

Fig. 3 Variations in wind direction 14.00-15.00 hrs, Nov. 7 1970

plantation by man. It may or may not be significant that a village is located at the centre of what was the most infested area and at the point of local convergence of valley airstreams which provide a major transport mechanism for the aphid.

1. Ojany, F.F. (1966) 'The physique of Kenya: a contribution in landscape analysis.' *A.A.A.G.* Vol. 56, No. 2, pp. 183-196.

2. Brown, K.W.

3. Data collected

In studying the importance to estimate suppliers. The pattern of the extent of the trade distinct hierarchical centres are dependent the same time Marshall of a set of centres centres with regard that the spatial linkage achieved.

In the course of District, Eastern Uganda linkages between the places supplying six alternatives were import) and Local (to replies for each establish the centre as a whole. between the numbers of necessarily relate to may have to be carefully few replies. The distortion the pattern of primary linkages may be misleading.

Figure 1 indicates centres. The hierarchical procedures. It is evident to those places which have associated with Mbale. District as such but lies

2. Brown, K.W. (1970) 'Tests of insecticides against pineus spp., in East Africa.' *E.A.A.F.J.* Vol. XXVI No. 2, pp. 200-201.

3. Data collected by the Army Worm Division, *E.A.A.F.R.O.*

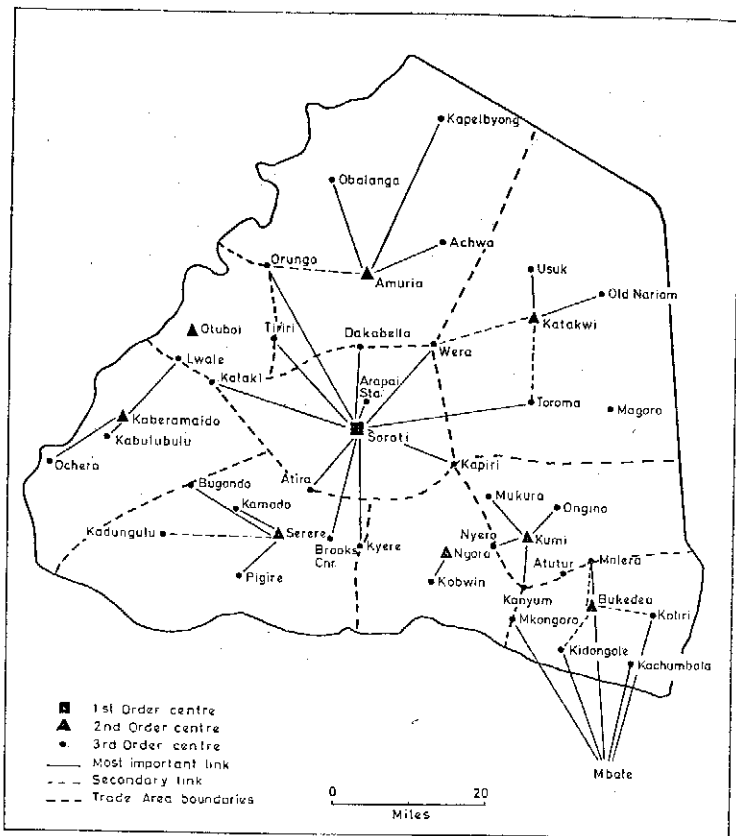
Patterns of spatial linkage in Teso District

Donald Funnell

In studying the spatial organization of retail outlets it is of particular importance to estimate the relationships between any given enterprise and its suppliers. The pattern of dependence thus found also assists in demarcating the extent of the trade area of suppliers. According to central place theory, a distinct hierarchical pattern of dominance should be found whereby the lowest centres are dependent upon the suppliers in the next highest level for goods. At the same time Marshall¹ has pointed out that a prerequisite for adequate analysis of a set of centres is the provision that this set comprises the total system of centres with regard to a pre-determined highest order place. This then requires that the spatial linkages should be determined, and closure of the system of places achieved.

In the course of a wider survey of retail and service provision in Teso District, Eastern Uganda,² an attempt was made to build up a pattern of spatial linkages between the centres studied. Each enterprise visited was asked to rank the places supplying its goods in order of importance. To facilitate data analysis, six alternatives were presented: Kampala, Jinja, Mbale, Soroti, External (direct import) and Local (to be specified). The data are presented in Table 1. The replies for each establishment were aggregated to produce an overall ranking for the centre as a whole. Unfortunately there were often considerable discrepancies between the numbers of actual replies received for each place. These did not necessarily relate to the number of establishments in a place, so that the results may have to be carefully considered. Some of the linkages are based upon only a few replies. The distortion caused by this is difficult to assess. It may be that the pattern of primary (most important) linkage is not much affected but other linkages may be misleading.

Figure 1 indicates the major suppliers (primary linkage) of second order centres. The hierarchical organization has been determined elsewhere³ by grouping procedures. It is evident that there is a basic division between the centres as to those places which have their major contacts with Soroti and those more closely associated with Mbale. It should be pointed out that Mbale is outside Teso District as such but lies only a few miles to the south. With the exception of



Serere, the division lies along the alignment of Awoja swamp. Further an analysis of the road distances between the second order centres and their main supplier points to the fact that only two of the eight are not nearest centre links. These two, Ngora and Kumi are situated between the two major centres. It is evident that this information alone casts some doubt on the wisdom of using the administrative unit as the demarcating criteria for a study of a central place system based upon Soroti. Though it is possible to show that the Teso area does provide evidence of a hierarchically organised system of centres, in fact the spatial linkages involved are partitioned between two major large central places.

ANALYSIS

	1	2	3	4	5	6	7
Soroti	1						
Dakabella				1			
Arapai Sta				1			
Kumi			1	2			
Mkongoro			1				
Atatur		no data					
Kanyum						1	04
Ngora			1	2			
Kapririr				1			
Nvero						1	04
Kobwin						1	08
Mukura						1	04
Serere			2	1			
Kyere			2				
Brooks Cnr				1			
Atira				1			
Ongino						1	04
Kadungulu				1		1	13
Kamod						1	13
Pigire						1	13
Bugondo						1	13
Tiriri				1			
Bukedea			1	2			
Kachumbala			1				
Kidongole			1				
Malere			1				
Kaliri			1			2	23
Kaberamaido	3			1		2	28
Kalaki				1			
Otuboi			2	1			
Kabulubulu						1	28
Obululu						1	28
Ochero						1	28
Lwala						1	28
Amuria			2	1			
Orungo				1		2	35
Kapelebyong						1	35
Wera				1		2	40
Achwa						1	35
Katakwi				1			
Toroma				1		2	40
Magora					no data		
Usuk						1	40
Ngarian						1	40
Obalanga						1	35
Col 1 Kampala							
Col 2 Jinja							
Col 3 Mbale							
Col 4 Soroti							
Col 5 Direct Importer							
Col 6 Local							
Col 7 Code of centre for							

ANALYSIS OF THE MAIN SUPPLIES OF MANUFACTURED GOODS

TESO DISTRICT 1969

	1	2	3	4	5	6	7
Soroti	1		2			3	01
Dakabella				1			
Arapai Sta				1			
Kumi			1	2			
Mkongoro			1				
Atatur		no data					
Kanyum						1	04
Ngora			1	2			
Kapririr				1			
Nvero						1	04
Kobwin						1	08
Mukura						1	04
Serere			2	1			
Kyere			2				
Brooks Cnr				1			
Atira				1			
Ongino						1	04
Kadungulu				1		1	13
Kamod						1	13
Pigire						1	13
Bugondo						1	13
Tiriri				1			
Bukedea			1	2			
Kachumbala			1				
Kidongole			1				
Malere			1				
Kaliri			1			2	23
Kaberamaido	3			1		2	28
Kalaki				1			
Otuboi			2	1			
Kabulubulu						1	28
Obululu						1	28
Ochero						1	28
Lwala						1	28
Amuria			2	1			
Orungo				1		2	35
Kapelebyong						1	35
Wera				1		2	40
Achwa						1	35
Katakwi				1			
Toroma				1		2	40
Magora					no data		
Usuk						1	40
Ngarian						1	40
Obalanga						1	35
Col 1 Kampala							
Col 2 Jinja							
Col 3 Mbale							
Col 4 Soroti							
Col 5 Direct Importer							
Col 6 Local							
Col 7 Code of centre for Col 6							

Examination of Figure 2 provides some interesting findings. This figure shows the pattern of 'dependency' between the lowest order centres and the other higher order places. It also portrays links which were determined to be of secondary importance. The first thing to note is the anomalous position of Otoboi. This apparently has no links with centres of the lowest order. It is probable that this is the result of data deficiency rather than indicating an actual situation. Several local systems can be seen to be present though, again the former especially in Bukedea county. In addition some of the local patterns only become evident when second order links are considered.

With this data it is possible to compare the extent of a centre's 'dominance' with that derived from an estimate of the trade areas of the supplier centres according to Reilly's model of retail gravitation.⁴ The location of the boundary between competing centres is given, in kilometres from B as:

$$\text{Distance A-B} = \frac{1}{1 + \sqrt{\frac{\text{Size A}}{\text{Size B}}}}$$

The distances were taken as the shortest road distances between the centres, whilst measures of size were: firstly population of the centres for the estimation of the boundary between Soroti and Mbale; secondly, number of functions in a centre for the second order centres. The difference was due to the fact that population data specific to the centres was not available.

With reference to the trade area of Mbale and Soroti, the boundary was found to lie just north of Kumi. Though not shown here this boundary does tend to follow the division already cited on the basis of the linkages described. The District is thus divided into nine second order market areas on the basis of boundary locations from the Reilly model. At the same time some comparison can be drawn with the extent of spatial linkages of these centres. The trade areas of Kumi, Amuria, and Serere tend to indicate greatest conformity with that of the retail gravitation model. Major distortions occur in the case of Bukedea where the influence of Mbale is particularly strong. Nonetheless, given second order linkages, a local system approximately conforming to the trade area seems to exist. Soroti as a main supplier penetrates the trade areas of Ngora and Serere by being the source of goods for Kyere and Brooks Corner.

One other interesting factor that emerges from this analysis is the frequency with which boundary locations estimated by the Reilly model tend also to be the sites of lower order centres. These are shown on the map. Thus in some ways this suggests that a process of interstitial placement of lower order centres is operative.

suggests that a process of interstitial placement of lower order centres is operative. Also, in so far as the second order centres have relatively similar numbers of functions, then the location is a midpoint position between competing central places. This might suggest that the area is being organised according to Christaller's transport principle.

Finally, the analysis of the pattern of links shows the relative weakness of the second order centres. The overriding significance of the highest order central places, particularly, is made evident when account is taken of the number of all lowest order centres supplied by the nearest centre of the next highest order. Just over 50% of the linkages are of a 'nearest centre' form, most of the remainder being accounted for by links with either Mbale or Soroti. It is these circumstances that reflect the fact that virtually all the specialised retail outlets are confined to the highest order centres.

The spatial organisation of supplier links in Teso has shown that:

1. The area is partitioned between Mbale and Soroti, the latter only having clear 'dominance' in the northern part of the District.
2. That the pattern of linkages is in approximate conformity with the trade areas suggested by the Reilly gravitation model.
3. That many lowest order centres are located at the boundary points of trade areas in a manner suggested by the concepts of spatial competition.
4. That the second order centres do not seem to have developed their systems as fully as might be expected.

1. Marshall, J.U., 1969. The location of service towns, Department of Geography, University of Toronto, Research Publications.
2. Funnell, D.C., forthcoming, Department of Geography, Makerere University, Kampala, Occasional Paper.
3. ibid.
4. Berry, B.J.L., 1967, Geography of market centres and retail distribution.

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