OMAN



## Preface

In 1973 the authors were asked by the Oman government to recommend how Oman's indigenous building methods could be used in meeting its current building needs. We spent an intensive four months, September to December 1973 travelling the length and breadth of the country surveying, interviewing, photographing and drawing as well as analysing government documents on the country's development and building activities and plans.

The resulting study took a further six months of analysis and the information gathered was enough to make both the required recommendations and write a study on Oman's indigenous built environment. This latter we did on our own time during 1974 on our return from Oman. The resulting publication (of limited editions) including the required recommendations and proposals were sent to the government.

In 1982, a generous grant from the Aga Khan Program in Islamic Architecture at Harvard University and the Massachusetts Institute of Technology made the publication of the study in book form a possibility.

During this period both Oman and our ideas inevitably developed and changed. The decision not to up-date the study accordingly was a difficult one. A letter to the Oman government requesting assistance and permission to visit the country to do such an up-date were unanswered. And on reviewing the study we realised the incorporation of our present ideas would require writing a new book. Hence the study remains largely as it was in 1973. It reflects the reality of the indigenous environment of Oman as it then existed and the ideas and approach of the authors as they were then.

## Introduction

This is a study of the indigenous built environment of Oman. It examines how and why the indigenous environment emerged, and its potential role in the development of Oman's built environment in the future. There are two basic reasons why such a study is appropriate: one that is generalisable to many Third World Countries and the other specifically relevant to Oman.

Third World Countries are undergoing rapid change. In this process indigenous methods of building are being replaced by imported methods. The influence of factors external to a country in bringing about change within it is as old and natural as culture itself. It is the scale and rapidity with which externally generated change is occurring and the extent to which Third World Countries are accepting these external methods to be superior to their own that is perhaps unique to these recent decades.

The position underlying this study is that indigenous building methods — developed over centuries — have much to inform us about how to further develop our built environment in a manner that is culturally, economically and climatically appropriate.[1]

This point becomes particularly relevant in Oman today. The country has very recently opened its doors to rapid modernisation after centuries of a much gentler pace of change. Much building activity will accompany this modernisation. This activity can either use the lessons offered by the indigenous environment or it can ignore and undermine these lessons with imported preconceptions of building technology and form. These preconceptions are already manifest in the buildings mushrooming in the Capital Area of Muscat Mutrah and Rui. Their undermining effects

are also spreading. Thus a resident of Nizwa, a small town near the capital, constructs a western style concrete and steel house (a replica of those being constructed in the Capital) which he declares hot, uneconomical *but* modern. (See pp. ???-???). This residents' legitimate desire to improve his housing condition has to be rapidly met with models of improvement that he can afford and in which he can be climatically and culturally comfortable. These models can best emerge on the basis of a thorough investigation of the problems and potentials of the indigenous built environment. If the experience of other Third World Countries are relevant, this environment and the lessons it offers will not survive long if neglected, now that rapid change has been introduced.

The study attempts to examine the indigenous environment while it still exists, and extract the lessons it offers, to show how building construction can meet Oman's modernising aspirations while nevertheless being mindful of the cultural, economic and climatic realities within which most of its people live.

The book is divided into two sections. The first section gives the basic reason for undertaking the study. (Just mentioned in this Introduction). It argues for a shift in building policies and programs away from the current emphasis on large-scale infrastructure and building construction projects focused on the Capital Area to a system of supports that reinforces the peoples' own efforts to provide an improved built environment for themselves. In particular it argues for small-scale construction projects providing basic infrastructure and community facilities in a regionally dispersed fashion in the small towns and rural areas (Chapter 1). It goes on to detail the types of designs and technologies that could be employed in the implementation of such a building program (Chapter 2).

The second section presents in more detail the study of the indigenous built environment that was carried out for each accessible region. The problems and potentials of the built environment are examined in the light of the physical, climatic and socio-economic characteristics of each region. The arguments for the building policies and programs and their complementary designs and technologies presented in the first section were developed from the study presented in this second section. The conclusion summarizes the main characteristics of the indigenous environment, its lessons for current building construction and the major problems foreseen in implementing these lessons.

1 For a fuller discussion on the potentials of indigenous building see Development Workshop, Cain, Afshar Norton, "Indigenous Building & the Third World", Architectural Design, April 1975, London.

BATINA COAST

CHAPTER #2

The Batinah is a narrow strip of coastland stretching from the frontier with the Union of Arab Emirates in the north down to Azaiba in the south where the mountains run down to the sea. Altogether some 270 km. long, the plain varies in width from 10 to 30 km., backed by the principal range of mountains in Oman, the Jebal al Akhdar. Near the coast the ground soil is sandy, inland more clayey.

Although scrubland trees are more scattered over the inner part of the plain, the cultivated belt is only about 3 kms. wide and immediately adjacent to the coast. This is principally a long and almost continuous belt of date palms and other fruit trees. Most settlement occurs either close to or actually within this belt, and few settlements are found further inland, where the water supply becomes increasingly difficult. Water is obtained from two main sources: one, the Falaj, is a system of underground and surface channels bringing water down to the agricultural area from the hills; the second source is wells, which supply most of the water, and, along the cultivated belt, appear to be reliable and capable of supplying quite large quantities. In 1973 about 150,000 people lived in this area.

The economy of the Batinah coast is based mainly on agriculture and fishing. A small percentage is engaged in trading and some service activities, such as the hospitals and schools.

At the time of the study, nearly all the fish were sold directly from the boats or in the local market. Only a small part of the catch was sold out of the area, the exception being at the southern end of the Batinah coast where the proximity of the capital provided a good market.

Various crops were grown in the cultivated belt. The continuous date gardens comprised one of the most extensive date palm areas in the world, but the dates were mostly consumed locally. Other crops included limes, mangoes, bananas, lucerne, and onions. Limes were the only crop exported on a large scale. Other produce was consumed by the farmer or sold in the local market.

The importance of the date garden was not only in the production of fruit, since the palm tree and the palm frond stem were an important and cheap source of building materials. Many of the coastal houses used palm tree trunks as structural members, and the palm frond stem (barasti) was used for walls, roofs and floors. Small fishing boats were also built out of the palm frond stems (shasha), fish traps used split stems, and rope, bags and mats were all made. The income of many families was not large enough to be able to afford expensive materials, and therefore the palm tree was an important commodity.

Other building materials used locally included mud brick and concrete, and in the past a small amount of fired red brick.

In 1973 the economy was basically self-contained with money circulating within the local community. Few people appeared to be living in great poverty, and most could afford to have a fairly large house, and often two. Some of the population, notably larger landowners and merchants, could afford to buy more expensive building materials, and in these cases the materials used in their houses were often an attempt to enhance their prestige to match their economic status.

With the introduction of the asphalt road leading to Muscat and Mutrah and the new industrial area, many of the new government buildings have been situated near the road; for instance in Sohar, the hospital, the new school, the police station, the wali's house, and, of longer standing, the government farm, are all near the new road. These have produced a new pattern where

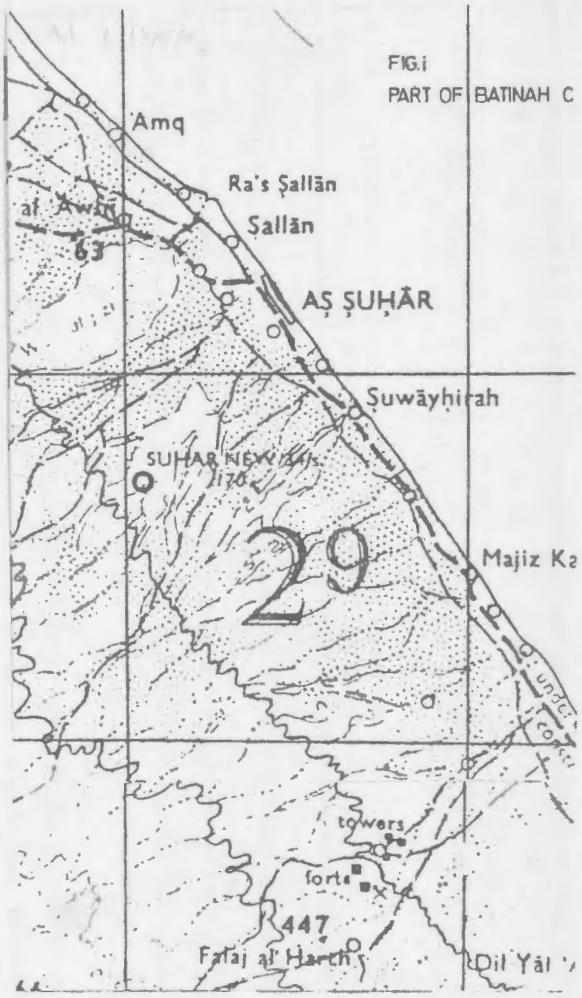
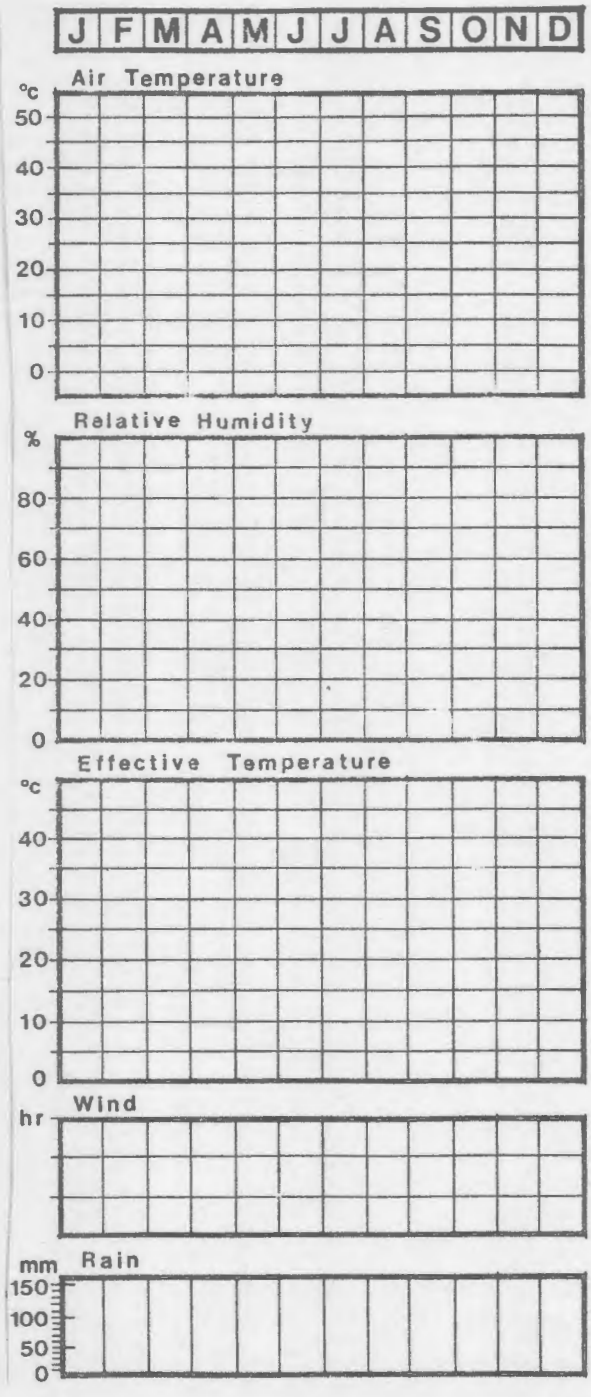


FIG.i
PART OF BATINAH C

people can get work away from the old town, and the influence of the new buildings is reflected in the people's houses. The road also allows people to work away from their local area, and to return for weekends, now a shorter journey time. A new class of people is developing, with new standards and a different economic status.




The Batinah coast has a climate directly affected by the proximity to the sea. The moisture content of the air and the sea's steady temperature has a modifying effect on the temperature pattern. Maximum temperatures occur in July (40°C) and minimum in December (15°C; daytime max. 25°C). The average annual temperature range is 25°C. The diurnal range is on average only 10°C. Both annual and diurnal range increase with distance from the sea. Relative humidity reaches 75% during summer and winter months, but drops to 50% during spring and autumn. Even though humidity is relatively high, rainfall is minimal and occurs usually during the winter months, but occasionally in August. Total rainfall for February is only 30mm, and decreases up the coastline, so that Azaiba has more rain than Sohar.

The beach and the cultivated belt, and to a lesser degree the area inland, are all affected by land/sea breezes. These winds are the result of the unequal heating of the land and water; in brief, subject to the same intensity of solar radiation, the temperature of the land rises faster than that of the sea and likewise cools faster.

Because during the day the land is hotter than the sea, a relatively low pressure area is created and a convection system develops over the land. Hot air rising is replaced by cool air drawn in from over the sea at low level, while an upper air current blows the other way. The greater the difference between land and sea temperatures, the stronger the wind becomes, so that as the land temperature in the afternoon decreases, the velocity drops until the direction is reversed at night time, the sea being warmer than the land.

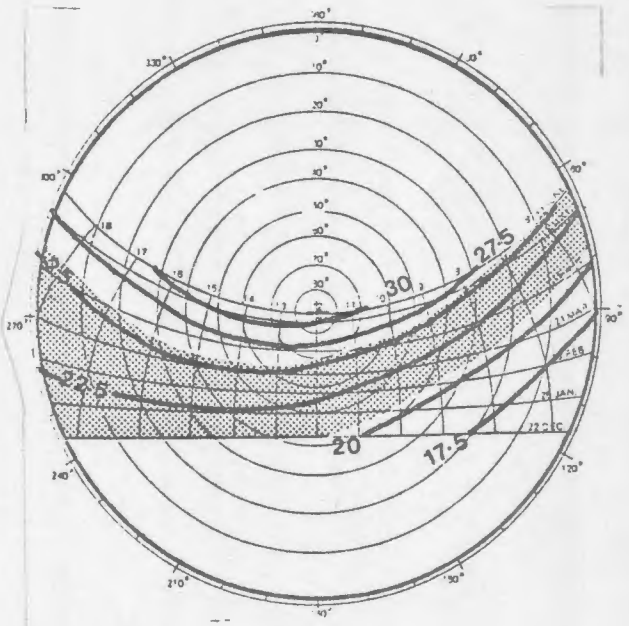
The onshore/offshore breeze effect is a local or micro-climate phenomenon and is predominant within 3 or 4 km. of the shore. Prevailing winds also modify this condition. Most of the year there is a prevailing onshore wind except for a couple of months in the summer. These prevailing north or north-westerly winds strengthen the daytime sea breeze and hinder the night land breeze. This results in strong daytime winds most of the year and a weak or non-existent night time breeze especially in the spring and autumn months. In July and August, due to shifting continental pressure systems, there is a prevailing off-shore effect with a south-westerly wind strengthening the night time breeze and reducing the daytime breeze.

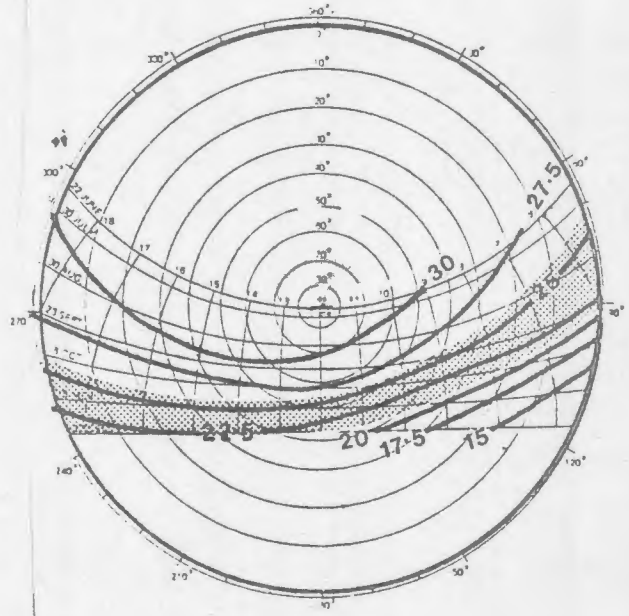
Inland of the cultivated belt, the prevailing wind takes over from the offshore sea breezes.

Tests were made by the authors to evaluate the influences of the onshore and offshore winds on the micro-climates of three adjacent areas as one moves inland from the Sohar beach to the date palm grove planted belt, and finally to the inland semi-desert open scrub land. Three stations were chosen, one in each area, and a fourth offshore in shallow water. A series of climatic tests were made using portable instruments in each area every two hours for a 24 hour period.

When this information is graphed (Fig. ) one can see clearly the daily pattern in the micro-climate of each area.

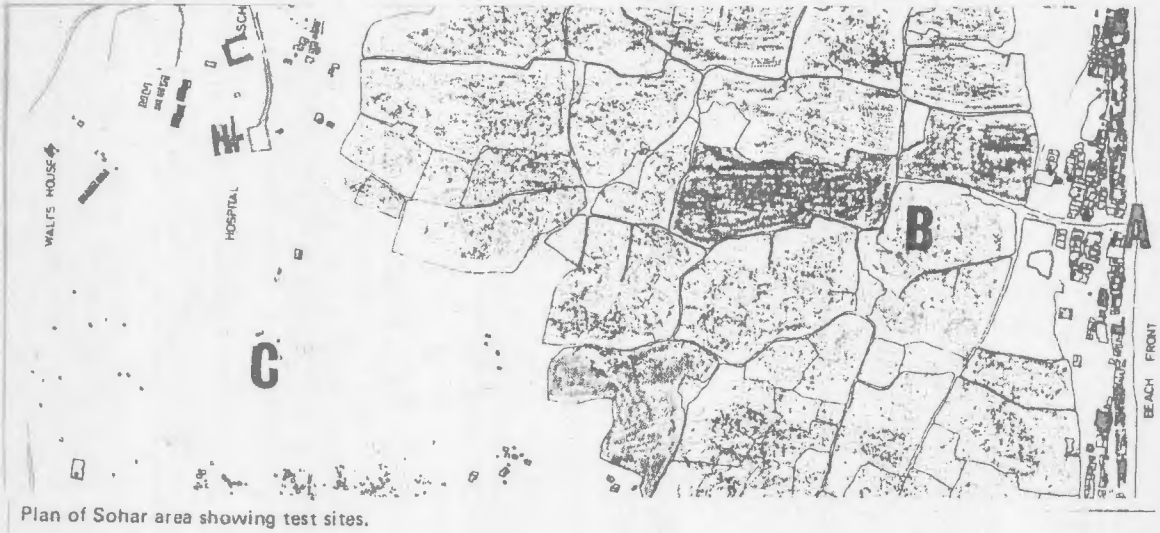
The temperature (Fig. ) of the water is clearly more stable than the land temperatures, fluctuating only about 4°C. between



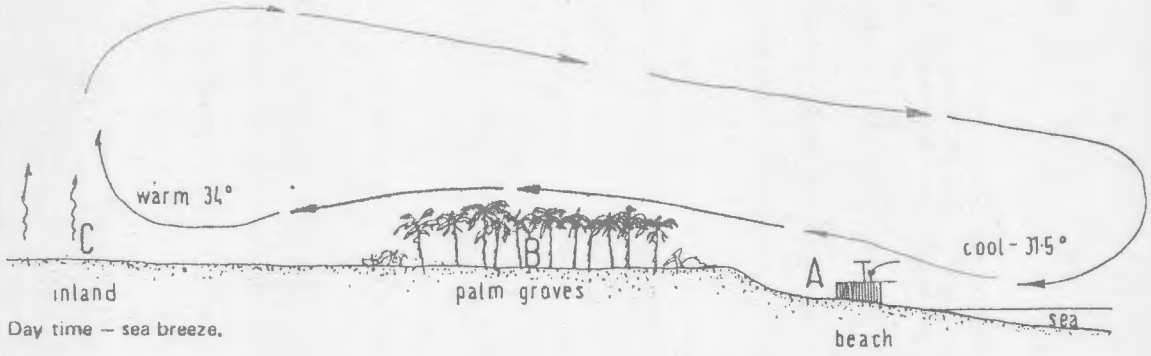



day and night while the land temperatures fluctuate as much as 9°C. It should also be noted that the peak in water temperature lags several hours behind the peaks in air temperatures. The same is true for the coolest temperatures.

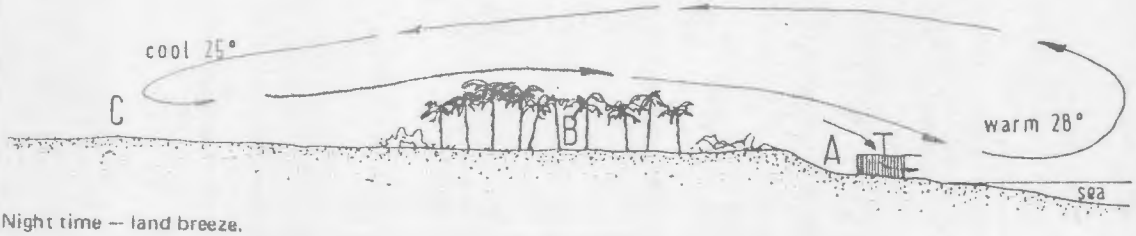
It can be seen that during the daylight hours when the air temperature is higher than the water temperature, there tends to be an onshore breeze (fig. ) but at the time that the air temperature falls below the sea temperature the offshore land




Plan of Sohar area showing test sites.




Day time — sea breeze.



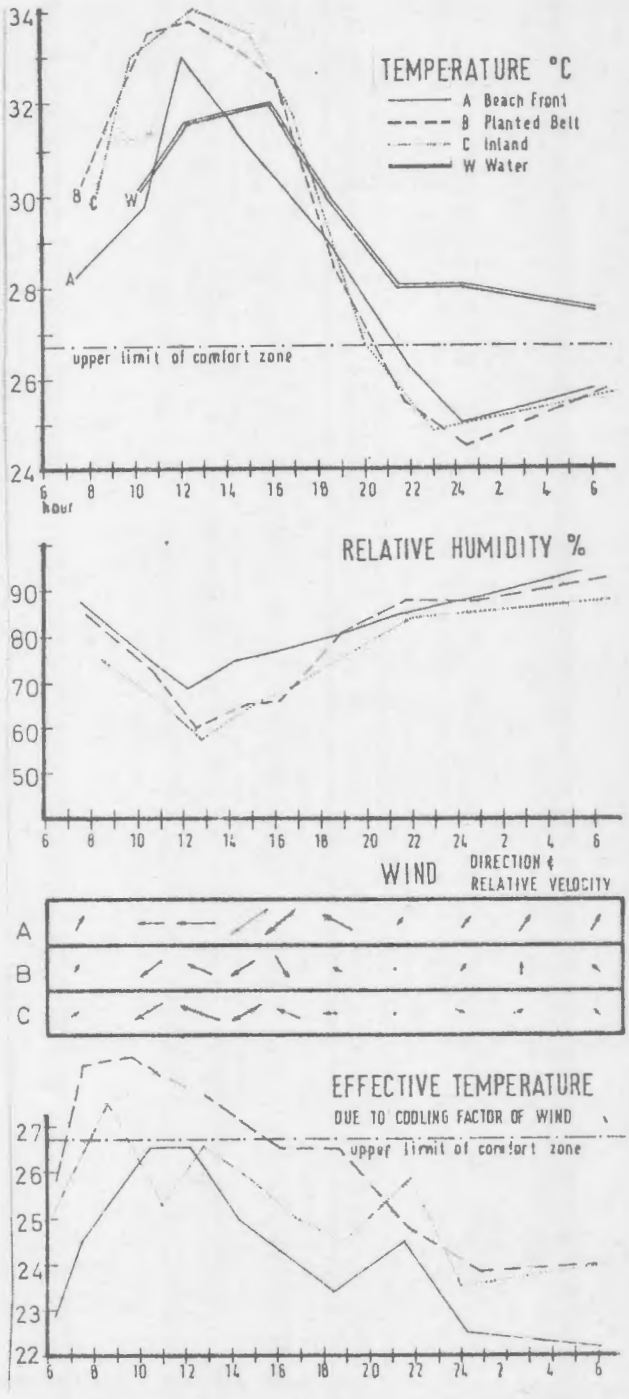

Night time — land breeze.

breeze influence begins to take over. The prevailing wind in this season aids the daylight onshore sea breeze.

The temperatures on the beach (station A) are moderated due to the proximity to the sea. During the daytime while there is a sea breeze the temperatures on the beach are one or two degrees lower than the interior stations, but at night while the land breeze is predominant the temperatures of the three land stations are much the same. The relative humidity (Fig. ) is about 10% higher on the beach during the day than the two stations further inland, though they are much the same at night.

The beach micro-climatic area would seem to be more comfortable than the other areas since it has a somewhat lower daytime temperature, but the fact that it also has a higher relative humidity tends to keep the condition above the comfort level.

Air movement becomes the most important factor in attaining comfort conditions. With air so heavily laden with water vapour it quickly becomes saturated and little evaporative cooling on the skin's surface can take place unless air next to the skin is continually replaced by air movement. Air movement due to the onshore/offshore effect is quite strong during the daytime especially on the beach, where the breeze off the sea is unobstructed. The wind's velocity is reduced through the planting belt, but is still a factor in cooling. The effective temperature (Fig. ), or the apparent temperature felt on the skin's surface after evaporative cooling aided by the air movement, is within the comfort zone on the beach front. For some hours of the day in the other two inland areas the effective temperatures still exceed the comfort limits.



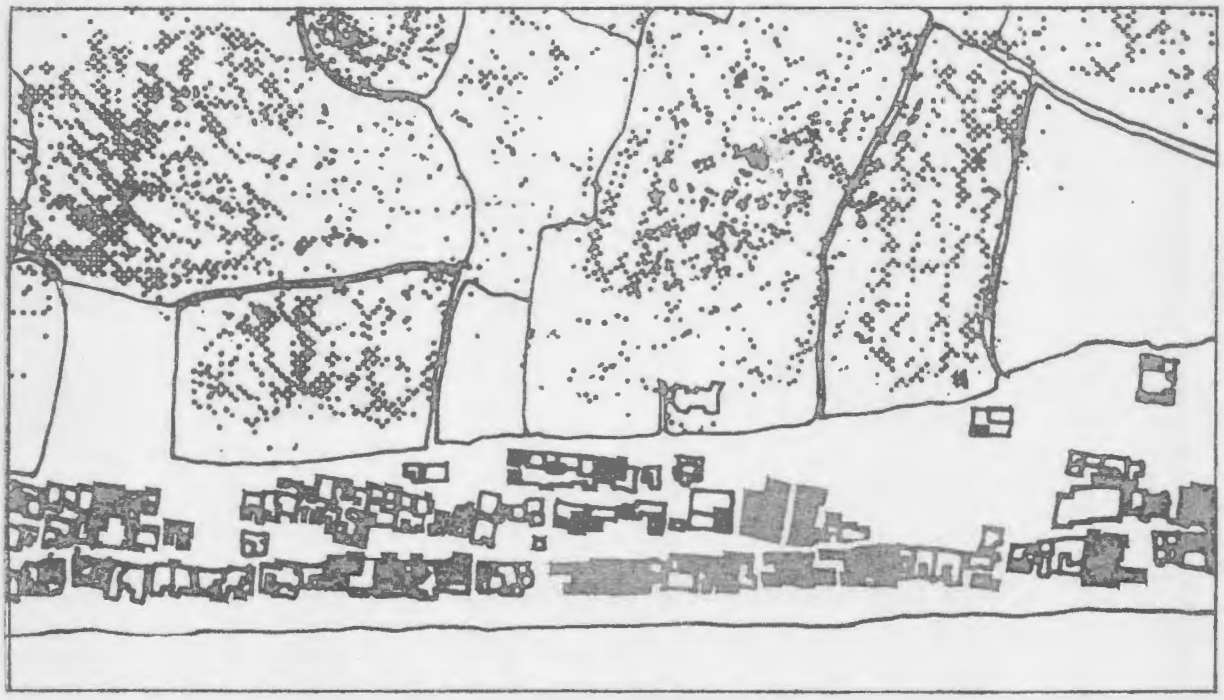
Settlement on the Batinah coast falls into three main groups:

a. The beach settlements
b. Settlements inland of the cultivated belt
c. Settlements within the cultivated belt.

The occupations of people dwelling directly on the beach front clearly had a bearing on the way the area was settled. Many of the people who lived on the beach front earned their living from the sea, and their choice of site was to be as close to the water front as possible. Most fishermen embarked from the beach directly in front of their house, and kept their boats pulled up on the beach below their property.

Major settlements had developed on the beach because before the arrival of road transport all produce came in by sea. Merchants and tradesmen also lived near to their work when possible and so nearly all the main settlements of the Batinah coast occur on the beach front. These include the towns of Sib, Barka, Musana'a, Suwaiq, Khaburah, Sahem, Sohar, and Shinas. Numerous other villages were strung out along the shore.

Except in major concentrations of settlement, where markets and public service amenities existed, houses were built facing the beach, to make maximum use of the land/sea breezes, so that a row of houses developed in a linear form (Fig. ). As more people built in the area, a second, and in a few cases, a third row developed. Further development behind this was limited

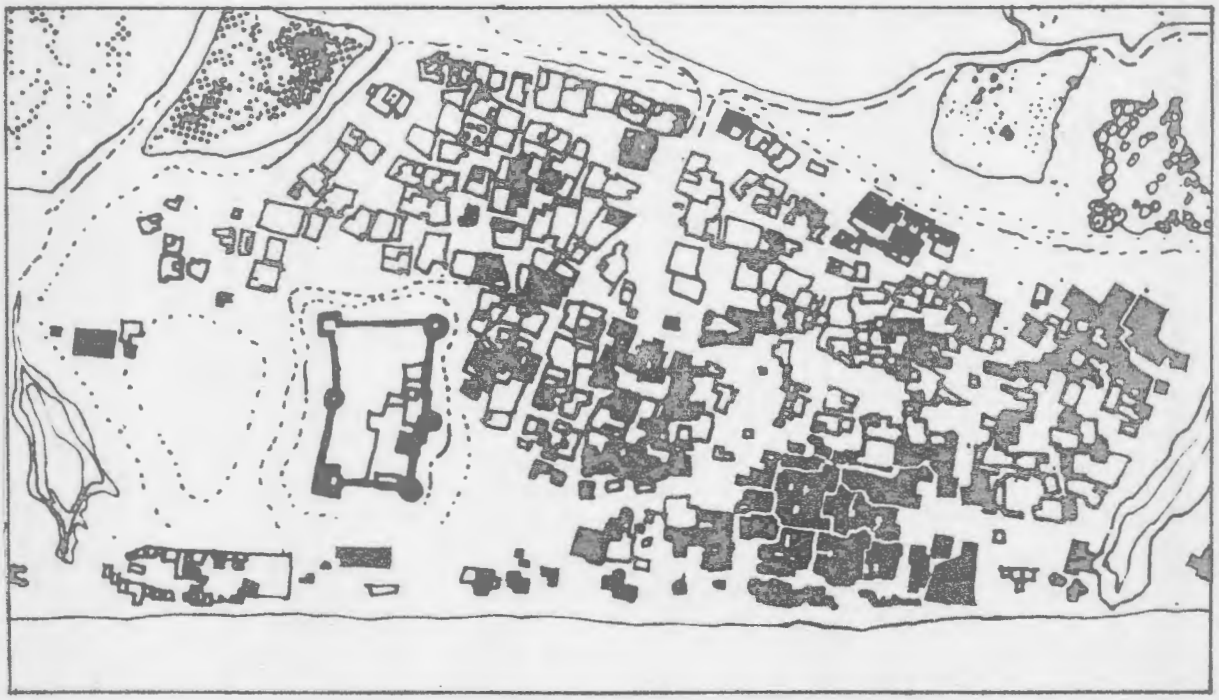


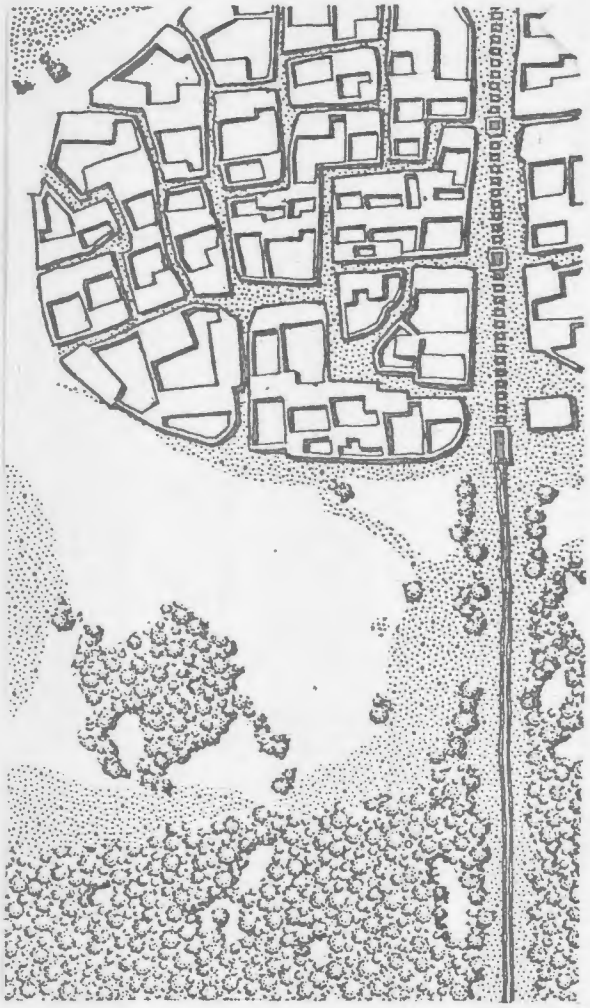
by two factors: firstly that the date garden usually prohibited further settlement back from the beach, an important factor in view of the value of the palm tree and cultivable land, which deterred the replacement of date gardens by housing areas; and secondly, that the houses placed too far back from the beach lost the benefit of the sea breeze, being sheltered from it by those nearer the beach.

In some areas where there were natural open spaces slightly inland from the beach and which were not liable to flooding, another row or two might develop, but normally in such a way that the wind could blow freely in from the sea.

Major concentrations occurred on sites where there was some natural formation to encourage their growth. Houses had developed further back from the beach where there is a rise in the ground level, raising those houses slightly inland up above the houses on the seafront, allowing air to pass over the lower houses to those behind. The spread of settlements back from the beach did not seem to happen purely because an open space was available. For example, in the case of Sohar the open space inland of the town centre was not built upon, being lower down than the town itself, and therefore in a sheltered area with hotter conditions and less air movement to ventilate the dwellings (Fig.  ).

Quite a number of medium size settlements had developed inland of the cultivated belt, and this trend was being increased because of the asphalt road running up the coast inland of the cultivation.

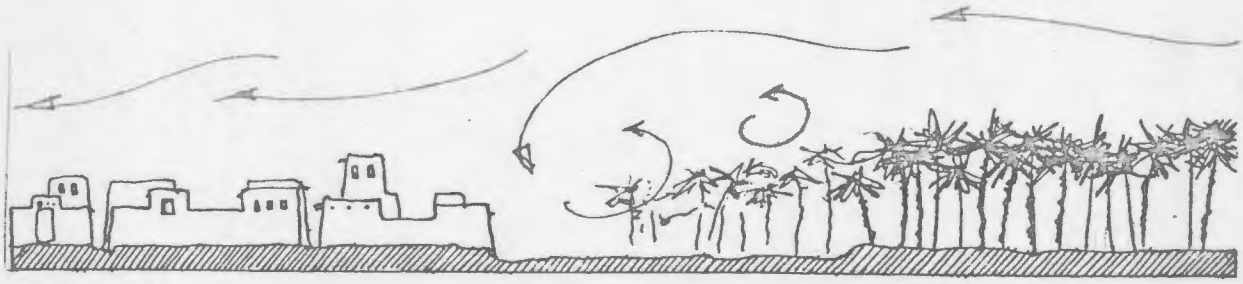




These settlements related to the cultivated belt, where the occupants gained their living. There was also the use of the scrubland behind for grazing purposes. A large number of goats, donkeys and camels were left to feed in this area.

Two basic types of settlement have been noted, both of which owe much of their formation to the nature of their water supply. Two examples used here demonstrate the differences.

This village relied upon a single falaj - the underground and surface channelled water system coming down from the mountains - for its water supply, passing through the village with occassional access water holes and a washing area down-stream just before it entered the date garden (Fig. ). The village was situated very close to the palm trees. All the houses were packed tightly together so as to be near the water supply. Houses were built predominantly of mud brick. Because of the tightly packed formation of the village, and its proximity to the date gardens, air movement passed over the village (Fig. ), so that the beneficial summer



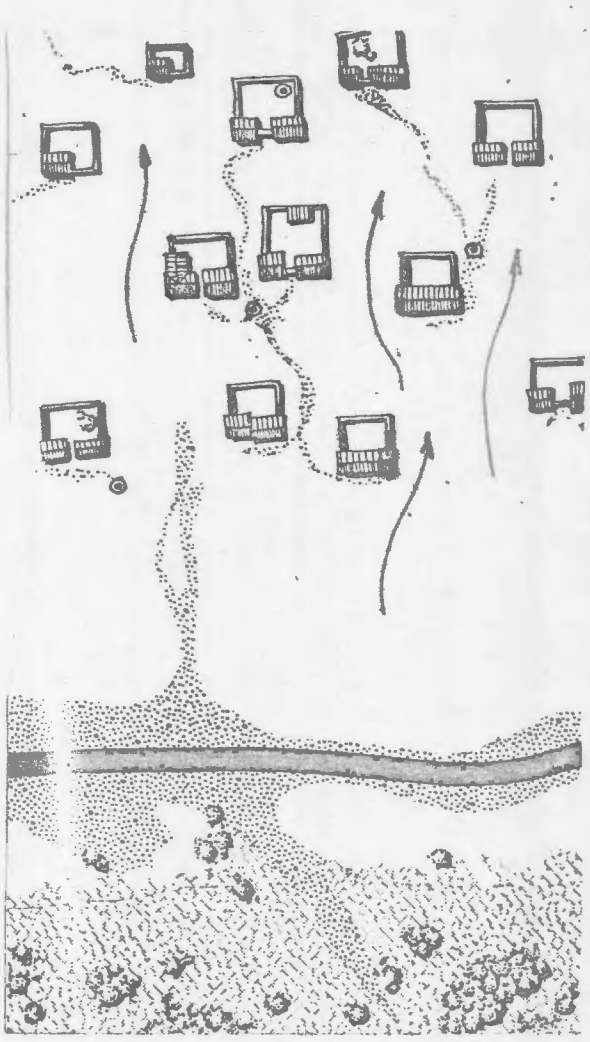
cooling effect of the wind was lost. But this is a winter village and the mud brick houses were a reflection of this, protecting the interior from the cold nights, and limiting what little air movement there was from entering the house, keeping it warm.

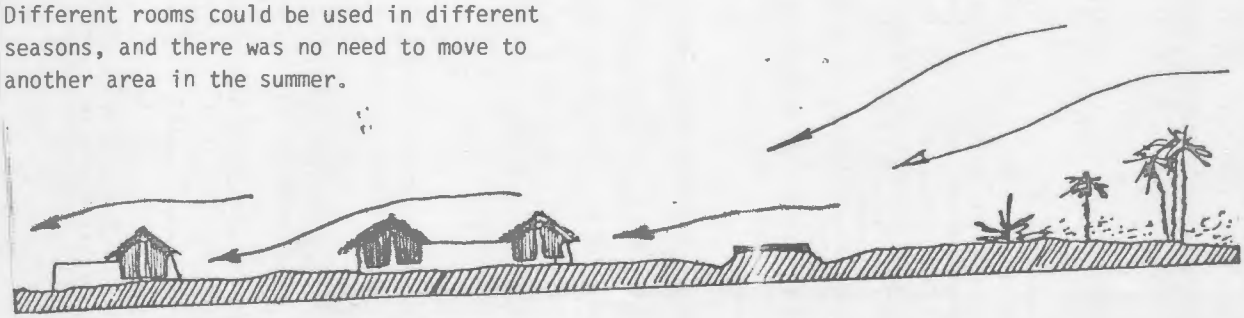
Local villagers said that the village was intolerable during the summer months, during which time they moved into the date gardens.

This village relied upon wells for its water supply. Each house or small group of houses used a well. The effect of this was that the houses were spaced apart from each other. The whole village was further away from the date gardens and the cultivated bit, and therefore did not lie in an air movement shadow (Fig. ).

More important than this is that each house was situated far enough from its neighbour to allow it to have a free passage of air round, and when necessary, through it (Fig. ).

In consequence, this village was occupied all year round, summer habitation being tolerable. Houses reflected this in that many of them combined various building materials - a room of mudbrick for the winter, with a flat mud covered roof, another room with mud walls and a palm frond stem (barasti) roof, and a third room made completely out of palm frond stems for summer use. Different rooms could be used in different seasons, and there was no need to move to another area in the summer.

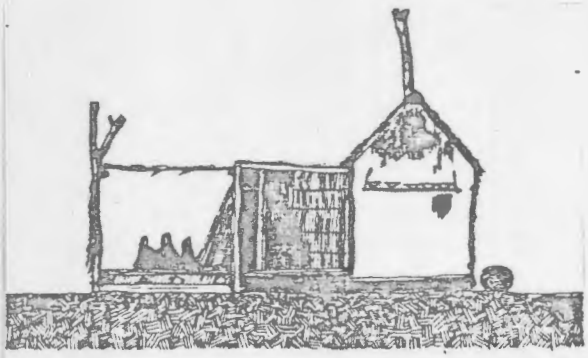


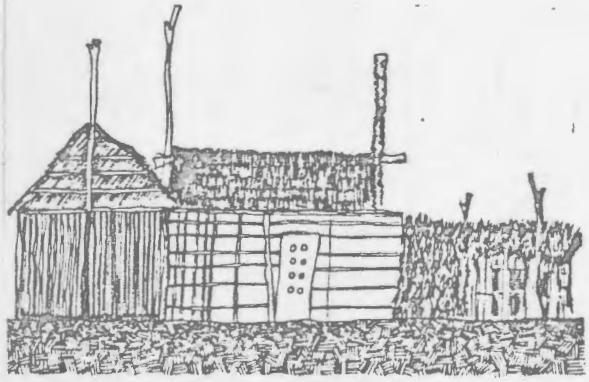


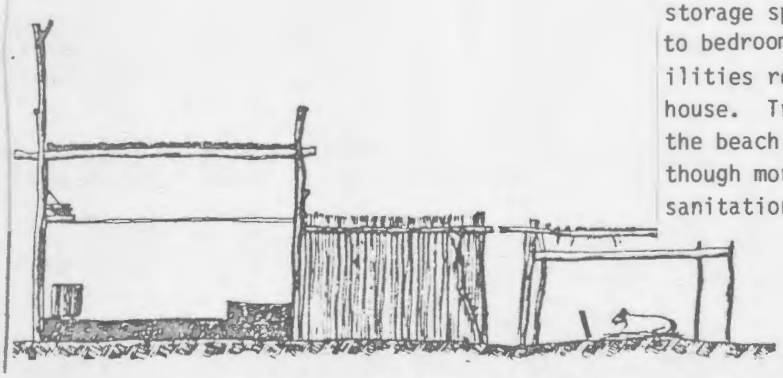
A number of dwellings and the occasional village were situated within the cultivated belt. Many people living in villages outside this strip during the cooler months moved into the cultivated belt during the summer because it was more comfortable in the shade of the trees. Most of the houses here were situated within individual plots of land, so that there was less of a rigid pattern of housing. People also moved to the cultivated belt at times when agricultural work demanded, although as dwellings these houses were predominantly for summer use.

A few villages occurred in open spaces within the cultivated belt, and these were in use all year round. There was a predominant use of barasti for the building of the houses. Nearly all of the houses were positioned facing the prevailing winds - land/sea breezes, but otherwise tended to be loosely grouped in a fairly random form, influenced by land ownership.

Some houses in this area, principally where they were isolated dwellings, formed the summer counterpart to winter houses and villages such as Falaj al Qabael.





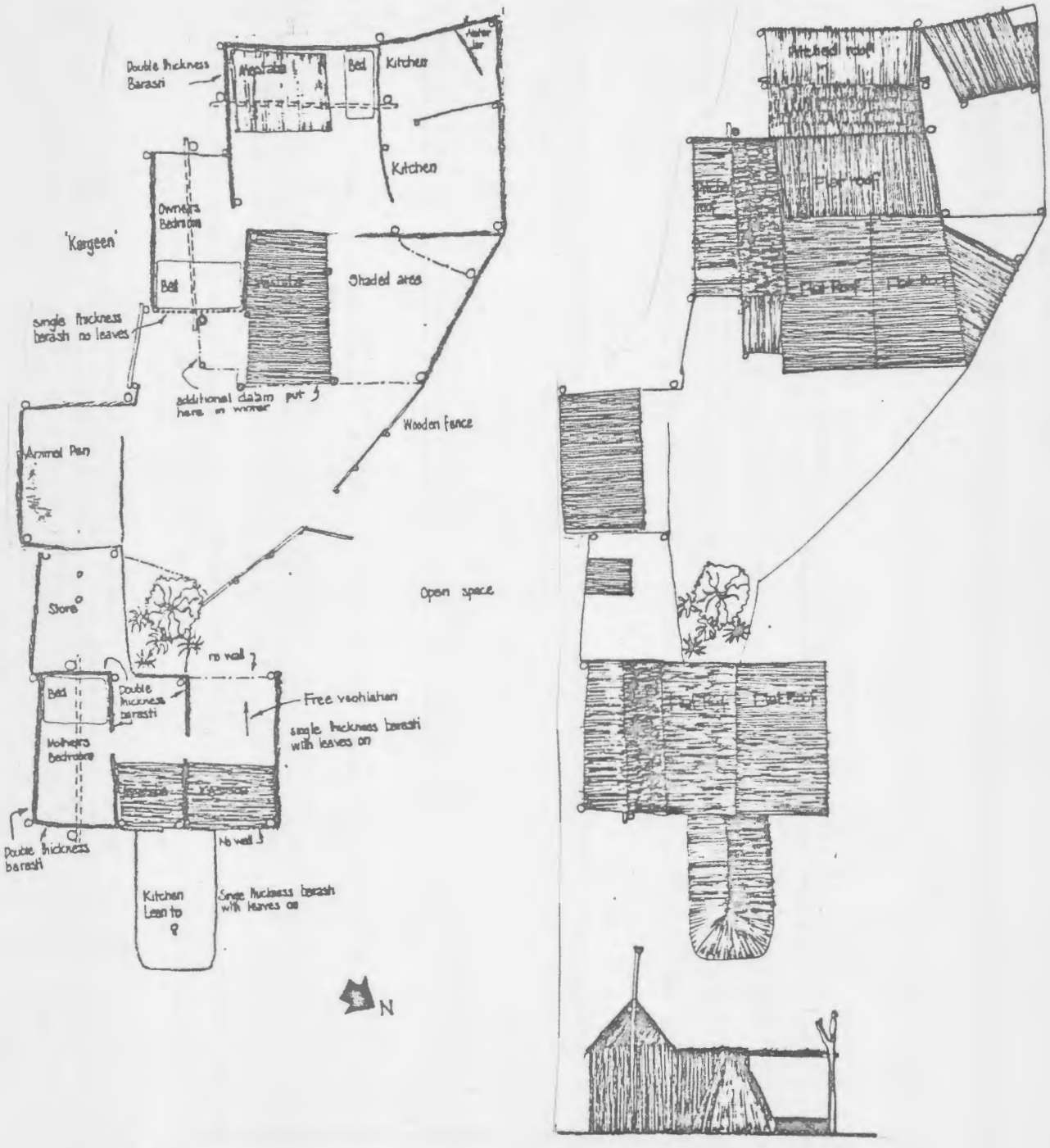


Houses on the Batinah coast were particularly influenced by the pattern of social behaviour and custom, and by the climate.

Socially perhaps the most prominent feature of the Northern Omani house, and sometimes the only one that many visitors saw, was the Maglisse. This room was nearly always situated adjacent to the entrance of the house and even sometimes actually outside the main house.

The Maglisse was used for entertaining special visitors and for special occasions, and it allowed the family life to continue inside the house undisturbed. Only neighbours and close friends whose presence would not disrupt the routine of the household were taken into the main body of the house.

Once inside, for those houses that had them, the courtyard formed a focal point of the whole building, and much of the activity of the household took place there. The rooms placed around, or at either end of the courtyard, were to some extent flexible in the way they were used. The kitchen, for example, becuase of the absence of plumbing to firmly locate it, was often moved according to seasonal climatic requirements. A space could be used as a kitchen in one season and as a living or storage space in another. The same applied to bedrooms. The absence of sanitary facilities removed another fixed point in the house. Traditionally the countryside or the beach had been used by most people, although more attention was being paid to sanitation in many houses recently.


Double thickness Barasti
Mosquito
Bed
Kitchen
Water Jar
Kitchen
Owners Bedroom
'Kargeen'
Bed
Shaded area
single thickness barasti no leaves
additional claim put here in winter
Wooden Fence
Animal Pen
Store
Open space
no wall
Bed
Double thickness barasti
Free vaohiahan
single thickness barasti with leaves on
Mothers Bedroom
Double thickness barasti
No wall
Kitchen Lean to ?
Single thickness barasti with leaves on
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Pitched roof
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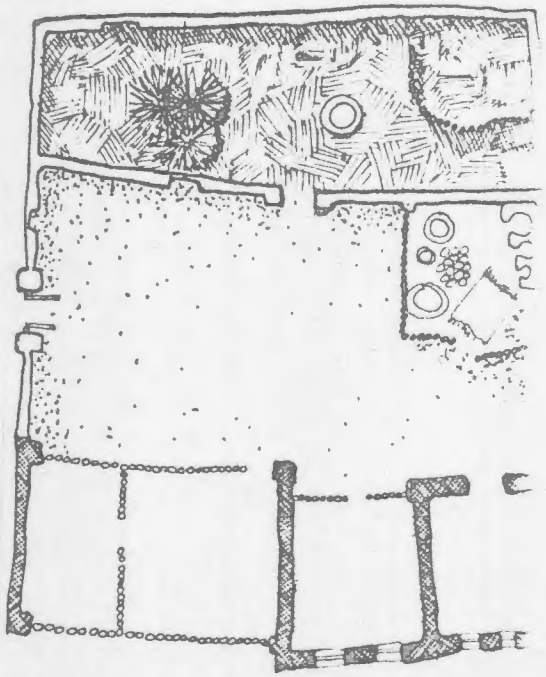
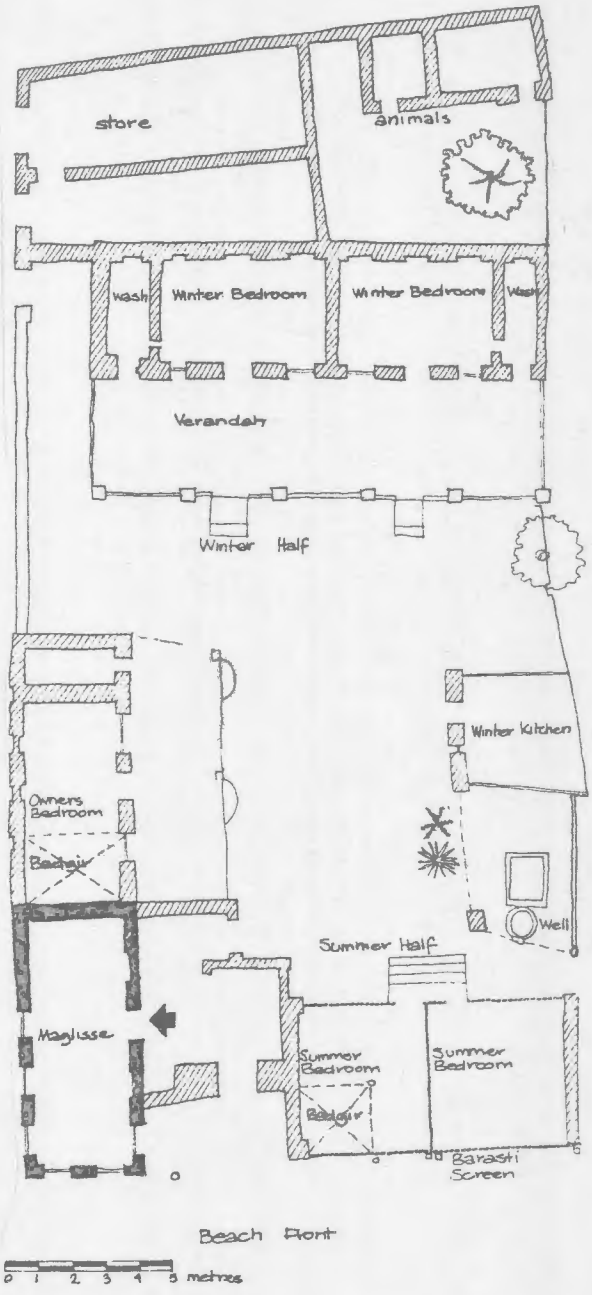
Because air movement is so important in achieving a comfortable environment for much of the year, but also because during the winter exactly the opposite applies, climate is really a major influence upon how the house is organized and used, and therefore it is worth looking at how the house form responds to seasonal climatic and activity changes.

House forms along the Batinah coast showed a definite attempt by the owner to have one type of structure for the summer period and one for the winter. In relation to a family's economy and its yearly cycle of activities as well as the climatic variations throughout the year, there were a range of examples of this pattern demonstrating a varying degree of sophistication.

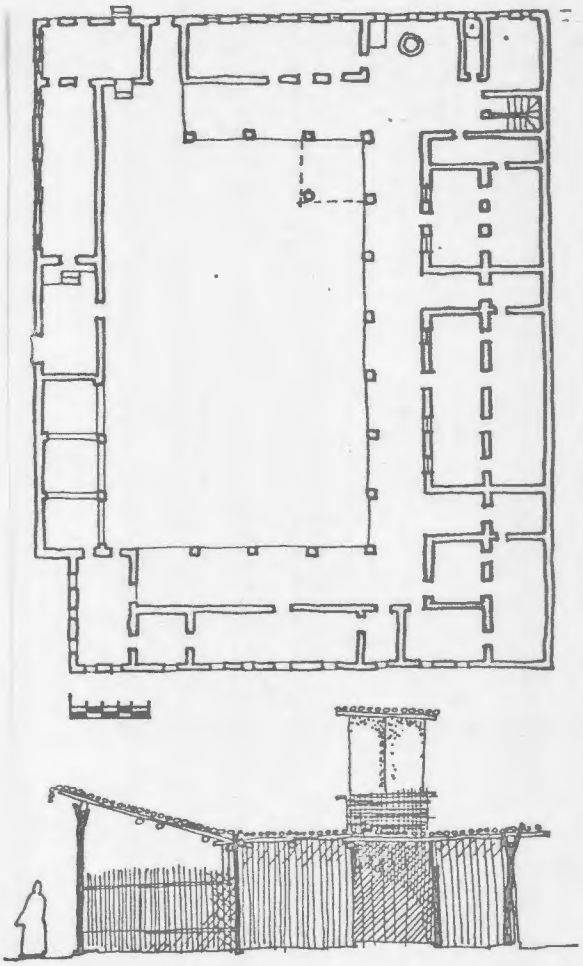


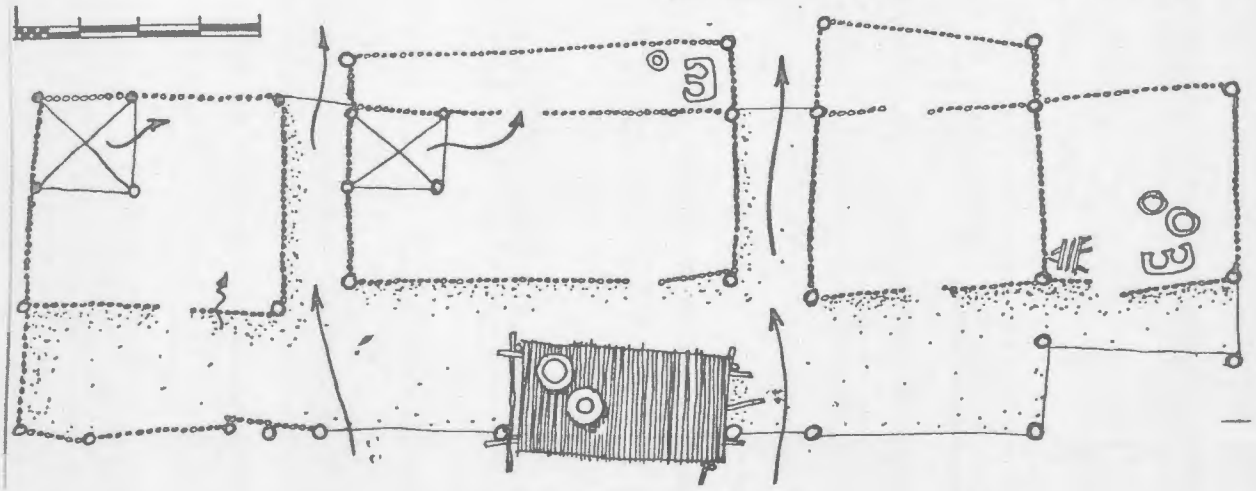


A family in the lowest income bracket sometimes lived in one house which was modified through the year to suit the change in climate. There was no change of location. Modification consisted of adding or removing palm frond stem screens (da'ams) to restrict or encourage the passage of air. Even though a variety of rooms might be used, they were in use throughout the year.

Another form for the family with one house had three rooms where each had a specific climatic fucntion and was used at one particular time of the year.

Common on the beach front, the "mirror image" house had one half of the house used for the wintertime, while the other half, facing it across the courtyard, reflected the same room use and relationship, but it was designed for use in the summertime. These houses were either in the form of a winter half using palm frond stems (barasti) in thick insulating layers whilst the summer





half used thin barasti screens allowing the breeze through, or houses where the winter half was built of mud or concrete block but the summer half still with barasti.

Both types of the "mirror image" house made use of air movement in the summer to create a comfortable micro-climate, and attempted to restrict the passage of air through the winter half, to keep the temperature as high as possible. Occupation of these houses was all year round but represented an increase in the financial staus of the family.

Some families migrated between a winter house and a summer house. Each house had been designed to suit a specific season. Summer houses sometimes incorporated sophisticated features such as a windcatcher (badgir) which allowed an even greater control of the micro-climate, in that it could be taken down as winter approached, creating warmer conditions and delaying the move to the winter house.

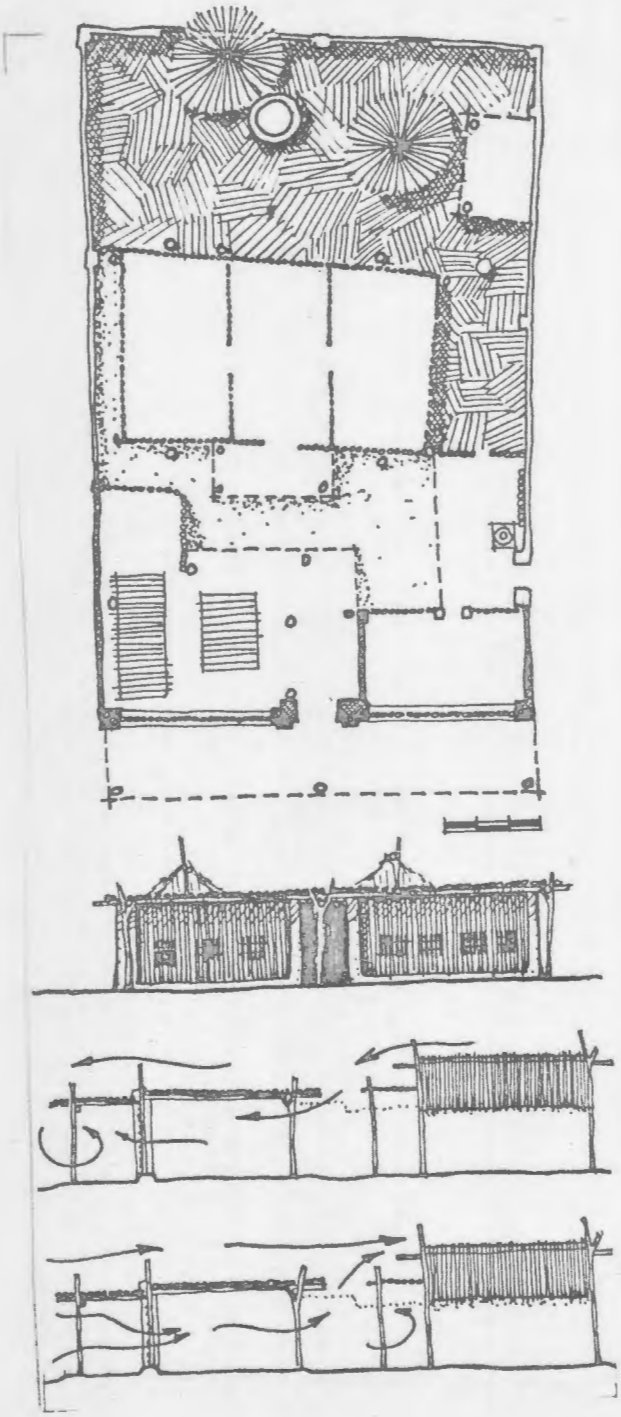
The major principles involved in these houses were the same as for the previous house types - protection from air movement in winter and encouraging it in the summer.

The seasonal migration of the whole village was an extension of this house type. Where for reasons of water supply and location the village got too hot in the summer, there was an almost complete evacuation of the settlement. Winter houses were built with an increased use of solid materials such as mud-brick, to retain the interior warmth and make maximum use of daytime solar radiation; there was little air movement. The summer migration to the date garden coincided with the season of maximum agricultural work. The houses, scattered amongst the date gardens or individual plots, were normally built of palm frond stems.

As with other features in the indigenous houses along the Batinah coast, air movement was achieved in varying ways, some more efficient than others, but depending closely upon the local environment.

In the simplest barasti houses on the Batinah coast at least one part of the house was composed solely of a roof and two side walls, with the two sides of the structure standing in the way of the prevailing wind left uncovered, so that the air movement could pass unchecked into and through the sheltered area, where the occupants received its full cooling benefit (Fig.  ).

Where a degree of privacy and security were required, the complete room could be enclosed with open weave barasti panels which allowed free air movement, but provided privacy and security.



The following examples show more complex ways of encouraging air movement through rooms at the time it is needed. Some of the Batinah houses used combinations of these techniques.

This house form occurred in all areas of the Batinah coast, and could be built either entirely of barasti, or mud-brick and other solid materials in conjunction with barasti. Two rooms were built with a corridor, in between which were no walls at either end of it, only a roof. In both of the two rooms the wall facing the prevailing day-time wind was constructed of a material allowing free entry of air into the room. In all the cases seen, this screen was made of barasti. The remaining walls were made of an impermeable material, which could be mud-brick, concrete block, or barasti packed tightly together, to limit the passage of air through these walls. The wall adjacent to the passage way had a door opening in it. Wind blowing through the passageway creates a low pressure area which causes air to be drawn from the adjoining rooms, ventilating them.

This air flow was encouraged by the windows found in the barasti wall facing the beach, created by spacing the stems further apart than the rest of the wall, and placed low enough that one could see outside when seated. At night-time these openings helped to draw air over the summer sleeping area.

In some areas of the Batinah coast houses were built with a living room at first floor level, with a shaded space underneath. By simply raising the level of the building, more air movement was available, since velocities at ground level were usually less than those higher up. This house type was found principally in the cultivated belt, where families moved in the hottest season. Rooms were built to allow the free passage with open weave palm frond screens.

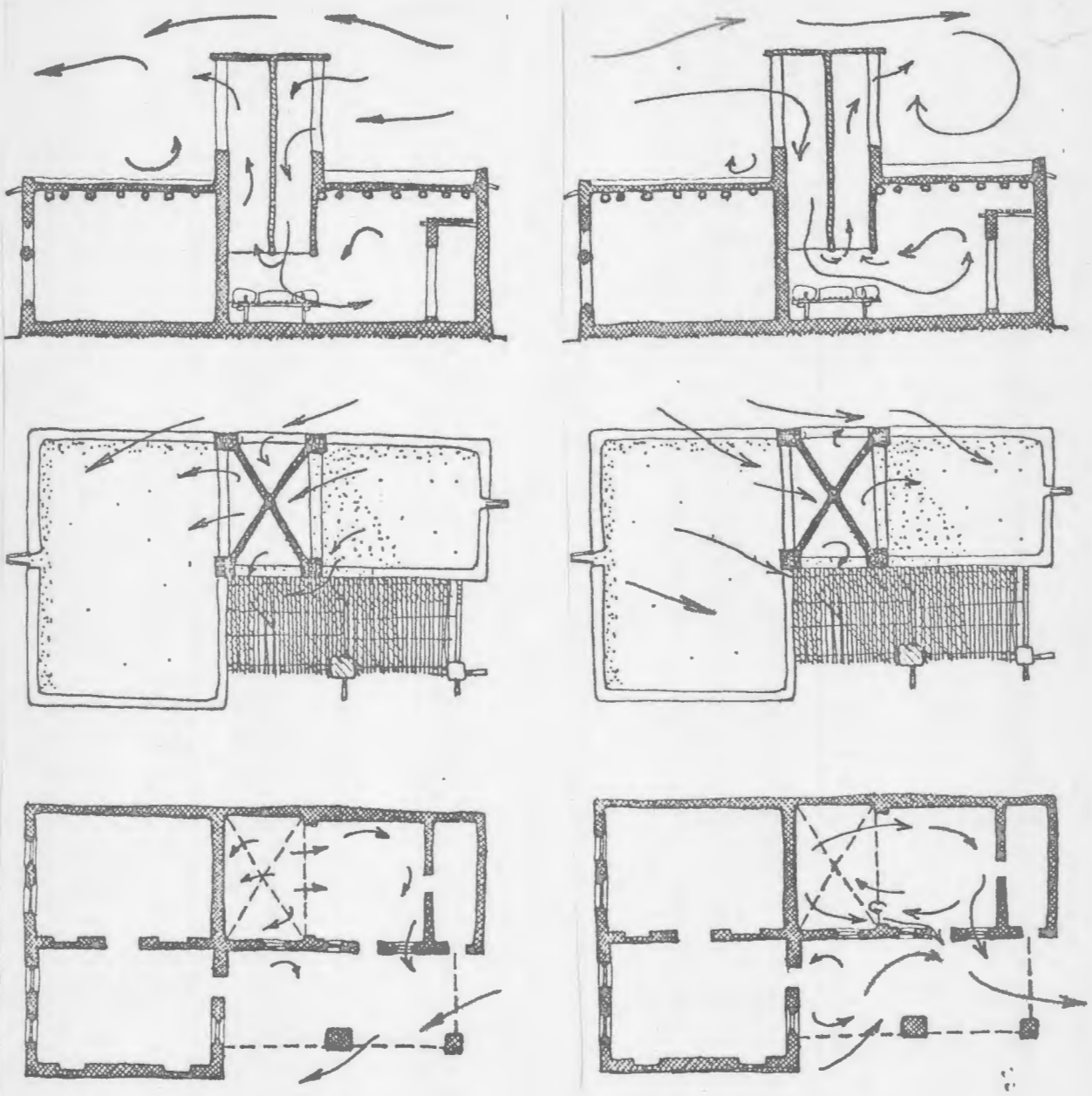
The windcatcher is a device designed to funnel air from the unrestricted zone above the roof level down into ground level rooms which might not otherwise have sufficient air movement to achieve a comfortable microclimate.

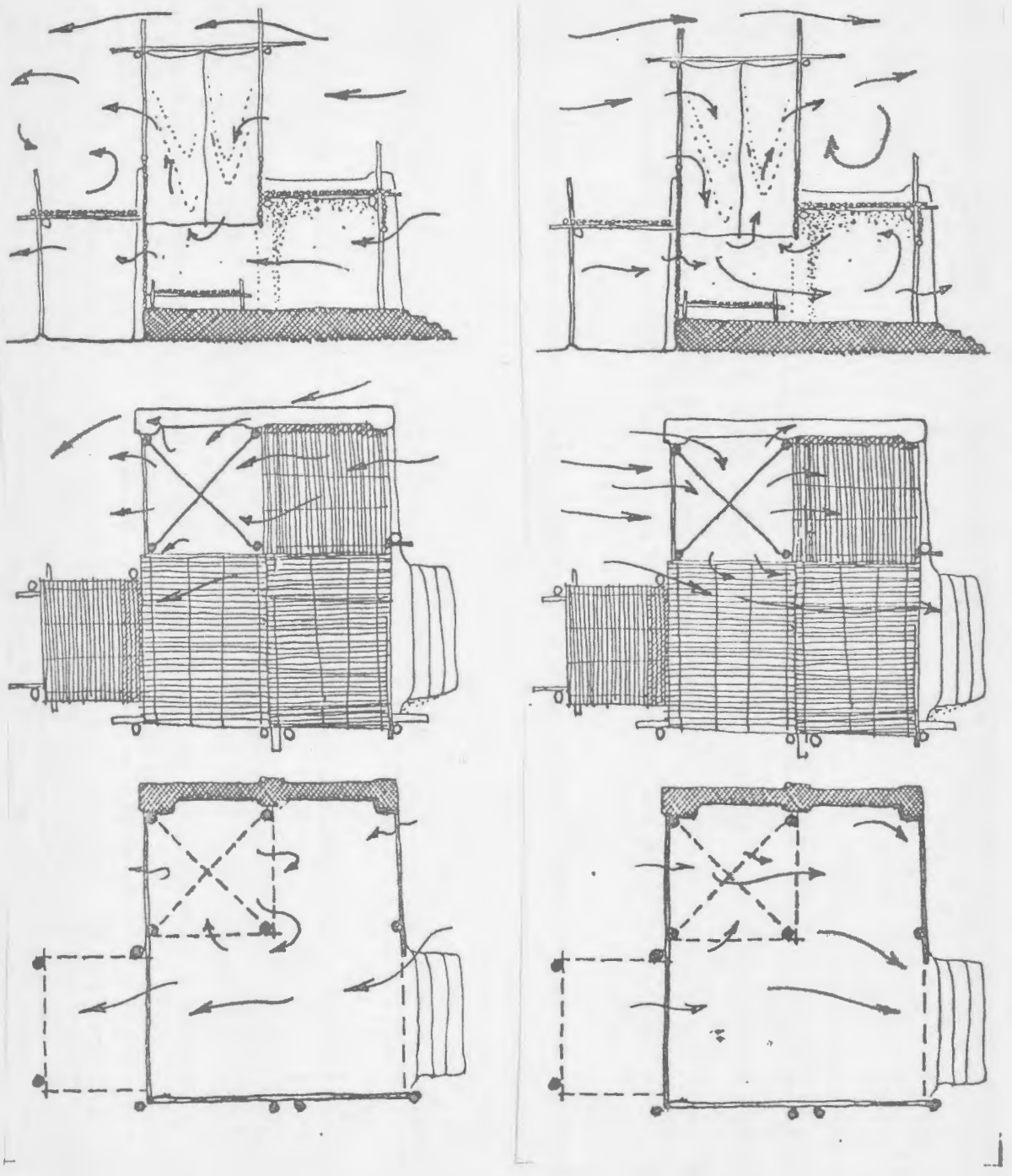
On the Batinah coast these windcatchers are multi-directional, so that no matter from what direction the wind is blowing, air movement will be caught and channelled down into the room below. Multi-directional windcatchers are probably Persian in origin and similar examples to those found in Iran can be seen in the Bastakia area of Dubai. Those seen on the Batinah coast of Oman are not as ornate but equally effective.

Variations in the room layout and the materials used lead to differing degrees of efficiency.

Two types of windcatcher are shown here in detail. Both examples were surveyed in Sohar.

The first example channelled air into a concrete block bedroom, used all year by the owner of the house. The windcatcher was built with concrete block columns rising up above the roof of the house, a column at each of the four corners of the windcatcher. From a height of about 1 3/4 metres above the floor up to the top of the windcatcher, the tower divides by an "X" formed of palm frond stems covered with gypsum plaster. In this way the tower can catch wind blowing from any direction. The arrows on the figures indicate how wind blows into the tower and is channelled down into the room, where part is sucked back up the opposite shaft of the tower, and part enters the room. In the case of daytime air movement (Fig. ), air blows down the shaft, and out across the room at low level. A small proportion of this air movement rises up the leeward side shaft; some of this air comes directly from the downward shaft. A larger proportion of the air leaves the room through the doorway and window openings. This process is advantageous for the daytime use of the room, when its central space is in use and therefore is the area requiring air movement to cool the occupants.





At night the wind direction reverses (land/sea breezes) and air blows down the opposite shaft (Fig. ). As can be seen, only a small proportion of air actually circulates round the main part of the room, and the surface of the bed, and then back up the opposite shaft. During the winter months, when air movement is unwanted, the openings at the top of the windcatcher can be covered with planks.

A second type of windcatcher is constructed with four timber posts, with the tower divided up in the same "X" form, but using sackcloth instead of plastered palm frond stems (Fig. ). Entry of air movement into the windcatcher is the same as in the previous case, but the room configuration is different, affecting the air movement pattern. This room is built of palm frond stem walls.

Although the two walls on either side of the room are made of impervious or relatively impervious panels, the two end walls in line with the prevailing land and sea breezes are made of open space barasti, forming a wall which allows a free passage of air through it.

During the daytime (Fig. ) the area immediately below the windcatcher will benefit directly from the air blown downwards: the rest of the room will be ventilated as much by direct air movement through the room from one side to the other.

At night-time (Fig. ) the wind direction reverses helped by the negative pressure zone on the leeward side of the building. The windcatcher helps to increase the velocity of the air movement, and therefore, in the summer, the degree of beneficial cooling. In the previous example the windcatcher is the only source of air movement, but in this case an equally important proportion comes in through the walls, which gives more widespread air movement at night.

As the climate gets cooler in the late autumn, the cloth windcatcher is removed and the roof opening covered over, leaving only the supporting posts (Fig. ).

# CHAPTER 3

## Northern Upland



Dividing the Batina coastal plain from the interior desert of Oman is an extensive range of mountains running from the northern limits of Oman through to the north-eastern coast. The principal area of habitation is the central valley lying at the foot of the Jebal Akhdar, massive limestone mountains rising to the immediate north of the plareau. Low hills divide the area from the desert, Rub-al-Khali, to the south, but to the south east the land opens out into the desert. Towards Bahla and Hamra the flat valley areas become increasingly reduced. At all times the mountains form an impressive backdrop to the scattered settlements.

The largest town of the area is Nizwa, once the capital of Oman proper. As with the majority of towns and villages in the area, the settlement is surrounded by, or adjacent to, an area of date gardens and garden plots. Water comes from the underground irrigation (falaj) systems, and many of the cultivated areas also supplement this supply with wells. Some of the river beds have water but most are dry. Flash floods can occur from time to time, filling the dry beds with several metres of water. Cultivation occurs in localized areas in between which there is little vegetation. The valleys often have fertile soil, except for the immediate vicinity of the river beds, which are filled with gravel and boulders. There are five main settlement areas within the region each with their associated planted belts: Al Hamra, Bahla, Nizwa, Izky, and Manah to the south-east.

Historically, the Northern Coastal Plain and the Northern Uplands were often in conflict as separate states. The Coastal Plain was a Sultanate centered in Muscat, while the Northern Uplands known as "Oman", had an Imam (an elected religious leader) in Nizwa. This tended to cut the uplands off from outside goods and influence. Some trade continued, for example, in importing gold and silver for making ornaments, which were then exported. High quality dates were also grown and exported.

Generally, the Northern Uplands developed as a self-sufficient inward looking area. Ample food and goods were produced locally to meet the area's needs. Craft industries were particularly well developed, producing a wide variety of goods from gold and silver work to woven cloth, pottery and copper utensils. There was a developed traditional education system, financed on profits made by water distribution.

This self-sufficiency was also reflected in the built environment. Indigenous building methods were well developed, particularly in the use of mud brick, of which several storey structures were built. Local cultural expression was advanced, as evident in the articulation of buildings and in paintings on walls and ceilings. The built environment was generally well maintained.

There were basically four economic classes. Firstly, the established tribal leaders, the wealthy peasants. The second related groups of merchants and craftsmen, who sometimes also owned land. There were poor peasants with very small holdings and finally herdsmen often living in separate small settlements on the mountain slopes and providing seasonal labour for the valley people.

With the opening up of the Uplands to the Coastal Plain and beyond, all this was in a state of unprecedented change. This process of change was probably more perceivable here than in most areas of Oman since there was a strong social structure that had only recently been seriously challenged.

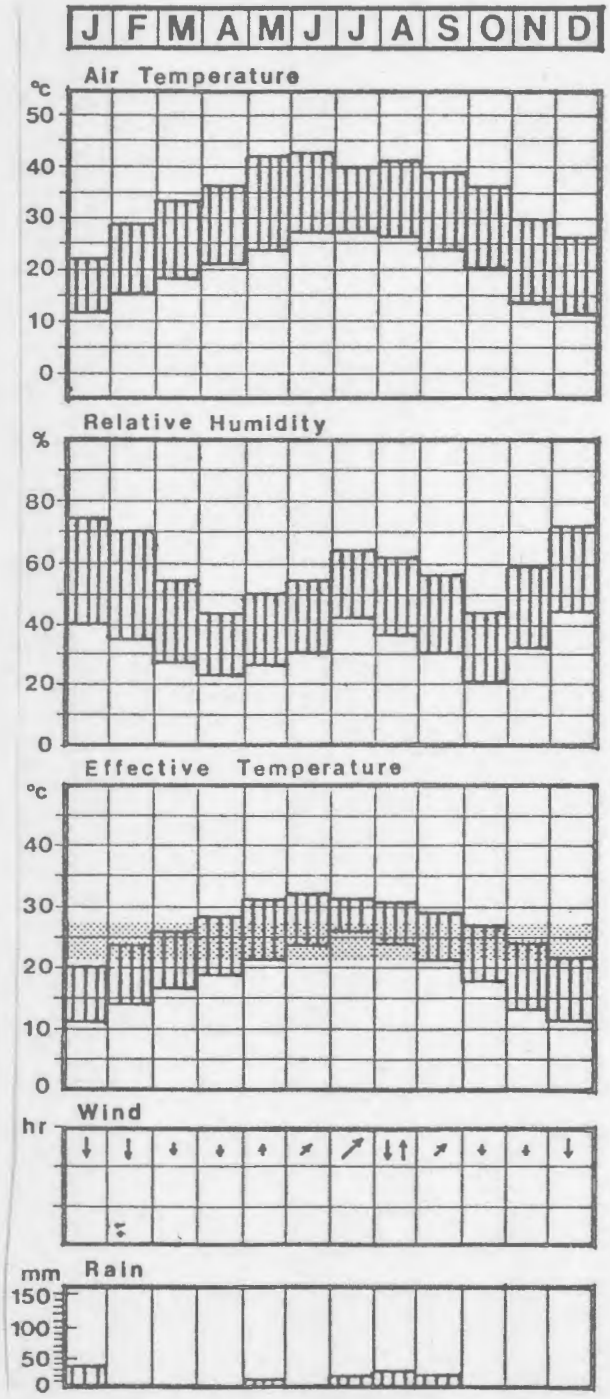
The rate of change also clearly diminished the further inland one went. Thus, although the influx of cheap imported goods from abroad began undercutting the local craft industries, it remained the most vigorous craft production area in Oman. Tinned food from abroad more slowly replaced the home grown diet. Concrete block houses in imitation of government buildings were being built (often at considerable expense) by some local people but their form closely resembled the indigenous house (Fig. ).

On the other hand, an eight year old boy drew a detached European house, probably from his school text book, when we asked him to draw his own very different mud brick house (Fig. ).

Another example of impending change was in the introduction of modern banks. The indigenous system of banking is to convert wealth into fine gold and silver ornaments, which keeps the gold and silver craft industry flourishing. But the need to encourage people to save currency in banks lessens the demand for gold and silver work and has a detrimental effect on the craft which was of a very high quality.

A new class of people had also emerged to add to the four previously outlined - those taken either off the land or from craft production to work for the government in the new hospital, municipality, school or the army camp, or for the Petroleum Development Company. In addition, there were a significant number who had been drawn out of the area in search of work in the many building projects on the Coastal Plain and in the Capital Region in particular.

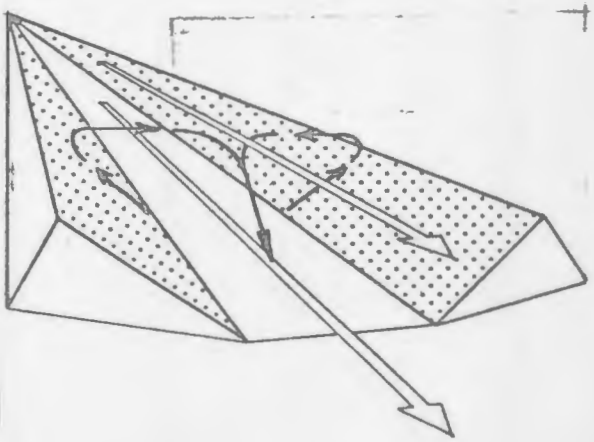
Nizwa most clearly shows both the positive and negative aspects of all these changes. It has a new fifty bed hospital, a school, municipality, post office and a new house for the Wali. On the other hand, the price of goods had risen along with those along the coastal plain, many houses being abandoned, their owners gone to Muscat in search of jobs, and the built environment was generally neglected and rundown compared to settlements further inland. Inland villages like Bahla and Hamra were still self-contained stable communities functioning comparatively smoothly.




The mountain terrain of the Northern Uplands is the chief factor modifying the climate. The high altitude is responsible for the somewhat cooler temperatures. Being inland from the coast and in the lee of the mountains, the air is drier than that on the coast. Daily and yearly ranges in temperature are greater than on the coast where the sea acts as a moderating factor.

From the effective temperature chart (Fig. ) it can be seen that the climatically critical months for which building designs must cater are from May to August, when large parts of daytime temperatures exceed the comfort zone, and from November to February when temperatures are too cold for much of the day and night.

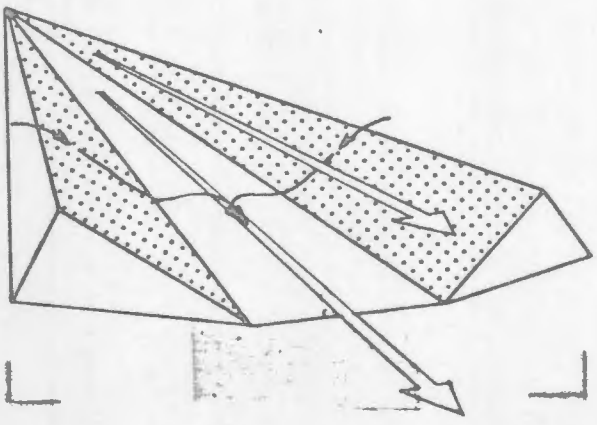
Winds are greatly affected by the mountainous terrain. The layout of settlements in the valleys depends on prevailing wind direction and the position of the valley, being either sheltered from the wind by the hills around or subject to winds which are funnelled along the length of the valley. Pre-

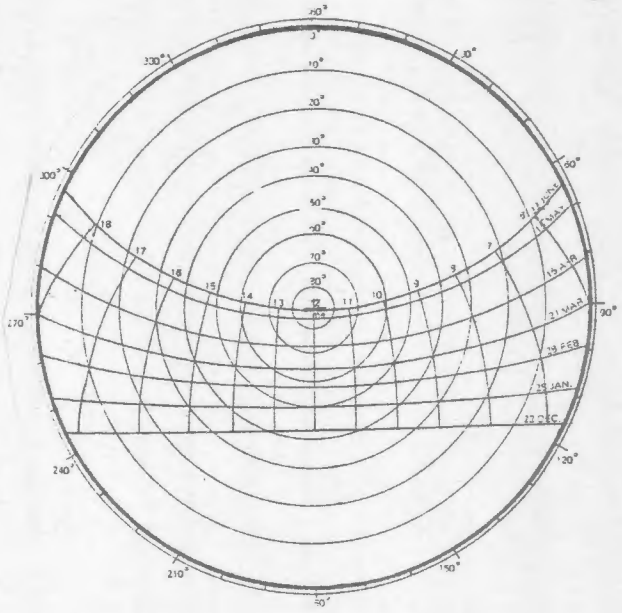


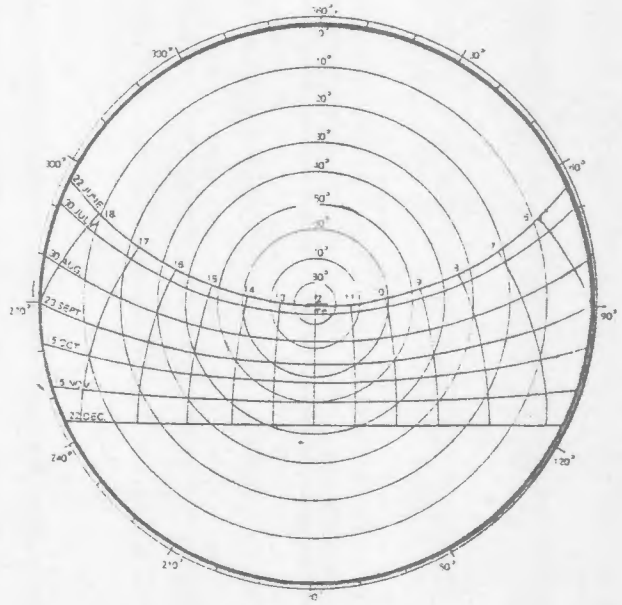
vailing winds are Northerly from October to May and South-westerly from June to September but within this there are diurnal fluctuations caused by the heating and cooling cycle of the valley slopes during the day and night. Upslope winds occur during the day and downslope at night (Fig. ).

During the daytime the slopes receiving solar radiation heat up. Hot air on these slopes is light and therefore ascends creating a low pressure area. Cool air which has collected in the valley during the night moves up the slope toward the low pressure area. Daytime upslope cool breezes are created in this manner.

During the night, the valley slopes lose heat by radiation to the sky and become cooler. Air on the slopes is cooled and becomes denser and heavier and descends, flowing down the valley slope. Night-time down slope breezes are thus created. Daytime upslope breezes tend to be more intense than the night-time down slope breezes.







The majority of settlements lie in or on the edge of large flat valleys extending from the Jebel Akhdar. They are often beside rocky water courses (wadis) which are dry, except in the rainy season when they can fill up during flash floods with several metres of water. The traditional supply of water came from the ancient system of tapping the water table through a series of underground channels known as Falaj. This was also supplemented by wells. Cultivation was restricted to localized areas that could be serviced by these water sources. Thus the Northern Uplands were mostly uncultivated except around pockets of settlements lying by wadis. These were comprised of a built-up area surrounded by a larger area of date gardens and smaller vegetable plots.

Because easily cultivable land was at a premium, most built-up areas were usually on land unsuitable for this purpose. Cultivated land was rarely used for building on; to cut down a palm tree required specific permission which was not easily obtained. Since the wadis are liable to flash floods dwellings by them were situated on higher ground, and sometimes a compact settlement occurred on an outcrop of rock, surrounded by lower lying agricultural areas.

The use of higher pieces of land also related to the traditional need for protection, villages and towns focussing round their fort which stands on the highest ground in the vicinity. Some villages made use of the inaccessible backdrop of the mountains and ran up the hillside where the natural landscape provided protection. In these cases the richer houses were usually nearer to the bottom of the slope, closer to the water

supply, which is normally easier down in the valley, while poorer houses were further up the slope. Hamra is a typical case of a town of this type, showing a clear progression from rich houses at the bottom of the slope to poor at the top. In this town the whole settlement takes on the character of a fort, houses being clustered together to form a fortified wall.

The position of the village or town market (Suq) within the town is also important. The Suq has functioned for centuries in the Islamic world as a social gathering place, and continues to do so, embodying much of the collective expression of the people. As a meeting place, particularly when combined with a cafe, it functions as a centre for the exchange and development of ideas. The Suq incorporates both the intellectual and commercial development of the town.

In this role it plainly acts as a focal point in the settlement pattern and often comes adjacent or near to the fort, representing two important areas of the town. The fort has in the past been the seat of the local governor or mayor (Wali), attended on by a bodyguard of locals. The Suq and the fort were nearly always close enough to allow communication and movement between the two. However, this traditional axis had begun to shift with new government building outside the traditional centres.

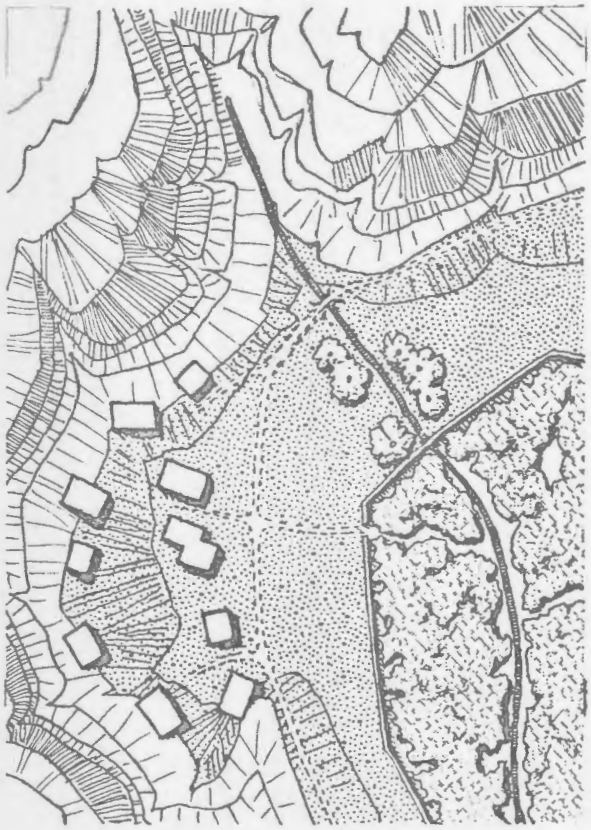
Ethnic relationships were reflected in the towns where there were often several tribal areas separated from each other by the main streets of the settlement. Each tribe operated in some aspects like an extended family. There was, however, a degree of social intimacy to the extent that the Mosques were totally integrated amongst the other buildings of the area, even occurring on the upper floors of a building, so that only intimate knowledge of the settlement would identify it. This is unusual in comparison to the prominent position that the Mosque has in most Islamic settlements throughout the Arab world, and is to a certain extent a characteristic reflected throughout the north of Oman, where the Mosque is often a modest building, bearing out the personal and private nature of Omani religion.

The water channel (falaj) distribution system had an important role in determining settlement pattern. The hierarchy of distribution was not only determined by functional considerations, but was a reflection of wealth and social status; wealthy landowners having first use before the channel reached the settlement's poorer inhabitants.

The actual distribution of falaj water was organised in such a way as to minimalise the chance of contamination. A definite linear utilization pattern was held to, as the water flowed through the settlement, ensuring clean water for drinking before contamination by washing and animals.

Drinking water was always taken from the falaj at the point that it emerged from the ground. Water was often collected at this point and deposited in pots further down the channel, for public drinking. Some houses of rich families had built private wash places over the channel, while washing for poorer members of the community was done in public wash houses. Water was distributed to private garden plots in return for a proportionate tax; the income of this being used for supporting education of children and social services.

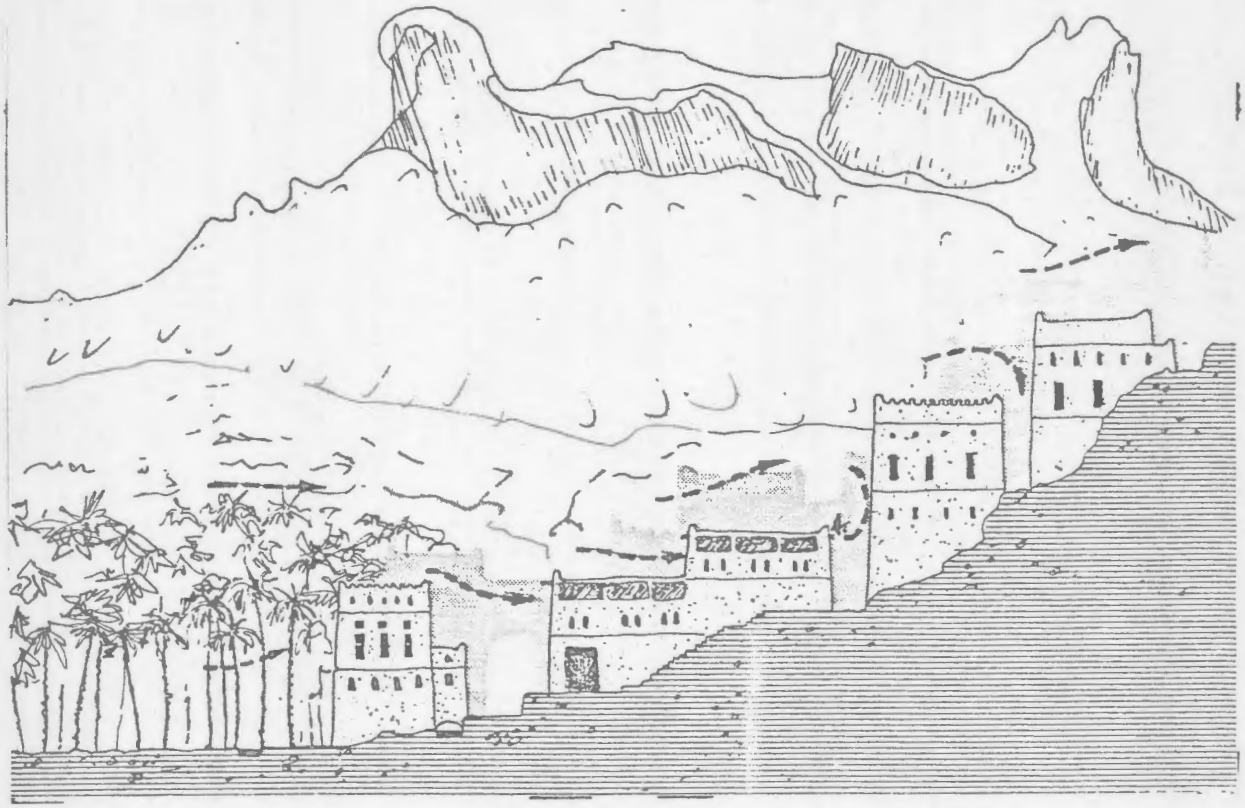
In some cases, overlooking such settlements were smaller communities of goat-herdsmen who has established themselves by a mountain stream. The goats fed on the mountain scrub while the herdsmen managed to cultivate small vegetable plots for their own use (Fig. ). Their houses were single storey, often single room buildings, the walls built of flat limestone pieces stacked without any mortar on top of each other. Roofs were similar to those of the valley settlements, consisting of timber beams and rafters, palm matting and mud.



Built-up areas such as town centres are limited to lands which lie above the wadi's high water mark as well as building limitations on fertile lands, which have economic priority. Due to these pressures, town areas tend to be densely populated. Houses often share common walls, and streets are narrow providing plenty of shade and a trap into which cool air can settle at night and be held during the day. The dense clustering and the predominance of mud brick as a building material results in the built fabric maintaining a relatively high thermal capacity. This means that both heat loss and heat gain between the building cluster and the external environment is limited. In other words internal temperatures remain moderate, at about the mean of the average daily range, because of the clustering effect. This is advantageous in the Northern Uplands which experience a relatively wide daily temperature range.

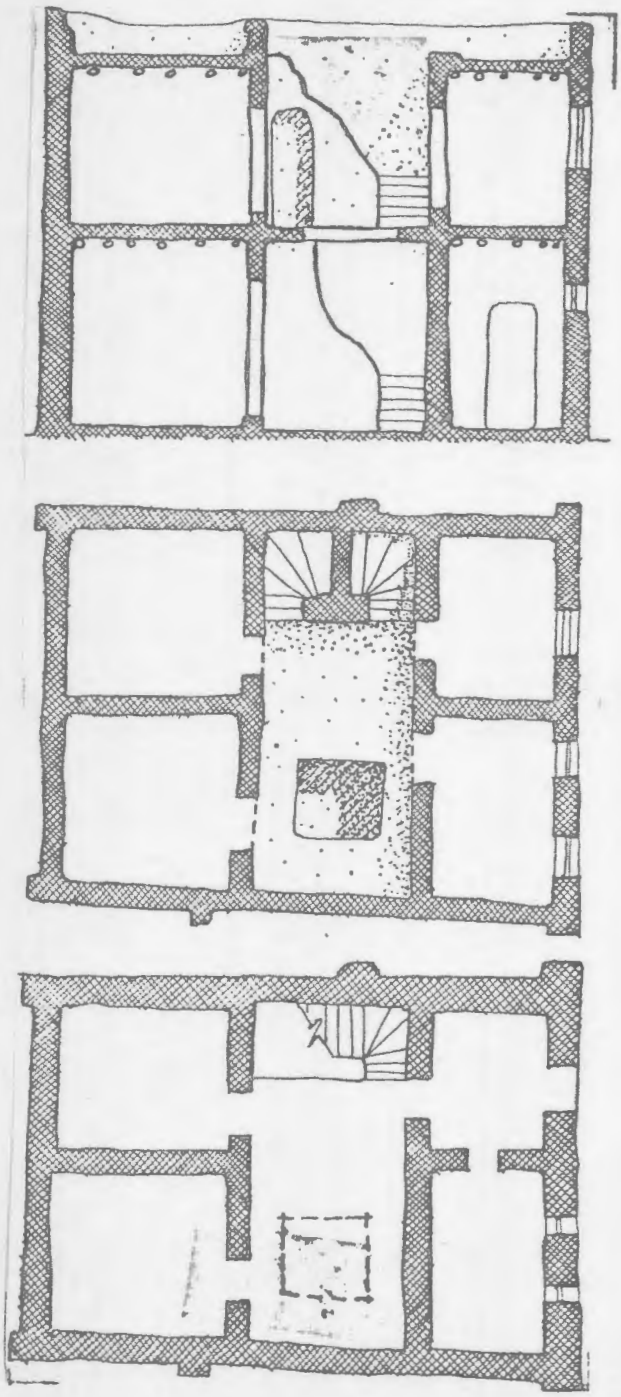
This settlement pattern is not conducive to the encouragement of air movement. Because of the moderate relative humidity, air movement as a cooling factor is not as important a feature as it is in coastal areas where humidities are high. Although air movement is favourable in the summer time it is a disadvantage in those months when temperatures fall below comfort levels.

Hillside towns, like Hamra, are examples of settlements which are both densely clustered and also make use of air movement for cooling (Fig. ). Although the streets remain narrow and shaded the whole town is integrated into the side of the hill in a terraced manner. The upslope valley winds come into play here drawing cool fresh air from the date groves in the valley up through the settlement during the daytime.



Upper floors of buildings have windows opening on one side of the house and face only toward the valley breeze. On the other hand the downslope night breezes which are often unwelcomed, especially during the winter months, have little effect on the settlement because houses are built into the face of the slope and present very little wall surface (windowless) to these night-time winds.

The dense town centres are thermally most comfortable during the cool season. During the summer in towns such as Nizwa there is often a move to the nearby gate gardens. This should not be seen solely as a climatic response but also an economic necessity to tend the gardens. The shade and moderating effect of planting on the temperature, and easy access to water, produce conditions much more comfortable than the town centre. Houses are no longer clustered but set individually on private garden plots. Air can therefore move freely around and through these houses which are built in a much more open way: the breeze aiding evaporative cooling.



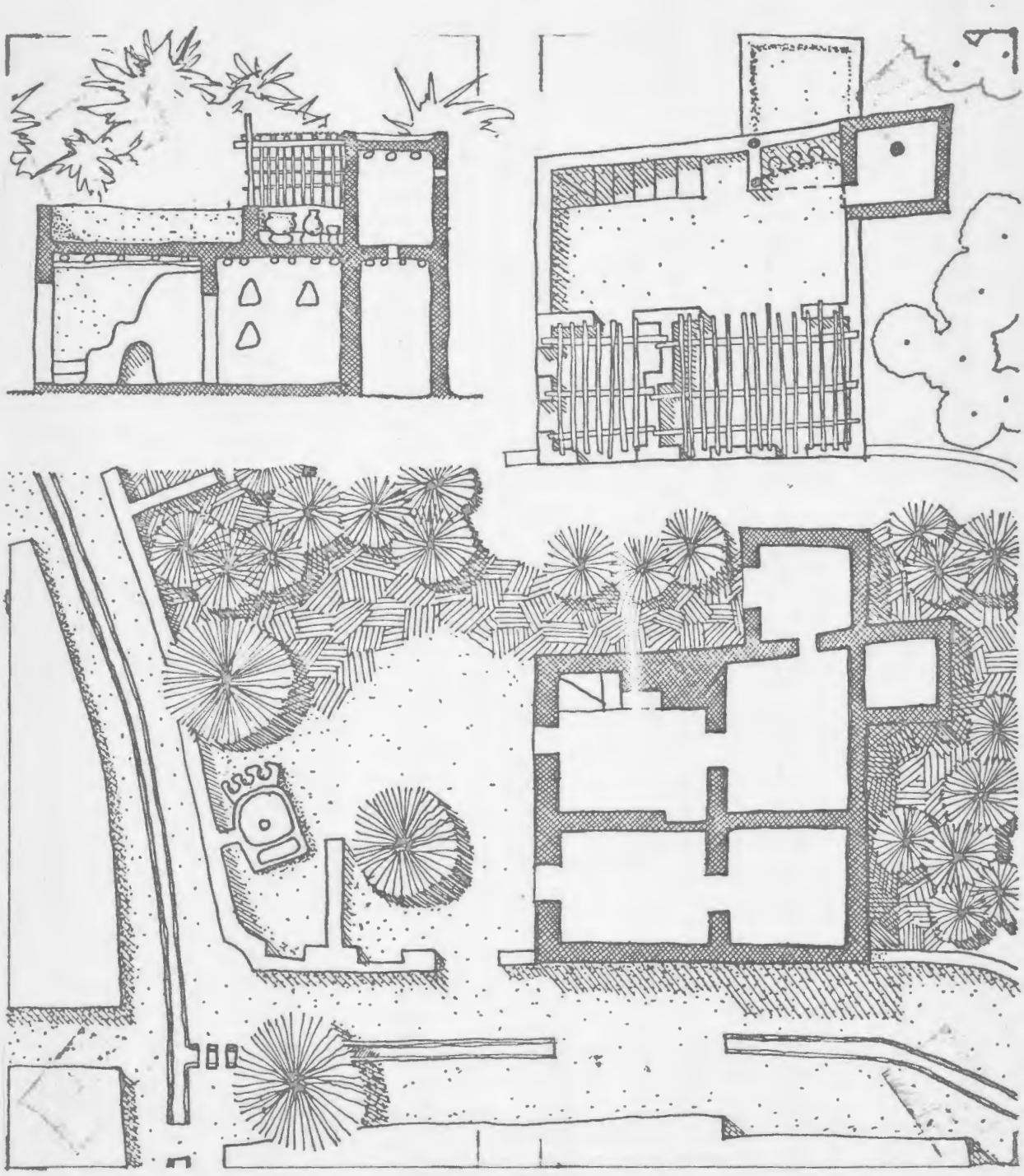
Town houses are predominantly built on a central courtyard plan. Because of the density of housing in settlements of this area, the dwellings are usually two or three stories high. In this context the courtyard is basically a light and ventilation shaft for the lower levels of the house. Most of the houses are arranged in such a way that privacy is ensured, courtyards being deep and narrow. Often parapet walls rise up above the top floor level so that there is no view into the neighbour's house.

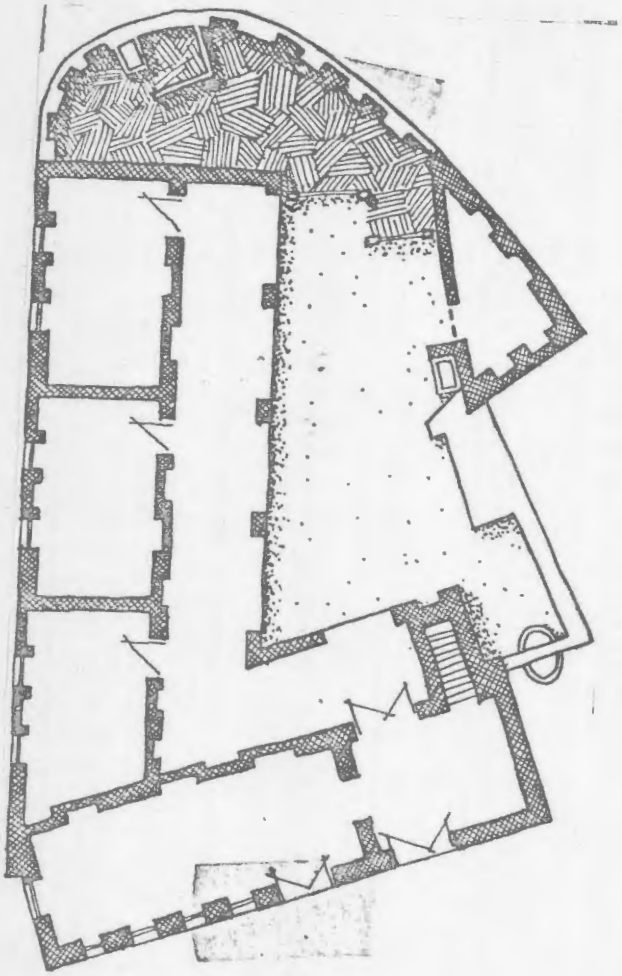
The 'Maglisse' is a common feature in most houses, providing a room for special social occasions and visitors. It is usually located in a position near to the entrance of the house, or, in houses where the ground floor is used for storage, in a convenient place on the upper floor.

The uses of the maglisse is more varied in the Northern Uplands than for example on the Batina Coast. The maglisse accomodates activities other than the strict social ones. Because town houses are generally quite small space has to be used economically; a craftsman may for example use his maglisse as his workshop as well.

Town houses are largely enclosed and inward looking and rooms dark. In many cases the well and sanitary facilities are located with-in the house, the latter a kind of two storey pit latrine with an enclosed retention pit at the ground floor. The ground floors are often dimly lit with small windows or sometimes have none at all. These rooms are generally used for storage. Upper floors on the other hand are better illuminated and provide most of the living space.

There is a strong traditional influence





in the way that houses are built; the use of alcoves in the walls, the form and layout of rooms are defined by the indigenous concept of the house. Some of the new houses built of concrete block still followed the form of the older houses. A new house recently had been completed in Izky; though built of concrete block, followed the form of a mud-brick house. Walls had been built as thick as if mud brick had been used and the resultant cost had imposed a serious and heavy financial load on the owner/builder. The enhanced prestige of his concrete house somewhat compensated for the lifelong debt he had incured.

The seasonal migration of much of the towns' population to the date gardens demonstrates a clear response to the climate. In the summer date garden house rooms are well ventilated, with open staircases and the use of roof spaces for sleeping as well as date drying. Large windows let in the breeze and there is an emphasis on outdoor activities. Kitchens are often outdoors. When ever possible water is channeled through the courtyard or wells are incorporated into the design of cooking areas (Fig. ).

Summer houses like those of the town are predominantly built of mud-brick, making use of the low heat transfer rate of the material. Walls are pierced by numerous large openings, which are usually carefully placed to face away from public places so as to retain a level of privacy. Roofs, though often built of heavy mud and timber, are sometimes simple shelters from the sun of a lightweight construction. Roof top matting for date drying, supported by racks a meter above the surface, act like a double skin roof to keep room interiors cool.

# Buraimi Oasis

## CHAPTER 4

An oasis is an area of vegetation and water supplies surrounded by the desert, and can be so small that only one or two trees find enough water to grow, or it may stretch for miles, providing huge areas for agriculture in an otherwise barren area.

Buraimi is one of several oases situated on the border between Oman and Abu Dhabi, and gives its name, being the largest, to the whole area. The main settlement lies about 16 km. to the west of the mountains which are the north-west extension of the Jebel Akhdar, and is roughly at the point where the gravel foothills finally merge into the rolling red sand dunes of the desert. This group of oases is divided up between Oman and Abu Dhabi, although there is free movement from one country to the other. There are altogether about eight settlements in the Buraimi oases, each of which traditionally received its water supply from falaj systems running down from the mountains in Oman. The two main settlements are Buraimi in Oman and Al Ain in Abu Dhabi. The principal communication link is an asphalt road from Al Ain to Abu Dhabi on the coast.

In 1973 there was also an extremely poor rough track across the mountains linking Buraimi with Sohar, but this road did not play the important role it could if it were greatly improved. Buraimi also had a dirt airfield used by small transport flights from Sieb (near Muscat) which provided the best limited link with the rest of Oman.

The weakness of Buraimi's links with the rest of Oman left it in the shadow of Al Ain. Al Ain had developed into a sizeable town with many facilities ranging from a Hilton Hotel and cinemas to an air conditioned Suq.

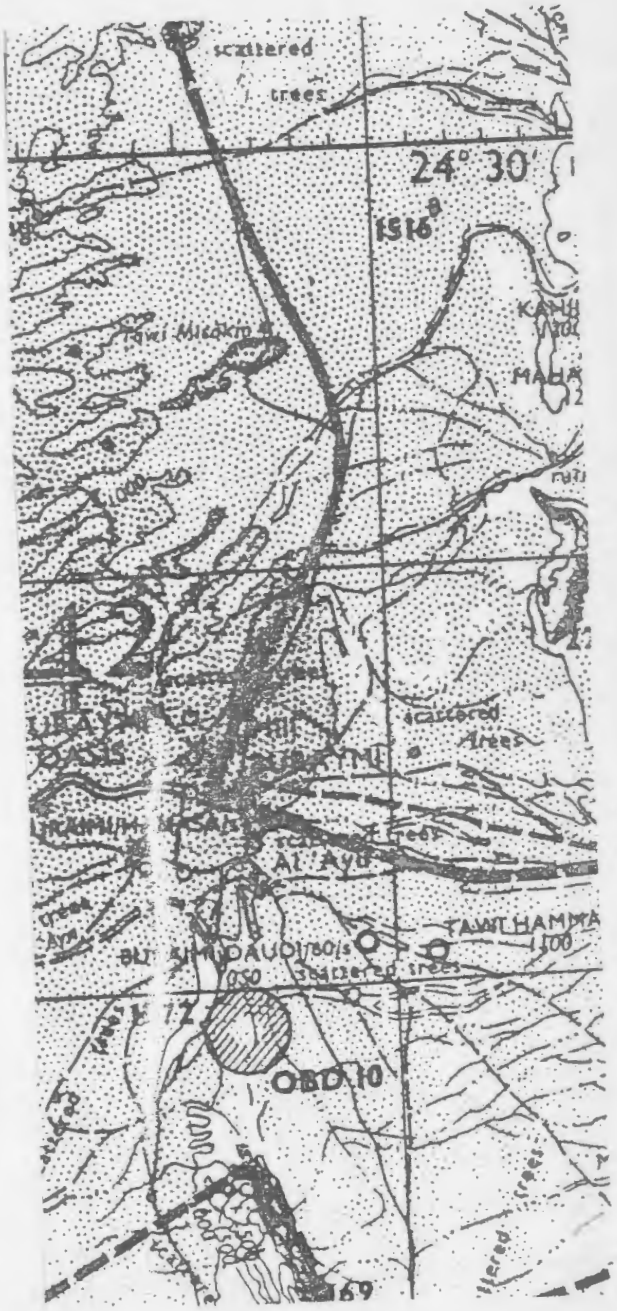
The asphalt road links Al Ain with Abu Dhabi and Dubai whence produce for the area was imported. There were also schools and a government welfare housing system. Development had eclipsed the more prominent role that Buraimi played in the past, when it supplied dates and vegetables to the local arab

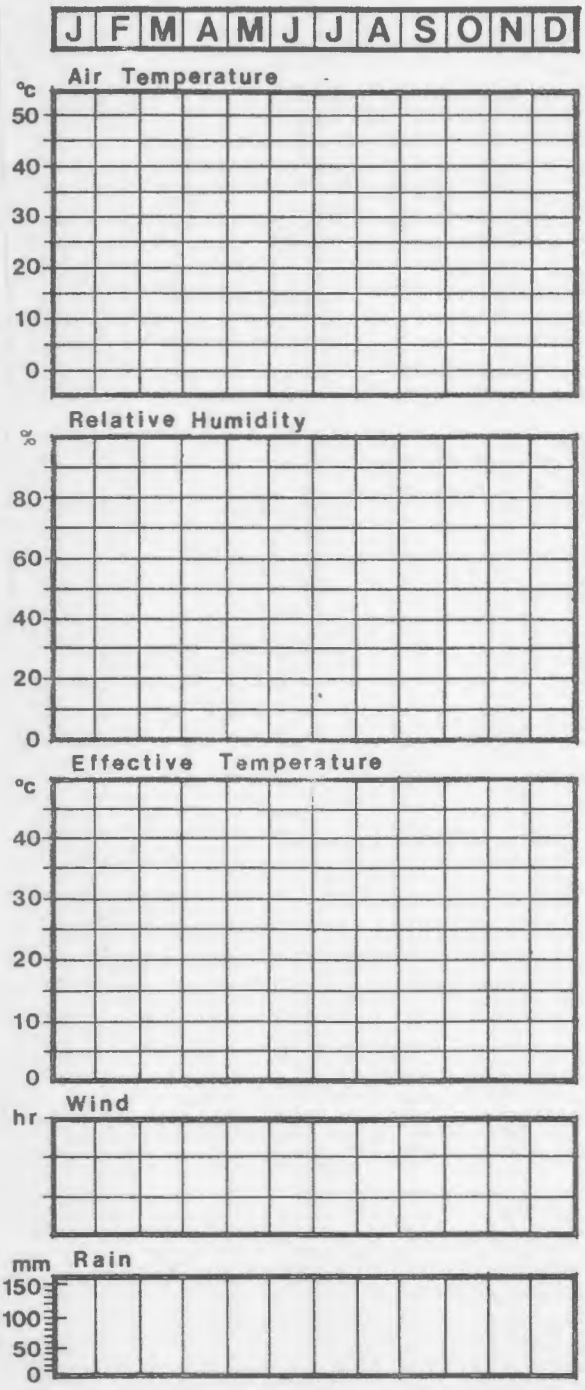
tribes. The result had been to draw people from Buraimi into Al Ain for their work, education, entertainment and shopping. In 1973 most of the arab shopowners had left the Buraimi Suq, leaving it largely occupied by Persian, Pakistani and Indian shopkeepers, who complained of the difficulties of keeping up their trade in the face of Al Ain's competition.

Al Ain had a service economy subsidised by oil revenues from Abu Dhabi as a whole. The built environment reflected the expenditure on foreign methods and materials and often inappropriate design. Buraimi has an agricultural potential which is capable of being exploited to replace some of the food imports and to develop a more productive and diverse economy, in turn offsetting dependence on the oil industry.

In the early 70's the production of dates had dropped because of disease in the trees, and some other crops, such as grapes, were not successful, but vegetables seemed to thrive and had potential for increase.

The relationship between the two settlements reflects a microcosm between Oman and the Emirates. The Emirates have developed depending upon oil as their source of income, and almost all their requirements are imported. Oman, on the other hand, has a limited oil potential, with supplies running out in the forseeable future. Oman is fortunate in that it has a natural agricultural potential and the development or consolidation of rural industries could lead to a viable diverse economy involving the whole population and not dependant solely upon oil.

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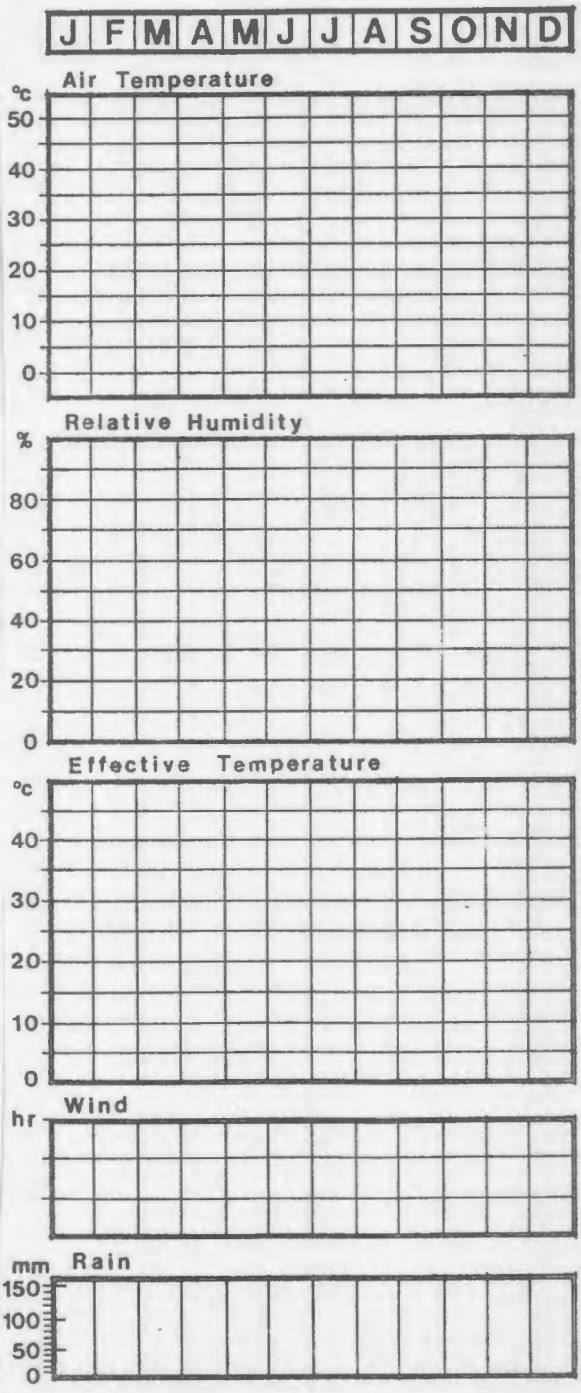
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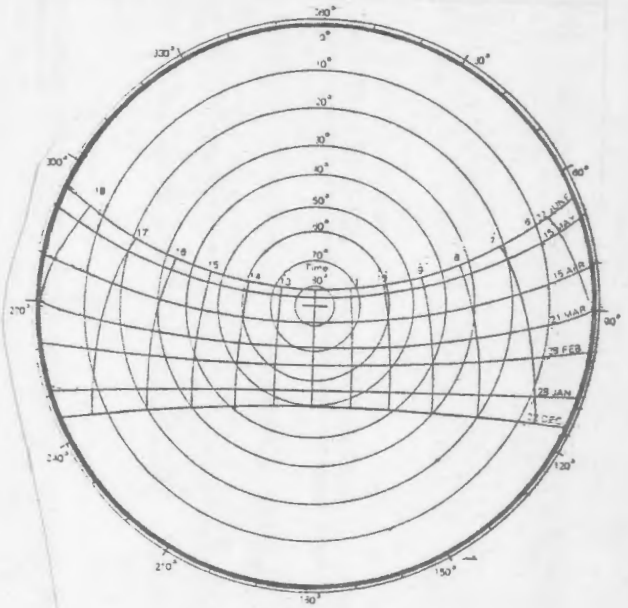
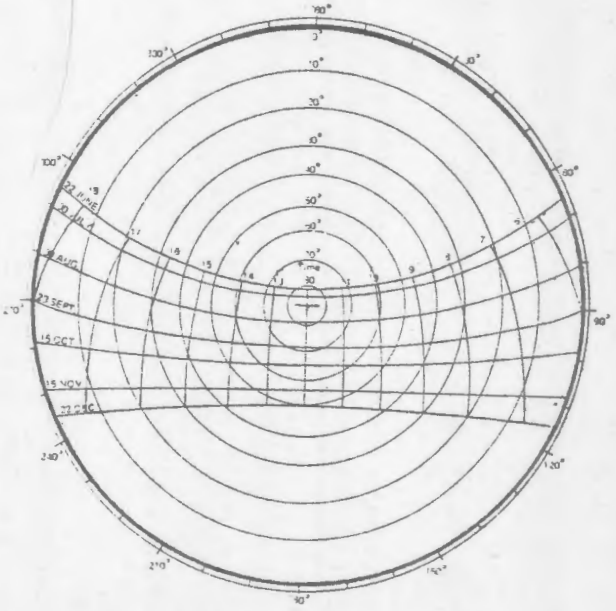
Considerable differences are found between desert climatic conditions and oasis conditions even though they are in the same general area. By irrigating an area of desert, the temperature, humidity and air movement will be changed.

In a desert the high temperatures are largely the result of the sun's rays radiating off the soil (solar radiation) into the air. This is particularly strong near to the surface of the ground where air movement is practically nil (there will be vertical air movement due to hot air rising, but this has no cooling effect), and thus has no dissipating effect on the temperature, which can be twice as much at ground level compared to head level.

An oasis modifies the desert situation to a considerable extent primarily because of the high moisture content in the soil and plants. The dry air in contact with these surfaces allows evaporative cooling which in turn causes the moisture content of the air (relative humidity) to rise, and the air temperature to drop. The extent to which the relative humidity and air temperature are modified depends on the amount of moisture in the soil and the amount of air movement in the area. The relationship to the surrounding desert air movement is weaker in the oasis because the winds are partially deflected by the denser cool air mass and by the planting.

Also unlike the desert climate, the temperature in the oasis increases with height rather than decreases, being coolest near the moist soil and plants and warmer fur-



ther above and away from them. Thus there is no upward movement of air, dust does not rise and moisture evaporating from plants stays close to the ground.

Because of the darker colours of the planting and fertilised soil of an oasis compared to the light desert surroundings, an oasis in fact absorbs approximately 15% more solar radiation. This to some extent lessens the cooling effect in an oasis. Nevertheless, the average daytime soil temperature in the oasis is approximately 15°C. cooler than the surrounding desert, and the relative humidity is much higher.

Finally the influence on the desert of a small irrigated oasis is felt within a radius equalling approximately 1/3 of its diameter. The effects are most marked within several hundred metres of its boundaries, the strongest influence being in the area downwind of the oasis.

The Buraimi Oasis basically has a climate in between the hot dry desert and the maritime desert climates. It is not modified to the extent of the latter since it does not have effect of the large moisture content of the sea and the air over it, nor does it have the daily land and sea breezes. Equally, although there is a distinct hot and cold season and a wide diurnal range of temperatures neither are as extreme as in the hot dry desert climate. The relative humidity is much higher than the desert's but it is still quite moderate. There are seasonal prevailing winds which are stronger in winter than in the summer and rainfall is low, corresponding to the occasional flash floods that occur during the winter in the desert.

Water is the main factor which originally influenced the settlement pattern of Buraimi. It was supplied by falaj systems (underground and surface water channels), which by their very nature in an undulating area, being a gravity system, can serve only a limited area. Hence there was a need to use as much of the potentially irrigatable land as possible for agriculture, with the result that as in the settlements in the Jebel Akhdar Region the houses were generally built on land unsuitable for cultivation, i.e. land inaccessible to the water from the falaj. There were within this pattern two types of settlement. The major settlement areas, including the Suq and forts were all situated around the periphery of the date gardens. The main streets within each group of buildings were wide, and even the small side streets were not narrow enough to be protected from the sun, since the houses and shops were mostly one or two storey buildings, providing little shade to the open spaces in between. The Suq however was completely covered over, including the main passageway that ran its entire length.

As well as the main settlement areas, there were also houses scattered amongst the date palm groves. These houses, and the footpaths giving access to them had been set several metres above the level of the date gardens, which lay at the same level as, or slightly below, the falaj channel, to facilitate irrigation; the houses were in this way protected from flooding, which happened during winter, when water covers some areas to a depth of a metre or so, especially in badly drained hollows.

In more recent years there had been a shift away from date production to vegetable growing, which had proved successful, and the land around the date gardens was used extensively for this purpose. With the change in agricultural emphasis new houses were being built away from the older centres and nearer to the new fields. People tended to locate their housing as near as possible to the planted gardens to benefit from the cooler micro-climate.

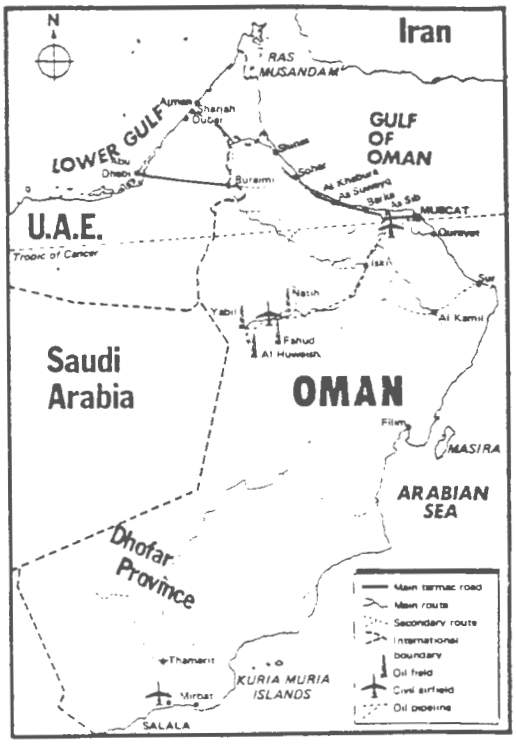
Because of the hot dry climate, maximum use was made of insulation from the exterior heat and for this reason the window openings in the houses of the Oasis were small, minimising the unprotected area of the wall. These small windows also helped to reduce the amount of dust being blown into the house, although the palm trees also helped to filter the air.

Four materials were used in the area: mud-brick, concrete block, palm frond stems and corrugated iron. The use of mud-brick is the same here as in the Northern Uplands. Its insulation properties are even more valuable in this situation where the annual

and diurnal range of temperature is greater. Concrete block has a poor insulation performance. The use of the palm frond stem is limited here, and occurs mostly in roof construction.

The use of corrugated iron in the Buraimi Oasis was extensive, especially in the rented part of the Suq, where a number of shops and stalls were constructed almost entirely with this material. Corrugated iron affords protection against rainfall, which is quite heavy occasionally during the winter. Furthermore, it is quick and easy to erect, providing a shelter of sorts quite cheaply, but, being a thin sheet of metal, it immediately transfers the outside surface temperature to the interior so that with no time lag, 100% heat transfer and the build up of heat within the room, temperatures well in excess of any conceivable comfort level will be reached, with discomfort to the occupants and certainly creating unhealthy conditions for keeping any kind of fresh food. Its use could only really be justified as a temporary measure in the absence of a better material or combination of materials within the financial range of the occupants. Its use in Buraimi was apparently rationalised by quick rental profits which could be achieved by the land owner who let shop units to traders who could not build their own.

# Capital Region — Muscat Mutrah & Ruwi




The region covered by what is known as the capital area runs up to Seeb at the southern end of the Batinah Coast, and is hemmed in to the South East by the mountains which run abruptly into the sea at this point, effectively cutting off the area from the coast further East. The region includes four natural bays, two of which are the respective sites of Muscat, the capital of Oman, and Mutrah, the main port. The other two bays have smaller fishing settlements around their shores. Muscat itself is completely hemmed in by mountains, which have restricted its growth. This is also one of the factors which accounts for the extremely high relative humidity in Muscat. Mutrah has much the same physical constraints, but the passes into the open area behind are low and accessible, linking Mutrah with the main area of expansion. Ruwi, situated in a large flat valley which, like Mutrah and Muscat, has practically no vegetation at all except for isolated areas of cultivation. The whole area is dominated by the rocky limestone mountains and the sea.

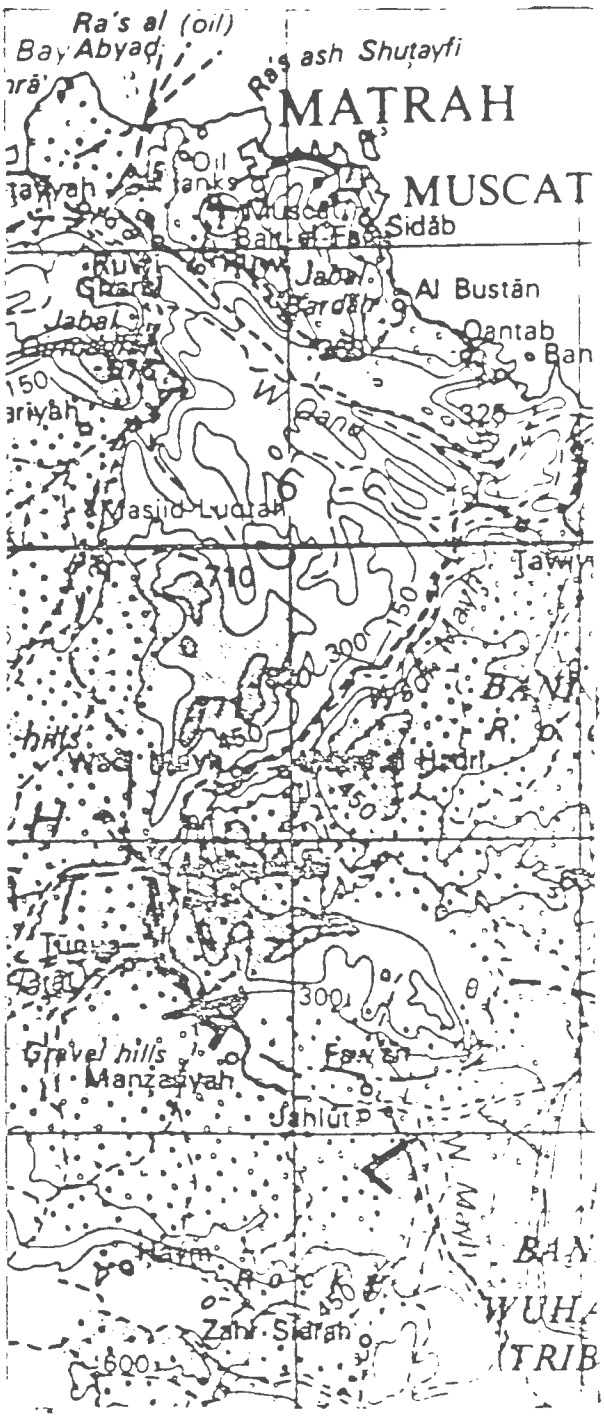
A narrow valley runs northwest through the mountains out onto the slopes leading to the Batinah Coast. The division between the capital region and the Batinah comes at the point where the cultivated date garden strip ends at Seeb, the land towards Muscat being arid and rocky, but, as with Ruwi, is the site of much new building, including the airport, hotels, army barracks and the oil terminal. The water supply for the whole of this region comes from wells in the Seeb alluvial fan which acts as a large reservoir collecting water from the mountains and is piped to Muscat, Mutrah and Ruwi.

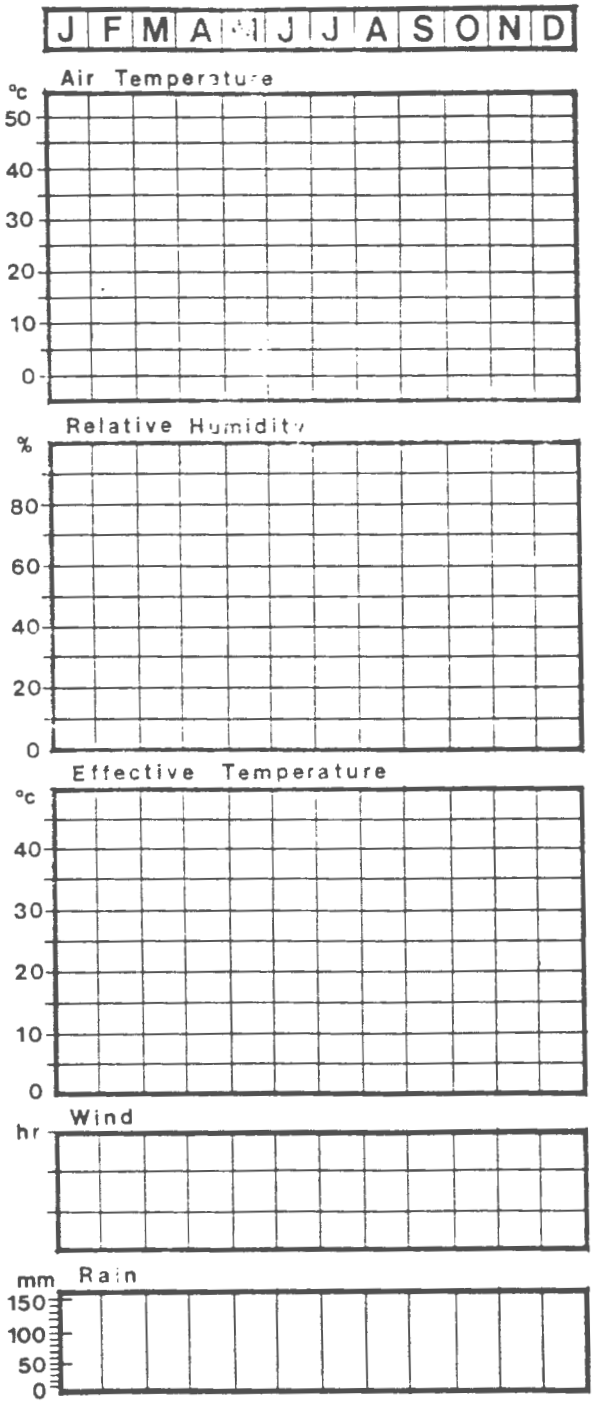
Muscat and Mutrah are the two major established towns in the north of Oman. Their traditional importance derives largely from their location. They lie next to each other in two twin bays, strategically placed at the mouth of the gulf. Mutrah Bay forms a natural harbour. For a combinaton of military trade and communication reasons these settlements were and still are in choice locations. Muscat and Mutrah have been major trading post towns for several centuries now. 16th century Portuguese forts attest to their long standing military importance. When Oman was divided into two states, one a Sultanate along the coastal plain and the other an Imamate in the hilly interior, the Sultans seat of government was Muscat. Even when unified as one state under the Sultan it was known as "The Sultunate of Muscat and Oman", reflecting the importance given to the town of Muscat.

In 1970 as a further unifying measure this was changed to "The Sultanate of Oman". However, the settlement's naturally advantageous location continues to insure its increasing importance. Muscat, Mutrah and the Ruwi valley immediately beyond the hills ringing these towns up to Mina al Fahal and Sib have been designated the capital area. In the early 70's a large proportion of the country's investment had been committed to this

area. Mutrah developed into a modern sea port, at Seeb there is a new international airport and Ruwi, not long before an empty plain was a vast construction site, with offices, hotels and houses springing up everywhere. Petroleum Development (Oman) have their terminal base and international outlet at Mina al Fahal. Employment opportunities in this area increased rapidly. Consequently there was a large influx of people from other parts of Oman and from abroad.

There are five main occupational groups in the capital area. Firstly there are the long established influential wealthy Omani families, often occupying major government and business posts. Secondly there are also the long established Indian and Pakistani communities who came over as merchants several centuries ago and still run most of the businesses in the area. Thirdly many Omanis educated abroad are returning to fill professional, management and technical posts. There is also a sizeable expatriate community in higher consultancy or skilled technical jobs. Finally there are large numbers of unskilled workers, either from the rural areas in Oman or from the Indian subcontinent, working in service and construction jobs.[1]






## Climate of the Capital Region

The region encompassing Muscat, Mutrah and Ruwi is in close proximity to the Batinah Coast and hence has a somewhat similar general climate. Seasonal prevailing wind patterns at high altitudes are similar as is the daily land/sea breeze system. On the other hand, settlements in the capital region are found in basins surrounded by rough hills, while Batinah settlements extend along the flat coastal plain. Muscat is the best example of this physical situation, with its protected harbour opening onto the sea but the town itself surrounded on three sides by steep rock faces.

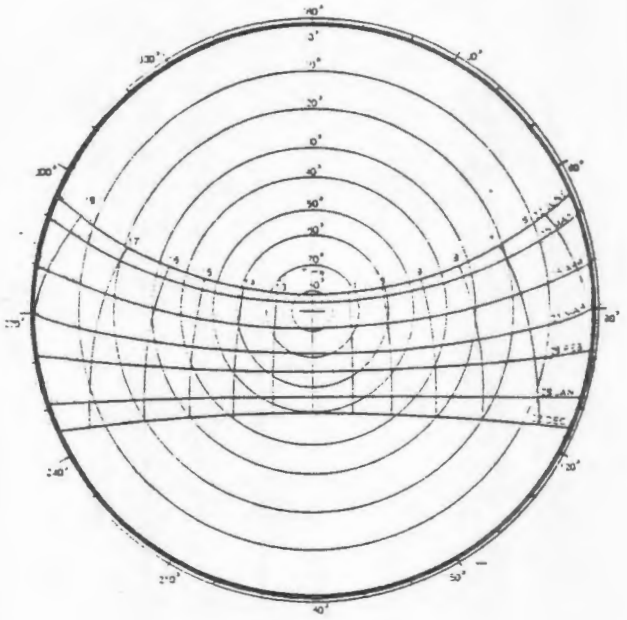
The light coloured rock faces around Muscat reflect solar radiation focusing heat from the sun onto the town. Heat continues to be re-radiated from these hills even after nightfall because of the heat storage capacity of the rock, which has been collecting radiation from the sun during the day only to emit it later. It is for this reason that Muscat is said to consistently have a temperature five degrees higher than the surrounding country. The heat storage capacity of the hills around accounts for the small diurnal range in temperature.

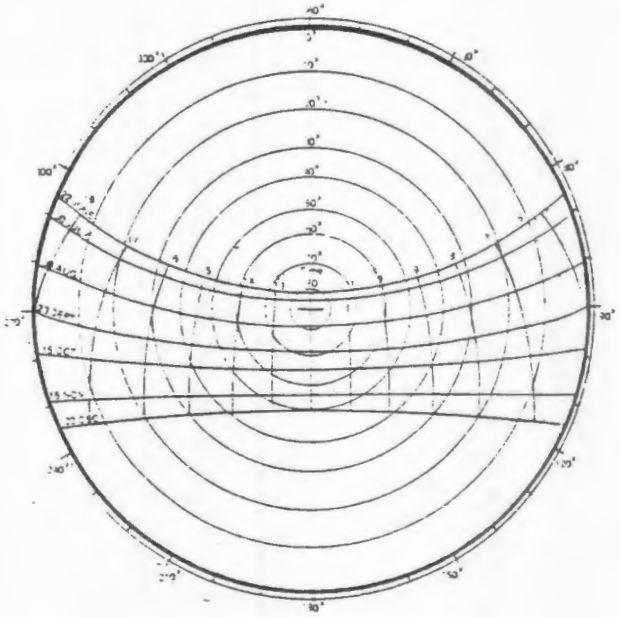
Hills protect Muscat from the cooling effect of prevailing winds, except those which blow from the north, off the sea. Muscat therefore depends to a large extent upon local winds induced by particular micro-climatic conditions. Two systems work together here to produce daily land breeze. sea breeze effects. Because of Muscat's coastal location the daytime onshore and nighttime offshore wind effect caused by the different rates of heating and cooling of land and water offer some relief in the uncomfortable climate.

Temperature differentials at various altitudes exist on the hill slopes themselves and cause local winds which change through a daily cycle. Up slope winds occur during the daytime and somewhat weaker down slope winds occur at night. The daily

shifts in the valley slope winds corresponds to and encourages the onshore offshore sea breezes, and helps to strengthen the local wind pattern.

It can be seen from the accompanying climatic charts that both air temperatures and relative humidities are consistently high and show little variation over daily or yearly periods. For design purposes the critical months, or those for which cooling devices or systems must be designed, extend from April to October. From the effective temperature chart it can be seen that the comfort zone is usually exceeded during this period.





## Settlement Patterns — Capital Region

The four main settlements in the capital area are Muscat, Mutrah, Rui and Seeb. Seeb is a large village strung along the seafront, west of the other three settlements. Although it had gained a new souk, a school and some new buildings at the time of this study, it essentially retained its village character. The many *barasti* houses, spaced in irregular rows parallel to the sea, followed the pattern of other coast-line settlements such as Sohar up the coast.

Oman comes closest to a traditional urban settlement in Muscat and Mutrah. With new developments in Rui, the beginnings of an urban conglomeration could be seen.

Muscat and Mutrah have the same physical location, between bays and hills and being next to each other shared the same locational advantages with regard to trade, communications and military on which they were established. Climatically they are in hot, humid areas where both shade and air movement are required. The ideal settlement here climatically is one of shaded streets that nevertheless allow for air movement in them and into the houses. But Muscat and Mutrah have different characteristics. Muscat functioned largely as a seat of power. This was the Sultan's residence in the

north country, as it was for many of the influential people who lived in Oman, whether native or foreign. The Sultan ruled from here. Today it performs basically the same function. Major embassies, government and commercial offices are in Muscat. (It is the wealthier residential area.) The buildings in the settlement are more widely spaced than in Mutrah. They are free-standing, larger, more spacious and well maintained. Thus, while the car can be more easily allowed for and houses more open to air movement, the wider streets are exposed to the sun and uncomfortable for pedestrians. The exception is the souk, which is compact, shops separated by narrow winding alleyways that are shaded and cool. It reflects its clientele by being stocked with a high percentage of luxury and leisure items.

New development has been largely the replacement or conversion of individual buildings that are either physically run-down or for which more profitable uses can be found by the owner. The most common conversions are into offices or upper-income flats. Thus the settlement pattern by the early 70's had not been significantly altered. Influential land-owners have probably resisted greater densities and comprehensive redevelopment. The established land use of government and upper-income residences has been continued.

Mutrah, on the other hand, is the major trading centre of Oman. It is settled largely by Indian and Pakistani merchants and shopkeepers. It is much more densely built up with shops, houses and offices closely packed together. These is a much larger population in an area roughly the equivalent of Muscat. Streets are narrow and to the scale of the pedestrian, the cart and the camel. In terms of shade this remains an advantage. Otherwise, especially where the car has begun to penetrate and with increased population pressure the general result is one of congestion. Even those roads that have been adapted for the car are difficult to negotiate, crowded as they are with pedestrians and all types of vehicular traffic.

The houses are grouped together closely both physically and socially into community clusters. The most identifiable grouping is the residential cluster built by the early Indian merchant community for themselves and within which most of the merchants and their families lived. The guiding principle is security and an identifiable separation from other ethnic groups. Thus there are only two access gates into this area. These gates lead into narrow alleyways from which the houses are entered. The houses are two or three storeys high and form a protective wall around the area. The house walls that face the outside of the area do not have openings on street level.

The built environment in Mutrah was in a much more rundown condition than Muscat for a variety of reasons. Being more densely built and intensively used it suffered greater wear. Ownership had been in the hands of businessmen and it may be argued they were less concerned with appearance and prestige than governing families had been. However the many fine houses built many years ago by the predecessors of these same businessmen must modify this argument to a point. A major reason for the lack of maintenance of existing buildings must stem from the uncertainty felt by the owners about the future of their property in any redevelopment plans the government may have for the area. We personally had these fears expressed to us by several persons in Mutrah. The redevelopment that has taken place has also contributed to this rundown of Mutrah. New road links cutting through the town not only mean the inevitable demolition of existing houses but also damage to houses that suddenly find themselves adjacent to a busy road. One house, for example, had only a partially paved road running in front of it. Cars raised so much unaccustomed dust that often the large windows facing this road and the direction of the sea-breeze had to be kept shut. Openings on this face, specially designed for air-movement within the house had also been blocked as a result. Thus the house could not function


MUSCAT

as efficiently as it had originally been designed to.

The corniche and two way traffic link cutting Mutrah off from the beach front provides another example. The beach originally functioned as a lavatory for Mutrah residents, a common use for most settlements by the sea. The corniche left only a small strip available for this purpose. With no alternate sewage system provided this greatly aggravated the unsanitary conditions that developed within Mutrah.

At the time of the study it was still not too late to develop a plan for Mutrah that would have allowed the car access only where necessary. A system of cul-de-sacs servicing the souk and residential areas would be better than roads cutting through the town. Redevelopment plans need to first carefully assess what exists and how this can be improved. New plans and buildings need to draw on what can be learnt from the existing settlement pattern and houses so that Mutrah can develop consistently with its environment.

The high hills surrounding Muscat and Mutran may have once been a military asset but today they merely restrict further expansion. Thus the most active development area is the Ruwi valley immediately inland of these hills. A comprehensive redevelopment plan had been drawn up for this site, and is being rapidly built upon with a wide variety of construction types, from pre-fabricated structures to concrete tower blocks. The buildings going up represent the overspill of Muscat rather than Mutrah, multi-storey government ministry buildings, offices, embassies, hotels and high-rise apartments for top government officials. In addition housing is also being built for the new professional class, both local and expatriate, that has grown with Oman's development.

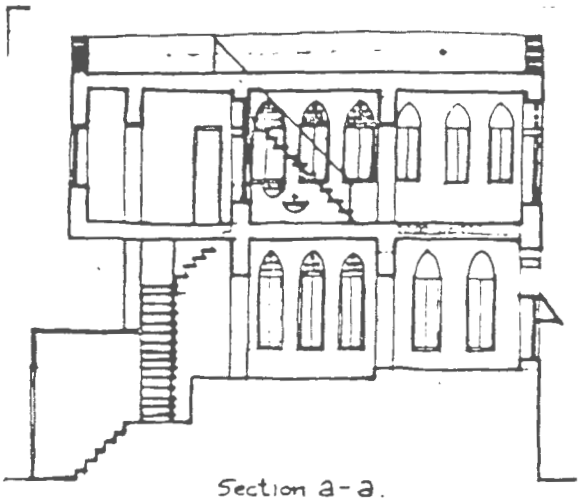
Another growing urban class resulting from development in the capital area are the unskilled often rural emigrés, providing the necessary labor for the construction projects as well as filling the lower echelons of govenment and commercial

posts. Their built environment was in something of a twilight zone. The biggest concentration lived between Mutrah and Rui in a shanty settlement of *barasti*, concrete block, hessian sheets and any urban waste that could be translated into a building material. New ingenious patterns result.

Nevertheless with little spare money to invest and no security of tenure to encourage investment, their environment remained ramshackle and rudimentary. The location of the shanty settlement had a certain logic lying between Muscat and Mutrah on one side and Rui on the other. Thus both jobs and shops were reasonably close for those for whom transport is at a premium. This location too is by no means assured as it lies adjacent to the new Mutrah harbour and cold store site. Plans for the expansion of these projects would dislodge the settlement.

At the lowest rung of shelter are those many encamped under trees and adjacent to building sites that could be seen all over Rui. Besides the basic lack of money their situation may reflect their condition as recent arrivals (or seasonal labourers) who had not yet been able to build a more substantial shelter.

These groups of shanty and "tree" dwellers were the single most numerous class, providing the essential labour for Oman's development, the poorest and the most in need of some sort of housing aid. Land, located with proximity to places of work and essential shopping, as priorities, with basic services, security of tenure, organised provision of building materials and technical advice and help could go some way in meeting this area of urgent need.



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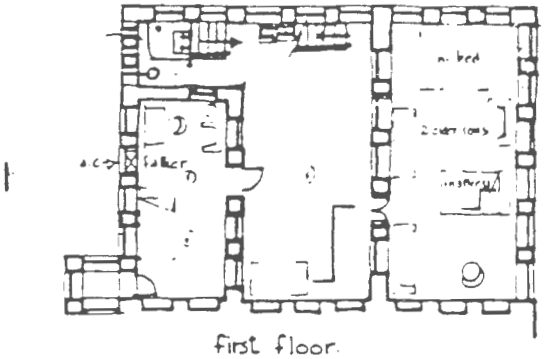
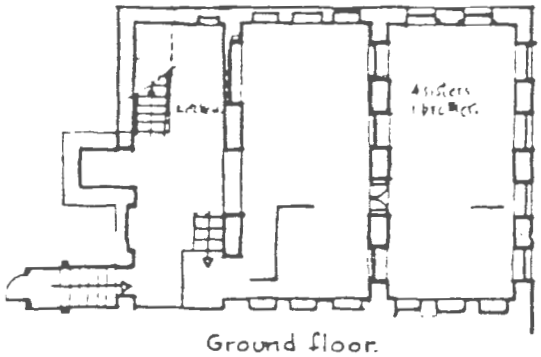


first floor.



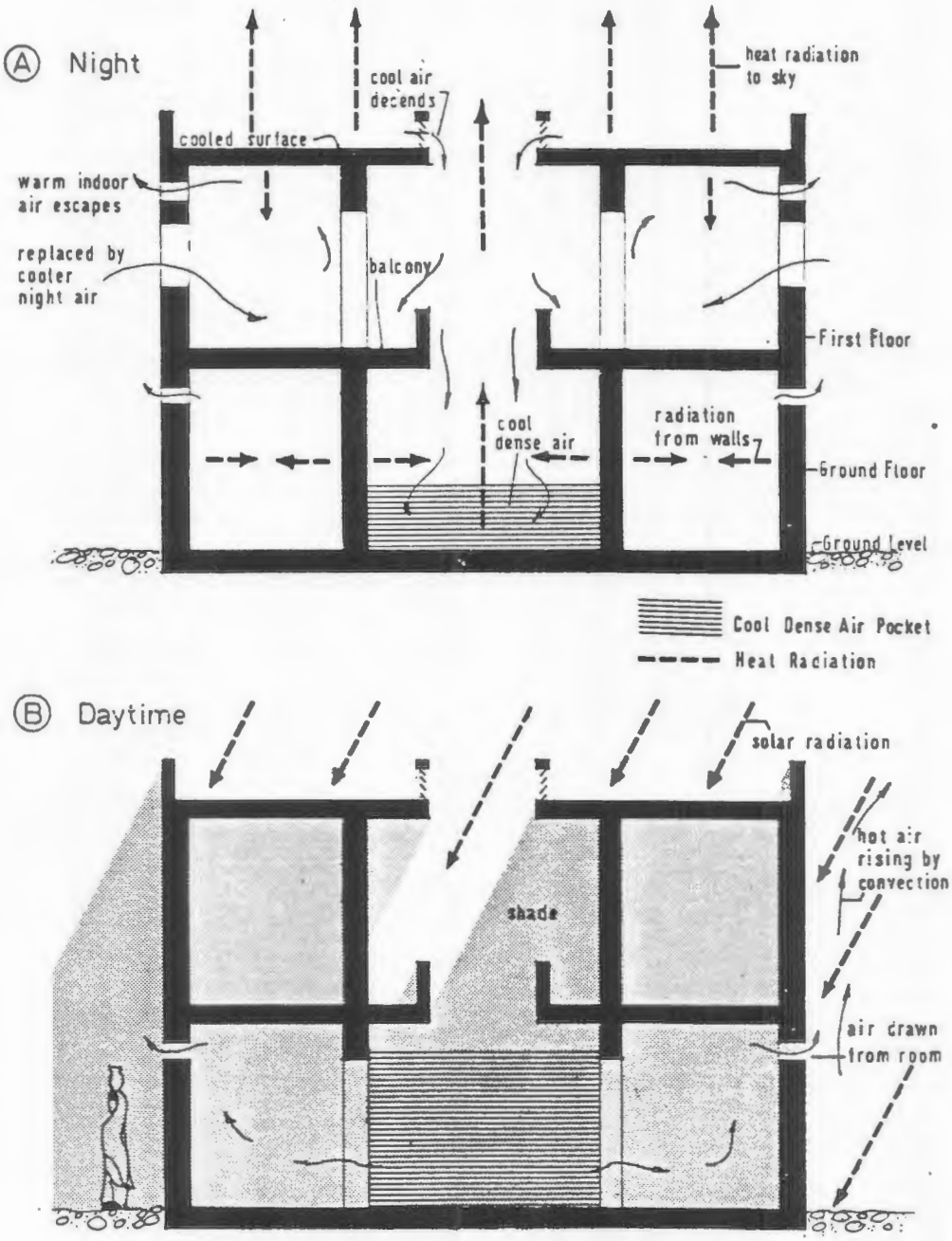
Ground floor.

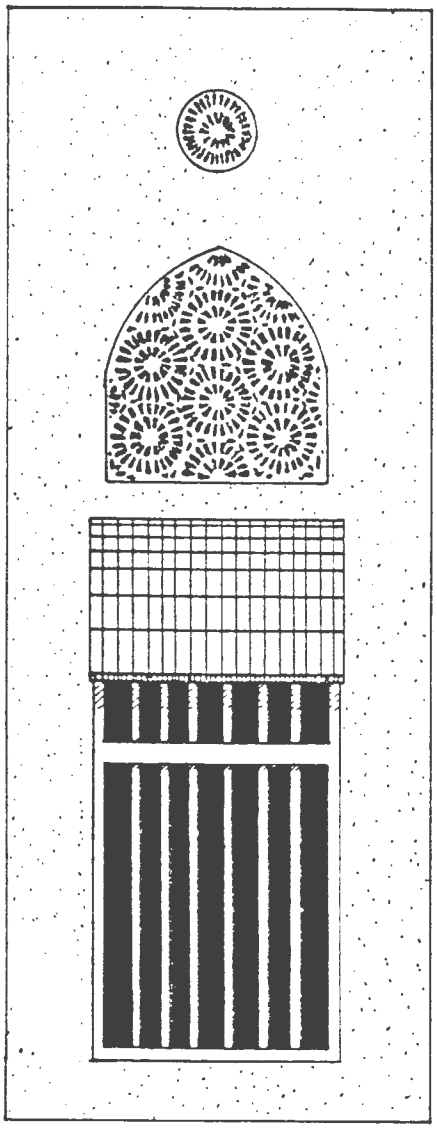
## Climatic Influences on House Form in the Capital Region

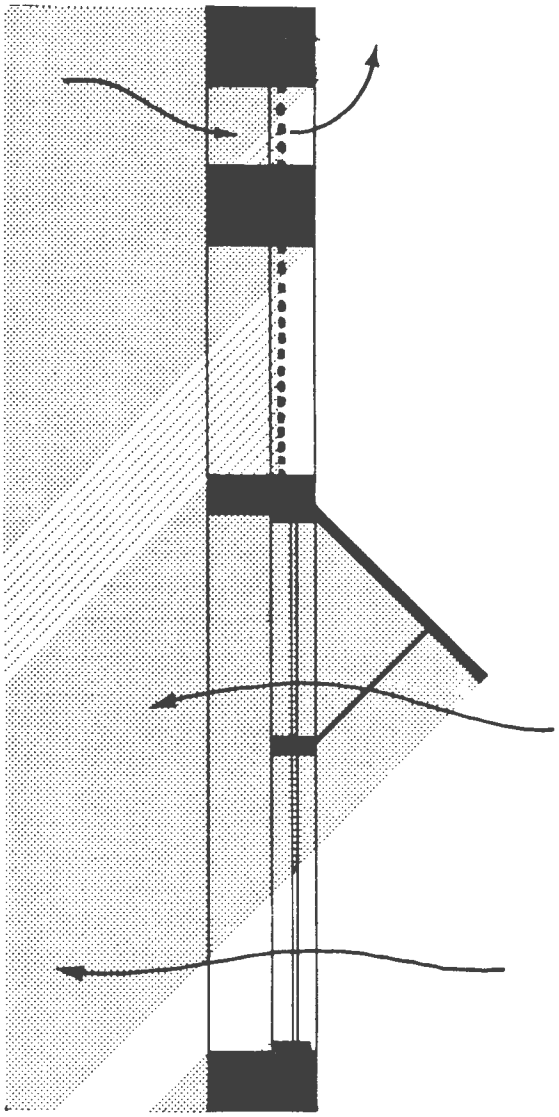
The climatic differences and similarities between the Capital Region and the Batinah Coast have been discussed earlier. It was suggested that there are similar atmospheric conditions of wind and high humidity and temperature in the two regions, but areas such as Muscat have climatic problems which are intensified due to their location in "basins" protected by hills around. Population pressures also differ between the two regions and have an effect on how climatic problems are dealt with. In regions having high humidities as well as high temperatures one would expect to find a somewhat scattered settlement pattern which would allow for air movement around and between buildings. Because of high population and the scarcity of available land for building a relatively dense settlement has evolved. Therefore other means must be found to encourage air movement and cooling. The courtyard house is one example Muscat and Mutrah also have some examples of interesting designs for window openings which facilitate air movement and help to keep interiors cool.

Typical windows in the indigenous houses of Muscat and Mutrah have multi-level openings. The function of these windows is not clearly seen without an understanding of the climatic performance of the whole house. Windows of one of a typical house on the beach front of Mutrah are illustrated. The walls of this house are limestone and because of their thickness and thermal capacity the temperatures of the walls' internal surfaces remain relatively constant throughout the day.

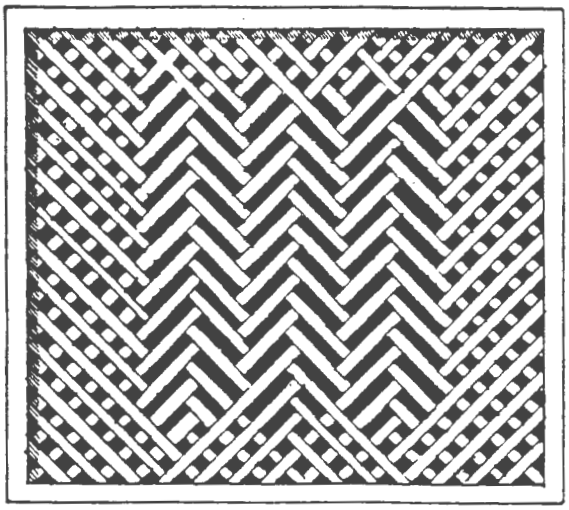
The outdoor temperature fluctuates throughout the day and for some times it will exceed wall temperatures and at others it will be lower. In the hot season it is therefore advantageous to isolate the dwelling's interior from outside air temperatures when the wall temperatures are below air temperature by closing window shutters. When


A Night
heat radiation to sky
cool air decends
cooled surface
warm indoor air escapes
replaced by cooler night air
balcony
First Floor
cool dense air
radiation from walls
Ground Floor
Ground Level
Cool Dense Air Pocket
Heat Raciation
B Daytime
solar radiation
hot air rising by convection
shade
air drawn from room

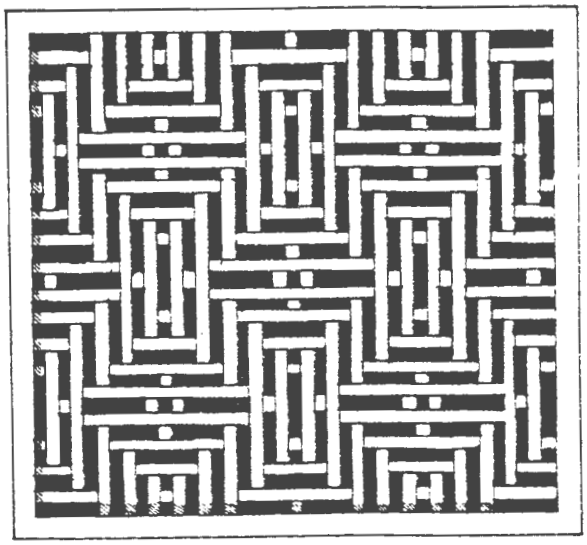




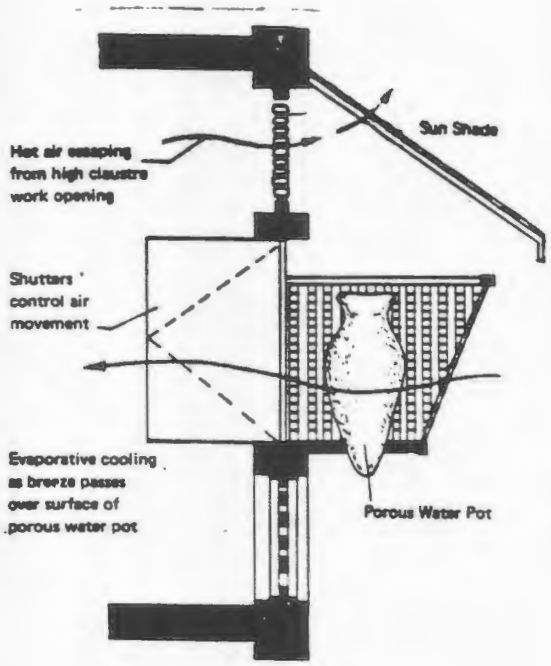
wall temperatures exceed air temperatures window shutters are opened to equalize indoor and outdoor air temperatures. On the other hand, during the hot season, when the air is humid as well, air movement must be encouraged in order to aid the body's cooling mechanism. Muscat and Mutrah receive daytime onshore sea breezes which aid in cooling. Windows are designed in a way as to allow for air passage into the dwelling when it is advantageous, but to exclude solar radiation which would raise indoor temperatures. Shading devices such as the wooden "awning" type construction shown ????? is one example and the lattice window is another. The lattice windows of Muscat and Mutrah are generally elaborate, finely detailed gypsum panels set into the wall.



The purpose of the lattice is generally to allow for daylight, air movement and a view while excluding glare and solar radiation and maintaining visual privacy. In the houses of the Muscat/Mutrah area, lattice openings are usually found in the upper portions of the window or as high window and ventilation openings. Because of the air's high moisture content the sky reflects a great deal of light and skies are much brighter than one would find in dryer regions. Because of the glare problem of bright skies the high windows opening to the sky are generally lattice work. Openings high up in rooms are also necessary to allow for the escape of warm air which collects in the upper reaches of a room due to convection.



Another example illustrating a sophisticated window design is the elaborate detailed windows of Bait Mughub (Eastern perimeter of Muscat) which have incorporated an evaporative cooling system. This cooling unit uses a porous unglazed water jar, which is placed in the window opening so that air entering the room passes over it. Water seeps through the water filled jar and keeps the outer surface of the jar permanently moist. Air passing over the surface causes the water to evaporate, absorbing heat energy, thus cooling the air and providing a supply of cool water for drink-




ing. Shading devices and lattice windows are also used to prevent solar radiation from entering the room. The quantity of air entering the room is controlled by opening or shutting any of the shutters which are incorporated into the window design. The highest lattice opening of the window allows for the ventilation of hot air which will collect in the upper portions of the room.

This same evaporative cooling system (using porous water jars) can be found employed in the design of windcatchers of some buildings in the Sind region of Pakistan. A similar but more sophisticated windcatcher using trays of wet charcoal rather than water jars, designed by Professor Hassan Fathy for one of his schools in Upper Egypt, produced a drop in temperature of 10 degrees Centigrade.[1]

The high rate of evaporative cooling could not be expected in Muscat because the humidity is much higher than in Upper Egypt, the effectiveness of evaporation depends on the dryness of the air.

1. Gourna a Tale of Two Villages, pp 115 — Hassan Fathy 1969.

SUR

CHAPTER #6

Sur is strategically located on Oman's coast in an important trading position, at the southern tip of the mountains which run through the central northern uplands, and is the terminus for trading routes which stretch across the desert extending into Dhofar. Sur is near the point where the Oman Gulf opens into the Indian Ocean.

Sur proper, Ayqa and Bilad as Sur, form an economic unit. Bilad as Sur is basically an agricultural town, being an oasis-like area a few kilometres south-west of Sur, while Sur, the market and trading centre, is located on the coast but surrounded almost completely by water or tidal flats. Ayqa is a smaller settlement, an extension of Sur proper and lies on the point of land across the narrow straits east of Sur. Coomunications are maintained by ferry.

The town of Sur lies on a peninsula with the Gulf of Oman to the north and is, except for a land link to the west, almost completely surrounded by a lagoon-like bay. The coast on the "Gulf" and "Bay" side is unstable and much of the apparently dry land is covered seasonally by water. The town of Sur is almost all permanently dry land. It is densely built up, and, outside of public open spaces, is built an average of two stories.

Sur was and continues to be a port of call on the Dhow shipping route connecting Salala and the African coast to the south, with Muscat, the Gulf, Iran and India to the north and east. Sur even at the time of the study showed signs of having been a great wooden ship building port.

Sur's importance as a trading centre in the past had resulted in a large community of Indian merchants and shop keepers. This merchant community probably had roots in the Sur area going back several generations, and in 1973 seemed still to be the most prosperous sector of the society.

The inhabitants of Sur and the surrounding area in some cases had tribal connections with peoples of the interior, apparently even as far as Dhofar. Trade and economic connections therefore extended accordingly.

Sur no doubt became important as a trading centre not only because of its strategic position, but also because of its natural harbour. The sea is known to be rough in certain seasons and ships rounding the point at the extreme eastern end of the Arabian Peninsula would often find refuge at Sur. The water of the narrows flowing out of the sheltered bay behind Sur is naviagable, but

low tide in the bay often leaves ships high and dry.

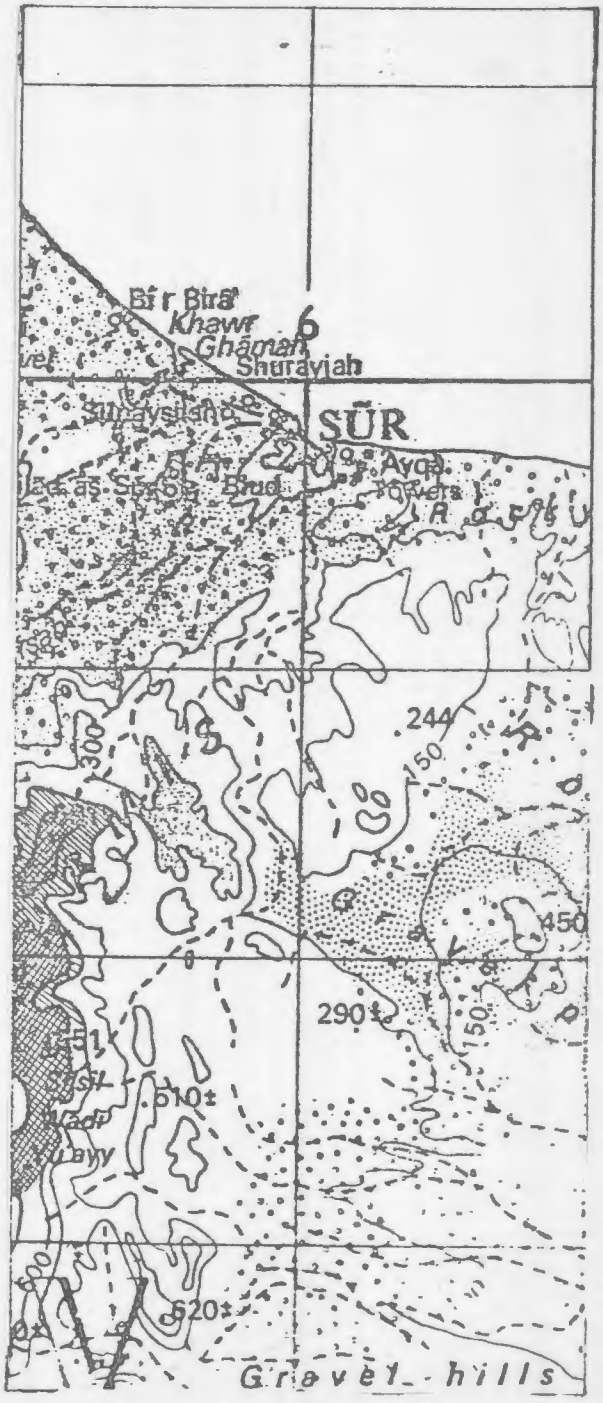
Although Sur has an excellent natural harbour there were no sophisticated docking facilities. Ships or large boats which could not beach had to be loaded and unloaded using small boats, a somewhat laborious task.

With the lack of a docking area goods could not always be monitored, but a customs house was located at the Sur side (western bank) of the narrow between Ayqa and Sur where goods were usually loaded and unloaded.

Fishing is another of the important sea-oriented industries of the area and was carried out primarily as a family activity by people living along the shore. Small boats could be drawn up on the beach adjacent to the house when not in use. Fish were sold fresh in the market or dried and salted to be stored or sent inland or traded elsewhere. Dried fish or fish meal can be used as an agricultural fertilizer and no doubt was widely used in the planted areas of Bilad as Sur.

In general it could be seen that the economy of Sur had been in decline for some time. Unemployment was very high. Few local crafts and trades still flourished in Sur proper. Bilad as Sur on the other hand still supplied staple foods to Sur but had in turn felt the effects of the decline in Sur's prosperity. Government building projects such as the school and hospital had provided some limited employment, but no long term industries had been established.

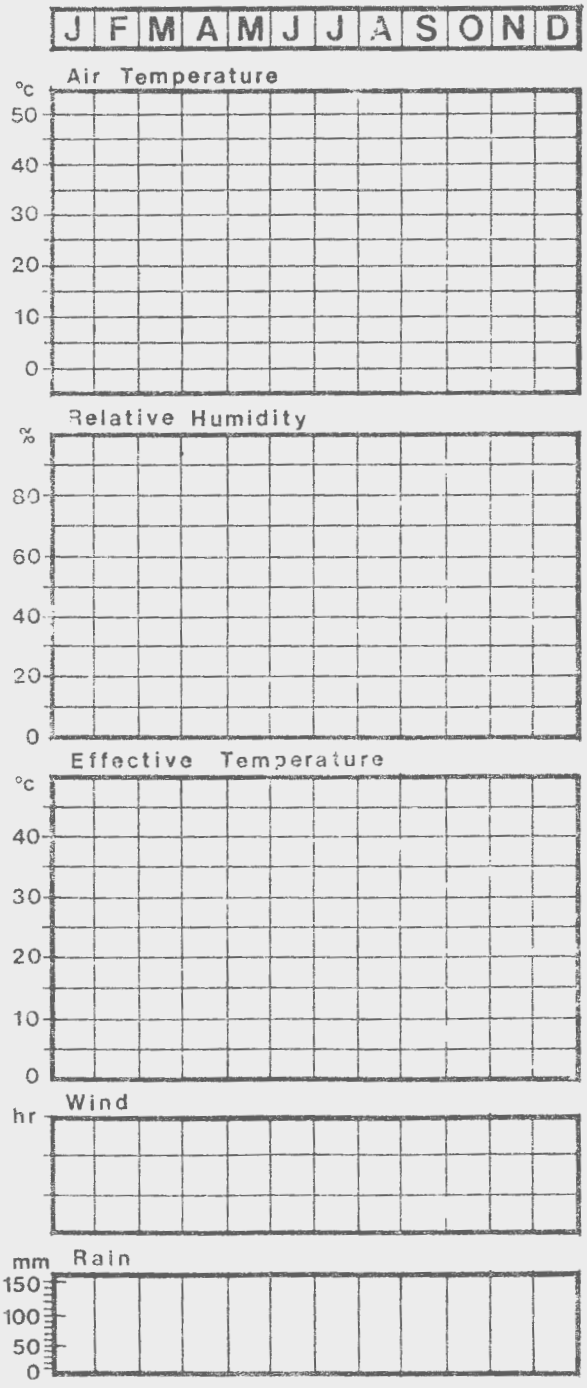
Local unemployment had resulted in the migration of workers to the Gulf region or to Saudi Arabia where employment was found in the oil industries and related construction projects. Only the working members of the



Sur is uncomfortably warm in the months between May and September. Midday temperatures in late spring and early autumn are above the comfort level. Generally, spring and autumn conditions are favourable. Winter nights are uncomfortably cool.

Sur experiences a relatively high humidity all the year, being on the coast. The late summer sees a rise in the humidity owing to shifting continental pressure systems which relate to the monsoons of the Indian Sub Continent.

Because of Sur's coastal position it experiences daytime northerly onshore and night-time southerly offshore wind conditions. This daily wind fluctuation is modified by seasonal variations in the prevailing wind system. In the winter the northerly onshore sea breeze is favoured. The prevailing northerly breeze strengthens the daytime winds and negates or even reverses the normal night-time breeze. On the other hand, in the summer a southerly land breeze prevails strengthening the evening and night-time winds and somewhat reducing the daytime sea breezes. This is an unfavourable condition in that air movement is required particularly for cooling at midday in the summer when temperatures and humidities are high. The stronger evening breeze provides a welcome relief.



Because of physical restrictions the built area of Sur is limited, bounded on three sides by water or tidal flats. Since economic activity for the whole region centres on Sur because of its harbour and trading facilities, a densely clustered built environment is the result. Sur's high density is therefore a response to a combination of economic and physical pressures.

The occupants of dwellings on the extremities of the settlement cluster tended to be involved in activities related to the sea or which would require access to the sea. Fishing and boat building were the chief occupations of these inhabitants. The residential areas of Sur had a relatively uniform high density (generally a two storey built area), with houses, mosques and the occasional shop built either immediately beside each other sharing a common perimeter wall, or separated by a tiny alley or passageway. Streets are narrow and corridor-like and run roughly at right angles to each other. Principal streets connect the perimeter of the settlement (shore area) to the market (suq) area.

The Suq area was the social and economic focus of the community. Tradesmen's and craftsmen's workshops were found along with a number of cafes. The Suq area was the only area that differed from the typical dense settlement pattern. The market activities were located around a large open square, which was unobstructed by permanent buildings. The area had been left open for sellers to set up temporary stalls during the market times. A great many of these

merchants had not sufficient goods to maintain a permanent shop, or dealt in food stuffs which tended to be seasonal. Open space for such a market was therefore essential. Fish and meat sellers also operated in the open square selling their goods on mats on the ground, sometimes in quite unhygenic conditions.

On a social level the open space of the market lace is essential when seen in the context of Sur's high density settlement pattern. The openness contrasted with the confinement of the narrow street. The market becomes a place for larger groups of people to meet and interact, with the cafes acting as foci.

Although the traditional economic focus of Sur had been on the market, it had recently begun to shift with the Government financing new building outside the town. A new hospital and schools had been built west of Sur providing initially some construction work and later some ongoing maintenance work for a limited number of the local population. These institutions obviously served more than just the town of Sur and included Bilad as Sur as well.

Various proposals had been made for the development of Sur. One suggested the extension of the built area of the Suq into what was now the open space. If large parts of what had been open was built on, the local use of the area would be drastically altered. Existing shops and cafes had been organized as they were then because they faced on to an open square. The function of the open square as a place for temporary sellers who are indispensible with their sales of fresh foods) would be disrupted if the area was built up. On the other hand, the square as it existed then was hot and dusty and facilities could have been developed to aid the temporary food sellers and the shoppers. Fish and meat selling should have been upgraded in order to ensure hygenic conditions.

Another proposal saw the shifting of the economic centre away from the traditional town centre. It was understood that Sur town had been physically built up to its maximum extent and very little land was available. Following the logic of the siting of the hospital and school, new development was proposed in an area outside to the west of the existing c tre.

Both plans tended to turn their backs on the old town areas where the majority of people lived. While new commercial and social services facilities were undoubtedly needed, attention also needed to be paid to improvements which could be made in the existing residential, public and commercial areas. An "upgrading" approach could assist in the developing of the community without loss of its existing positive potentials.

The critical climate conditions occur in Sur in the summer months when there are high temperatures as well as high humidity. During this season air movement could provide relief to uncomfortable hot conditions. In high humidity areas such as Sur, means must be undertaken to encourage air movement in the hot season. In the settlement pattern this requirement usually demands the wide spacing of building units to encourage uninhibited air movement to each building.

Due to the pressures of space and Sur's restricted site a high density settlement has resulted. This density unfortunately inhibits air movement which is needed in the summer months. It must also be remembered

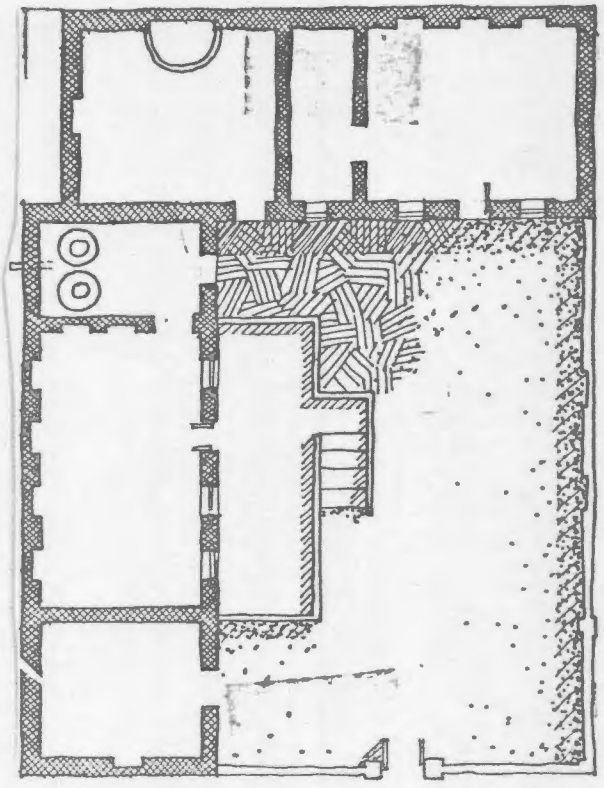
that during the daytime during the summer months wind velocity is relatively low and only increases in the evenings. Air movemeny must be induced in other ways.

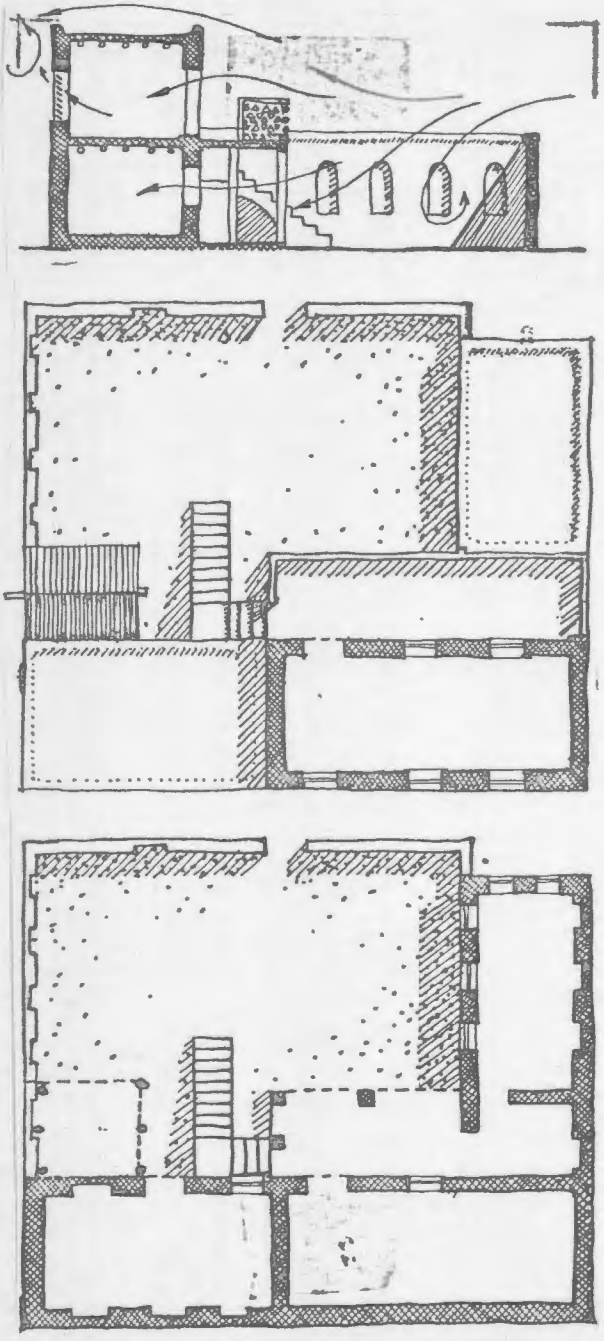
The narrow streets and passageways of Sur remain in shade most of the day and therefore cooler than larger open spaces such as the central square of the Suq which is unshaded and heats up due to the sun's radiation.

Local convection systems will result as hot lighter air in the open sunny spaces rises and is replaced by cooler heavier air from the shaded streets. Localized air movement is therefore induced along passageways as it is being drawn to open spaces. Similarly, courtyards within the houses heat up depending on their size and the amount of radiation absorbed and draw air from the shaded streets through the house and aid cooling. This phenomena is observed often in densely clustered communities in hot dry regions where there is a clear sky and solar radiation is intense and there is a very marked temperature change between shaded and sunny areas. Sur, on the other hand, has a humid atmosphere, meaning that the sky will tend not to be as clear, hence the contrast between sunny and shaded areas is not as great. This phenomena of induced air movement can not be expected to function as efficiently as one would find in a drier climate area.

The courtyard house was the dominant town house form observed in Sur. This model was basic to houses of wealthy merchants as well as to those further down the economic scale.

A perimeter wall generally 2.5 metres or more high defined the site, and a door opened through this to the street. Generally one passed from the street directly into the open courtyard. The built area of the house followed along the perimeter wall. Rooms would generally added one by one starting with building from the back wall of the courtyard, eventually extending along two or three walls of the courtyard but not usually enclosing it completely on four sides. A first floor usually followed. Though material may differ this same type of form occured in recently constructed houses as it did in older houses, demonstrated by the two houses studies, one 150 years old (Fig. ) and the other recently constructed (Fig. ).





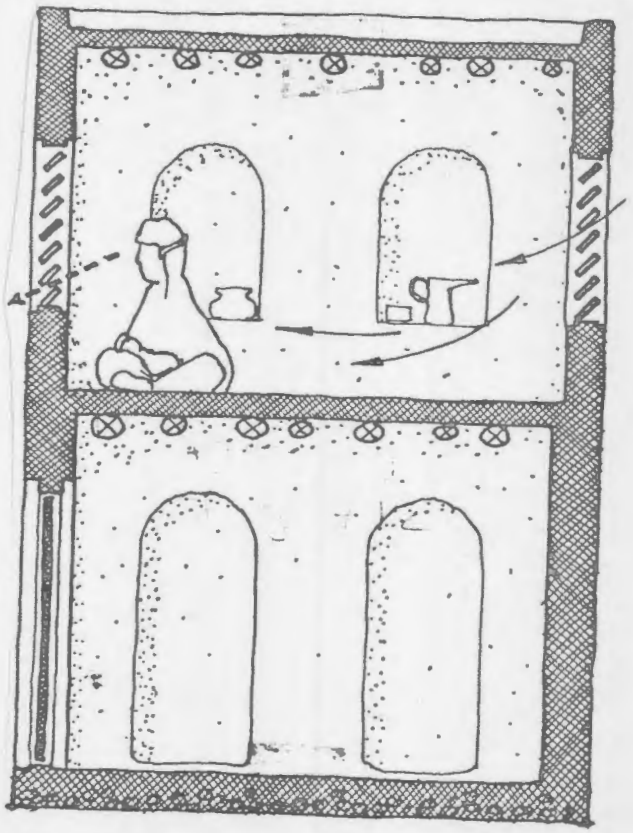
In a densely built up settlement where population density is also high, provisions for privacy become important. Where many houses had two floors and usable roofs, and the dominant form was the open courtyard, visual privacy between houses becomes important. A view of someone else's courtyard is socially unacceptable. First floor decks were arranged whenever possible so that no such view can occur. Walls between houses were built up for visual privacy, just as were the courtyard walls. Areas of the house, i.e. roof or upper floor deck, which may have had a view of a neighbour's house were unused, out of bounds.

Windows were kept to a minimum on the ground floor and rarely opened onto the street. Windows which once existed but due to new building around then had a compromising view were blocked up. Lattice windows and claustre work screens maintained visual privacy by allowing a view out but not in, while allowing air movement freely through. In the past, lattice screens made out of palm stems were used in windows. These were set into the walls of even substantial limestone houses.

In more recent houses these lattices had evolved into more sophisticated louvres. In a house studied, louvres were used in a first floor room (Fig.  ). Windows were placed on opposite walls so as to allow for cross ventilation. Windows were set at a height low enough so that the breeze would blow at floor sitting height. One window opened onto the owner's courtyard. This one had louvres with slats set so that one could look down into the yard and follow the activities there. The other window faced onto the neighbour's roof. Louvre

slats in this window sloped upward so that a view down to the neighbour's house was not possible.

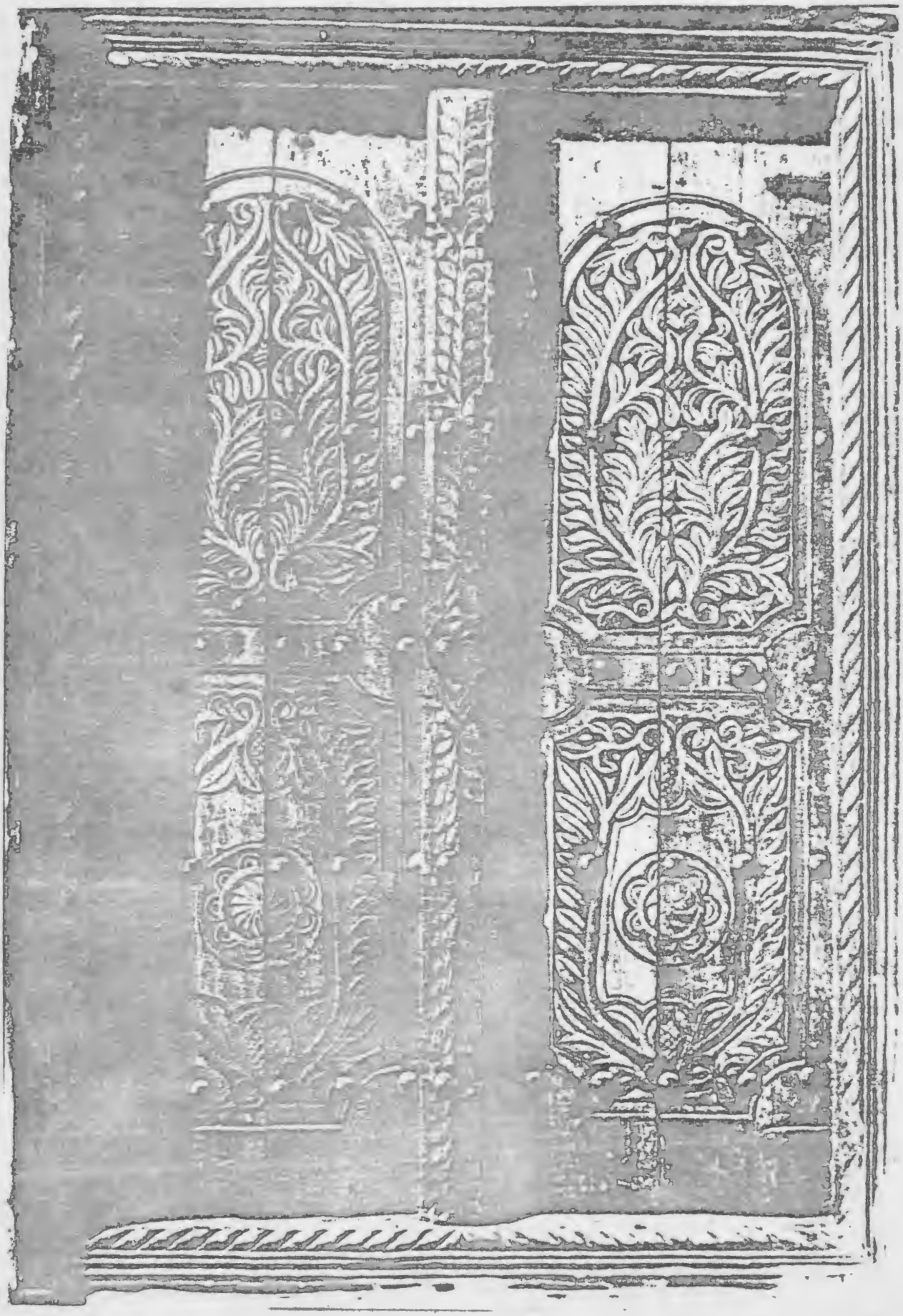
Although the settlement appears dense at first glance, within the house's perimeter wall there is a considerable amount of open space in most cases. From the climatic tables (Fig. ), particularly the wind chart, it can be seen that during the daytime hours when air movement is needed most for cooling, there is a northerly sea breeze most often. The consideration of this fact is reflected in how the built area of the house is organized within the perimeter walls. It is found quite often that the rooms of the house are built along the south wall of the site leaving an open court in front. However, as the house expands the court will begin to fill up and an open space is left in the northern portion of the site. A second storey is added above the southern part of the house in order to leave the court as large as possible. This open space allows the wind to somewhat regain its original force after being slowed by resistance from built forms in its path. Every obstruction in the path of the wind, has behind it what could be called a wind shadow, or an area of decreased velocity. The reason for the absence of building on the northern part of the site is because this area invariably lies in the wind shadow of other buildings. Further stories built above ground level accept more air movement since wind velocities increase the higher one gets above the ground. The dense clustering and narrow streets also ensure that walls remain shaded most of the time and do not heat up due to solar radiation.



The winter months, on the other hand, are found to have cold nights which tend to be uncomfortable. Since the majority of buildings within the town of Sur are made of thick limestone construction, their thermal properties will act to moderate the temperatures. Exterior walls heat up in the daytime and slowly transfer their heat into the interior. The interior wall surfaces tend to maintain a temperature which is the average of the day and night-time temperatures. Thus night-time internal temperatures being about the daily average are above the cool outside air temperatures.

Sur, unlike other dense urban areas further north (i.e. Dubai), had not adopted the windcatcher or badgir. The windcatcher tower extends above the roof level into the clear air stream and draws the cooler air down, into rooms of the house where it helps cooling. This feature could have been advantageously adapted to buildings in Sur.

Woodworking crafts were still in existence though declining in number. Only three or four workshops remained that made doors, windows and cabinets. These, in most cases, had adapted to the use of newly available timbers and had become somewhat mechanized using powered equipment. Along with these new techniques had come imported styles (particularly from India) and a certain amount of standardization. The extremely fine motifs for door and window woodwork around Sur seemed to have been forsaken (Fig.  ). This may have been a result of handwork giving way to machine production.



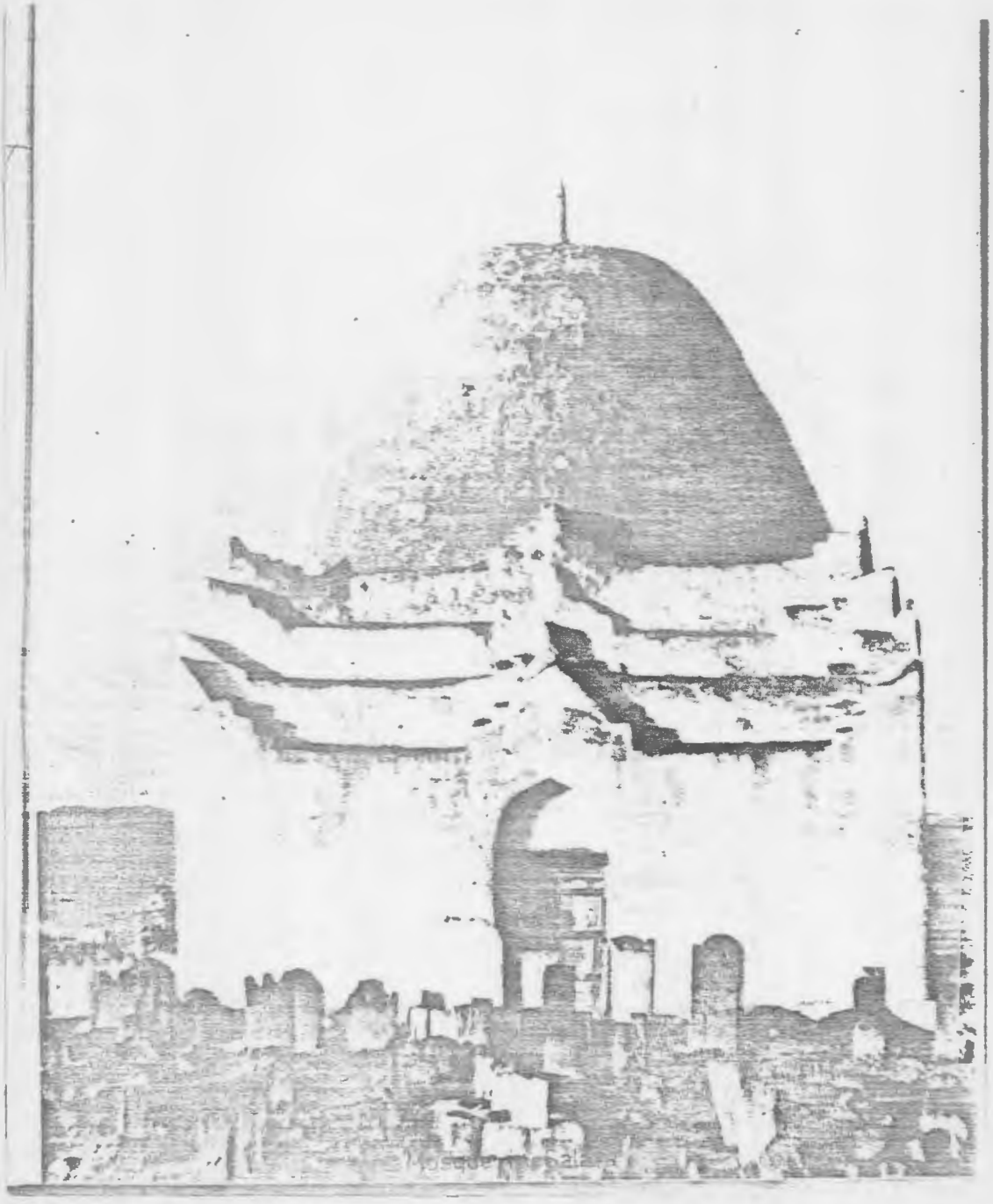
Limestone was the material used most often in the town houses of Sur. A mud mortar was used to set stones in place and a gypsum plaster often used on the exterior walls. The quality of limestone varied greatly. Soft stone was quarried along the shoreline and harder stone further inland. The soft stone weathers easily and had to be maintained periodically. Smaller loose stones were often collected for wall building and were set with mud to form a wall which showed properties of both mud and limestone, and also had to be kept in good repair and rendered often.

Cement block was just beginning to be used in the newer buildings at the time of the study. Its regularity meant that construction was easier. On the other hand, cement block was more expensive than the loose stone which could often be collected by the owner builder. Quarried limestone block, cut and standardized often proved more expensive.

In many cases houses were owner built, though local builders did exist. Stone and concrete walls could be easily constructed by labour which could be supplied from within the family. Wood construction and detailing on the other hand [illegible]e by craftsmen, generally in their [illegible]ops.

Dofar Costal Plain

CHAPTER #7



The Dofar coastal plain, stretching along the southern shoreline, is widest between Rayzut and Salala (4 to 5 km.) and tapers to a narrow stretch between Taqah and Mirbat to the east. The rocky hills and mountains behind rise to almost 1500 metres. The coastal plain is predominantly a limestone shelf with only a thin layer of fertile soil. While planting along the coast mainly consists of palm groves, which were at one time supported by a sophisticated irrigation (falaj) system, agriculture is general has been in decline in recent years. The southern slopes of the "jebal" are green with grasses and leaves of small trees during and after the rainy season.

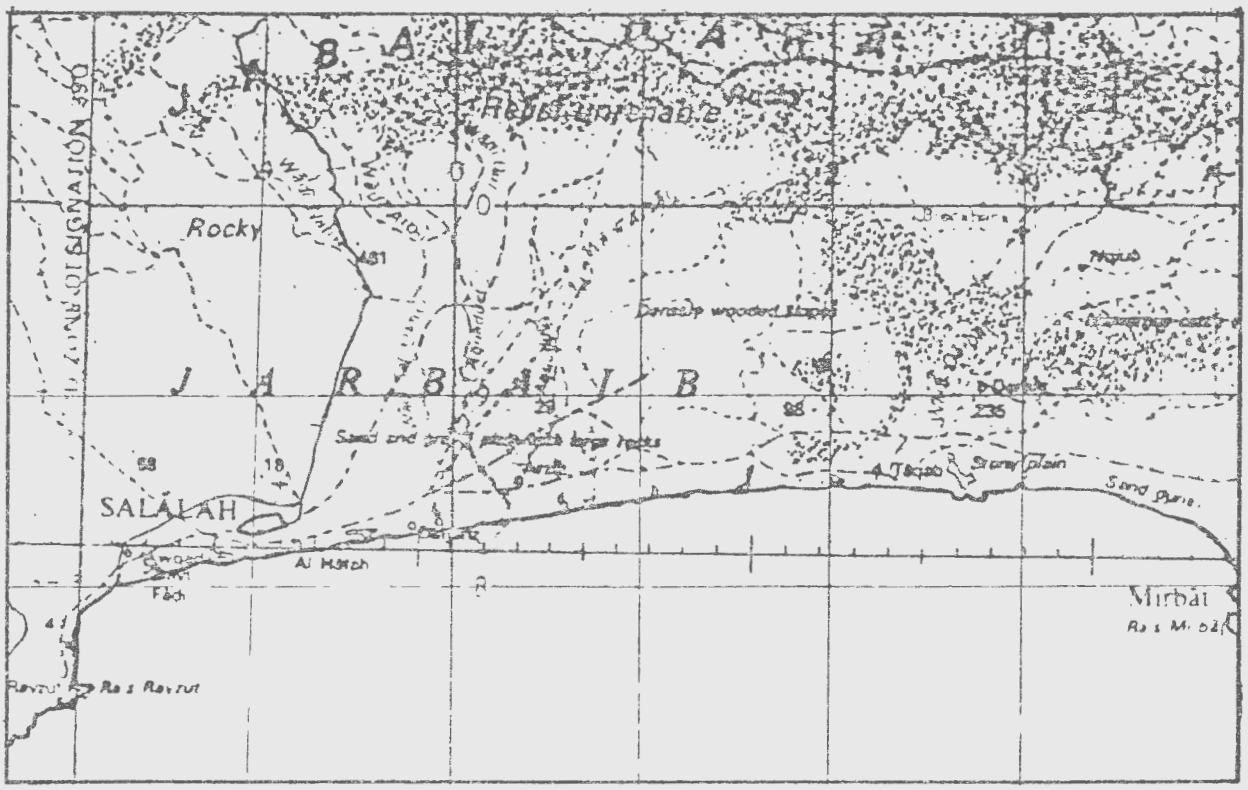
Salala lies just inland on the Dofar coast, facing the Indian Ocean, with its back to the hills and mountains of the interior.

Even though in 1973 Salala found itself isolated, historically there had existed strong ties between the town the the people of the interior. The economy of Salala was dependent upon its coconut plantations ar its fishing industry. Sardine fishing, though in decline, still employed about 1/5 of the working population of Dofar

Traditionally a greater part of the Salal. population was involved with some aspect of fishing or processing in the winter sardine season. A large catch was taken then composted and dried on the beach. Oil was collected and exported to the Gulf or used as a wood preservative (water proofer), and the dried residue was either used for agricultural fertilizer on the coast or sold as cattle fodder in the interior.

The people of the interior (Jebbelese' are herdsmen, grazing their cattle on the grassy slopes for most of the year. In the dry

At the time of the study in 1973 the guerilla war in Dofar was at its peak and Salala and a few other coastal settlements found themselves as government controlled enclaves. The security situation was one of the prime factors in producing a crisis in human settlement in the region. Shifts in population, whether induced by the war or planned strategic resettlement, produced localized problems of housing and services. Migration to the city had consequently accelerated at a rapid rate, creating in Salala an extreme example of the kind of urban problems experienced by all the other growing population centres in the country.

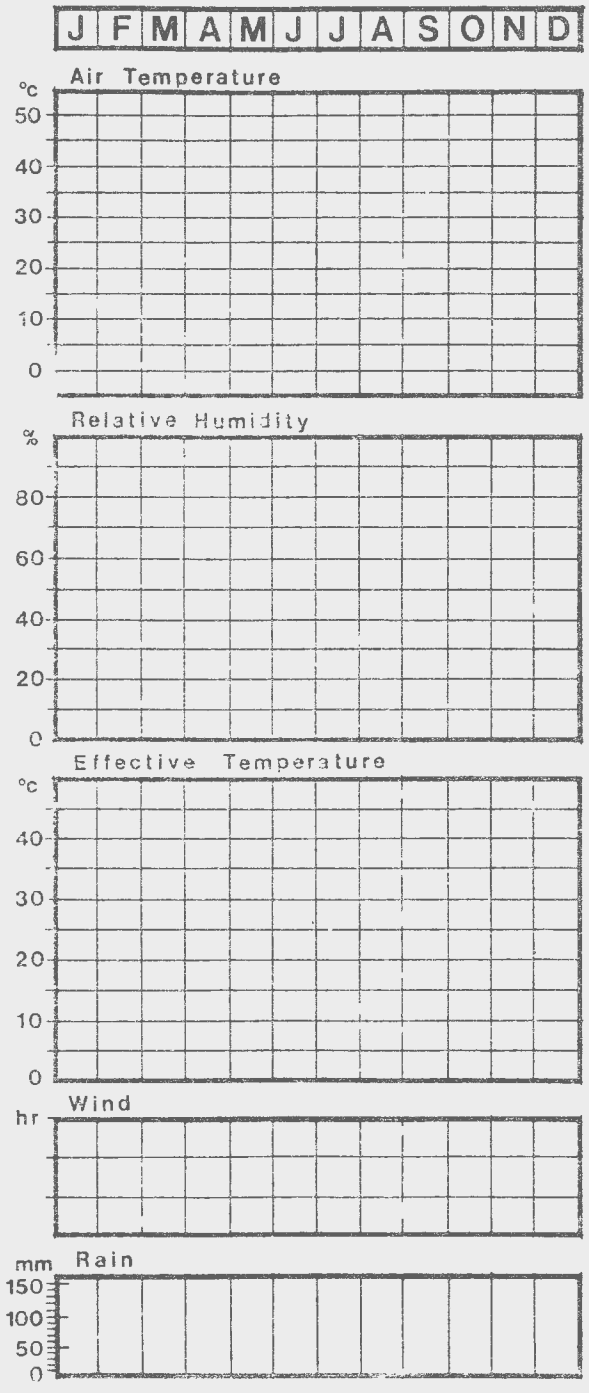



season, before the monsoon when the hills were bare of vegetation, the herdsmen would rely on dry sardines to feed the cattle. This was one of the basis for trade between the hills and the coast. Cattle were traded for sardines and other basic commodities required in the mountains and interior villages.

The war had cut off the trade which was basic to both the cattle raising and sardine fishing industries and both the Jebbelese and the inhabitants suffered because of it.

Salala had become to a large extent dependent upon imports. Local inhabitants tended to be employed by expatriate companies or the central government. Small scale agriculture was in decline, although several foreign firms were beginning to develop large industrialized farms. The cattle herding system had been largely disrupted by the war.

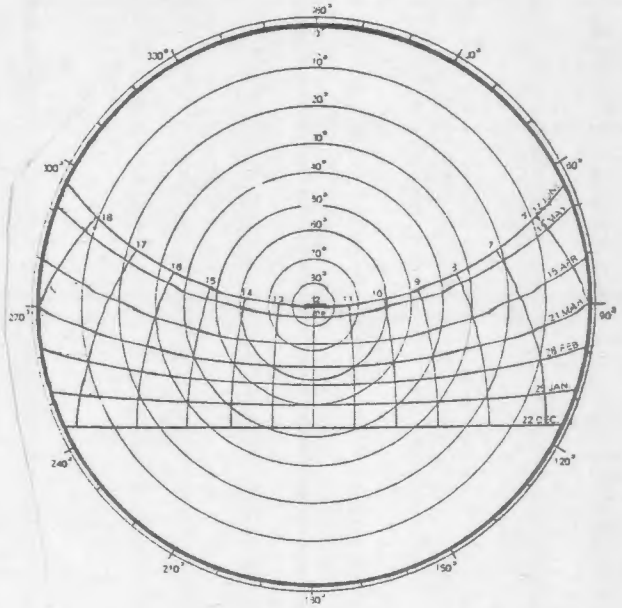
The influx of refugees into the Salala area had resulted in a great demand for land, causing severe planning problems, and an over taxation on building material resources. On the other hand, this sudden increase in population had stimulated the building construction industry. Building tradesmen and craftsmen came in to Salala from India and Pakistan because of the demand. These people, along with large expatriate contracting companies, brought with them western developed ideas and construction techniques, not always in tune with Salala's particular needs.



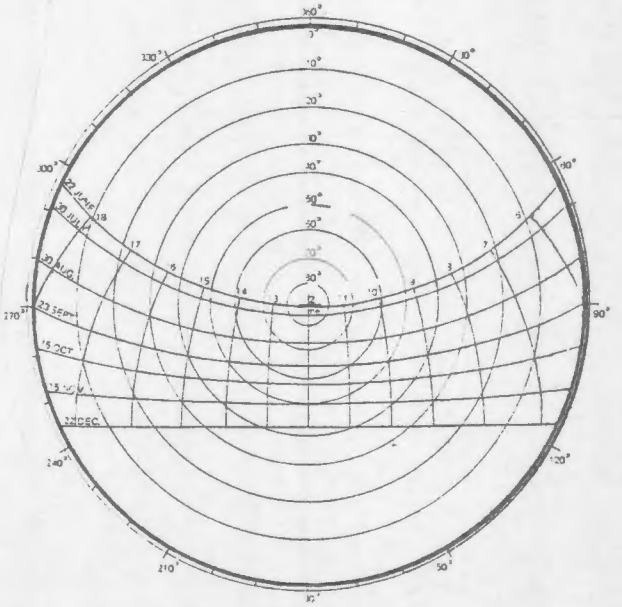

Salala technically lies in the Warm Humid Tropical Zone, and is often said to be in the monsoonal area of influence.

"Monsoon is a misleading description as it has little in common with the weather pattern of this name that affects India. It seems likely that stronger southerly winds that start in May cause cool water to be drawn to the surface of the sea and this lowering of temperature results in an almost saturated air. This cool damp air moves up over the Jebel as a thick mist which rapidly dissipates at it passes over the mountains. The area which benefits from this mist is clearly defined by the belt of vegetation along the coast."

Salala is an area of relatively moderate humidity for most of the year, but during the summer it is very high for the above reason. The so-called summer monsoonal season is not a season of rain, but one of mist and a slight drizzle, the humidity averaging 95 percent in July and August. The area in fact receives very little rain with a total of only 25 mm. in each of those months and a yearly total of only 80 mm. on an average.



Concerning thermal comfort, critical times of the year found to be too hot are May and June and again for parts of October. The months of July and August, though uncomfortable due to the high humidity have relatively lower temperatures because of the moderating effect of the moist onshore winds. In the winter months the temperatures are found to be relatively cool, lying outside the comfort zone, in the mornings, evenings and night-time.



The Salala coastal plain is subject throughout most of the year to the localized condition of daily onshore-offshore winds. Daytime winds are onshore from the south and northerly night-time winds are from the hills. This general pattern is modified by seasonal shifts in the prevailing wind pattern providing a generally dominant southerly wind in the summer and a northerly condition in the winter. For 15 to 20 days in the winter highly destructive dry cold winds tend to occur. These gale force winds carrying sand and dust can damage crops and built structures.

Because of the fact that Salala is a coastal settlement between the mountains and the sea it tended to develop linearly, parallel to the sea. The coconut palm plantations back of the beach were a natural dividing line between the coastal fishermen and barasti houses of the onetime slaves and the substantial limestone town houses inland. Because of the relative scarcity of agricultural land there were few buildings within the date grove plantations and the coastal settlement was effectively separated from the town settlement of Salala proper.

The availability of materials obviously helped determine the type of housing in each area. The barasti houses were located close to the palm groves and the limestone houses in areas where the soil is thinner and limestone could be readily quarried.

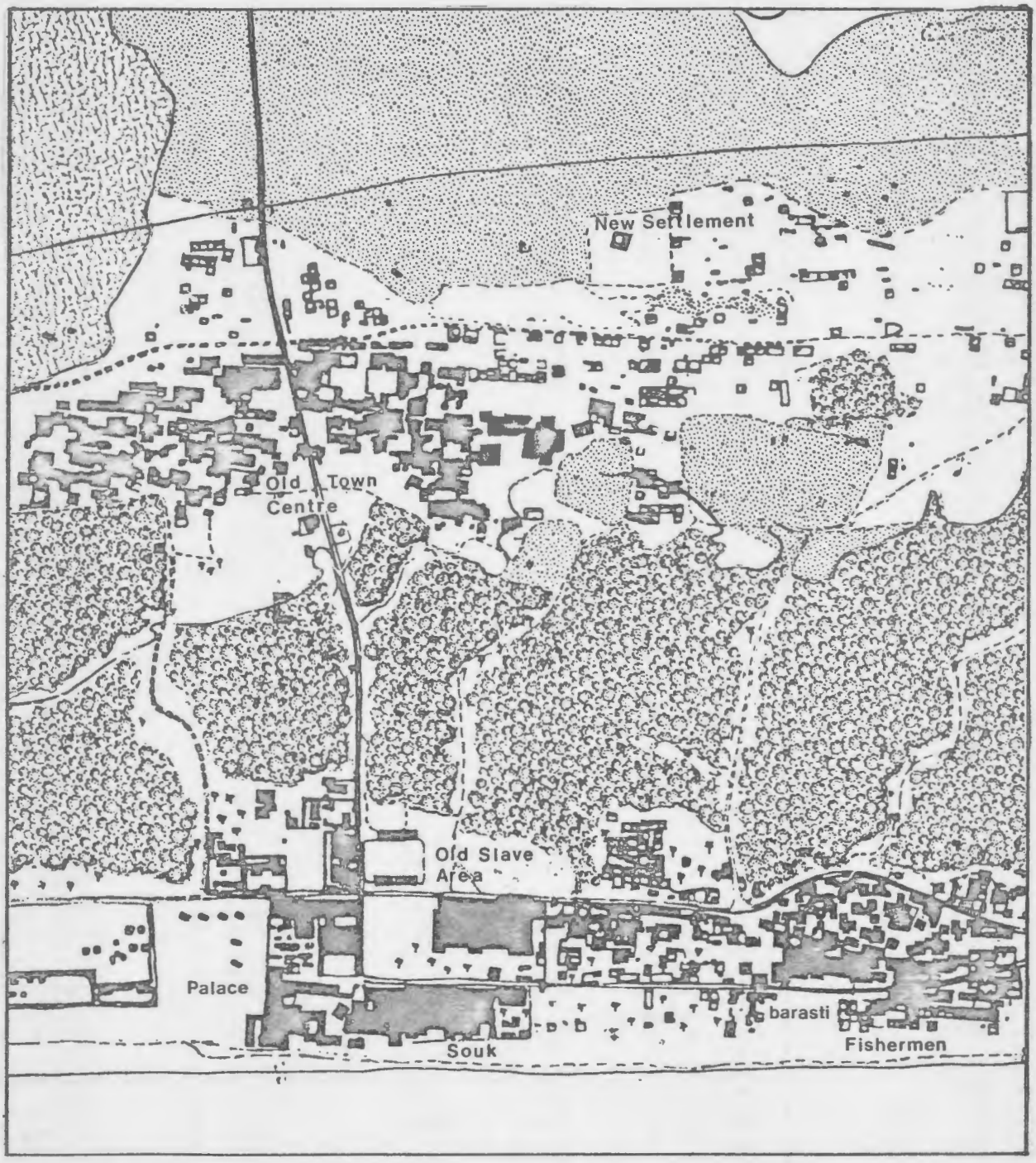
The indigenous settlements of the Salala region strongly reflect social or economic groupings. The fishermen's barasti and mud-plastered barasti houses were located along the beach, where the fisherman could be near his livelihood and keep his tools nearby (his boat, nets and catch). A large barasti settlement of one time slaves was situated nearby the Sultan's seaside palace where their employment was traditionally found.

Local tribes each tended to fit into some particular economic or occupational group and the settlement organization of the town of Salala reflected this. Even though houses in the overall settlement appeared to be widely spaced and scattered they were grouped into definite tribal and family areas. Local sheiks in each tribal area still tended to hold a great deal of the power on the municipal level. The Suq-market area was located centrally near the palace and between the beach (shipping convenience, customs, etc.) and the old residential town centre.

With the huge influx of refugees into the Salala area changes had occurred in the settlement pattern. The growth of the town was limited by the boundaries of the militarily secure area. An increase in population density had resulted. Since the indigenous pattern is scattered, most of the first new settlers built in open spaces in their own tribal areas in the existing town.

The efficiency of the natural ventilation system described in the previous section is dependent on a certain spacing between buildings. The system breaks down when houses are clustered together. In fact, the optimum density was found in the town centre of Salala proper. Any new construction would only interfere with the air movement. Another problem in increasing density of the town is found in the traditional primitive sanitation system. Because there is bedrock close to the surface of the ground, sewage had no chance to flow away or be purified by natural organic action; it quickly saturated the soil and became a health problem. This had been a problem even in the widely spaced traditional layout but with an increased density became serious.

The local municipality was trying to cope with this sewage problem by encouraging the digging of cesspits into the bedrock where liquid sewage could be drained. The sewage was periodically collected by the municipalities pump truck to be used in its raw form as agricultural fertilizer. The sewage in its liquid form could be fed directly into the traditional irrigation system. The safety of this system is questionable for health reasons, in that it could possibly

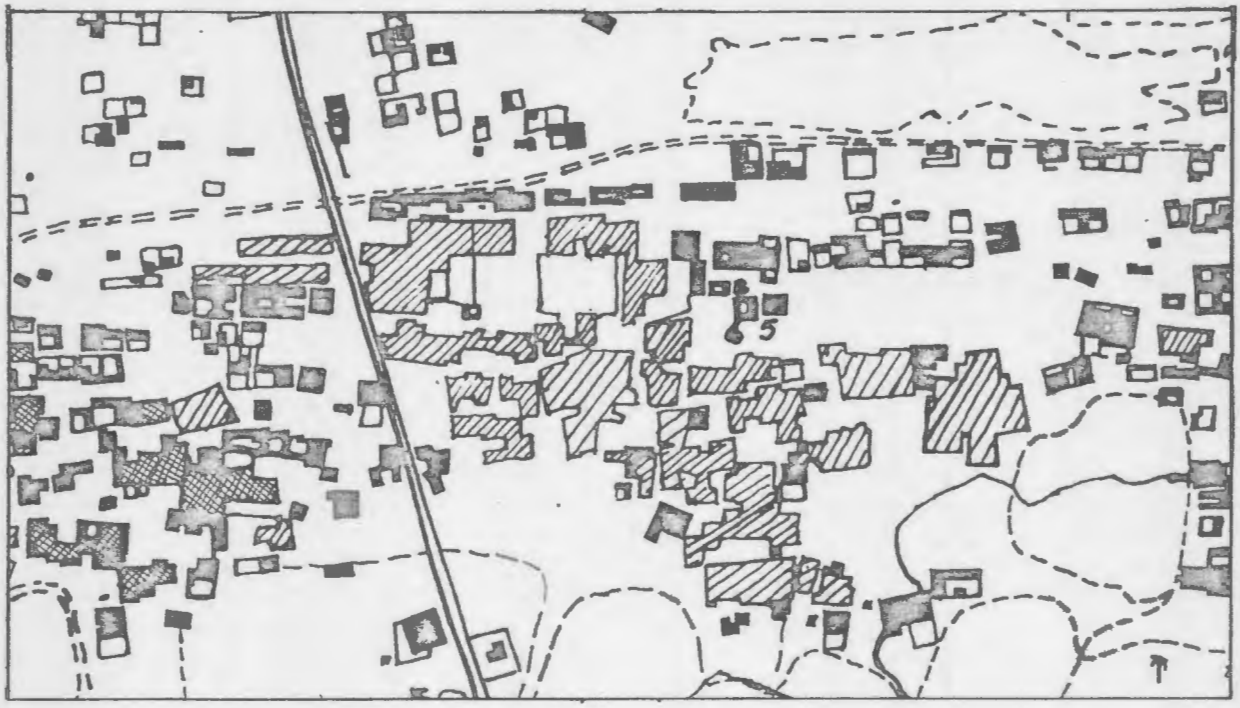

New Settlement
Old Town Centre
Old Slave Area
Palace
Souk
barasti
Fishermen

pass on parasites through food which might be raised on this raw sewage fertilizer, though this system was being monitored for safety. The municipality did not have the facilities as yet to cope with the present expanding population of Salala and in general services did not exist for a majority of the population.

New areas for settlement of refugees nad been opened up outside the old town, at a density greater than the traditional pattern. Standard 20m x 20m plots were assigned by the government for building. The construction of houses was purely the responsibility of the owner of the plot. The plots were laid out so that the house could be aligned with the prevailing wind if desired and spacing between the lots whenever possible allowed for air movement and future services However, the problems of increased density

existed in the new areas as well as in the old town. Minimal shelters of very low standard had appeared in open spaces throughout both the new and old areas, built with discarded materials, such as oil drums and cardboard. However there were signs that these too were being slowly upgraded as the occupant felt more secure in rights to the land he was on and his material position improved.

Added problems occurred with the traditional tribal nature of settlement groupings. New settlers wanted plots adjacent to their old tribal area or areas where members of their tribe had already settled. This situation had created tensions and problems which were extremely complex and could only be solved with time.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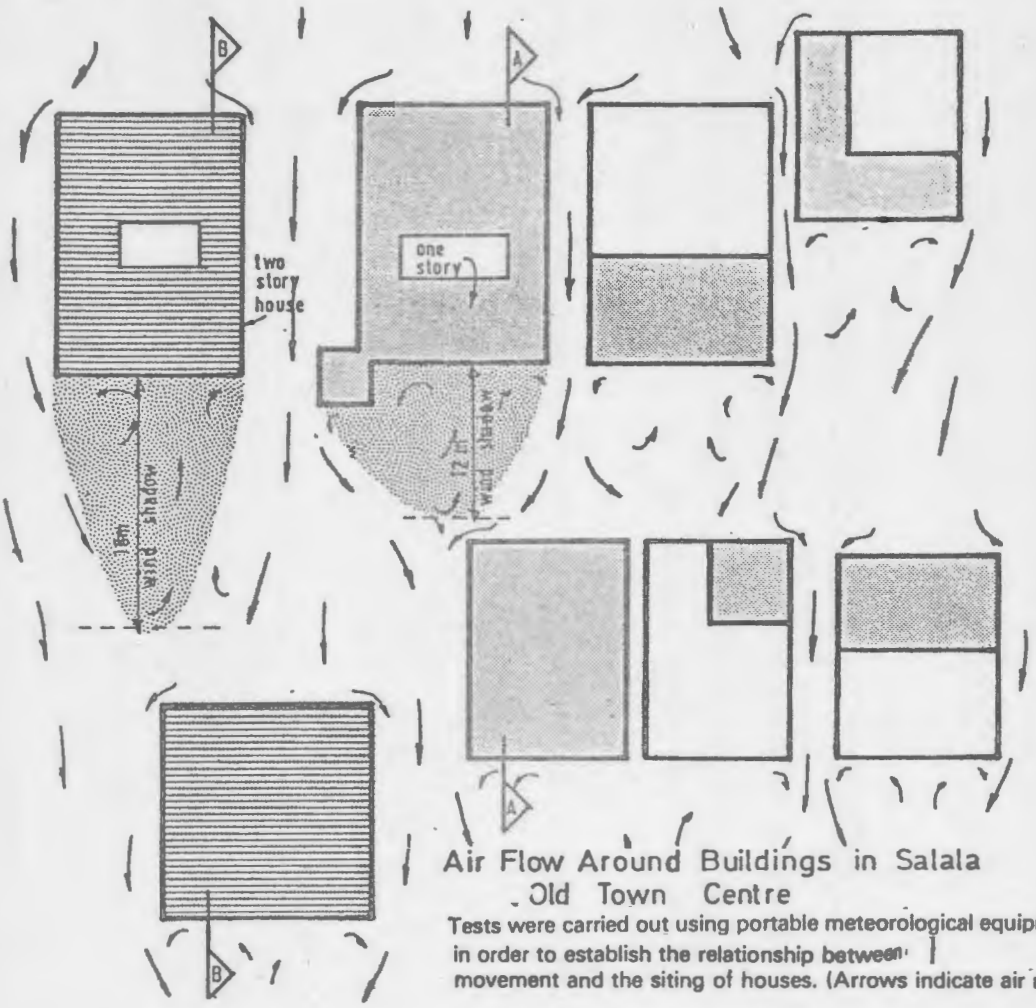
The major climatic factor affecting the situation of buildings in the Salala area is air movement. During the summer the onshore breeze is encouraged into each house. Air movement is the only natural relief to the constant warmth and extremely high humidity conditions of the summer months. Houses must be situated not only to accept maximum breeze but so as not to severely block air movement to the houses behind. Buildings are generally well spaced and oriented to facilitate maximum air movement, although houses along the beach are found to be built clearly side by side, each having an open front to catch the breeze.

Ideally one would choose to have one's house situated so that there were no obstructions between it and the southern exposure so that air could reach the front of the house with its maximum velocity. It can be noted though that when one places an obstacle in the path of the wind, a wind shadow or reduction in its velocity occurs; but at some distance to the lee of the object maximum velocity will be regained. Of course the dimensions of the obstruction influence the extent of the wind shadow.

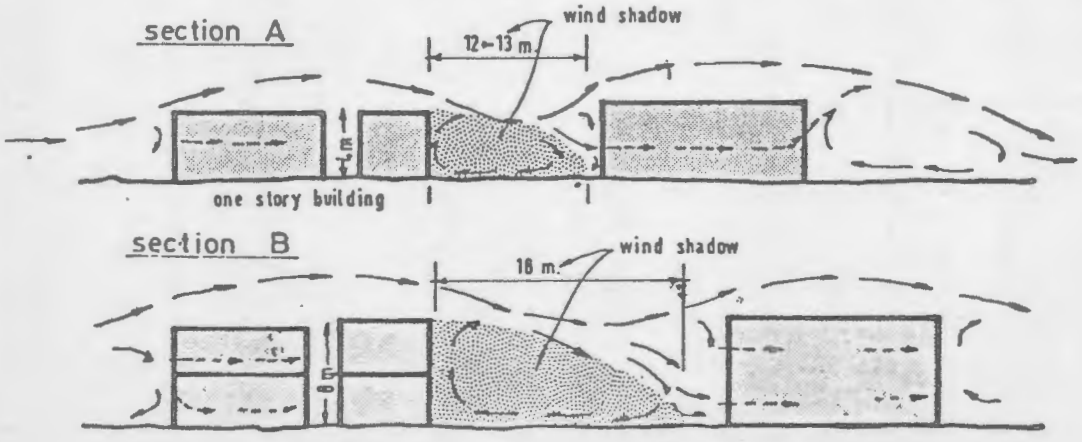
This phenomena suggests a possible reason why the Salala town houses were placed well inland of the planted belt windbreak. Settlement tended to be in bands parallel to the coast. In Salala proper this was true. Although there were traditionally no formal roads there were wide open spaces between rough lines of buildings. This spacing allowed the southerly breeze enough distance to regain sufficient velocity, after being obstructed by neighbouring houses, to provide the required cooling effect once it had passed into the house.

A predominant feature of many of the traditional Salala town houses was the large yard in the south front of the house which is defined by a low perimeter wall. This open area was the property of the house owner, and served the function among others, of ensuring that no building could be erected too close to the front of the house to interfere with the breeze reaching the windows of the south wall.




Air Flow Around Buildings in Salala
Old Town Centre

Tests were carried out using portable meteorological equipment, in order to establish the relationship between movement and the siting of houses. (Arrows indicate air movement).



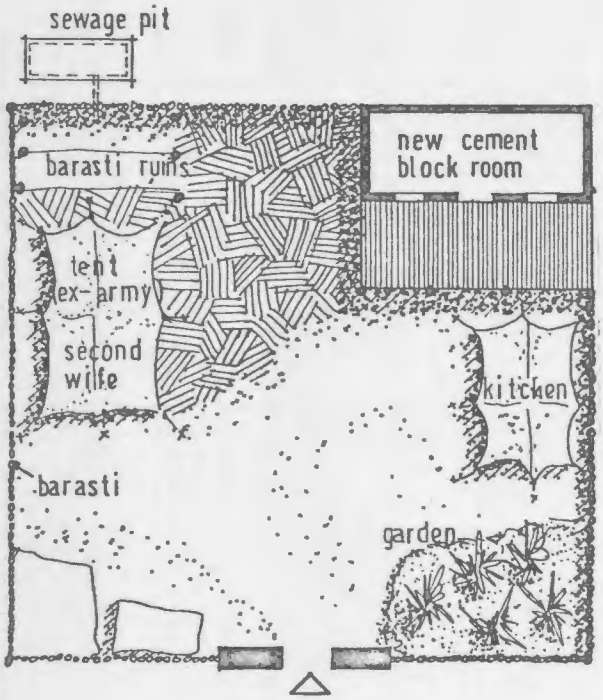
The basic social unit was traditionally the extended family. Quite often a number of brothers would occupy the same house with their respective wives and families after their parents had died. The extended family unit also tended to exist as an economic unit, with the elder member directing or in control of the family enterprise (whether it be fishing, trading or herding) as well as being the family head in social matters. Junior members of the family were given fewer responsibilities in decision making. The family house was inherited by the heir to the family power. The house therefore could be seen to represent the accumulated wealth of many generations. As the family grew more rooms could be added to accomodate it. In this way the growth of the house need not reflect an accumulative growth in the wealth or prosperity of the family from generation to generation; each generation need only extend the house as much as the previous generation to see a continual growth.

Originally, a family gaining a plot of land would build on it as to their financial resources at that time permitted choosing materials, and methods of construction, but always allowing for future growth and change.

A family with little wealth would firstly establish a perimeter wall and a temporary shelter within. This may be built of barasti as a short term measure, but if they had the possibility of advancing their economic position they would likely soon begin to build with a more permanent material such as limestone. They would always have in mind to eventually build on more than one floor, or at least to provide the base for their children to do so when the need arose. Limestone was therefore an excellent building material. Load bearing walls could be built to take several stories and limestone could be re-used in future changes to the house.

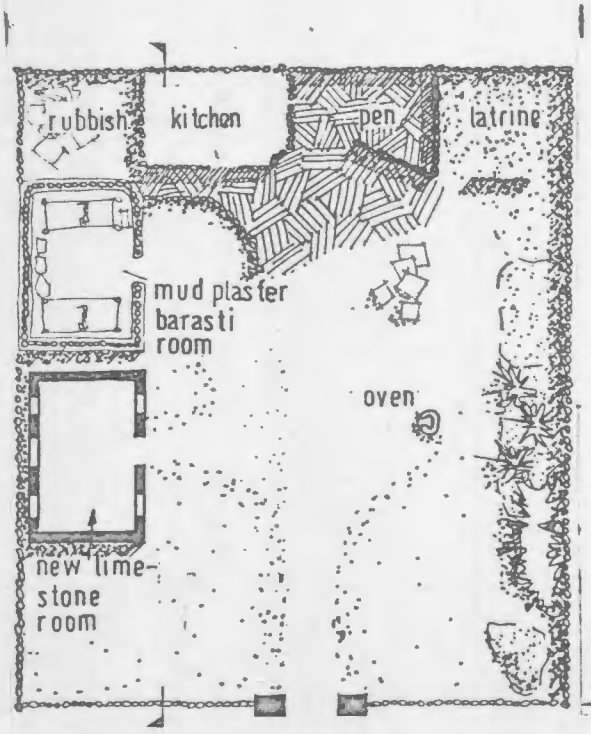
In recent years the traditional economic systems of Salala had been weakened or changed due to a number of reasons, including the war. Little employment was offered in the traditional crafts or trades, and young people had looked outside to the Gulf region for employment. The social structure of the family had changed correspondingly with a shift of economic power away from the elders to the younger members. The young sons now with money of their own had much more independence, resulting in many more houses being constructed for young families, or families of brothers working in a co-operative way. This phenomena in combination with the influx of refugees had resulted in a great increase in the rate of building. Building on the other hand had taken forms very similar to the traditional evolutionary house growth. A family always built bearing in mind future expansion. This may have been the reason for the continued preference for limestone over other materials such as concrete, even though the price was increasing. Limestone's reusability is advantageous when considering growth and adaptability and its massiveness forms a base for the addition of more floors.

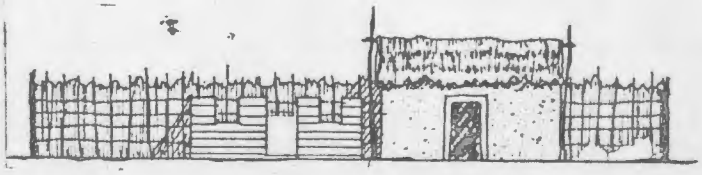
Because of the increase in building activity it was possible at the time of the study, by surveying various houses of families in differing stages of building, changing and extending, to clearly see the evolution of the house form particular to the Salala region.




The basic form is the courtyard house. Once the perimeter wall surrounding the house plot is established rooms begin to be built around a central courtyard. Plots tend to be square. This is always true in the new government assigned areas. The basic plan is almost always symetrical, with the entrance on the southern wall in the centre or slightly off centre. The first room to be built either at the front (south) of the plot with windows facing the open space in front of the house, or at the back of the site opening onto the courtyard. One of the factors considered here is the encouragement of air movement into the rooms.

As stated earlier, if the house builder is poor he may begin to build in barasti. Gradually with time he will upgrade his house by possibly using mud plaster (Fig. ) or extending hishouse or replacing parts with more substantial materials such as limestone or concrete

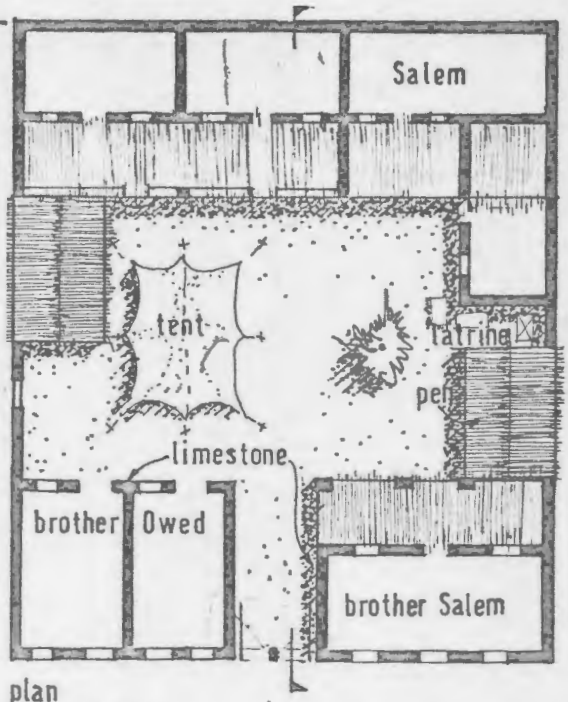


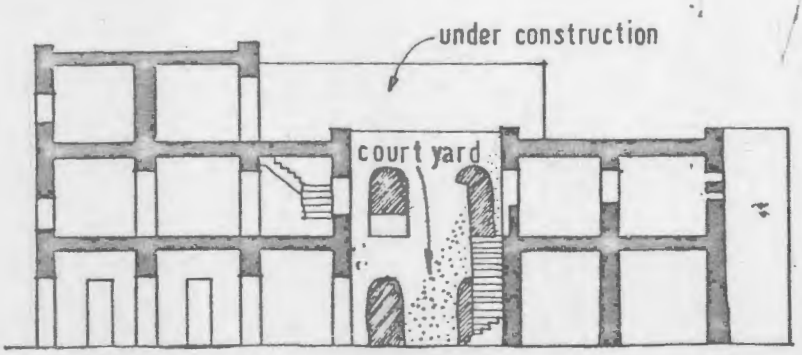
(Fig. ). Many houses make use of a conglomeration of materials indicating various stages of the evolution of the house.

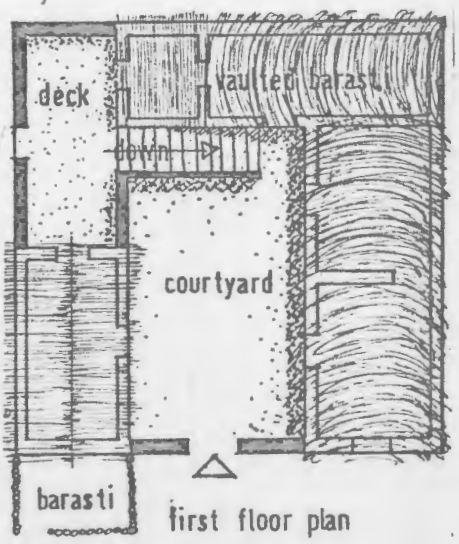
The growth of the house in time takes place in almost a spiral manner. Once the ground floor is completed using load bearing materials, rooms are constructed at the front (south) on the first floor. Construction continues to the back around the courtyard, then construction next begins at the front on the second floor (Fig. ).

In many cases the houses are completely owner built; this is particularly true for those using indigenous materials, but in some cases the house owner will contract out certain parts of the construction, such as roofing or concrete walls. Often he hires labour to help in the work, but since the extended family and tribal ties were still strong, labour could be organized in a co-operative way for these building tasks.




plan
ground floor




first floor plan

Limestone was the most common indigenous material used in the construction of permanent buildings in Salala, while barasti was used extensively in less substantial and cheaper construction. Limestone buildings were still standing which are said to be 200 years old or more. Because of the reusability of the material it is quite likely that there were sections of buildings or at least material being used then which were much older.

Limestone continued to be used despite the costs which had risen astronomically in the last few years. Because of the political and military situation affecting the access to particular materials some building techniques had altered. But in general, when the owners or local builders constructed a house it followed in many ways the design and social functional layout of past builders. On the other hand, it became apparent that changing living patterns and the use of non-indigenous materials, furnishings and implements were beginning to influence the use of many buildings. This may have resulted in the change of house form.

Imported materials such as cement for block making were beginning to be used in home building in Salala, especially in government projects. The price was 22 Rials/100 rather than 30 Rials/100 for similar sized limestone block. However cement block had several disadvantages when compared with limestone.

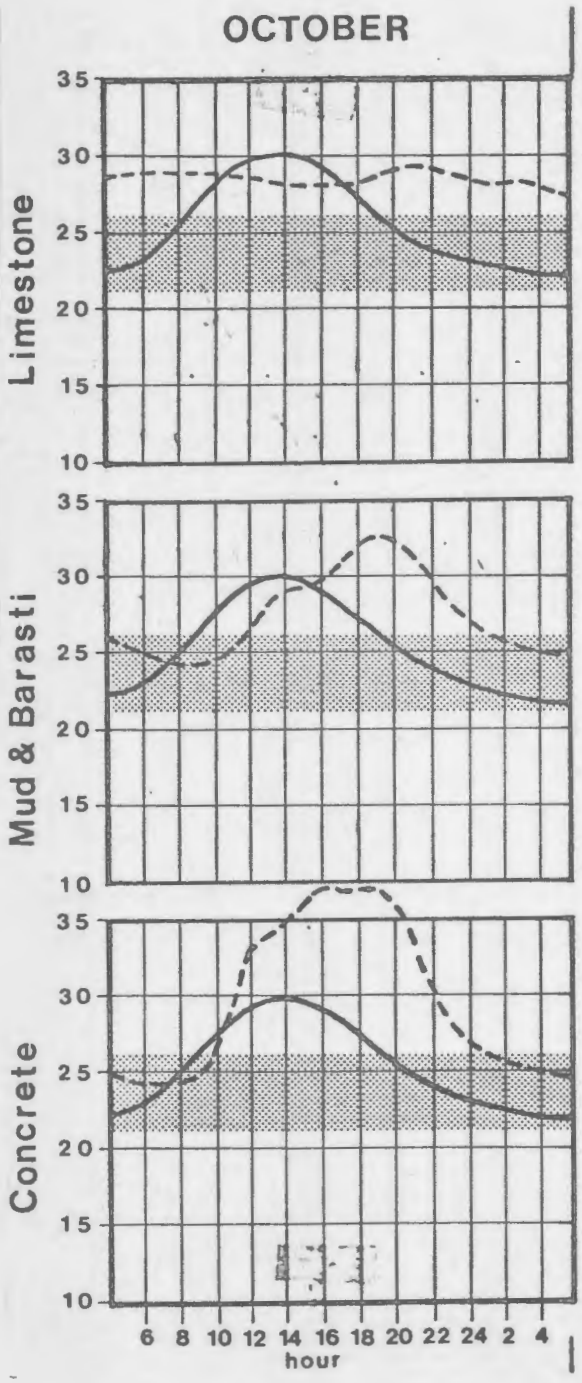
1) It is thermally inferior in its response to climatic conditions.
2) It is not reusable as was limestone block.
3) Its price depended on world market fluctuations and because of shortages was continually increasing in price.
4) The capital invested in an imported material was lost to the community, where capital invested in limestone went to increase the buying power of local people and kept the money circulating in the community.

Concrete blocks do have the advantage of being a regular size and can be handled more easily in the construction process.

Coconut palm frond stem (barasti) construction was widely used especially along the beach front. It was the cheapest commonly used material in the area, and relatively simple structures were made using it. The lowest social group tends to live in barasti houses. More sophisticated houses of barasti and mud plaster were found inland.

Of the two predominant traditional building types in the Salala area, the first, coconut palm frond stem (barasti) structures are found close to the seaside, and the second, limestone houses, are found inland or in the old established built-up areas.

The use of a particular material was partly influenced by social class. The barasti houses on the coast being occupied by the descendents of slaves of the Sultan were near the palace. Sardine fishermen along the shore also lived in barasti houses. Barasti is a far less expensive material to use than limestone. It also can be seen to respond directly to the local micro-climate. The atmosphere in the area directly adjacent to the beach has a relatively higher humidity to that further inland. As a result air movement should be encouraged to induce a certain amount of cooling. Barasti walls generally allow air movement as they are porous. Open lattice walls and openings to allow cross ventilation are predominant design features in this area.




As one moved back from the beach it could be noted that barasti was used in combination with a clay plaster to produce more substantial buildings. The rendered walls stop air movement so that windows were incorporated into these houses. The clay barasti walls have thermal insulative properties which are advantageous in the cool winter nights and stand up much better to the abrasive actions of the severe winter winds.

Limestone construction has been used as the principal material for houses of the townspeople and merchants. The traditional town houses of Salala take on fortress like appearances and the use of heavy limestone construction is a response to somewhat hostile social and physical conditions.

A study was carried out on building materials used in the Salala area in order to understand their response to thermal conditions which change from season to season. Qualities of each building material, particularly their heat ransfer properties, have an effect on modifying internal microclimates of buildings. Each material transfers the heat, built up on the outside faces of a building exposed to the sun, into the interior of a building with a different rate and with varying efficiency.

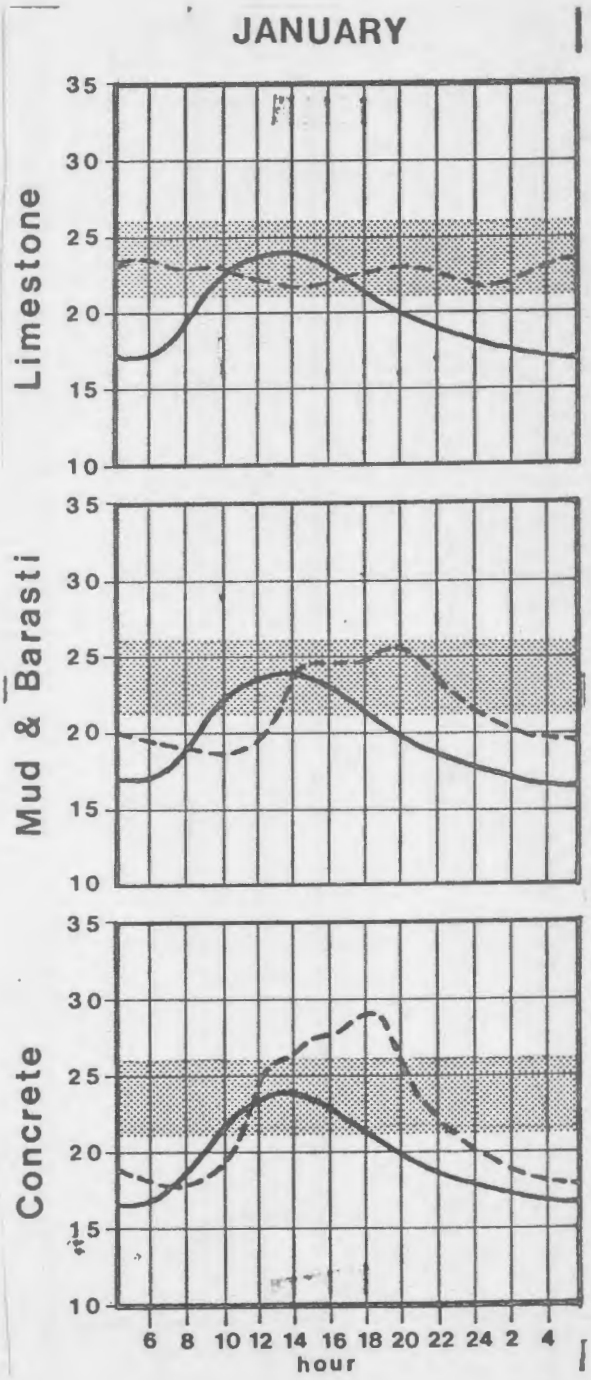
The materials chosen for testing were limestone, barasti panels plastered with mud on both sides and concrete block. Rooms were selected from houses in the new settlement area of Salala which were built in each of the three materials. Each room tested had the same orientation and was free standing. Limestone walls are approximately 50 - 60 cm. thick while mud plastered barasti walls are 8 - 10 cm. thick and concrete block walls 15 - 18 cm. thick.

The thick limestone walls transfer heat quite slowly having a high thermal capacity. Solar radiation causes exposed exterior wall surfaces to heat up. It generally takes about 18 hours for a portion of this heat to reach the interior of the room (Fig. ). This means that some of the noon time heat from the outside is transferred slowly through the wall and is radiated into the interior at about six o'clock the next morning, which is the coldest time of day. This is advantageous whenever the night-time temperatures fall below comfort levels. This happens in the winter months in Salala. On the other hand, in the late spring and summer months, during the season of high humidity, there is very little direct sunlight as the conditions are generally misty or cloudy. The fact that interior surfaces do not heat up as much due to solar radiation and there is a very small daily temperature range results in the limestone walls heat transfer action being negligible. In this season air movement must be encouraged to maintain comfort condtions.

Mud plastered barasti walls and concrete block walls transfer heat much more quickly into the interior than do the thick limestone walls and more of the heat built up on the exterior surface actually reaches the interior.

The time that it takes for heat to be transferred by conduction through the mud plastered barasti wall is five hours (Fig. ). Approximately 60 percent of the external heat reaches the interior.

The heat transferred through a concrete block wall takes 3½ hours to be conducted from the external to the internal wall surface. 75 percent of the external heat



passes through to the internal wall surface.

In comparing the performance of the three materials it can be seen by looking at internal air temperatures that in each case comfort limits are exceeded for most parts of the day. Air temperatures within a limestone room are consistently one or two degrees above the upper limits of the comfort zone. Within a mud plastered barasti walled room the temperatures will be comfortable in the morning and at night but will be above the comfort limit in the afternoon and hottest in the evening. Air temperatures within a concrete block room will be well above comfort limits by late morning and continue through the afternoon and evening.

To discover how the three materials, limestone, mud plastered barasti and concrete will respond to the Salala climate during the coldest month of January, graphs can be drawn (Fig. ) using information extrapolated from the three previous graphs and the climatic charts (Fig. ).

In the winter season it can be seen that the temperatures within the limestone block room are consistently found to be comfortable even though the temperatures outside fall below comfort limits during the morning, evening and night.

Temperatures within a mud plastered barasti walled room (Fig. ) fall into the comfort zone in the afternoon and evening but are below comfort limits in the morning.

Within a concrete block room (Fig. ) temperatures are found to be comfortable at noon and in the evening but too hot in the afternoon and too cold at night and in the morning.

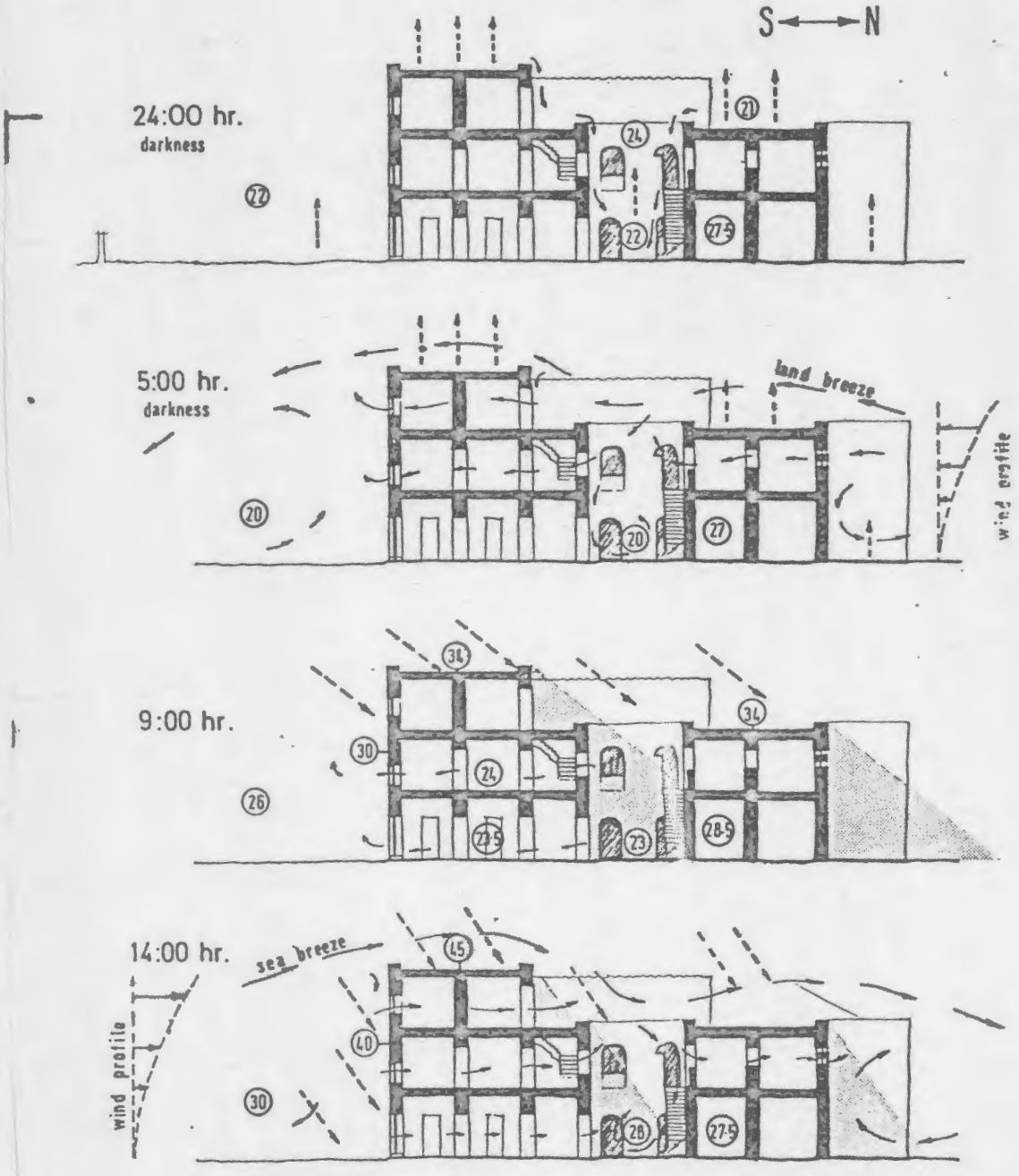
It can be concluded that the heat transfer properties of thick limestone walls are advantageous in maintaining moderate comfortable temperature conditions within a building, particularly in the cooler winter months. During other times of year the heat transfer properties of each material tested are incapable of producing a comfortable thermal environment inside buildings. Therefore other factors such as air movement must be considered in the design of buildings in the Salala region.

The traditional town house of Salala (Fig. ) incorporates a large open front yard facing the south (toward the sea). Climatically this ensures that this space will remain open to allow air to reach the front of the house. The south wall of the house itself is pierced with numerous large openings (above ground level) to allow air to pass freely. The predominant house form being the courtyard house reflects this need to encourage air movement. This form allows the house to be set up so that at any point
cross ventilation can always occur.

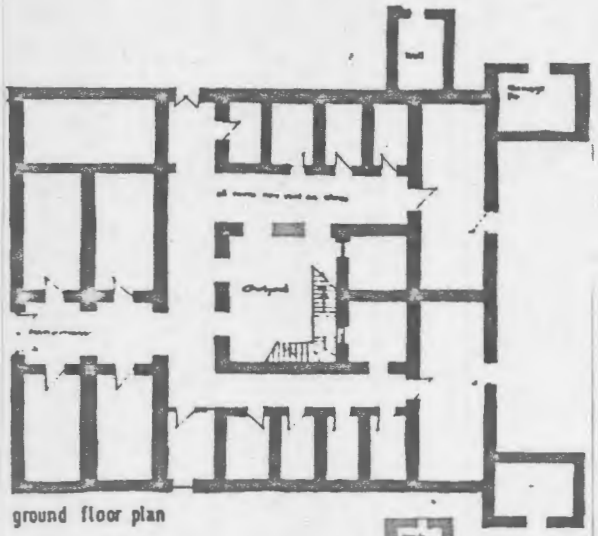
While the south wall is open to accept the summer breeze, the north wall has few openings and they tend to be small. This blank north wall protects against the cold, dusty northerly winter wind.

A study was carried out in order to determine the response of the traditional courtyard house in Salala's climate.

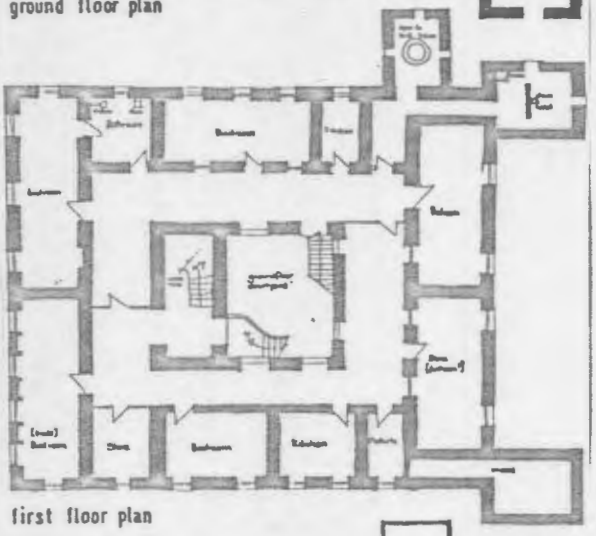
The courtyard house, typical to Salala's particular micro-climate. Its response to the climate is seen over the span of a typical day.



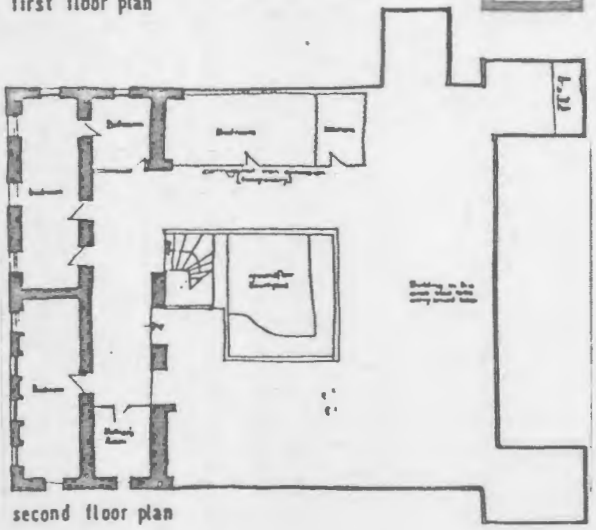

Climatic Response of Salala Courtyard House · Oct. 28, '73



ground floor plan



first floor plan



second floor plan

At night (Fig. ) there is little air movement due to the diminishing effect of the land/sea breeze. The flat roof rapidly cools by radiating heat to the night sky. The cool dense air on the roof settles into the courtyard, displacing any warm lighter air which may have remained there. The courtyard becomes a cool air "well".

As the night progresses to early morning (Fig. ) the land continues to cool. A land breeze results. The north wall with small openings receives little air movement.

With the morning sunlight (Fig. ) air movement tends to disappear and roofs and south walls are heated up. The courtyard remains shaded and its pool of cool air is protected. As the temperature of the house rises, cool air from the courtyard flows into the rooms off the court.

As the day progresses the land warms (Fig. ) and the sea breeze takes over. Air movement passes freely through the upper rooms of the house. Velocities are greatest on the second floor level and diminish towards ground level. Air movement is encouraged to aid in evaporative cooling, particularly on the top floors, while at ground level the courtyard remains in shade and stays cooler.

# Building Policies and Realities

## 1. The Existing Situation

The Economic Report 1972 for the Sultanate states:

**"Regional Development should be at the heart of the Government's development strategy and should have as its objective the stabilization of rural society. Development is as much a social as an economic concept which should mean that people work together to build up their village rather than become a rootless class of urban industrial workers".**[1]

Given the above objectives, a program for improving the indigenous built environment, much of it in the smaller settlements and rural areas, would be obviously relevant.[2]

However what was observed happening in 1974, if permitted to persist, would make the achievement of the stated objectives and the program to be proposed here very difficult to achieve. It is therefore worth setting the study's proposals within a discussion of these current trends and their implications.

Two interrelated trends were marked in 1973. Firstly, an emphasis on large-scale infrastructure and building projects relying heavily on capital intensive, mechanised construction and sophisticated technologies. Secondly, the rapid development of the Batinah region, specifically the capital area — Muscat, Mutrah-Rui — relative to the rest of the country as manifested by the concentration of these projects.

Some Examples: The new Mutrah harbour-cost £20 million — using the most advanced and expensive design of breakwater unit (as yet untried elsewhere), Seeb International Airport — cost £5 million, 232 Kilometres of road between Muscat and Sohar-cost £10.5 million, a low-cost housing scheme of 250 units — cost £1 million.

Some emphasis on developing the Batinah Coast is understandable given its strategic location vis-a-vis trade and security consideration and its status as a national capital. Certain construction projects are by their nature necessarily capital-intensive and require sophisticated technologies. For a newly emerging nation such as Oman, the attraction of such projects is also naturally great since they are associated with the success of industrialised countries and carry much prestige. They thus serve well to herald Oman's entry into an age of development.

It is not within the scope of this study to assess the extent to which the emphasis on such projects and on the Capital Area is warranted by the above factors. However, it is worth considering the characteristics of such projects and their impact vis-a-vis Oman and its development objectives.

By definition such projects make severe demands on capital resources, particularly foreign exchange. The capital requirements are even more so compared to similar projects in developed countries since much of the materials, equipment and skills for construction usually need to be imported. Furthermore such imports may have to carry on at least for a time until local materials and expertise can deal with maintenance and repair. Where the country does not have a well developed transport, technical and managerial infrastructure, implementation takes longer and is more prone to errors thus adding to cost. Finally contractors' overheads and profit margins in large-scale projects can amount to a significant proportion of total costs.

Such projects may still make sense where capital is plentiful and labour scarce. This is not the case in Oman.

At present Oman's capital needs are being met by its oil revenues (approximately 85 percent of all revenues[3]). Oil reserves are expected to last another 20 years. The extent to which this limited capital is already being depleted was underscored by the Economic Report.

"The infrastructure projects now being built and planned will require annual recurrent expenditure. There is a danger that if building continues at current rates, within a few years there may be insufficient funds to meet all the consequent expenses."[4]

To make up this shortfall in capital, domestic and foreign investment is urged. But the experience of other developing countries shows that such sources are seldom adequate. Massive development loans have to be solicited, and from the same experience, it appears that, above all, these result in crippling debts for the recipient country from which recovery seems impossible.[5] In fact a recent U.N. conference outlining strategy for developing countries proposed that the only way to deal with these debts was to simply cancel them.[6]

Superficially, Oman's population of ???,000 may suggest the need to adopt capital-intensive methods. However, a closer look at the employment situation suggests otherwise. Labour shortages exist in the semi-skilled and skilled categories, while in the unskilled categories, there are more Omanis employable than there are jobs available. Capital-intensive projects per Pound investment tend to create a greater demand for the skilled and semi-skilled than for the unskilled. Thus such projects aggravate the existing imbalance in Oman's employment situation rather than easing it. The task of training sufficient skilled workers, at best of times difficult, becomes more so when the gap between existing skills and those required is widened as when demand is created for skills in unfamiliar and relatively sophisticated construction technologies.[7]

In housing projects a critical measure of the inappropriateness of such an approach is that the resulting costs per unit are too high for most Omanis to afford and clearly beyond the nation's resources to subsidise in sufficient quantities. Typical costs for government construction 'low-cost' housing schemes were £4500.0 per unit.[8]

This was clearly not affordable by the low-income Omani household whose total annual income was probably something less than £360.0 or £30.0 per month.[9] Thus even assuming the unrealistic, that is the government has the capacity to construct enough houses and finance mortgages *interest-free* with 50 years to repay, the household would have to set aside 25 percent of its income for repayment (monthly £7.5). International experience indicates that low-income people can afford to invest no more than 6% to 10% of their income towards housing.[10]

At one time or another some developed and developing countries alike have applied industrialised housing techniques to try and achieve the number of houses required at reduced costs. The basic characteristics that make capital-intensive, high-technologies problematic also apply to such housing production methods. They make demands on scarce resources of capital and skills and require a well-developed matrix of infrastructural and service supports. To quote Charles Abrams, a leading authority on housing in developing countries:

"Industrialised housing techniques have been tried by less developed nations with smal success and sometimes near disaster — in the less developed world where labour is cheap and plentiful and where standards are simple, the precast house is unessential and premature. Despite the glib sales talk of prefab peddlers from abroad, the handicraft product is still cheaper, more expandable and more realistic."[11]

Now there are circumstances in which large-scale construction of flats and housing or even prefab units are necessary such as when an industry urgently requires housing for its workers, or emergency shelters are required after an earthquake. However such methods should not constitute the main thrust of a nation's housing effort.

Given the current emphasis on large scale, capital-intensive methods for meeting infrastructure and building needs and their characteristics as described above, we can now see how their benefits are limited spatially and to the upper-income groups. Since such projects are expensive they can only be a few and cannot be replicated across Oman. Furthermore, they must also be located where infrastructural and service supports are most available or are easiest to create. The natural choice therefore is the already advantaged capital area. Thus in 1973, 81 percent of development funds were invested in projects in the Batinah region leaving only 19 percent for the rest of the country. Of this 81 percent, 31 percent was spent in the capital area alone.[12]

The proportion of this investment that is not lost to other countries as import payments is captured by the relatively few indigenous Omanis who either entrepreneurially or professionally are involved in the construction related business thus generated. Similarly the facilities produced such as housing benefit the few who can afford them or are favoured with subsidized units. And while the capital requirements of such projects ensure that this region captures most of the government's financial resources, the manpower requirements for their construction insures that the same region captures much of the country's labour resources.

The shanty towns springing up everywhere around Muscat-Mutrah and Ruwi are filled with those who have left their lands and homes in other parts of the country in the hope of a job. From our interviews with these people it was clear that many at best were only intermittently employed. On the other hand interviews in villages showed that both housing and cultivable land was being neglected by owners who had diverted their attention to the hope of a better life in the capital. The prospects for employment of all these new migrants once the construction boom is over are not promising.

## 2. An Alternative

If "regional development", "rural stabilization" and "people working together to build up their villages" are Oman's objectives then an alternative strategy is obviously required, one that restricts large-scale capital-intensive construction to when absolutely necessary and emphasizes instead an improvement of the indigenous built-environment of the small towns and rural areas.[13] That is, what Oman outside the Capital Area consists of, and it is there that the majority of Omani's live and work. This program of improvement must command enough resources at the sites of implementation so that it can be implemented in a spatially decentralized manner and be inexpensive enough to be replicable at a scale large enough to have significant impact.

It must therefore achieve two complementary objectives:

1. Increase the total resources-financial and in kind available for improving the built environment.
2. Reduce the cost of this task of improvement.

Before outlining such a strategy it is useful to make explicit a fundamental difference in perception that underlies this alternative strategy versus current practice in Oman. Underlying current practice seems to be the perception that built environment needs — physical infrastructure, community buildings and housing — are commodities to be manufactured with certain minimum quality specifications and sold on the market or rationed at subsidised rates to specified groups. Underlying the strategy to be proposed here is the view that the indigenous system of meeting environmental needs should be reinforced. This system is the incremental upgrading and expansion of habitable space by the occupants of that space.

What is required is a framework of supports that will encourage and complement individuals' and communities' willingness and capacity to invest their own resources in meeting their built environment needs. By encouraging private resources to complement those of the government, the sum total of financial and material resources for improving the built environment is increased. By encouraging incrementally inexpensive but cumulatively significant improvements we can insure their costs and complexity remain low enough to be widely replicable.

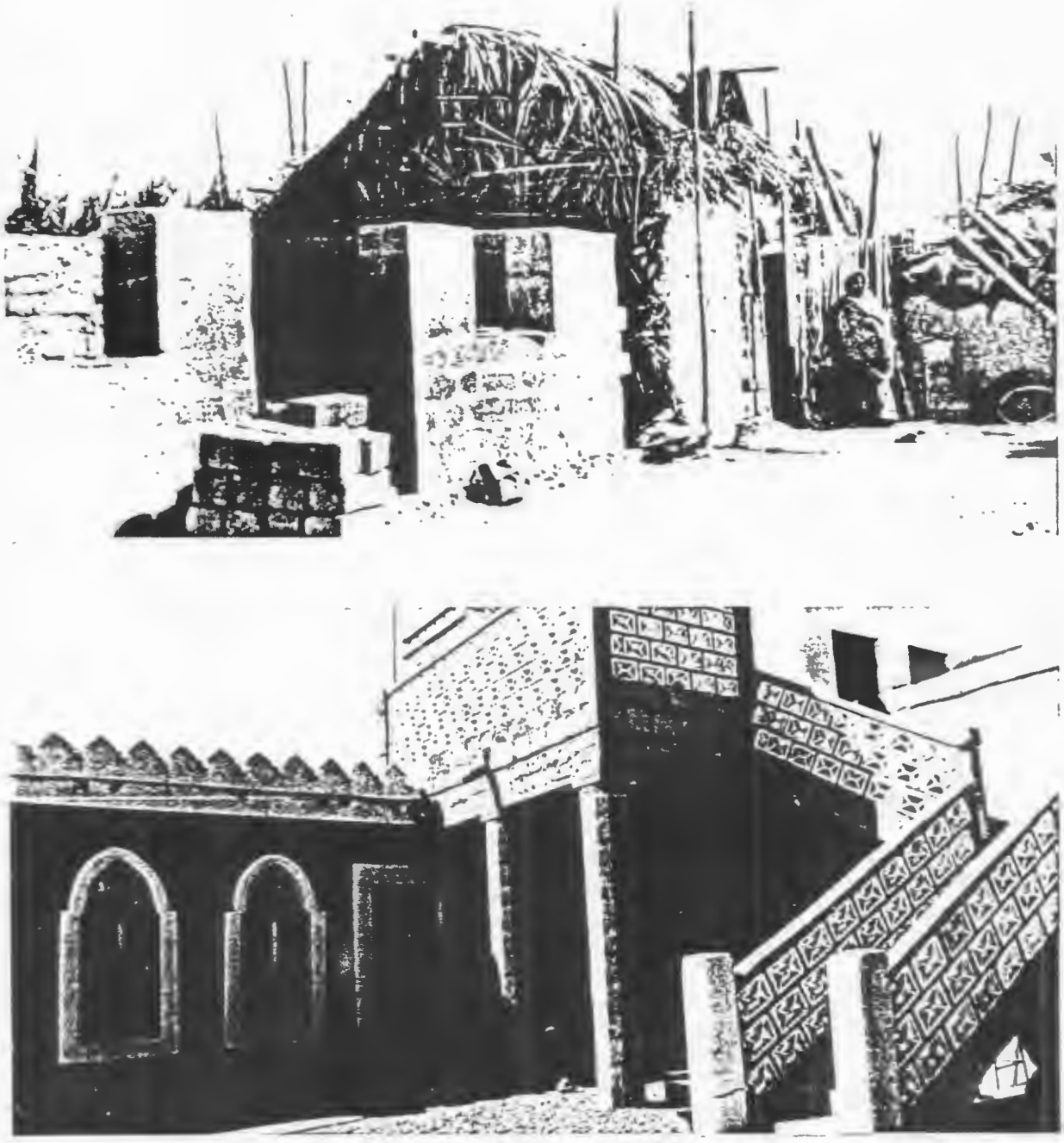
Let us illustrate with two examples from the Omani indigenous built environment.

An old Arab proverb says to complete your house is to end your life. Examples of housing from past and present Oman showed that this was not simply some mystical quote but one that reflected in reality the nature of housing. In Sallala for example the old courtyard houses had been constructed room by room, floor by floor over generations as the occupants became wealthier and family members increased. In 1973 several of these houses were still having rooms and floors added to them.

In the same town the government, in an enlightened move, has laid out an area for new migrants and alloted them plots to settle on. Consequently, the whole community is busily involved in constructing their own homes. Shelters of different types and quality can be seen. It is not uncommon to see a tent, a *barasti* shelter and a limestone structure, gradually carving out a courtyard space on a single plot, repeating the various stages the old courtyard houses must have gone through before they became the substantial three and four storey stone structures of today. Indeed some houses in this relatively recently settled area have already been upgraded to this level.

The government grant of a plot has assured occupants they will not be ejected and therefore encouraged them to invest their resources in home construction.

However in most cases, land provision, though basic, is not sufficient for insuring a well planned



Housing built by the user begins as a basic shelter and develops into a substantial house, in time, with the user's needs, income and self-expression.

and fully serviced community. The household willingness, capacity and indeed legitimate responsibility to upgrade the environment declines as the object of improvement moves further from his private dwelling space. The community may participate in lane paving and drainage but may rightly refuse to do so in main road construction. Thus the framework of supports should not only cover all aspects of the built-environment but also take account of diminishing community responsibility and increasing government responsibility.

In outline the following can be suggested as the necessary supports:

1. Finance schemes such as housing loans designed for the repayment characteristics of low-income households and matching grants designed to stimulate community participation in basic services such as lane paving and drainage.
2. Affordable land with easy access to employment sources and major services such as transport, roads, water-supply and main drains.
3. Access to cheap construction materials and implements.
4. Advice and training on the technical and managerial aspects of construction to house owners, builders and small-contractors.

Complementary to the above strategy that increases the availability of resources for upgrading the built environment, should be one that reduces that cost of this task. Another example from the indigenous and main environment will suggest how this second objective may be achieved.

In Sohar many families have improved their houses in a simple but effective fashion. Concrete block has been used up to plinth level and as supporting columns, leaving the rest of the structure in *barasti*.

The builders have selectively used the relatively more expansive concrete block where it will be most effective, and continued to use the cheap

Indigenous builders make appropriate use of both new and traditional materials.

and locally available traditional material *barasti*, where it is most advantageous. The concrete block plinth provides a dry base and firm durable structure. Isolating the *barasti* infill walls and roof from the floor damp, increases the material's life span significantly. Furthermore, wall and roof sections can be repaired, progressively upgraded or replaced without requiring the dismantling of the whole structure. The lattice screen openings, strategically located in the infill walls, allow ventilation and cut glare, both essential to comfort in a sunny and humid climate. Finally the same lattice screens permit an occupant to view the outside without being seen, another great advantage in a society where privacy has a high premium.

Some housebuilder with a firm grasp of the problems and potentials of his indigenous built environment has developed and demonstrated an innovation that is sensitive to local climatic and cultural constraints, represents a significant improvement in housing quality and, most of all, reduces the cost of improvement to affordable levels. (The previous only alternative to *barasti* and mud walls was the relatively expensive all concrete block or brick walls). Thus appropriate, significant and affordable, the innovation has caught on and spread.

This indigenous process of innovation needs to be reinforced. Thus to reduce the cost of upgrading the built environment the strategy should be a program of Research, Development and Demonstration (RD&D) of low-cost improvements to the indigenous built environment. In its implementation such a program should actively elicit the collaboration of local building materials' craftsmen such as limestone quarriers, brick and tile producers, and building craftsmen such as carpenters, masons, *barasti* mat makers, etc., on a regional basis. The tasks of this program should include at least the following:

1. An assessment of materials, materials industries and skills and how their quality and supply can be improved in a low-cost fashion. (See for example discussion on limestone in Sallala Section).
2. An assessment of the design and technology of the built environment-housing community buildings, water supply sanitation and roads — and how these could be improved and yet remain low-cost. (See for example, low-cost improvements developed through this study and proposed in the following section).
3. Laboratory and small-scale testing of promising low-cost alternatives (see for example sections which describe laboratory tests carried out by the authors for this study).
4. Dissemination of information through (1) pamphlets and publication, (2) training workshops, and (3) demonstration projects.
5. A program of construction in the smaller settlements which applies and demonstrates the results of the R&D while simultaneously providing necessary buildings and physical infrastructure.

Such an RD&D program can in the first instance be undertaken by a research cell located in the Planning Ministry with direct links to all construction departments, and those dealing with building related industries. It may later be upgraded to an Institute serving all these departments. It is important that a strong link exist between the RD&D program and the building departments, since the latter may be resistant to adopting innovative technologies and procedures unfamiliar to them.

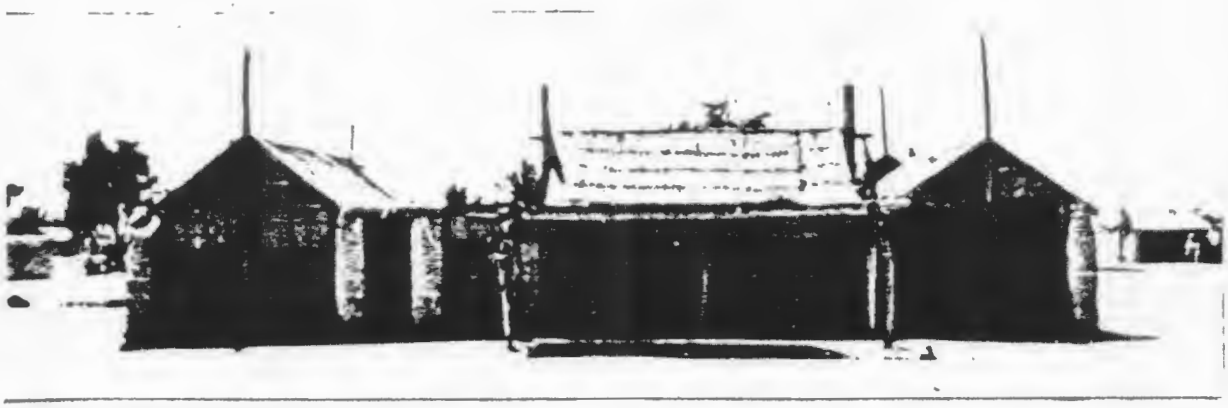
To develop the small towns and rural areas a modest nevertheless significant building program has been launched by the government. Essential buildings such as schools, hospitals, government administration buildings, Wali's (mayor's) residences, police stations, experimental farms and rest houses are being constructed.

The investment embodied in these buildings, although small relative to the amounts spent in the Capital area, could be a significant instrument for generating development in the host communities. The construction program proposed in point 5 above could use the funds earmarked for the current building program, construct the same building types but in accordance with the general objectives of the proposed RD&D program. Before discussing the proposed construction program further it would be useful to discuss the existing program.

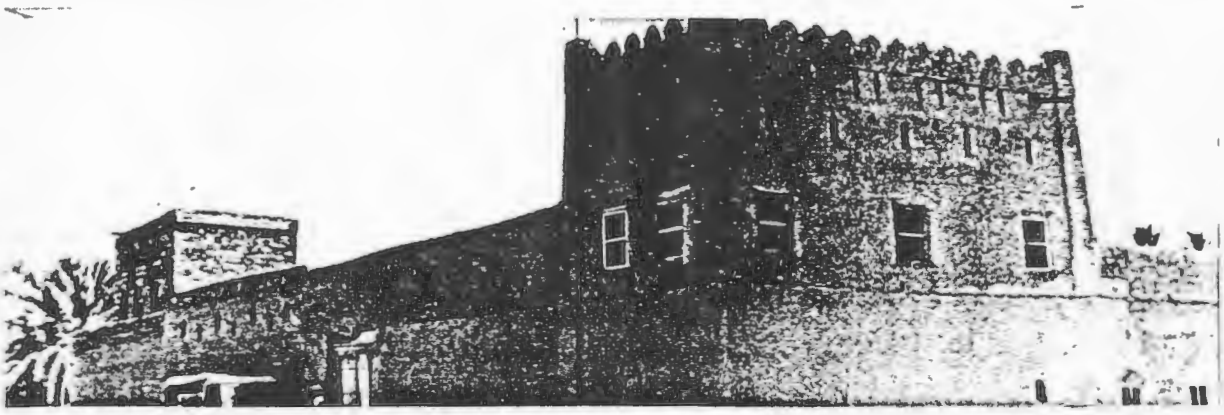
The manner in which this program has been designed and implemented does not fully tap the developmental potentials of building activity. In some cases this program may be having detrimental effects.

By and large the program ignores the indigenous built environment and the local resources of the area. Many settlements we visited had a well-defined traditional centre of social, commercial, administrative and religious activity manifested by there being cafes, a suq (market), a fort used as the Wali's residence and offices and a mosque in close proximity. This traditional centre was surrounded by the residential neighbourhoods. This was the case in Nizwa and Buraimi for example.

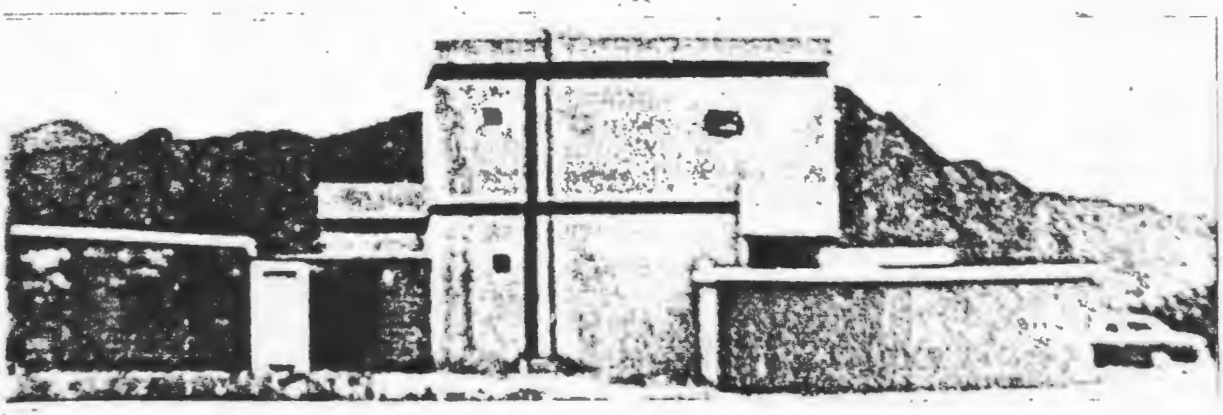
The building program largely ignored the existing settlement. The newly constructed buildings were



Indigenous rural housing in Muladah.



Wali's traditional house and headquarters in Iski.



Recent building, such as Wali's house in Nizwa set new models for aspirations.

set apart from it often at some distance away. Thus children had to walk some distance to get to the new facilities. Similarly the Wali in his new residence was also physically set apart from the town-folk.

Secondly, the buildings paid little recognition to the cultural and climatic conditions and the material resources available in the area. Their design, materials and technologies, brick, concrete block, reinforced concrete lintels and roofs — were direct copies of new construction in the Capital Area (where too they bore little relation to the indigenous environment). Thus doctors and patients complained of the glare and heat in the new hospitals. One Wali was adding a *maglisse* (reception room to meet visitors) to his new house since the design had not made adequate separation of this room from the private quarters.

As potential demonstrations of environmental quality improvements, the buildings failed since they were either climatically or culturally inappropriate or too expensive for most of the inhabitants to adopt. Those who did, risked severely straining their financial resources.

Finally since the buildings used imported technologies they naturally also used contractors and skills from outside the region. The hospitals with adjoining schools for example were one of six identical turn-key projects contracted to a Swedish firm to construct in different settlements for £4 million. Needless to say the benefit to the local populace in terms of income employment and skills upgrading was minimal. This was limited to the temporary employment some building workers received during construction.

As a result of these new buildings and their locaiton, one could envisage a settlement pattern emerging that has already proved so problematic in other places such as Cairo and Dubai. That is a new town centre develops, favoured by government funds, higher quality buildings and facilities to which the wealthier gravitate with their residences and commercial establishments. Meanwhile the indigenous centre and residential neighbourhoods where the poorer majority continue to live, deteriorates into slums for want of funds and facilities. The westernised form of the buildings and the life-style of its occupants also set the new centre apart from the indigenous one.

The government's objectives to provide essential buildings and infrastructure could be met along with the RD&D objectives outlined earlier and with much wider benefits to the community. What is required is an alternative program design and implementation method, one with emphasis on upgrading the indigenous built-environment low-cost designs and technologies and community participation. The guidelines for such a building program should include at least the following:

1. As far as possible rehabilitate or upgrade buildings and infrastructure in the indigenous town centre — the Suq, fort, residences, etc. in which the new facilities should be housed. Where this upgrading is not possible or inadequate, the new buildings should be integrated within or adjoining the indigenous centre. This infusion of new construction and facilities will revitalise this centre and its surroundings the upgraded access ways, water supply, and sanitation facilities will benefit those who already reside in this centre, and it will be easier to extend these facilities to the adjoining neighbourhoods.
2. Low-cost designs and technologies develpoed from indigenous methods and yet tangible improvements of these methods, using indigenous materials and skills and appropriate to the climate and culture, should be used in the construction. Thus the construction projects will be visible examples of appropriate and affordable building quality improvements that the local people could adopt in their own construction.

3. The project should advise and assist local entrepreneurs in the efficient development of building materials' industries. By specifying matierals using local resources, such as stabilised mud-brick, timber or brick and tile in the buildings, and encouraging their use amongst the inhabitants, the program would stimulate a demand for such industries.

4. Local labour and masons should be given intensive training workshops in preparation for the main construction work followed by in-service training during construction.

Points 3 and 4 would insure that a maximum proportion of the building investment would accrue to the local community through the incomes and employment gained by local residents involved in materials production and construction work. A cadre of locals trained in these activities would also result who may then be used as trainers in similar projects elsewhere.

5. Individuals and community groups could be encouraged to implement the low-cost infrastructure and building quality improvements within their own neighbourhoods and homes through such mechanisms as educational workshops informing them of the advantages of these improvements, loans and matching grants. These measures would now be more effective since the community will have visible demonstrations of these now affordable improvements, a core of trained masons to implement them, and an incipient industry to supply the materials. Once private housing adopts these construction methods the sustained demand for the required builders and materials would have a more substantial effect on generating local incomes and employment as well as developing the local materials' industries.

6. The cost of such a program should not exceed what the government has currently budgeted for buildings in these settlements. The additional costs implied in the educational and training components would probably be offset by the considerable savings accrued by using much lower cost materials and technologies

This study has done much of the groundwork illustrating the various components of the RD&D program including the construction component just outlined. Naturally more work is required particularly in materials industry research and in designing an operational construction program. Given these the next step would be one or two pilot projects from the experience of which a regional program could be implemented.

In conclusion one can say that reorientation of construction priorities and implementation methods urged in this study would not only help Oman towards achieving its own stated objectives but would also be an invaluable precedent guiding other developing countries who share the same problems and aspirations in improving the lot of their people.[14]

1. Sultanate of Oman: *Economic Survey 1972* Prepared by Whitehead Consultants, introduction p.? This report was the most comprehensive document on development conditions, objectives and strategies of Oman that was available to us. We were informed that it should be the reference point for our study and proposals

2. Apart from the capital area Muscat-Mutrah-Ru (pop. ???,000), all Oman's settlements are small towns or villages. The largest of these settlements are Sallala (pop. ??,000), Nizwa (pop. ??,000), and Buraimi (pop. ??,000).

3. Middle East Economic Digest Report on Oman July 1973

4. Sultanate of Oman: Economic Survey 1972 p. 'Key Points for the Government to Consider'

5. Mexico's annual repayments £260 million much of it interest for its £900 million loan ("Guardian" 28th January 1974, London).

6. UN General Assembly Special Session on raw materials and development. April 9th ??? May 2nd 1974

7. "In the unskilled category there are many more people employable than there are jobs. In the semi-skilled and skilled categories however there are many more jobs available than Omanis to fill them. Such training as is taking place is wholly inadequate." *Economic Survey 1972*, Employment and Skills Section.

8. Quoted by the housing engineer, General Development Organization (later the Planning Ministry) which deals with such projects. He also said there had been some discussion on whether kitchens should be of the traditional or western type. The latter was adopted adding to cost.

9. Our estimate from interviewing Omanis across the country. No income survey was available as yet. Income per capita figures exaggerate real income in a country such as Oman where oil earnings account for 80 percent of revenues and income distribution is highly skewed.

10. See Turner, J. (Feb. 1974) "The Fits and Misfits of Peoples Housing". RIBA Journal.

11. Abrams, Charles. (1971) The Language of Cities. New York: Viking Press, p. 243.

12. Calculated from investment figures for Oman's development projects in the Middle East Economic Digest, July 1973. Included in the 19 percent spent on projects in the rest of the country is a building program for the smaller settlements and rural areas. This program will be discussed in the next section.

13. A larger question surrounds the one presented here. This is whether Oman's development strategy should emphasize capital intensive *industries* or agriculture and agro-linked small-scale labour intensive industries. The former tends to concentrate near larger urban centres and requires similarly concentrated construction investment of the type noted in Oman, whereas the latter disperse economic activity largely in the small towns and rural areas and require supporting infrastructure and building construction programs of the sort to be elaborated on in this section.

    This latter agricultural and rural industry strategy with its complementary construction program would better promote regional development and rural stabilization objectives through creating employment and improved living conditions in a regionally and rurally dispersed fashion. We do not pursue the larger development strategy question beyond acknowledging it since the construction aspect is the focus of our study.

    One might add that "rural stabilisation" meaning *no* rural to urban migration may be unachievable and even undesirable since agricultural improvement usually leads to a shift from farm to non-farm urban jobs. What rural oriented strategies and construction programs can achieve is a slowing of this migration to keep pace with urban job creation preferably in the first instance in the smaller settlement.

14. Some of the ideas presented in this section were subsequently implemented by the authors albeit modified according to the different circumstances, in a rural project in Iran. See Development Workshop. "The Seiseleh Integrated Development Project in Loristan, Iran." in *Rural Development Technology: An Integrated Approach*, Pergamon 1978 and "The Development Workshops Work in Iran" in Mimar 1, 1981.