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INFLUENCE OF MONSOONS ON MOVEMENT OF DHOWS  
ALONG THE EAST AFRICAN COAST

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It has always been acknowledged that monsoons have a pronounced influence on the movement of dhows between the East African coast and the peripheral lands of the Arabian Sea. On the other hand, it has invariably been assumed that monsoons have little, if any, effect on the movement of dhows along the East African coast itself. The only exceptions appear to be the accounts of the nineteenth century visitor, C. Guillain 1856, *ibid.*, esp. pp. 369-71, 380-2, who described the times of sail between Zanzibar and the mainland ports, and of A.H.J. Prins 1885 esp. pp. 198-5, who analysed the months of departure of all dhows from Lamu. The varying importance attached to monsoons with respect to seasonal and local dhows presumably stems from the belief that the former have a 'deep-sea' trajectory and must therefore rely on a following wind, while the latter operate on a 'short-sea' run and can therefore "steal" from one port to another irrespective of the seasons. This article sets out to test this common belief that monsoons have no influence on the movement of local dhows and thus complements the already published analysis on the impact of monsoons on seasonal dhows B.A. Dattoo, 1970.

HYPOTHESES

On the premise that monsoons have an influence on local dhows, a number of *a priori* research hypotheses can be set up which can then be tested both visually, via a cartographic presentation, and statistically, via a significance test. Dhows can put in at a port from points to the north or south of it. There are also large offshore islands in East Africa, such as Zanzibar and Mafia, and though these may be said to lie roughly north or south of a given port, it may be helpful, initially at least, to distinguish these arrivals from others. The direction of ports of origin of dhows is important since it is this which is hypothesized to determine the season of sail.

Dhows which arrive from the north would be expected to utilise the northeast monsoon which prevails between November and February and those which hail from the south to use the southwest monsoon either during its 'build-up' in April-May or its 'tail-end' in August-September Dattoo, p. 1. Those which come from the offshore islands may sail to the opposite mainland almost throughout the year but for travel further north or south they would use either monsoon depending upon the location of the island vis-a-vis the port. So far the periods of movement of local dhows are not in theory much different from those of seasonal dhows. However, limited north-south movement and cross-wise navigation between offshore islands and the mainland may occur particularly during the bi-annual season of calms and variable winds between the monsoons.

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Therefore,

Hypothesis 1 is: There is a difference in the times of arrival of local dhows at any East African port depending upon the direction of origin of dhows.

The peaks of arrivals from any one direction would, however, be expected to vary slightly from one port to another. The northeast monsoon spreads gradually southwards from the Arabian Sea and so arrivals from the north in the northern ports of East Africa should peak earlier than in the southern ports. Similarly, the southwest monsoon extends progressively from the Mozambique Channel and consequently arrivals from the south should peak earlier in the southern ports during the early part of the monsoon and in the northern parts in the latter part of the monsoon. Where arrivals are during the seasons of variable winds, no such time-lag need be expected as the time span of these seasons is so limited. Thus,

Hypothesis 2 is: There is a difference in the peaks of arrivals of local dhows from north or south at East African ports depending upon the latitudinal position of ports.

Only arrivals have been considered in the above formulations, but the two hypotheses can likewise be made to apply to departures. Rather than investigate arrivals and departures separately, however, it seems more useful to examine one or the other and then to discover the relationship between them. Local dhows tend to ply between the same two ports. One might then anticipate a certain time-lag between arrivals from and departures for a given direction. Hence,

Hypothesis 3 is: There is a difference in the times of arrivals of local dhows from one direction and their departure for the same direction at any East African port.

Hitherto the discussion has been based on movements to and from East African ports. It is necessary to extend it to Somali ports since it is movement along the coast which is to be considered. It becomes imperative to distinguish the nationalities of dhows involved in the coastal traffic for the distance between Mogadishu and Lamu alone is over 800 km. Somali dhows, like all seasonal ones, would be expected to sail south with the latter part of the northeast monsoon and to return home with the 'build-up' of the southwest monsoon, whereas East African dhows would fashion the northern voyage during the 'tail-end' of the southwest monsoon and the return passage at the commencement of the northeast monsoon. This schedule would minimize the length of sojourn in ports of destination of either category of dhows. Consequently,

Hypothesis 4 is: There is a difference between dhows of East African and Somali origin in the times of their arrival at (or departures from) East African ports from (or for) Somali ports.

#### METHODOLOGY

To test the above hypotheses, it was decided to analyse the dhow traffic at the two more important ports of Mombasa and Dar es Salaam; and to reduce the risk of an abnormal year unduly affecting the analysis, it was deemed wise to take a three-year time span, 1967-9. Data on arrivals and departures were extracted from dhow registers kept at the above ports. While all dhows of East African origin were included, all those of foreign origin save some Somali and Indian dhows were excluded. These foreign craft usually Dutch, are motor coasters and as such are not subject to monsoonal controls. Only those Somali and Indian vessels were enumerated which appear from the registers to ply regularly between ports on the east coast and which do not venture beyond the Persian Gulf or western India. It was felt that these deserved the designation "local" despite their nationality.

Data were then aggregated separately for arrivals from and departures for ports to the north or south as well as offshore islands. One problem inherent in the first two categories is that they subsume both long and short distance journeys when only the former may be expected to be influenced by the monsoons. Any division between long and short distances would, however, have been arbitrary and it was therefore decided to sum all the occurrences from or to a given direction. As for the offshore islands, only Zanzibar has contacts with Mombasa whereas both Zanzibar and Mafia have connections with Dar es Salaam.

Frequency polygons for arrivals and departures were drawn for each port Figs. 1 and 2, and so as to make visual comparison easier between arrivals and departures from or for a certain direction at any port, they have been placed alongside each other. It should be noted that the abscissa begins with November not January, in conformity with the pattern of seasons. The graphs only show the preponderance of movements to and from certain directions at certain periods. It is, therefore, necessary to supplement them with tests of significance to ascertain whether or not the differences so revealed are statistically significant.

Since the comparison is between frequency distributions and interest centres on whether samples are from populations which differ in any respect (and not just central tendency), a non-parametric test of significance was used. The most appropriate for the purpose at hand is the chi-squared ( $\chi^2$ ) test for unlike samples. It becomes possible, therefore, to determine first the significance of the differences among all categories before examining them in pairs to establish which among them contribute to the differences. The method of computation of  $\chi^2$  is outlined in all standard statistical texts e.g. Siegel, 1958, pp. 175-9 and involves the calculation of expected frequencies which are then compared with observed frequencies. The  $\chi^2$  test demands that expected frequencies should not fall below a certain minimum, and fortunately, this requirement was not violated in the analyses. It might be noted that given certain degrees of freedom, the larger the value of  $\chi^2$  the more likely it is that differences between categories are statistically significant.

## ANALYSES

Some general remarks may first be made before each of the hypotheses is examined in turn. Table 1 shows monthly percentage arrivals from north and south at Mombasa and Dar es Salaam, arrivals from offshore islands here being included in one or the other category. It is evident that dhows come from both directions in all months of the year, though a greater proportion of arrivals from a given direction is accounted for in a specific season. Moreover, in March and October arrivals from the opposite directions at Mombasa and Dar es Salaam respectively are nearer equilibrium. Table 1 also shows the percentage of total arrivals in each month and it can be seen that June registers the lowest per cent at both ports, and the adjacent months of May and July almost second and third lowest. This is the period when the southwest monsoon is at its most boisterous *Datoo*, Fig. 1A, p. 4, though arrivals do not fall below six per cent of the total.

Even a cursory glance at Figure 1 shows that there are differences among various categories of arrivals at Mombasa and Dar es Salaam *Hypothesis 1*.  $\chi^2$  test confirms that these differences are significant at 0.1 per cent probability level. The differences between any two categories appear in some instances more marked than in others and Table 2 gives the results of the test for each such pair. At Mombasa the observed and expected patterns more or less correspond, but while the differences between north and south and north and Zanzibar are indeed shown to be highly significant, those between south and Zanzibar are not significant. The observed pattern at Dar es Salaam, however, deviates slightly from the expected in that there is a second season of arrivals from north between July and September and that one of the seasons of arrivals from south spreads between December and April.

$\chi^2$  shows that all the differences are significant, except for those between south and Mafia and Zanzibar and Mafia.

Despite a certain measure of similarity in the general pattern of arrivals, the peaks differ from one port to another *Hypothesis 2*. Northerly arrivals reach a zenith at Mombasa in December and at Dar es Salaam in March, but there is a second equally important peak at the latter port in July. The differences between these arrivals prove to be significant at 0.1 per cent probability level ( $\chi^2 = 103.16$ ). On the other hand, southerly arrivals attain a maximum in May and January-February at Mombasa and Dar es Salaam respectively and yield a subsidiary peak in the two ports in August and September. Mombasa therefore conforms to expectations better than Dar es Salaam but the differences do not emerge as statistically significant ( $\chi^2 = 17.47$ ). Of the offshore islands, the data allow only arrivals from Zanzibar to be tested. The differences between the two ports ( $\chi^2 = 34.49$ ) are significant at 0.1 per cent, but this is apparently due to variations in the first peak rather than due to greater number of arrivals in September than October at Mombasa and vice versa at Dar es Salaam.

Before the relationship between arrivals and departures was examined *Hypothesis 3*, a check was first made on the pattern of movement of local dhows. A 25 per cent random sample of the months included in the analysis (i.e., 9 out of 36 months) showed that of the arrivals from mainland ports at Mombasa, 87 per cent of the dhows departed in the same direction, and of the arrivals from offshore islands 58 per cent of the vessels returned to those islands. The relevant

Table 2

Matrices of  $\chi^2$  results for arrivals of local dhows at Mombasa and Dar es Salaam

<u>MOBASA</u>				
	Overall = 73.4*			
From	North	South	Zanzibar	
North				
South	47.61*			
Zanzibar	42.14*	10.24		

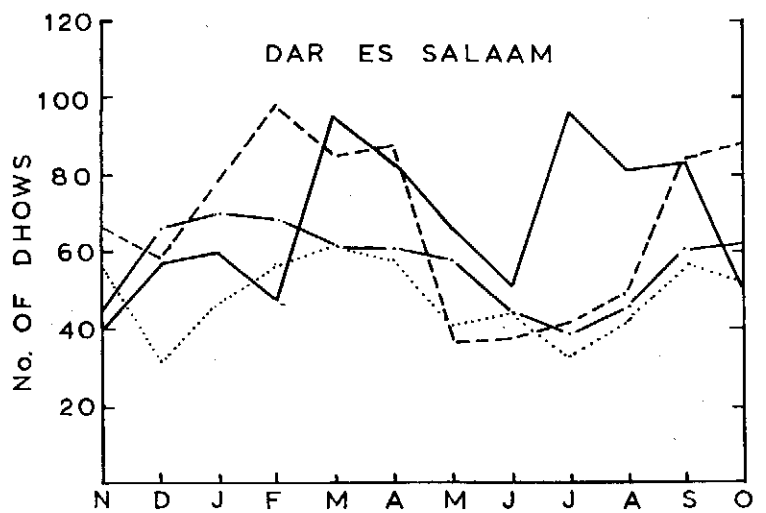
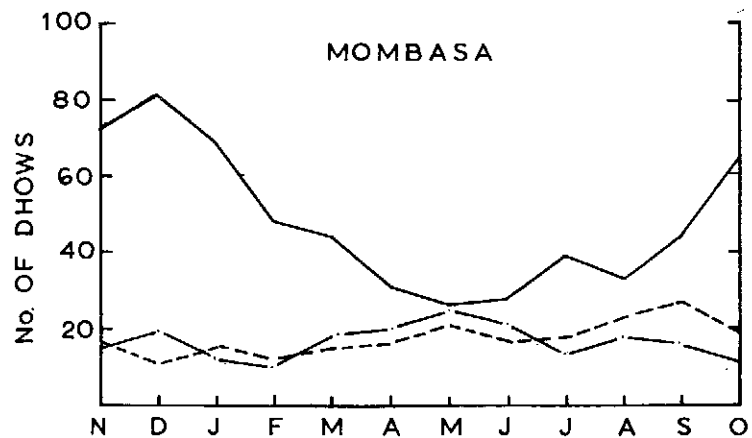
<u>DAR ES SALAAM</u>				
	Overall = 113.3*			
From	North	South	Zanzibar	Mafia
North				
South	49.20*			
Zanzibar	76.37*	23.09 <sup>+</sup>		
Mafia	41.11*	12.89	15.68	

\* Significant at 0.1%

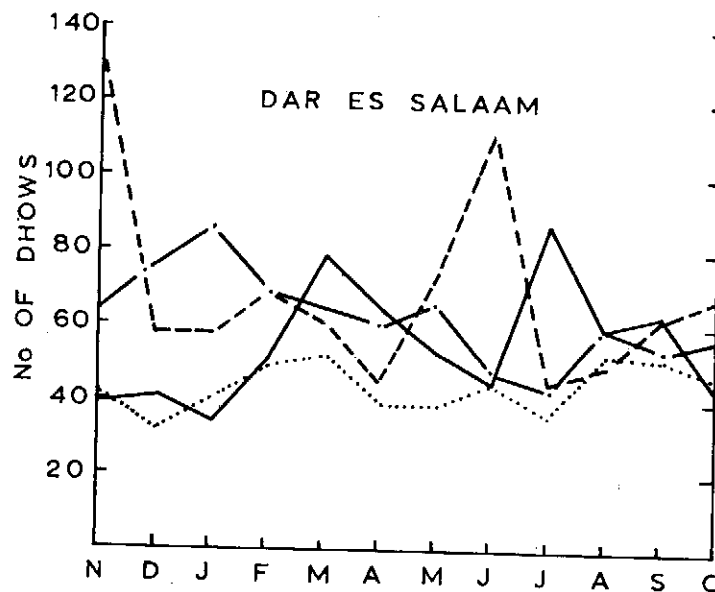
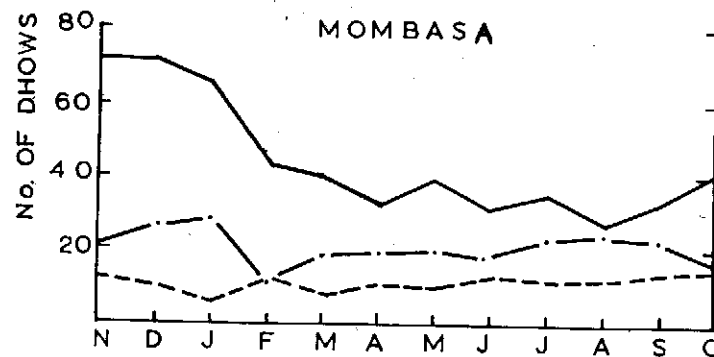
<sup>+</sup> Significant at 5.0%

figures for Dar es Salaam were 72 per cent and 79 per cent, respectively. Visual comparison of Figures 1 and 2 show that on the whole arrivals from a given direction more or less coincide with departures for the same direction and the results of  $\chi^2$  test on arrivals and departures in Table 3 confirm that the only exception is journeys between Zanzibar and Dar es Salaam.

Data on movement to and from Somalia *Hypothesis 4* have been processed only for Mombasa as numbers appear to become negligible further south along the coast. The distribution of dhows over the months is such that the data can neither be shown cartographically nor analysed statistically. Instead Table 4 is presented and it can be seen that generally more than 50 per cent of the Somali dhows arrive in March-April and depart in April-May, while the same proportion of East African dhows leave in September-October and return in November-December. Once again arrivals or departures of dhows of either nationality are not exclusively restricted to the months enumerated above.



— Arrivals from North    --- From Zanzibar  
 — From South            ..... From Mafia



— To North                --- To Zanzibar  
 — To South              ..... To Mafia

Table 1  
Monthly percentage arrivals of local dhows  
at Mombasa and Dar es Salaam, 1967-9

Port	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
% of arrivals from NORTH	11.5	8.0	8.2	5.8	4.3	4.7	6.5	5.5	7.3	11.6	12.6	14.0	100.0
% of arrivals from SOUTH	8.5	8.9	11.1	10.5	6.4	5.5	8.5	8.1	10.3	8.5	6.5	7.2	100.0
% of TOTAL arrivals	6.6	5.4	8.1	8.8	11.3	9.3	7.6	10.0	10.5	7.4	7.6	7.4	100.0
	9.2	9.9	9.7	9.4	7.8	7.0	5.7	6.9	9.1	9.0	8.6	7.7	100.0
	9.5	6.9	8.1	7.0	7.1	6.5	6.9	7.4	8.7	9.9	10.6	11.3	99.9
	8.8	9.4	10.5	10.0	7.0	6.2	7.3	7.6	9.8	8.7	7.5	7.4	100.2

Table 3

Matrices of  $\chi^2$  results for arrivals and  
departures of local dhows at Mombasa and Dar es Salaam

		MOMBASA			
Arrival from/ Departure for		North	South	Zanzibar	
North		9.13			
South			10.06		
Zanzibar				5.29	
		DAR ES SALAAM			
Arrival from/ Departure for		North	South	Zanzibar	Mafia
North		7.38			
South			4.19		
Zanzibar				102.24*	
Mafia					6.73

\* Significant at 0.1%

Table 4

Monthly percentage arrivals from and  
departures for Somalia at Mombasa, 1967-9.

Month	Arrivals		Departures	
	East African Total : 10	Somali Total : 15	East African Total : 67	Somali Total : 28
January	-	-	3.0	7.1
February	-	-	4.5	-
March	10.0	26.7	6.0	7.1
April	10.0	20.0	7.5	39.3
May	-	-	4.5	28.6
June	-	-	4.5	3.6
July	-	-	-	-
August	-	-	4.5	-
September	-	-	16.4	-
October	30.0	20.0	31.3	3.6
November	30.0	20.0	13.4	7.1
December	20.0	13.3	4.5	3.6
Total	100.0	100.0	100.1	100.0

## DISCUSSION

The above analyses show that hypothesis 1 is upheld if all arrivals are considered together but only in two-thirds of the instances if considered in pairs; hypothesis 2 is upheld in the case of arrivals from north but not from south; hypothesis 3 is rejected except for movement to and from Zanzibar in the case of Dar es Salaam; and hypothesis 4 is upheld though data only for Mombasa were considered. It is now proposed to examine the implications of the results of significance tests, and more especially, to attempt to account for some of the anomalies revealed in the patterns.

Arrivals from north and south are generally governed by the northeast and southwest monsoons respectively, but arrivals from offshore islands may or may not be distinguished from either direction depending upon the distance between the island and the port. Thus Mombasa and Dar es Salaam lie north of Zanzibar and Mafia respectively and an appreciable distance away from them, so that it is not surprising that differences between arrivals from those islands and from south are not significant. But at Dar es Salaam differences between north and Zanzibar are significant which perhaps indicates the importance of the seasons of variable winds for trans-channel navigation. Secondly, arrivals from a given direction are not generally differentiated from departures for that same direction. But in the case of journeys to and from Zanzibar at Dar es Salaam, there is a clear time-lag which perhaps underlines the problems of sailing against a prevalent wind in the open waters as opposed to close inshore.

Chief among the anomalies are one of the peaks in the pattern of arrivals both north and south at Dar es Salaam. So as to detect the influence, if any, of an abnormal year, data on those arrivals were disaggregated for each year and  $\chi^2$  test run for northerly and southerly arrivals. While differences among arrivals from north during 1967-9 emerged as significant at 0.1 per cent probability level ( $\chi^2 = 58.32$ ), those from south were not proved to be statistically significant ( $\chi^2 = 18.92$ ). It is apparent from the breakdown of the former figures that anomalies are in fact due to the undue influence of a single year. Thus the second peak of arrivals from north is in September in two years and in July only in 1968 which, however, accounted for 48 per cent of total arrivals from that direction. Further, it is worthy of note that the bulk of arrivals in July 1968 were from Utundwe and Kitame, both within a relatively short distance of Dar es Salaam.

On the other hand, since the differences among arrivals from south during 1967-9 were not significant, the explanation of the peak in January-February at Dar es Salaam must be sought elsewhere. Perhaps it is due to the location of that port on the western side of the Zanzibar Channel. For even during the season of the northeast monsoon which, incidentally, does not blow with any degree of constancy into the Channel beyond January Dattoo, p. 6, the East African coast current continues to flow northwards from about Cape Delgado to 3° S latitude, even though it has a mean drift of only 13 miles per day between November and January compared with 27 between May and July Admiralty, 1939, p. 38. Further, the continental shelf, which closely skirts the coast itself, widens roughly between the Pangani and Rufiji rivers to embrace Zanzibar and Mafia islands so that the shallow straits between them and the mainland have the characteristics almost of a sheltered roadstead. Within this region, therefore, dhows may be aided by a favourable current in the face of an indifferent wind.

It is evident from the cartographic and statistical analyses that the influence of monsoons on movement of local craft is no where as decisive as on seasonal dhows. Both Table 1, which does not show any month with less than six per cent of all arrivals and Table 3, which shows that arrivals from a certain direction are not generally differentiated from departures for the same direction, heavily underline the point. Yet, as is likewise apparent from the graphs and tables, the monsoons do explain some of the peaks and the troughs. Even with cross-wise movement in the Zanzibar Channel, the patterns are far from random. Two factors, moreover, mitigate the impact of monsoons: an appreciable proportion of the vessels included in the analysis are designated as motor vessels and long and short distance journeys are not distinguished in the analysis. The truth is not that local dhows cannot or do not sail if winds are contrary, only that the length of the voyage is quadrupled Noble, 1963, p. 498, and operations at sea become arduous, if not hazardous Prins, pp. 249-53. It is no wonder then there is a certain degree of order in the pattern of dhow movements along the East African coast.

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