand fences disappeared, and the sand found its way back on the traffic junction. As such, during the months of June – September 2009, the adjacent roads were almost entirely covered by a carpet of sand. Nevertheless, in November 2009, two low frontal dunes with a significant 'ipomoea' cover can still be identified. If left undisturbed, the accreted sand is bound to evolve into stable sand dunes (Fig. 2C).

Fences have saved sand dunes the world over. Once these mounds of sand grow in size and fences are gradually buried, planting of appropriate vegetation can stabilize these artificially created sequences of sand dunes. Planting of appropriate dune plants is the best and the cheapest method available as these species act as excellent sand binders. This exercise

will not only preserve dune vegetation but will also fix sand that is in a constant state of mobility on Miramar beach; sand dunes will thus remain stable.

In summary, our endeavour on the restoration of coastal dunes assumes significance for several reasons: (a) The remarkable performance of sand fences endorses the success of our dune building initiative; (b) Regeneration of damaged dunes is a unique concept, never attempted in India; (c) Miramar is a high-value tourist coast and hence calls for an integrated management approach; (d) The scheme offers scope to monitor sand accumulation through a natural process, but fashioned artificially; (e) Restoration of coastal dunes can be adopted elsewhere in Goa and along the Indian coasts, wherever coastal dunes are levelled or damaged due to natural processes or human interference.