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## THE REACTION OF RURAL POPULATIONS TO DROUGHT: A CASE STUDY FROM SOUTH EAST ARABIA

With 3 figures

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*Zusammenfassung:* Die Reaktion ländlicher Bevölkerungen auf Dürre: eine Fallstudie aus Südost-Arabien

Dürrestudien jüngerer Datums haben sich beinahe ausschließlich mit Afrika südlich der Sahara beschäftigt. Diese Studie untersucht die Folgen des Niederschlagsmangels in einer Siedlung Südost-Arabiens. Sie zeigt die fortschreitenden Auswirkungen auf die Landwirtschaft auf und diskutiert die Versuche der örtlichen Bevölkerung, die schädlichsten Folgen zu mildern. Diese Anstrengungen kamen verspätet und waren wirkungslos, z. T. als Ergebnis der Auflösung der lokalen Sozialstrukturen, aber hauptsächlich, weil die Gemeinde sich zunehmend auf Geldsendungen der Wanderarbeiter verlässt und weniger Interesse an traditionellen Beschäftigungen bekundet.

Diese Schwächung des traditionellen landwirtschaftlichen Sektors, die zu verstärkter Empfindlichkeit gegen Dürre führt, ist ein weit verbreiteter Vorgang von allgemeiner Bedeutung.

The recent plethora of literature about drought, and the nature of human responses and problems associated with it has been of varied forms, ranging from colour supplement reporting to detailed models. It has in common though, reference restricted almost entirely to sub-Saharan Africa—in a recent "overview", O'KEEFE and WISNER (1976) do not draw from a work based upon studies of hardship outside Africa, or even to the north of the Sahara, except for passing reference to that of CHAPMAN on Bihar Farmers (1974). There has been little examination of responses in other areas where populations live with a constant awareness of the likelihood of drought, and where, at any time, there are localities suffering from a shortage of rainfall. Whilst this concentration on sub-Saharan

Africa is in some ways an illustration of the admirable response of academics in applying themselves to a critical and acute problem in a short space of time (see, for example, DALBY and HARRISON-CHURCH, 1973), it might also be considered a myopic approach: one which has not drawn as widely from experiences outside Africa as it could have done.

For instance, in Arabia, many rural communities live under a chronic threat of drought, and have developed a series of responses to shortage of rainfall. From the study of these Arabian processes it might be possible to derive further understanding of some of the sub-Saharan reactions to drought, and perhaps to gather ideas to help shape the future of some of the marginal savannaland rural areas.

What constitutes a drought is as difficult to define in south east Arabia as in Africa (O'KEEFE and WISNER, 1975) or Australia (HEATHCOTE, 1969). Several years of low, or even a complete absence of rainfall may have little impact upon some of the larger lowland agricultural settlements with relatively secure water supplies. However, a similar period may have a devastating impact upon some of the smaller communities higher up the watersheds, the water supplies of which are much more quickly rainfall-responsive, having a smaller area of collection.

The picture is further complicated by the nature of Arabian rainfall, which tends to fall over only limited areas at one time, except for very occasional widespread rains (HALCROW, 1969; STEVENS, 1969, 1970). The result of such vagaries of precipitation is that whilst a watershed, or a part of one, may be suffering acute drought, having received no substantial rainfall

for five or six years, adjacent wadis may be enjoying relatively pluvial conditions. Thus, at any one time, there is usually a settlement, or a group of villages, suffering a water shortage. Such small scale drought does not attract or require international attention and aid, but it can nevertheless lead to severe local problems.

#### Recent Drought in the Sultanate of Oman

In 1973–75, sections of the Western Hajar Mountains, in the Sultanate of Oman, were suffering a shortage of rainfall. Although adjacent wadis were well-watered, sections of the Wadi Hawasina, above the village of Ghayzayn (Fig. 1) had not received substantial rain for three years, leading to what locals referred to as the worst drought within the watershed for some two or three decades.

There are eight villages in the Wadi Hawasina, all of which were affected by low rainfall during the study period. Ghayzayn, with a population of 505, is the biggest settlement in the valley. It was also the village suffering most acutely from a water shortage, and was selected for detailed monitoring and study.

The village is located at the downstream end of the gorge in which the Wadi Hawasina leaves the mountains to flow in an incised channel through the alluvial terraces to seaward (Fig. 1). The cultivated land, amounting to some 50 hectares, is on the left bank terraces of the wadi, and is irrigated by a *falaj* system, similar to the qanats of Iran (CRESSEY, 1958; TWISLETON-WYKEHAM-FIENNES, 1970; WILKINSON, 1974). A groundwater spring is tapped by a tunnel which, running at a lesser gradient than the land surface, brings the water up to the ground level whence it is distributed on a timed cyclical basis to the gardens through radiating lined and unlined channels. The water arrives by a series of tunnels, aqueducts, inverted siphons, and diversion dams comprising a complex engineering system.

In the absence of local rainfall figures relating to a period before the drought, it is in the decline of the *falaj* water flow that the drought suffered by Ghayzayn is best measured. In November 1973 a flow of 820 gallons per minute (g.p.m.) was measured at point (f) on Fig. 2. By September 1974, this had fallen to 50 g.p.m., of which only 30 g.p.m. were reaching the village. In November 1974 this had declined to less than 20 g.p.m.

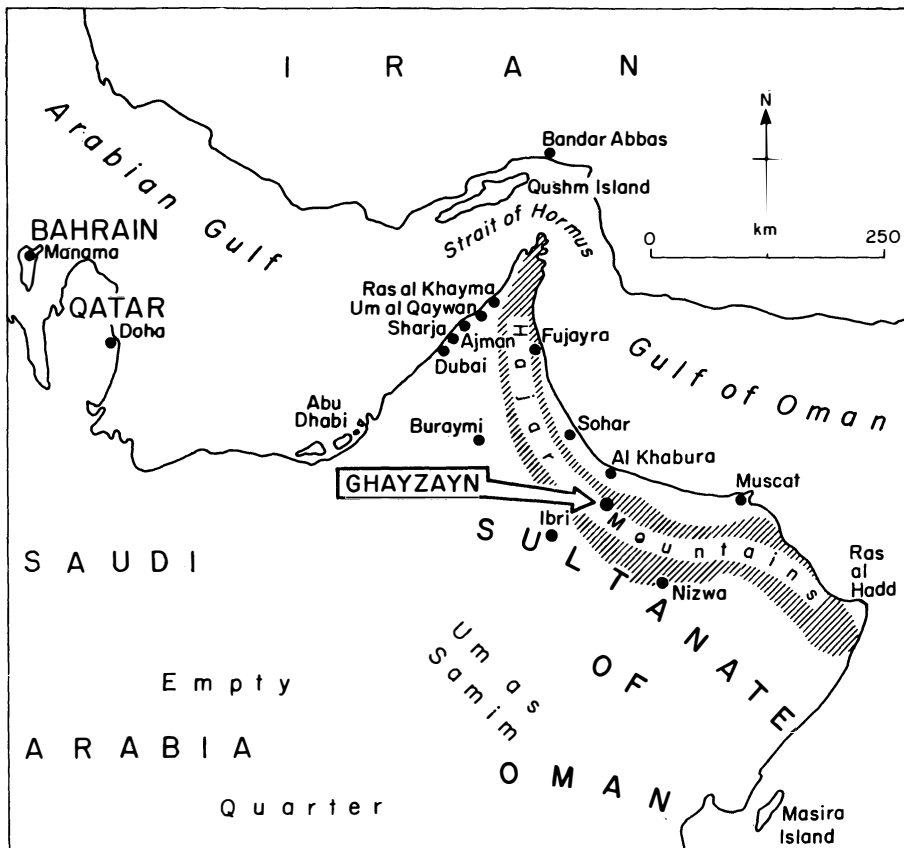


Fig. 1: The location of Ghayzayn

### *The Impact of the Drought*

This reduction in water flow to about 2.5% of the 1973 volume had great impact upon agriculture within the oasis. Prior to 1974 the flow had been relatively constant, only a small decline having occurred in 1973. All the 800 g.p.m. of irrigation water was being utilized; apart from the palms, which were being copiously watered, the villagers were cultivating several areas of wheat and alfalfa, comprising over 10 hectares together with small areas of other seasonal crops: tomatoes and onions. These field crops were the first to be abandoned; in June 1974, when the flow had declined to less than 90 g.p.m., irrigation of the last area of alfalfa ceased. All water was then utilized within the area of palms. The 1974 date harvest had already become unalterably low, however, because the palms had not received enough water early in the year. Indeed, it was becoming difficult to keep the dates alive, and to ensure some fruit (however little) for the 1975 harvest.

As the temporary crops were allowed to die, the animals owned by the villagers, normally stall-fed on field crops and dates produced within the village, became entirely dependent upon alfalfa brought in from outside. This was expensive, not only because of the need to purchase the alfalfa but also because of the cost of transport by landrover. The villagers, therefore, sold several head of livestock between May and July 1974 because of the poor date harvest, and the anticipation of a worse one in 1975. Thus the drought began to erode the wealth of the community.

Also in July 1974 the villagers, with the continuing rapid fall-off in flow to about 70 g.p.m. at point (f), decided to irrigate using only one of the two major distributaries at any one time. Previously, the *falaj* flow had been divided into two on entering the village and had been used to irrigate the two sections of the village simultaneously. The use of only one channel meant that the cycle of irrigation for each garden was lengthened from seven to 14 days. In fact, few palms were watered every 14th day, because the amount of water was insufficient to water all plots in one cycle. Therefore many palms were only irrigated every other irrigation cycle: every 28 days. This, in the summer months, resulted in rapid deterioration of their condition, and a fall in their yield. Some young palms, with under-developed root systems, died, as did the lime trees, which were intermingled in small numbers with the dates. Thus the community's capital was further reduced.

Soon after deciding to use only one of the two distribution channels, the villagers brought the cistern into operation. Normally, the *falaj* flows directly to the gardens, but when flow is reduced, this becomes inefficient because of proportionally larger losses by infiltration into unlined distribution channels. Use of a cistern reduces these losses — the *falaj* water is ponded

back in the cistern by a temporary dam and released periodically, the flow along the distributaries to the gardens being greater than the *falaj* volume because of the extra head of water. In this way, the *falaj* can be made to reach the most downstream parts of the oasis which it might otherwise not have sufficient head of water to do.

When the flow of water drops as low as in Ghayzayn, other factors than infiltration further impair the efficiency of irrigation. There is a reluctance to plough, or to disturb the soil under the palms at all, because this causes individual plots to absorb too much water, reducing the number of trees which can be irrigated each cycle. However, this means that losses by evaporation from this hard-packed surface rise, benefits to trees are much reduced, and the likelihood of an accumulation of salts in the upper levels of the soil increases.

Low *falaj* flows create other incidental problems. As the volume declined, the water became dirtier, and less suitable for drinking, so women had to walk further up the *falaj* to (d) on Fig. (2) in order to collect drinking water. But even higher up the channel it was of poor quality, and several families refused to drink it. The alternative source of water, a shallow well in the wadi bed below the village, dried out in June. Some people thus came to rely upon drinking water brought in by landrover from adjacent settlements, requiring further cash outlay.

### *Factors Behind the Human Response*

Thus the population of Ghayzayn felt itself to be in a bleak situation. Dates were few and expensive, costly animal fodder was being brought in, the flow in the *falaj* was continuing to fall, and even drinking water was becoming short in supply. Yet, no efforts were being made by the villagers to increase water flow; they did not even attempt to survey the underground section of the *falaj*, or to remove tree roots and weeds to aid the flow. More surprisingly, they did not improve the surface channel, and in July there were still leaks between points (l) and (m) on Fig. 2. This section of channel is perched some 35 ft up the wall of the gorge and so is relatively difficult of access, but the water loss could easily have been stopped.

The reasons behind the villagers' lack of work on the *falaj* were contradictory and spanned extreme optimism and abject pessimism. The same people, drawing upon a series of observed natural phenomena and superstitious beliefs, oscillated between asserting that there was no need to attempt to improve the flow, because the drought would break within a few days, and then later claim the drought would be so long and severe that no action taken by them would ameliorate the impact. Procrastination was also engendered by certain aspects of the Ghayzayn com-

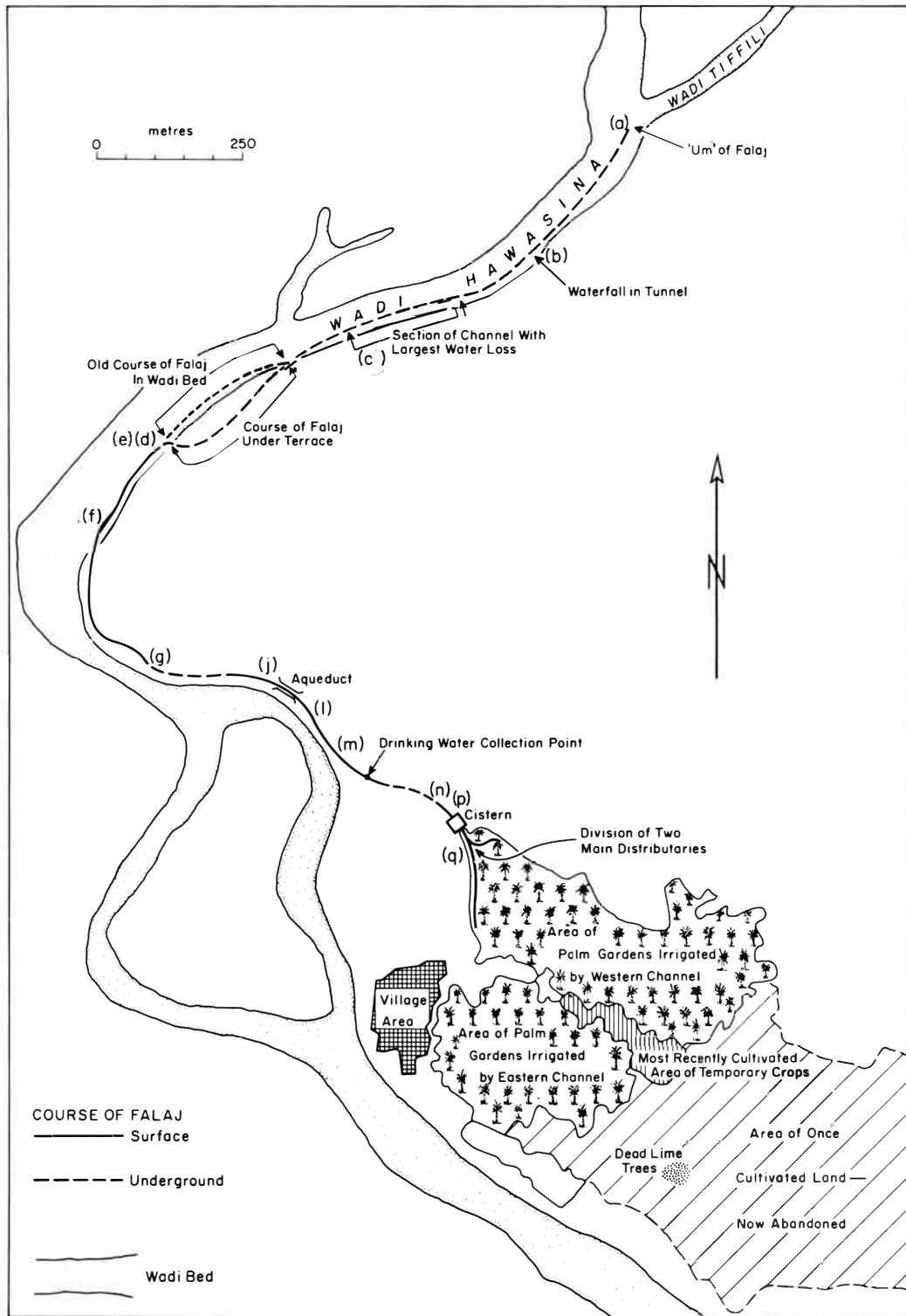


Fig. 2: Ghayzayn Falaj, Wadi Hawasina

munity: many of the gardens were owned by absentee landlords, who had property elsewhere, and so were not highly motivated to invest in improving the water supply at Ghayzayn. These landlords were also of high rank within the tribe predominant in the area; their disinterest therefore also meant that no initiative was forthcoming at a tribal level. The headman of Ghayzayn, not a forceful character, would or could do little under these conditions to raise the aid from the rest of the tribe that was traditionally due to the population of the village. In the absence of this charity members of the local community were reluctant to act, both because of their lack of resources, and because the absentee landlords would benefit without having made any contribution. Inactivity was compounded by a fear that some of the men of Ghayzayn had of the *falaj* tunnel, resulting in reluctance to work in it. Furthermore, as time passed the community found it increasingly difficult to begin work on the *falaj*: the continued purchases from outside of alfalfa for the animals and of dates for human consumption were impoverishing the villagers.

As a result of their developing poverty, the temporary movement of migrant labourers out of the village increased. Before the drought, about 54% of men between the ages of 15 and 39 were working away from home; subsequently, in July 1974 over 70% of males in these age groups were absent (BIRKS, 1976). They had departed to earn money to cover the unusually large purchases of alfalfa and dates that their families were having to make. Cash income had become of increased importance. There were two immediate effects of this increased absenteeism. The condition of the gardens deteriorated even more rapidly, as inputs into cultivation decreased further; in consequence the efficiency of irrigation fell more quickly than it might have done – less care was taken over embanking bunds, making dams, etc. Secondly the potential labour supply available to work on improvements to the *falaj* structure in order to increase the flow was further reduced. Thus the longer the community procrastinated, the more difficult it became to mount an effort to work on the *falaj*: fewer able men remained, and these, because of their dwindling numbers, became progressively less inclined to work on the *falaj*, which would benefit the absentees.

As hardships grew, three families departed permanently from Ghayzayn, amounting to a fall of 4% in the population. These people who moved out were some of the most dynamic and astute economically of the population – the loss to the community was greater than numbers imply. Several other families began to consider leaving.

It was partly these departures which finally spurred the senior shaykhs of the tribe into organising some action to improve the *falaj* flow. As a result, in August the tunnel was opened up for examination and cleaning. Weed growth and obstruction of the channel was

minimal; the problem was found to be in the nature of the construction of the *falaj*.

### *The Physical Structure of the Falaj: Critical Water Loss*

The first 300 metres of the channel are tunnelled in cemented wadi gravels. The tunnel here is in good condition, without marked meanders, and there is little leakage. Water is, however, ponded back towards the motherwell by the hard ridge of rock at (b) over which the flow has made a fall and plunge pool.

From point (b) to (c) the water flows about 10 feet lower than in the upper section in a bed of unconsolidated sand. Its loose nature results in lateral erosion and meandering underground; the tunnel has become enlarged and unstable, with slumping from the roof and sides. It is in this length of channel that the water loss is most marked.

Between (c) and (d) the channel runs through a relatively new section of channel – it previously used to run the wadi bed – tunneled into the left bank, from whence it surfaces to run in a lined channel to the village some 2.5 kilometers downstream (Fig. 2). There is, as noted, some water loss from this long, and often perched channel, but the problem of this surface section is small compared to those encountered underground.

The declining water flow experienced at Ghayzayn was the result of two factors combined. The long period which lapsed without heavy rain meant that the spring at the motherwell, which gives the entire irrigation water supply, weakened, reducing the volume of water entering the *falaj*, (Fig. 3). This caused the early, relatively slow rate of decline. The reduced flow of the spring was contemporaneous with a fall in the water table within the wadi gravels. This led to the more rapid rate of decline which took effect in June 1973, beginning when the water table in the wadi gravels fell below the level of the length of

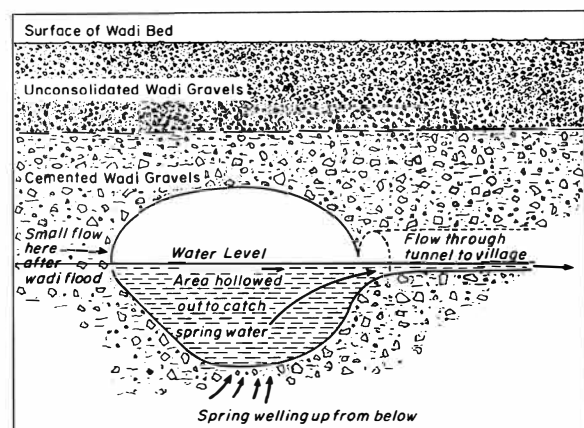


Fig. 3: Cross-section of motherwell of Ghayzayn Falaj

channel between (b) and (c). So unconsolidated is the material in which this section of channel runs that the great majority of the water brought into the *falaj* by the motherwell spring is lost by infiltration once the water table falls below this length of the tunnel.

A basic remedy for alleviating the drought at Ghayzayn is easily defined—the lining of this section of underground channel below the waterfall. The local community did not, however, embark upon this course of action. Villagers argued that they had neither the funds nor the human resources to undertake this task. Especially in view of the impoverished state of the village and its depleted labour force this might be thought true, but in fact the resources to undertake the lining of the channel could be assembled.

#### *Procrastination and Acceptance of Drought*

The village community, though relatively isolated in geographical terms, is part of a closely knitted social structure represented most obviously by the tribe. Traditionally the sections of a tribe are responsible to varied degrees to aid a community such as Ghayzayn which is in difficulties. Whilst the rapid change the Sultanate of Oman has undergone since it became an oil exporter in 1968 is eroding these communal responsibilities, they still exist and could be called upon to provide at least financial aid for Ghayzayn, provided the tribal authorities could be persuaded to act (BIRKS and LETTS, 1977). Furthermore, any funds so raised could be augmented by a contribution from Central Government sources which are responsive to such appeals provided they are well founded.

The same factors which caused the population to procrastinate before opening up the *falaj* to examine it, militated against the community's making effective appeals for aid. No member of standing within the wider tribally linked community with interests in Ghayzayn was prepared to make the necessary efforts, and those who were willing to appeal for aid and to organise the repairs were not of sufficient status for their efforts to be effective. The tunnel was therefore closed again without action being taken.

The population of Ghayzayn became resigned to the drought. They continued to buy fodder and dates from other villages and began to rely increasingly on drinking water brought in by landrover. Whilst half-heartedly attempting to minimize the impact of the drought upon the palms, the reduced community put little effort into agriculture. In spite of remittances from the migrant labourers, many families went further into debt as their purchases of dates and alfalfa outstripped their cash incomes. Morale dropped further, and several other families began to prepare to move away from Ghayzayn.

The drought, though only local, and of relatively short duration, had broken the spirit of the commu-

nity, and many had begun to accept an inevitable end to the settlement. This, in spite of the fact that Ghayzayn had suffered droughts and recovered several times quite recently according to local history. Many other examples of oasis settlements in Oman afflicted by drought suggest that there ought to have been a resilience about the community's response to water shortage which was absent in this case. Some aspects of the recent history of Ghayzayn explain partly the degree to which the residents acquiesced in their straitened circumstances. One factor is the number of absentee landowners. Their ownership of land in Ghayzayn stems from the time when it was a tribal capital, when the paramount shaykhs lived in the village. The important shaykhly families have moved on downstream, so that not only has Ghayzayn ceased to become the focus of their interest, but the community remaining is also left with the feeling of being in decline, and suffering a falling social and political status. In short, Ghayzayn has become increasingly marginal within the eroding tribal system, and so is suffering disproportionately from a withdrawal of traditional support from outside the immediate community.

This has been aggravated by changes that have occurred within the village society which are of more general applicability. Of great significance is the fact that, even prior to the drought, the traditional agricultural pursuits upon which the community was virtually entirely dependent only some two or three decades ago have assumed reduced importance in village life. The new direction taken by economic life in Ghayzayn is most obviously identifiable in the movements of migrant labour away from the village to Abu Dhabi, Bahrain and Saudi Arabia in order to earn a cash income. This withdrawal of labour from traditional pursuits has resulted in reduced yields, declined standards of husbandry, and a deterioration in the infrastructure of agriculture as a whole.

#### *The Wider Implications*

The change of socio-economic emphasis away from agriculture may pass almost unnoticed for some years. It is only when the milieu in which the community exists changes from those which normally prevail that the weaknesses within the evolving community and local economy become evident and important. In the case of Ghayzayn, the changed attitudes and aspirations of the population, and the erosion of the agricultural base in which this has resulted, only became of significance as a result of drought. Whilst still able to prosper under pluvial and average conditions the village agricultural economy was shown to have developed deep flaws as soon as water shortage set in. These were a consequence of the direction of labour and attention away from traditional agricultural

pursuits, and caused Ghayzayn to succumb so quickly to the consequences of a drought which it would not even have suffered some two or three decades ago: palliative measures would have been taken before agriculture had been affected. The water supply would not have been allowed to decline as it did.

The other aspect of the villagers' reluctance to invest time and effort into the drought afflicted economy is, of course, the ease with which non-drought affected employment could be obtained by migrant labourers. It was only because the villagers found work outside the village so easily that they did not devote more effort into improving water supplies and ameliorating the impact of drought. The reduced income from agriculture, extra expenses incurred in feeding animals and families, together with the increased movements of migrant labourers all militated in favour of the community's greater reliance upon cash income from outside. The villagers thus made decisions which have taken their village economy further away from the subsistence level into the wider, more modern economic system of developing south-east Arabia. That the villagers should be in receipt of a cash income is altogether desirable, but when this derives from movements of migrant labour, some severe disadvantages are associated with it. These were shown up by the drought. The reduction in effort devoted to farming in normal pluvial times makes the system more vulnerable to a deterioration of conditions; when any shortage of water supplies occurs, the reaction of the villagers is not to intensify agricultural activities in order to attempt to mitigate the impact of a falling water supply, but to withdraw further from agriculture, gaining an increasing proportion of their income from outside. After the drought, which, in the event, ended in late 1975, the extent of the cultivated area and the level of agricultural activity in the village are unlikely to equal those prevailing previously. The agricultural decline of the settlement, which in the first place made it more prone to drought, has been hastened. The community will be even less willing to, and capable of, taking the necessary action if Ghayzayn is threatened by drought again.

It would seem that similar social processes have been active in the erosion of the capability of savanaland societies to deal with drought. The passing of the traditional functionally adapted modes of land use and local economy from the centre of life because of the area's partial integration into a wider economy (by virtue of migrant labour movements, cash incomes, agricultural projects and small scale cash crop growing) has resulted in an increase in the vulnerability of these areas to drought, and a decrease in the resilience of social communities or at least in the determination of indigenous populations to maintain the traditional aspects of their economies when under stress.

#### Notes and References

Fieldwork in Ghayzayn was carried out between 1972–75 whilst the author was Field Team Leader of the Durham University Oman Research Project, of the Middle Eastern Centre, The Department of Geography, The University of Durham (see FISHER and BOWEN-JONES, 1974).

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