THE THEORY OF RIVER BARS

(Extract from a publication entitled: *Estuary Channels and Embankments.*)

by

BRYSON CUNNINGHAM, D. Sc., B.E., F. R. S. E., M. Inst. C. E.

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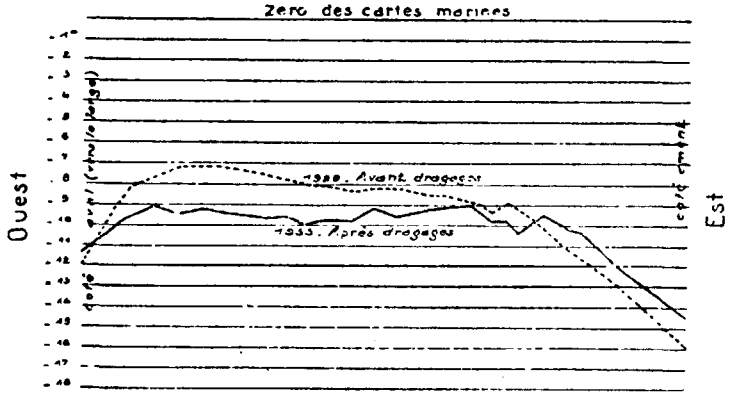
Bars are a notable feature of tidal and non-tidal rivers alike, but they are by no means universal. They are mainly found in connection with tidal rivers ; less often in connection with non-tidal rivers. On the other hand, some tidal rivers and a great number of non-tidal rivers possess channels, which, while they may be encumbered with shoals, are free from the pronounced obstruction of a bar. The Mersey, the Dee and the Rhone are afflicted with bars of an undubitable character ; the Thames, the Humber and the Severn have channels which find their way into the sea, perhaps through tortuous routes, but without encountering a serious obstacle of this kind.

A bar may be described as a ridge or narrow plateau, or even a succession of one or other or both, extending right across the mouth of a river, often more or less in a roughly circular outline, forming an elevated mound rising somewhat abruptly above the general level of the sea floor on one side and of the river bed on the other. It is only when the bar rises to such a height as to reduce the depth of water below the requirements of shipping that it demands treatment as an obstruction to navigation.

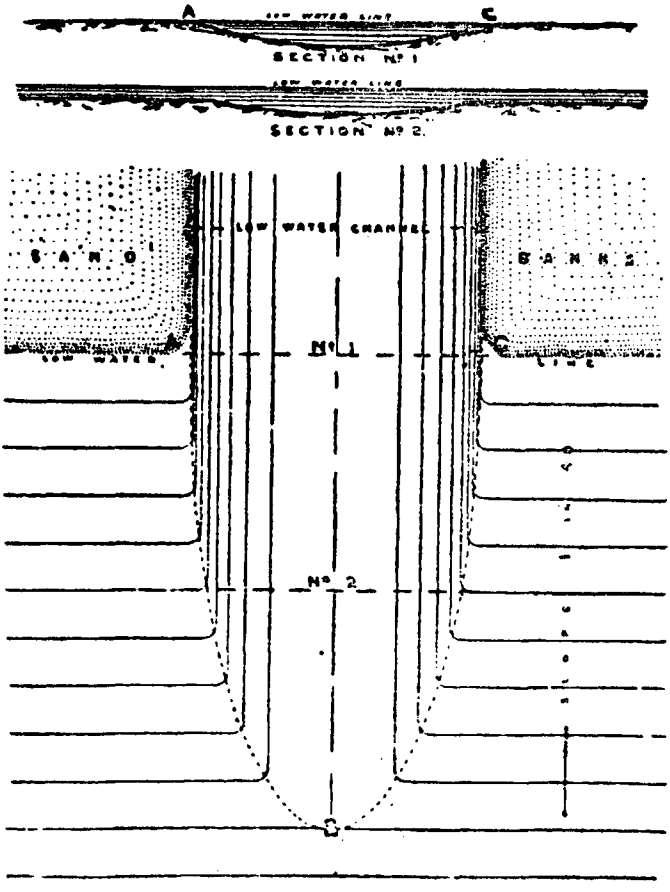
Origin of Bars.

The causes and origin of bars have been much debated and very conflicting views have been expressed on the subject. All rivers are more or less silt-laden, and most of them convey to the sea enormous quantities of detritus and alluvium which have been eroded in passing through their basins. While readily transportable by the normal force of the current in the river's downward course, the material is no longer so mobile when the river encounters slack or inert water at its mouth. Accordingly, it settles and accumulates, and in the case of tideless seas produces the peculiar deltaic formation so well illustrated by the mouths of the Nile and other Mediterranean influents. But this phenomenon, though some-



times adduced as a reason for the creation of bars, is not an adequate explanation of bars in tidal rivers, where the interplay of ebb and flow not only provides no prolonged period of slack water, but even changes daily the locality of the tidal nodes where slack water momentarily prevails.

A theory has been put forward by a distinguished port Engineer, now some time deceased (a former President of the Institution), in a Paper (1) read before the British Association in 1895, that bars are merely the natural fan-shaped contouring of a river outlet. Taking as a diagram (page 114), the simplest form of channel coursing through banks of sand and forming a right-angle with the contour of the outer slope, Mr. A.G. Lyster said "the general fall, or slope, of the banks will be radially from apices near the centre of their areas on either side of the channel, and their slopes will be considerably increased in the immediate neighbourhood of the channel. The intersection of a channel of the section shown in the diagram with the outer slopes of the bank, would, if it were effected by human agency, and a uniform section maintained throughout, result in a "groyne" or curved line of intersection, represented by A, B, C. When, however, in the case of rivers, the formation of the channel is effected by hydraulic agency, it must, as a result of natural laws, take a different form. Supposing the volume retained by the channel to be constant throughout its length down to a line of section drawn across the channel from A to C, it will be obvious that below that point, the waters which it carried can escape laterally across the line of intersection A, B, C, before referred to ; consequently, if a number of sections be considered between A, C and B, there will clearly be less water available for



the maintenance of each successive section between those points ; and, taking into consideration the relations of the velocity and material in suspension, there must be as a consequence a gradual reduction of sectional area and, consequently, a rise of the bottom of the channel between A, C and B".

(1) « Dredging Operations on the Mersey Bar » by Anthony G. Lyster.

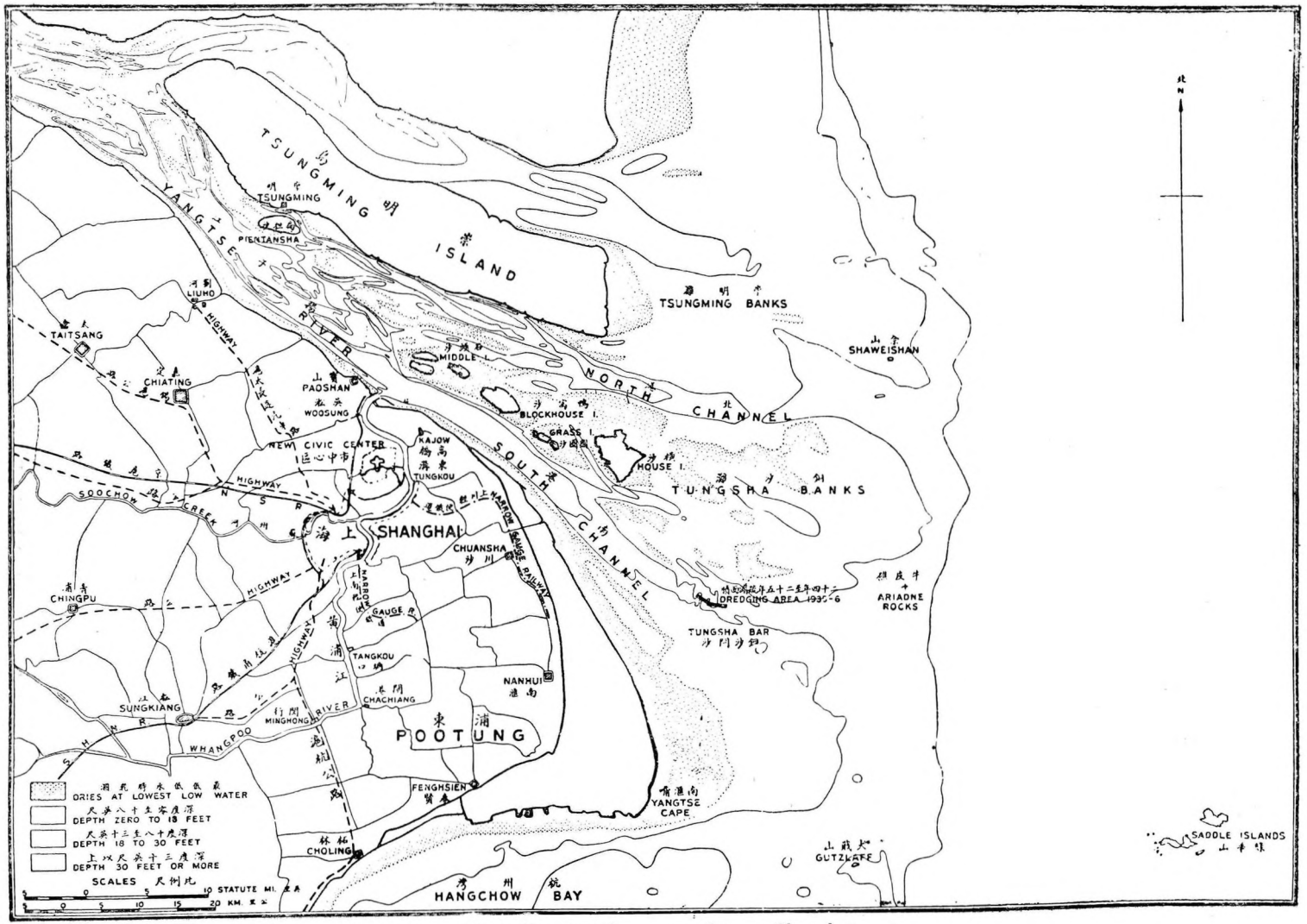


Chart Showing the approaches to Shanghaï.

Carte des Abords de Changhaï

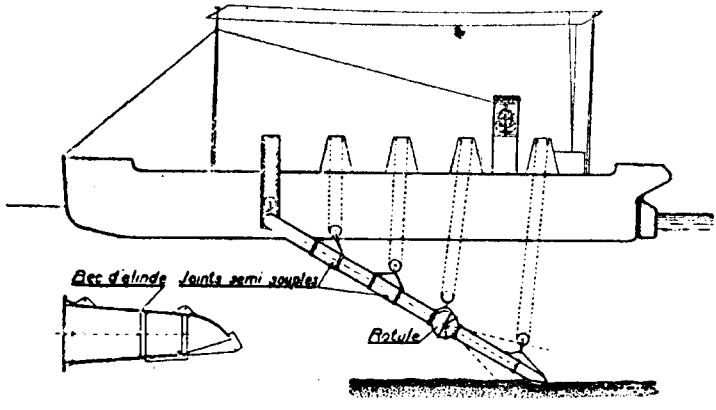
I have given the explanation verbatim in the writer's own words, since it carries weight in view of his long experience of the Mersey Bar, but I am bound to say that it is a theory which does not commend itself to my judgment for it takes no account of the erosive and dispersive action of the currents in tidal waters. Moreover, the rise in the bed of the channel of the bar is not gradual, as implied in the theory above stated, but generally abrupt.

Other authorities have attributed the formation of bars to wave action, apparently ignoring the fact that storms are intermittent and, for long periods in the summer season somewhat rare, so that a bar formed by wave action would have abundant opportunity to subside and dissipate, whereas the natural condition of most bars is fairly stationary.

The most satisfactory general explanation which I have seen put forward, at any rate for river mouths in Great Britain and on the Atlantic littoral, is that which connects the bar with the phenomenon of littoral drift. Passing continously along a coast-line, the drift trails across the mouth of an intervening river in a track, the position of which is determined by the joint action of the river and sea currents. This explanation would appear to be supported by the nature of the materials of which a number of bars are composed. If of a fluvial origin, the material at the bar would be mainly silt and alluvium. The Mersey Bar consists almost entirely of free sand of varying degrees of coarseness: that on the outer slopes being finest and mixed with mud, the coarsest and cleanest being found on the inner slopes. The bar of the Gironde abounds in marine shells, mixed with gravel and sand, such as are common on the dunes and foreshore of the French Atlantic Coast. In this case, the difference in the material dredged from the outer and inner slopes is even more notable. On the exterior side of the bar, the elements are coarse, and comprise a large proportion of shells. Towards the centre, the materials become progressively smaller and finer, especially the siliceous particles of sand and shingle. Then, on the inner face, the bulk is composed of dune sand, often covered with a fine grey sand, which indicates a reduction in the velocity of the currents, once they have crossed the obstacle formed by the bar. (*) There is no difference in chemical composition in the various elements, merely a grading, in accordance with their susceptibility of movement under the motive power of natural forces.

The Yangtse Bar.

The theory connecting bars with littoral drift is not of universal application, for there are bars, such as those of the Yangtse River, which are largely mud, mixed here and there with patches of elutriated sand, which Dr. Herbert Chatley points out have a definitely



fluvial origin. The entrance to the Yangtse is shown in the plan on page 116. The South Channel, the main shipping route, is almost straight. The bar, generally known as the Fairy Flats, is of considerable extent, over two miles wide, and the length in which

(1) Views of these materials were given in the issue of the Dock and Harbour Authority for January last. Vol. XVIII, pp. 86 and 87.

it affects deep-draft ships is about 20 miles. Over the crest of the bar there may be at times only 18-ft. of water. The policy pursued by the Whangpoo Conservancy Board has been to dredge a navigable channel, 1,000-ft. wide, with a depth of 9-ft. below the crest.

Other exceptional instances of bar formation must be mentioned. There are in certain rivers, bars of indurated material of a permanent character, such as rock, boulder clay and conglomerate. These evidently have a remote origin and are due to primeval geological causes.