

BOTANICAL GARDENS: THE INFLUENCE OF ISLAM, ARID LANDS, AND
WATER IN THE MIDDLE EAST

by

Catherine Clabby Sellers

A Thesis Submitted to the Faculty of the
SCHOOL OF RENEWABLE NATURAL RESOURCES
In Partial Fulfillment of the Requirements
For the Degree of
MASTER OF LANDSCAPE ARCHITECTURE
In the Graduate College
THE UNIVERSITY OF ARIZONA

1 9 8 8

STATEMENT BY AUTHOR

This thesis has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgement the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: *William H. Havens*

APPROVAL BY THE THESIS DIRECTOR

This thesis has been approved on the date shown below:

<u><i>William H. Havens</i></u>	<u><i>April 21, 1988</i></u>
W. H. HAVENS	Date
Professor of Landscape Architecture	
<u><i>Michael T. Deeter</i></u>	<u><i>4/22/88</i></u>
M. T. DEETER	Date
Professor of Landscape Architecture	
<u><i>Walter D. Jones</i></u>	<u><i>4/25/88</i></u>
W. D. JONES	Date
Professor Emeritus of Landscape Architecture	

ACKNOWLEDGEMENTS

In the production of this thesis I acknowledge the intellect and guidance of Professors Michael T. Deeter ASLA, William H. Havens ASLA, and Warren D. Jones FASLA. I thank George T. Sellers, my husband, for his encouragement and faith.

TABLE OF CONTENTS

	Page
LIST OF ILLUSTRATIONS	6
ABSTRACT	7
CHAPTER 1. BACKGROUND	8
Definition of the Botanical Garden and Arboretum	8
CHAPTER 2. HISTORY OF THE BOTANICAL GARDEN	12
Ancient	12
The Middle Ages	13
Renaissance	14
Industrial Revolution	17
Modern	18
Summary	18
CHAPTER 3. HISTORY OF GARDENS IN THE MIDDLE EAST	20
Western Asia and the Muslim Conquest.	20
Western Asia and Islam	22
Islamic Gardens of Spain	24
Islamic Gardens of Mughul India	24
Summary	24
CHAPTER 4. ISLAM	26
Religion and Culture	26
Economics	27

TABLE OF CONTENTS - Continued

	Page
CHAPTER 5. ARID LANDS, WATER AND PLANTS	30
Arid Lands; Geography, Climate, Topography	30
Water; Irrigation and Aesthetics	33
Plants Ancient and Modern; Salt Tolerance	33
CHAPTER 6. THE INFLUENCE OF ISLAM, ARID LANDS, AND WATER ON BOTANICAL GARDENS IN THE MIDDLE EAST	35
CHAPTER 7. CONCEPT FOR A BOTANICAL GARDEN; KUWAIT	40
Site Requirements	40
Functional Requirements	41
Design Elements	41
Cultural Elements	41
Plants	42
CHAPTER 8. CONCLUSION	43
APPENDIX A: PROGRAM FOR A BOTANICAL GARDEN IN KUWAIT	45
APPENDIX B: NOTABLE BOTANICAL GARDENS AND ARBORETUMS IN THE MIDDLE EAST	49
APPENDIX C: NOTABLE BOTANICAL GARDENS AND ARBORETUMS IN THE WORLD	51
APPENDIX D: PLANTS OF PERSIA	52
APPENDIX E: PLANT LIST FOR KUWAIT; SALT TOLERANT	56
APPENDIX F: PLANT LIST FOR KUWAIT; LANDSCAPE	61
APPENDIX G: CLIMATE ZONES IN THE MIDDLE EAST REGION	64
APPENDIX H: SALINITY TOLERANT PLANTS	68
LIST OF REFERENCES	71

LIST OF ILLUSTRATIONS

	Page
Figure 1.1 Map of the Middle Eastern Region	11
Figure 2.1 The Chahar Bagh	15
Figure 2.2 Plan of the Garden at Padua	16
Figure 3.1 Garden Design and Carpet Design	21
Figure 4.1 Map of Kuwait	29
Figure 5.1 Climate Map of the Middle Eastern Region	31
Figure 5.2 Soils Map of the Middle Eastern Region	32
Figure 6.1 Geometric Patterns Used in Islamic Garden Design	36

ABSTRACT

The concept of the botanical garden can be traced to ancient times. The idea of the 'garden as paradise', the 'garden as orchard' and the 'chahar bagh' are part of the Persian culture, dating to 6000 B.C.. Mesopotamia is the supposed location of Eden, the oldest garden of the world. To determine the design criteria most suitable for a new botanical garden to be located in the Middle East, a study is required of: botanical garden history, the religious and cultural aspects of Islam which have formed design-rules for gardens, features common to arid lands, and water as a finite resource. The purpose of this study is to determine criteria for a botanical garden most suitable to the conditions of the Middle East in general, Kuwait in particular, and to identify those criteria in terms of the public benefits of recreation, education, conservation and enhancement of religious experience.

CHAPTER 1

BACKGROUND

Definition of the Botanical Garden and Arboretum

Botanical gardens are institutions which collect and cultivate plants for scientific, educational or decorative purposes. Modern botanical gardens represent the plant kingdoms of the world. Plants may be grown outside, under glass or in protected growing situations.

" A botanical garden displays either herbaceous and small ligneous species only or species of all sorts, from the herbaceous to trees" while an arboretum " contains only ligneous species, from small shrubs to tall trees" (Duval 1982, p. 199).

The terms 'botanical garden' and 'arboretum' however are sometimes used synonymously. A botanical garden can include an arboretum. Arboretums differ from botanical gardens in that the purpose of an arboretum is to grow, label and study trees and shrubs which are the best examples of woody plants that will grow well in the local climate and soil. Arboretums are usually located out-of-doors as opposed to botanical gardens which are usually located partially inside. This study will generally use the term 'botanical garden' to include the idea of an arboretum.

Botanical gardens may have expanded functions. Recreation, community education, wildlife habitat, resource preservation and park and

museum-like amenities are features which are designed to co-exist with the scientific purpose of the garden.

Specifically, the functions of a botanical garden may be to: 1) show a complete selection of ornamental and woody plants which may be grown in an area, 2) introduce new plants to an area, 3) disseminate knowledge of plants to the public, 4) test the hardiness of untried varieties, 5) provide a living laboratory for students of horticulture, nature and botany, and 6) provide for recreational activities (Wyman 1947).

A 1977 survey of botanical gardens showed a total of twenty-one gardens located in the Middle East out of a total of 626 entries world-wide (Henderson and Prentice 1977). They were located in: Egypt (6), Turkey (3), Iraq (1), Iran (2), Pakistan (1), Israel (5), Libya (1), Tunisia (1) and the Sudan (1).

Modern botanical gardens in the Middle East are most often affiliated with the government (The Ministry of Agriculture) or a University. In Egypt, 4 out of the 5 listed botanical gardens function with governmental status. Their special services are usually related to plants of economic value. Most gardens are open to the public daily or by appointment. The sizes range from 1.2 to 48 hectares (2.471 acres) of cultivated area. Iraq's botanical garden in Baghdad functions similar to those in Egypt. It's area is 8 hectares. In Iran, the two botanical gardens are of governmental status and are 3 hectares (Karadj) and 150 hectares (Tehran) in size (Henderson and Prentice 1977).

For the purpose of this study, the term 'Middle East' will describe those lands in the part of the world generally located between

Eastern Europe and China, including the area lying south of the Black Sea and extending from Turkey to India. It will also include the lands of North Africa and the southern Arabian Peninsula. The term 'arid' will be applied most often to the very hot and dry areas and in the central part of the Middle East which receive less than 10 inches (4 cm) of precipitation per year (Figure 1.1).

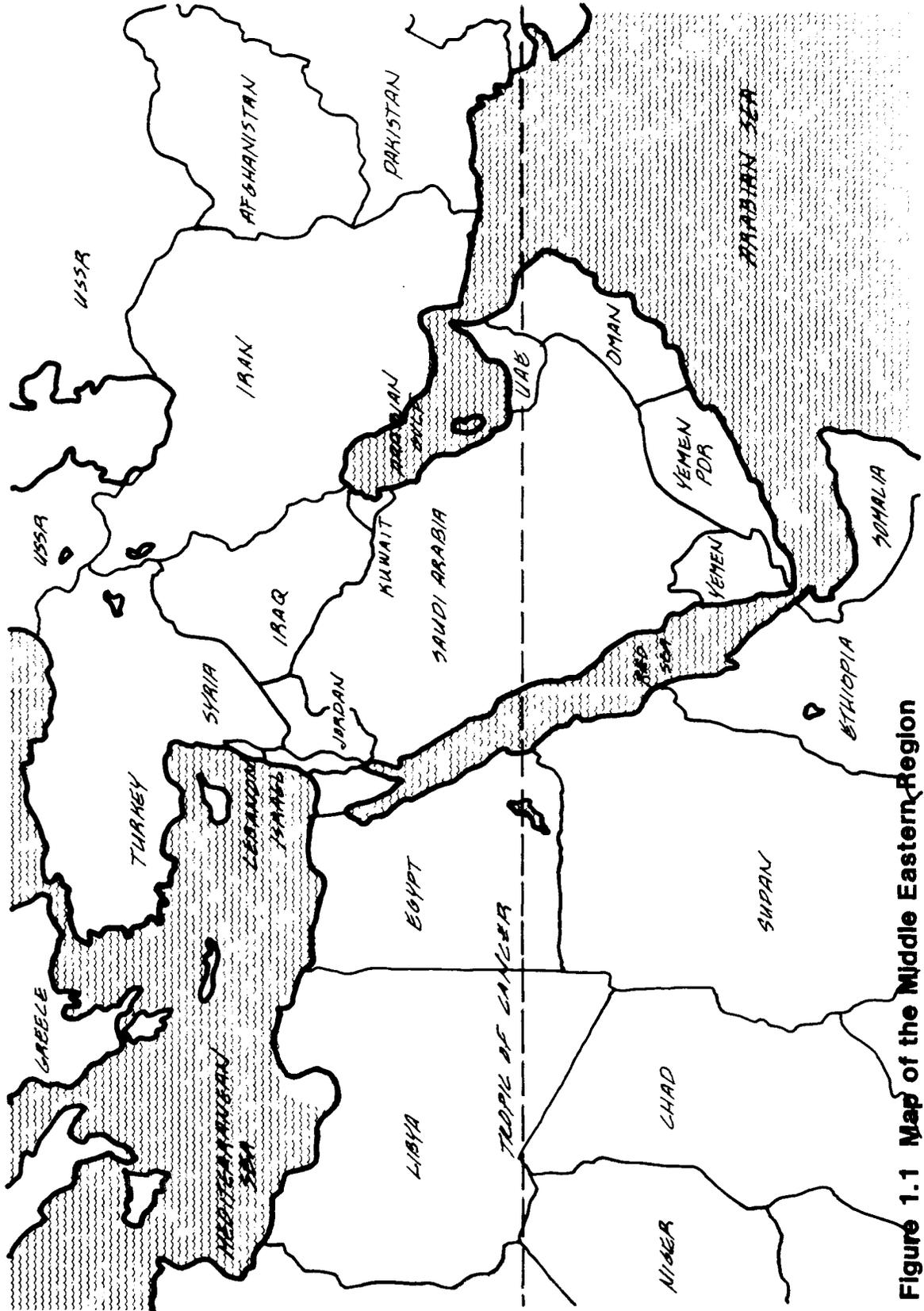


Figure 1.1 Map of the Middle Eastern Region

CHAPTER 2

HISTORY OF THE BOTANICAL GARDEN

Ancient

The concept of the botanical garden is an ancient one. It has persisted, over time, to become a place where international ideas, scientific and medical research, horticultural economics, agriculture and garden design are synthesized for public use.

As early as the Neolithic Era, 10,000 years ago, the first domestication of plants and animals began. As the knowledge of irrigation technology developed, so did the garden. The increasing complexity of civilization generated the botanical garden which paralleled the development of medicine, religion, literature, art and global exploration. Ancient, medieval and renaissance gardens presented the varied uses of plants for medicine, herbs, food, flowers, aesthetic value, and recreation. The gathering of plants for various uses besides agricultural crops and animal fodder distinguished the botanical garden from other gardens.

Knowledge of the value of the botanical garden started early in man's development. Aristotle kept a botanical garden, with the curator being Theoprastus (Prest 1981). Avicenna, wrote the 'Canon of Medicine', a discourse of Arabic medicine. Hippocrates studied plants, as did Pliny the Elder and Dioscorides, who in the first century A.D. examined growing plants for medical purposes (Duval 1982).

In the days of the Roman Empire, the Emperor Tiberius Claudius Nero, was advised by his doctor to eat a diet of cucumbers and used a simple form of a botanical garden to grow the vegetables; a greenhouse called a "specularium". Early botanical gardens were utilitarian, dedicated to raising selected food, fiber and healthful plants. These 'physic' gardens specialized in plants from which medicine could be made. The descendants of this arrangement were the medieval monastery and the herb garden (Grubb and Clabby 1982).

The Middle Ages

During the Middle Ages, the idea of the botanical garden, at least in the Western World, was often aligned with the Church. Benedictine monasteries had 'paradise gardens'. The connotation of the garden was that of the Virgin Mary as Paradise (Song of Solomon). The garden was most often enclosed, with animals excluded. Philosophically, the garden was a refuge from the deformed world outside (Prest 1981).

In Christian thought, the garden of Eden was both allegorical and literal. Christian writers "laid great stress upon the smell of the Garden of Eden, and upon dying in the odor of sanctity. The deliciously scented breezes noticed by sailors in the south Arabian seas lent credence to the contention that somewhere, nearby, lay the long lost and forbidden Garden from which our ancestors had been expelled, and in due course Milton wrote of perfumes carried on gentle winds which...

...whisper whence they stole
 Those balmy spoils. As when to them who sail
 Beyond the Cape of Hope, and now are past
 Mozambic, off at sea north-east winds blow
 Sabaeon odours from the spicy shore
 of Arabia the blest..." (Prest 1981, p. 29)

Renaissance

The dynamic 'age of the botanical garden' followed the discovery of the New World. The preeminent European gardens were; Padua, Leydon, and Montpellier (established in the sixteenth century), and Oxford, the Jardin du Roi at Paris, and Uppsala (established in the seventeenth century). These gardens developed as a result of global exploration for new plants for medicine and agriculture, and typically depicted an organization of plants similar to the pattern of the Islamic 'chahar bagh' garden (Figures 2.1 and 2.2).

At Padua, founded in 1545, at the university in Venice, Italy, the curator was the professor of pharmacology. Oxford and the Jardin du Roi promoted learning of medicinal plants (Prest 1981). A form of the traditional 'chahar bagh' was used in the plan for the garden at Oxford University (founded in 1621). It's three acres were square and divided into four quarters which represented the four corners of the earth (Europe, Asia, Africa and America) (Prest 1981). The Montpellier Botanical Garden was founded in France in 1593. It contained one garden for herbs and medicinal plants and one for the acclimatization of plants (Duval 1982).

Other seventeenth century botanical garden influences include John Evelyn's philosophical garden and the Dutch East India gardens established at the Cape of South Africa in approximately 1652. The purpose of the Cape garden was utilitarian, for it was located on the sailing route from Portugal to Goa. The garden supplied fruit and vegetables to the sailors en route. As well "it was perfectly situated to

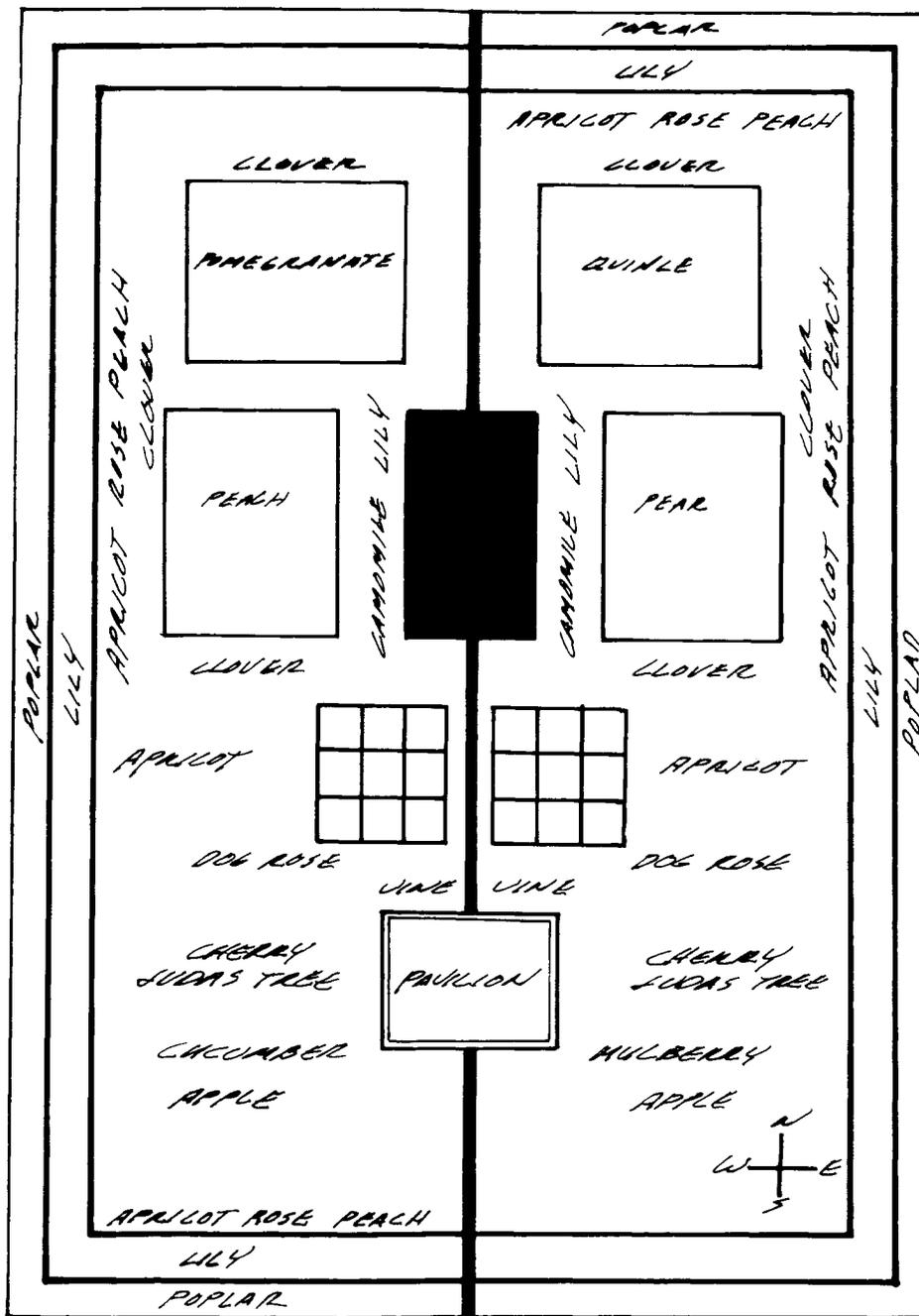


Figure 2.1 The Chahar Bagh

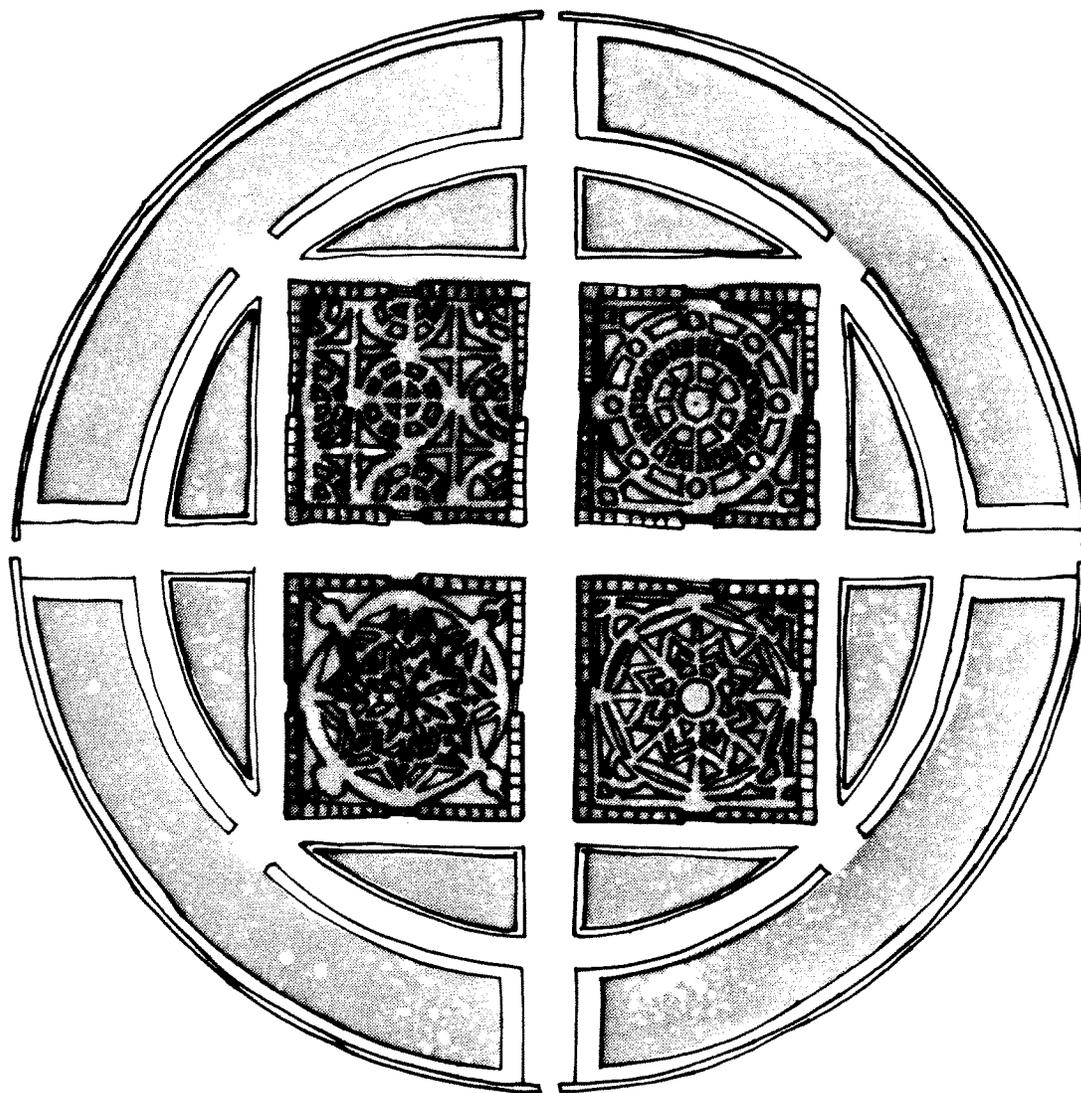


Figure 2.2 Plan of the Garden at Padua

act as a holding ground for the exchange and transmission of plants of all kinds between continents " (Prest 1981, p. 49).

Industrial Revolution

The industrial revolution affected the botanical garden and the science of botany as it did architecture and landscape architecture. By the late nineteenth and early twentieth centuries, the industrial revolution and the machine had adjusted the daily aspects of life. Emphasis was placed on the useful. Although the classification and knowledge of plants increased, the age of travel and exploration of plants was over. "By the end of the nineteenth century no one went off to die for flowers anymore" (Duval 1982, p. 191). The new task was to order and classify plants; laboratory and museum work was substantial.

Pharmaceutical discovery and the use of plants as raw material increased. National economies felt the influence of botany and the worldwide dispatch of plants. Sugar cane and coffee were distributed around the world. Quinine, a century ago, was the most powerful medicine in the world for curing malaria. (The drug comes from the bark of South American trees in the genus 'Cinchona' of the bedstraw family, Rubiaceae) (Hepper 1982). Natural rubber (caoutchouc) which comes from trees yielding latex growing in Asia, Africa and South America, became increasingly in demand for footwear, clothing and the auto industry.

"Coffee was being drunk in Persia and Arabia in the fifteenth century and spread all over the Turkish Empire in the sixteenth, but it was not until the mid-seventeenth century that it was introduced to Western Europe, usually, to begin with, by people with some kind of Levantine connection" (Girouard 1985, p. 207). In fact, coffee was at first

introduction, a curious substance to those outside of Persia and Arabia. It's power to stimulate the mind and body was initially feared.

Attitudes about plants also changed. The plants themselves took on a new category as science and psychology intermixed. Luther Burbank, in the late 1800s, researched the response of plants to environment. A book, 'The Secret Life of Plants', by Tompkins and Bird, explored the communication between plants and man (Duval 1984).

Modern

Botanical gardens were established on a scientific basis for the discovery of plants of the world and their classification, naming and investigation. The Kew Royal Botanic Garden, in England was the leading garden. Modern botanical gardens are research institutions which participate in the modern disciplines of biochemistry, cytogenetics and conservation.

Summary

A review of botanical garden history from the Ancient (pre-476 A.D.), to: the Middle Ages (5th-14th centuries), the Renaissance (14th-17th centuries), the Industrial Revolution (18th century) and finally to Modern and recent times is a simple one. The botanical garden developed in response to specific needs of people; plants for food, shelter, medicine, spiritual fulfillment, art and recreation. Global exploration for plants, scientific classification and the growing of plants in unnatural (i.e.; greenhouse) situations were specialized aspects required for the development of the botanical garden. All botanical gardens have a common factor; from Ancient to Modern history, botanical gardens have been the collection, arrangement and growing of plants for human use and comfort.

Ancient botanical gardens were primitive; devoted to raising plants for food and shelter. During the Middle Ages, botanical gardens specialized in plants for medicine (i.e.; herbs) and the planned arrangement and study of plants for spiritual fulfillment. Botanical gardens during the Renaissance and age of global exploration of plants became securely aligned to botany. The Crystal Palace, the Palm House at Kew Gardens in England, designed by Joseph Paxton in 1851 symbolized the culmination of the age of the Industrial Revolution and global exploration for plants. Modern botanical gardens, now aligned with the profession of Landscape Architecture, preserve the tradition: the collection and adaptation of plants for human use and comfort.

CHAPTER 3

HISTORY OF GARDENS IN THE MIDDLE EAST

Western Asia and the Muslim Conquest

The history of the garden in the Middle East began in the area of the Fertile Crescent (Jordan, Lebanon, Syria, and Iraq), and then expanded as travel to lands in the east and west occurred.

The 'paradise garden' was the forerunner of all gardens, including the botanical garden. The origins of the Paradise garden " are found in Old Testament History, which placed the first garden north of Babylon: 'and the lord planted a garden eastward of Eden... and a river went out of Eden to water the garden; and thence it was parted and became into four heads... and the fourth river is Euphrates.' This description contained the idea of heaven, whose shape on earth was symbolized by the square, and which has remained to this day the basic inspiration of garden design of the Central civilizations ". The symbolic paradise garden was a "square enclosed against a hostile world, crossed by water channels symbolic of the four rivers of heaven, and containing theoretically all the fruits of the earth " (Jellicoe and Jellicoe 1975, p. 23). Interpreted as the 'chahar bagh', the tradition of the paradise garden and its four divisions was displayed in Persian carpet weaving. Carpets are still woven with this design (Figure 3.1). They are commonly called 'garden carpets'.

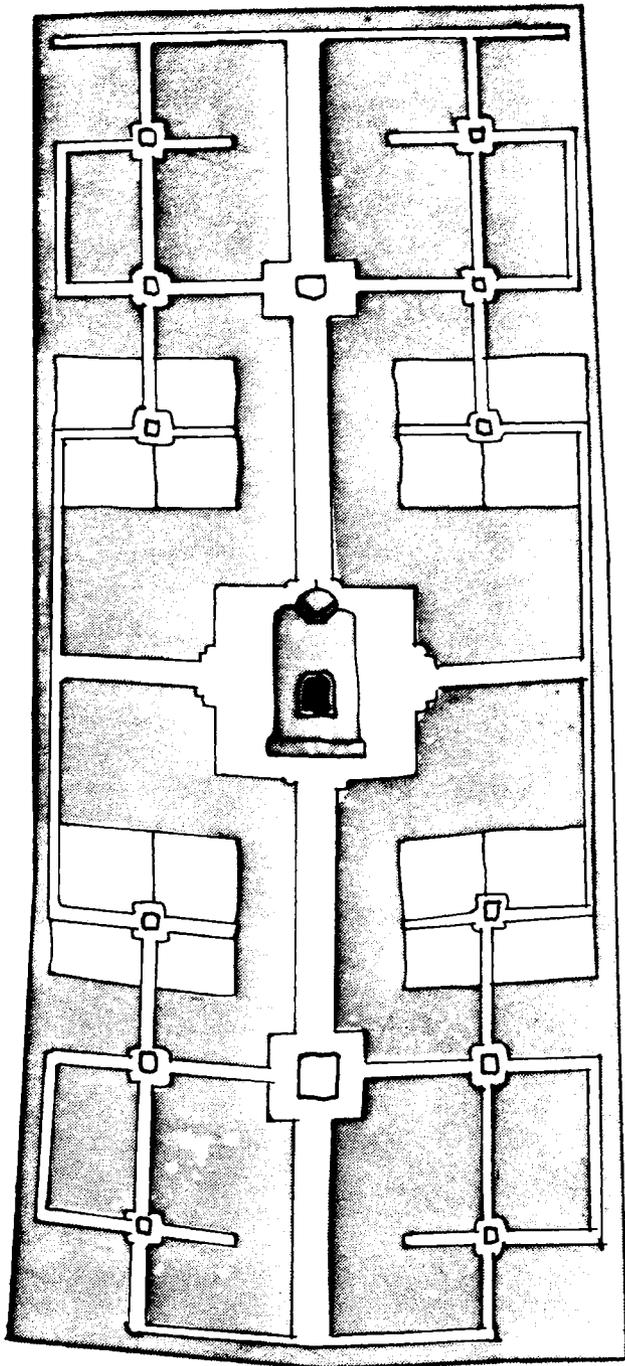


Figure 3.1 Garden Design and Carpet Design

The location of the earliest literate central civilization was the Mesopotamian plain and the delta of the Tigris and Euphrates. It was here that the Sumerian people established their capital city, Babylon in 2250 B.C.. The notable cities of Central Asia were Ur, Babylon, Persepolis and Ctesiphon.

The first designed landscapes were derived from the extreme severity and hardship of the climate. It was people's ability to channel water for irrigation and control climate with construction that gave form to gardens, buildings and planning. Gardens were geometric, walled; they contained irrigation channels and trees.

Western Asia and Islam

The Prophet Mohammed conquered Persia in A.D. 637. Baghdad, by A.D. 750, had become the cultural and scientific center of the Middle East. Baghdad, Sammara, Bursa, Constantinople and Isfahan were the major cities during this time.

Muslim life and philosophy was united by the Koran, which was the symbol of the Muslim faith. It was an "inspired code of behavior" (Jellicoe and Jellicoe 1975, p. 32) given to the Prophet Mohammed by One God, Allah, and the writing incorporated much of the Hebrew Old Testament. The success of the Koran was partially due to its adaptability and practical application to life.

"The idea of One God was simple and easily understood. The philosophy that 'the proof of God is in the perishable nature of that which is not Him' influenced all the works of Islam. Life was ephemeral: enjoy it while you may, but abide by the comparatively simple rules,

mainly those of abstemiousness, cleanliness and regular tranquillizing prayer " (Jellicoe and Jellicoe 1975, p. 32).

In the landscape and architecture the square was the dominant geometry of organization and construction. In plan, the square allowed for infinite expansion and adjustment. The dome, the minaret and the formal court were common. Wall decoration was two dimensional, excluding human images on religious ground; patterns were geometric or colored ceramic with calligraphic lettering from the Koran and plant or animal forms from nature. Due in part to the nomadic habits of the people, especially in northern Arabia, little furniture was used and the floor or ground plane was decorated with intricate geometric patterns. These design principles are still used in modern design and construction.

The interaction of Islam with the domestication of plants was most active in Persia, Turkey and India. Countries in the Arabian peninsula were populated with nomadic tribesmen who grazed the land.

The Persian garden was horticulturally aware. A work of note, "Irshad az-zara'ah" (a treatise on husbandry) by Qasim ibn Yusuf, written in 1515 at Herat includes subjects: "1) On distinguishing between good and bad soil. 2) On the choice of the astrologically "auspicious" time for planting; on the choice of crops, dealing with pests, etc. 3) On grains and vegetables. 4) Vines. 5) Vegetables." (MacDougall and Ettinghausen 1976, p. 82). Yusuf, besides this treatise, wrote others including; two on multiplication and division with reference to geometry and the third on the distribution of well water, topography and economy.

Islamic Gardens of Spain

By A.D. 750, the Muslims were in Spain, and by 1492 the Moors had been expelled from the country. During the Muslim rule, their philosophy of day to day enjoyment of life was adapted into the existing culture. Christians were allowed to live independently, and the ideas of Islam and Christianity intermixed.

The Alhambra and Generalife at Granada are commonly recognized as the premier examples of the Muslim garden in the west. The landscape is simple in composition, with mathematical proportion, human scale, unconfined views to the exterior and gardens which are treated as extensions of the building.

Islamic Gardens of Mughul India

Islam, and its expansion into Mughul India was concentrated between 28 degrees and 35 degrees north latitude. The famous site of Agra at Delhi and the Vale of Kashmir fall within this location. Babur (1483-1530) and Akbar (1542-1605) were the rulers who consolidated the Mughal empire in India. The greatest gardens of this time included; Ram Bagh, the Red Fort at Delhi, the Vale of Kashmir and the Taj Mahal.

In the landscape there was traditional garden geometry, but the result was broader, on a grand scale. The Mughul love of gardens and symbolism was inherited from Persia. Classic design features included: the square tank with fountain, watercourse, stone chabutra (platform for seating the Emperor), rich carpet, cypress and canopy provided shade.

Summary

Located in the middle latitudes of the globe, Mesopotamia, the Fertile Crescent and the area fed by the Tigris and Euphrates near the

Persian Gulf is documented, through excavation and literature, as being the general location of Eden. Gilgamesh of Uruk, the Sumerian story of the fictional search for Eden in Dilmun land translates Bahrain as being the present day site of the fictional Dilmun.

The history of gardens in the area, besides the notion of the paradise garden, provides knowledge of the ziggurat, hanging gardens, integrated architecture and landscape, constructed irrigation, domestication of plants, the 'chahar bagh', garden carpets and sophisticated geometric design. The garden carpet was (and continues to be) a functional and from a horticultural perspective, detailed, artistic and accurate way of communicating plant forms. The tradition of the 'chahar bagh' or 'four part garden' continues to be a design influence in Islamic landscape architecture. The term 'bagh' translates to mean "an entity comprising palace and garden" (MacDougall and Ettinghausen 1976, p. 75). The 'chahar bagh' (four gardens) is a term "denoting a particular type of garden.... usually interpreted as a rectangular walled garden quartered by two streams intersecting at right angles" (MacDougall and Ettinghausen 1976, p. 79). Other interpretations of this type of garden may include the area along broad avenues and the intersection of streets, a tower or a large garden with a palace complex.

The history of the garden in the Middle East is extensive and complex. In general, the historical development of the Islamic garden was environmentally orientated, horticulturally aware and artistically sensitive. As well, the gardens reflected the rules of behavior dictated by the Islamic religion.

CHAPTER 4

ISLAM

Religion and Culture

Islam is the dominant religion in the Middle East. Surveys of the world-wide distribution of Muslims show the Middle East area as most densely populated with Muslims and having over 85% of the population being Muslim (Ruthven, 1984). Many countries in the Middle East host an international society. In Kuwait, for example, there are expatriates from over 120 different nationalities. Islam unites the life and work of this international society where over 85% of the people are Muslim (Kuwait Ministry of Information, 1986).

The principles for understanding Islam are: Islam rules the entire life of the Muslim, is "totalitarian", and the religious source of authority for all Muslims is the Koran (Calverly 1974).

Islam dictates most of the cultural and societal activities of daily life in the Arab world. Since the nature of Islam is that all of the activities of the Muslim, by submitting completely to Allah, should conform to the Koran as instructed by the teaching of the prophet Muhammad, it follows that the individual, social, economic, political and spiritual life is guided. Values such as decent work, family charity and unity, marital fidelity, education and prayer and fasting are part of the Islamic doctrine.

Economics

The discovery of oil and the digging of artesian wells for water in the central Middle East basin profoundly changed the economic base of the area. Using Kuwait as an example, a date-line shows the typical pattern of modern and rapid economic growth of a desert city in an arid climate:

- 600 BC The Hellenes settled on Failaka Island.
- 300 The Greeks lived on Failaka Island.
- 623 AD The Arabs defended the Persians at Kazima.
- 1672 Kuwait town is established.
- 1773 Kuwait was attacked by an epidemic and most of its inhabitants died.
- 1907 Kuwaiti's transport fresh water from Iraq, using 49 dhows (boats).
- 1938 Oil was discovered in Burgan oilfield.
- 1942 The first monetary bank in Kuwait opened.
- 1946 The first Kuwaiti crude oil shipment was exported.
- 1952 The first Kuwaiti masterplan was drawn up.
- 1953 Kuwait's first sea-water desalination plant was commissioned. Utilization of underground brackish water begins.
- 1955 Oil was struck in Al-Rawdhatain, north of Kuwait.
- 1962 Pumping operations begin at Rawdhatain and Um Al-Aish for fresh, natural underground water.
- 1966 Kuwait University was established.
- 1981 Kuwait signed the Articles of Association of the Gulf Cooperation Council.

1985 His Highness, the Amir, survived an attack on his life. The Amir said, "Our decision will remain a free one that does not succumb to blackmail, terrorism or emotionalism" (Kuwait Ministry of Information 1986, p. 15).

Prior to the 1938 discovery of oil, Kuwait had neither the capacity nor the reason for establishing a botanical garden. Now, a botanical garden could become a desirable public feature, functioning within the sophisticated framework of modern Kuwait City. Although recent factors such as the fall in the world price for oil, the continuing war between Iraq and Iran, and the repercussions of the Souk Al Manakh (stock market) crisis have affected the economy of Kuwait, the construction of a new botanical garden is viable since Kuwait's economy is still essentially stable (Figure 4.1).

The religious, cultural and economic aspects of the Islamic world are unified by Islam. It is uncharacteristic of the religion to omit any activity of life; philosophical, political or economic, from consideration.

The criteria for establishing a botanical garden in terms of the public benefits of recreation, education, conservation and enhancement of religious experience require first of all an economic and cultural base which can support this type of facility. Kuwait offers a stable economic environment and an established urban city center with an estimated population of over 2 million people who live and work in Kuwait City and its residential suburbs. Appendix A lists specific criteria for a botanical garden to be located in Kuwait.

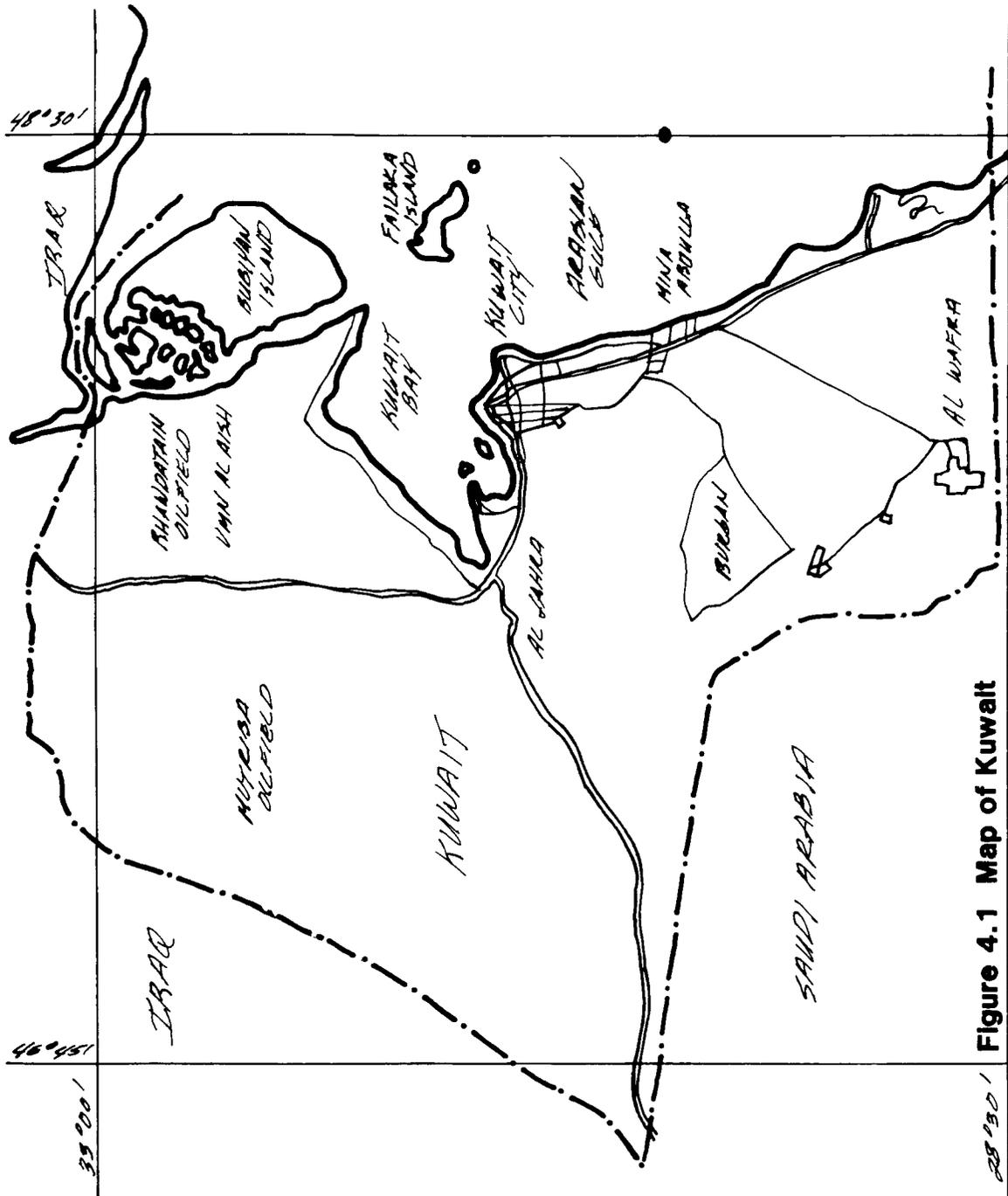


Figure 4.1 Map of Kuwait

CHAPTER 5

ARID LANDS, WATER AND PLANTS

Arid Lands;
Geography, Climate, and Topography

Ecological conditions of the Middle East, such as high temperatures, minimal rain, desiccating winds, sandstorms, infertile soils and saline water-tables, have influenced the design of the traditional garden where walled, inward-focused and shaded areas with a fountain are the norm. Mathematical order, balance, geometric design and the proportion of the 'chahar bagh' are still typical to the middle eastern garden because the designs work well in the geography, climate and topography (Figure 5.1 Appendix G).

Arid climates also determine the type of soils (Figure 5.2) and the landform of a particular location. The most common soil types in arid lands are: a) playa, b) gravel, c) sand dunes and d) loess. The landforms most common to the arid zone are: a) piedmont (pediment and alluvial plain), b) mesa, c) alluvial fan, d) floodplain and e) coastal plain (Golany 1983 p. 5).

The concept of arid lands in the establishment of a botanical garden is significant because hot, dry areas which generally receive less than 10 inches (4 cm.) of precipitation per year have in common, special control systems for growing plants.

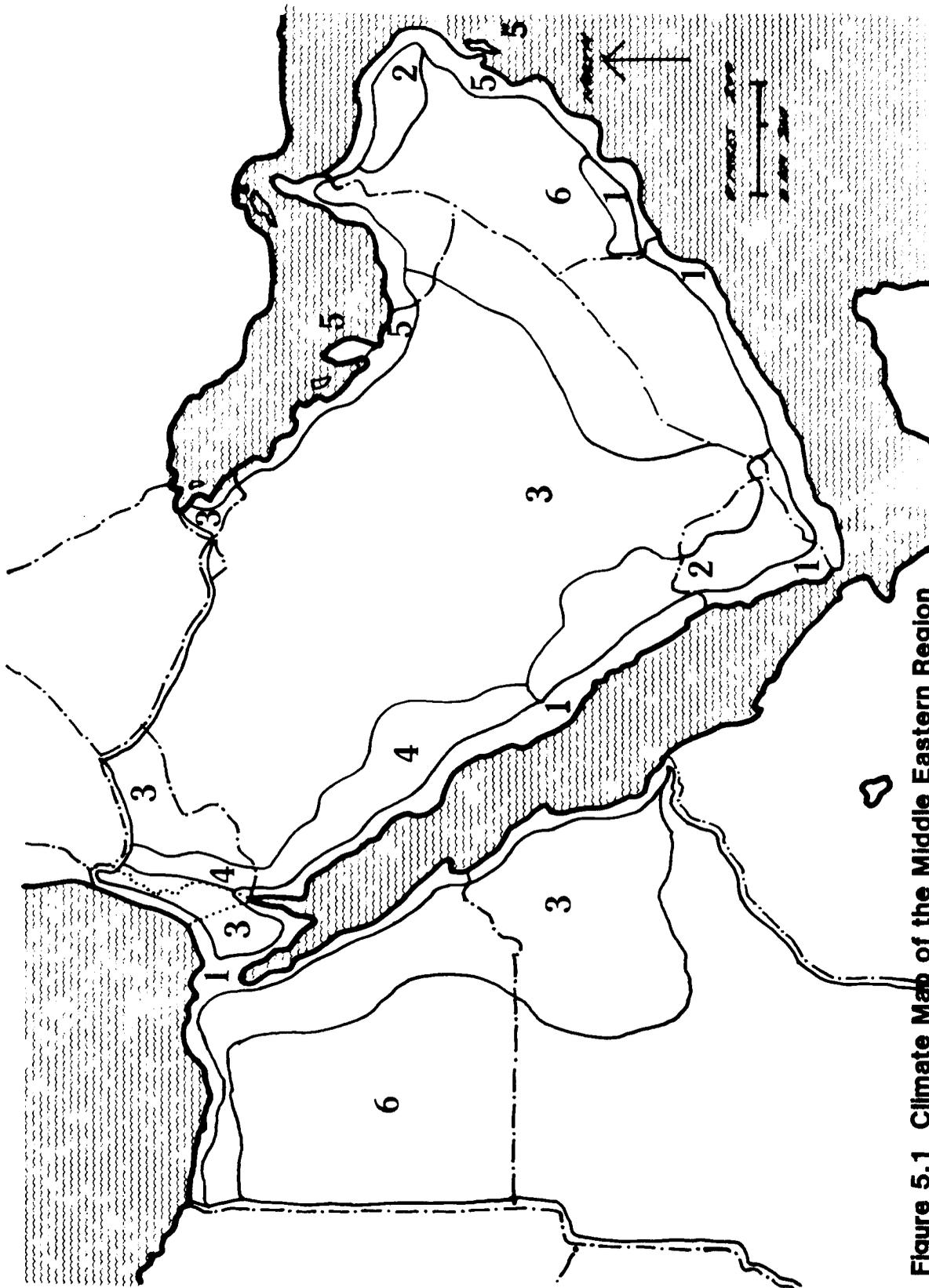


Figure 5.1 Climate Map of the Middle Eastern Region

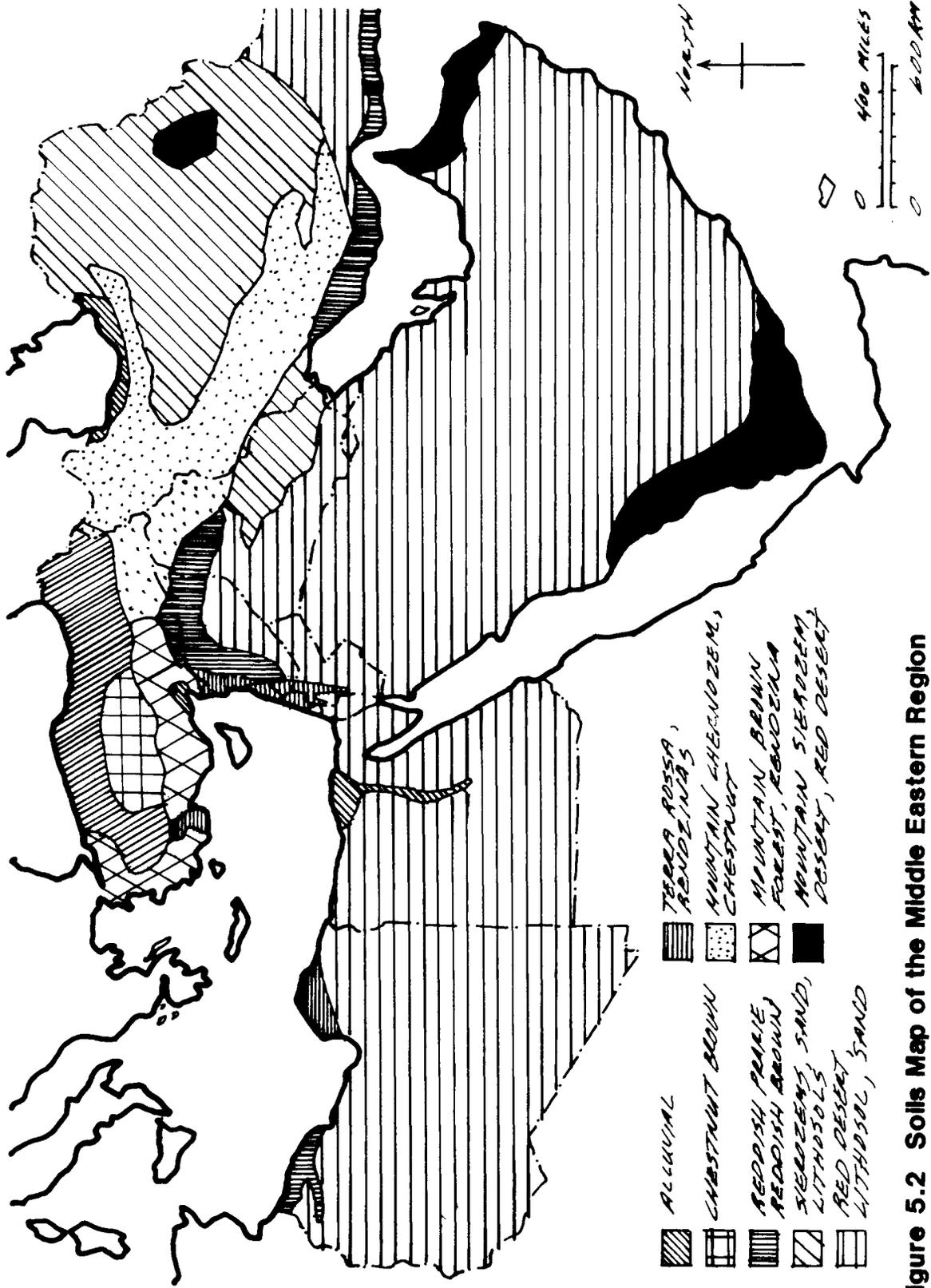


Figure 5.2 Soils Map of the Middle Eastern Region

Water;
Irrigation and Aesthetics

Water is, and has been historically, a precious element in landscape design for the Middle East. Underwater aquifers, water distillation, use of brackish (higher than average dissolved salts concentration), water desalination, waste water re-use, zoning for plant species to saline tolerance and conservative and efficient irrigation methods are critical issues in the development of a botanical garden where water is a finite resource.

During the early civilization of the Fertile Crescent, water technology took two forms: the use of the 'qanat', an underground water carriage system, and the use of river water channels. Now, a more diverse range of irrigation is available. The three major types are: flood, drip and overhead spray. All are available in most urban areas in the Middle East.

Plants
Ancient and Modern; Salt Tolerance

Ancient Persian gardens had a wide variety of plants, including: cypress, chenar, elm, ash, pine, mastic, oak, myrtle, maple, fruit, grape, pomegranate, pomecitron, orange, lemon, pistachio, apple, pear, peach, chestnut, cherry, quince, walnut, apricot, plum, almond, fig, date, melon and flowers for beauty and medicine (Jellicoe and Jellicoe 1975).

Traditional Islamic gardens also included a plant palette of: plane trees, poplar, willow, pine, mulberry, lime, hazelnut, pistachio, filbert, rose, daffodil, tulip, jonquil, hyacinth, lily-of-the-valley, marigold, gilliflower, ranunculi, pinks, carnation, jasmine, violet, sweet marjoram

and water lilies (Oldham and Oldham 1980). Appendix D of this study lists plants of Persia by both Arabic and English descriptors.

Historically, the Arabian peninsula, because of the severity of climate and limited access to fresh water, had a more discreet plant palette than the area of the Fertile Crescent. Emphasis was placed on the growing of plants for food. Date palms, grape vines and pomegranates were commonly grown.

In the Middle East, watering by brackish water is often the only method available for growing many ornamental plants for landscape use. As well, there is on-going research into herbaceous and woody crops for food and agriculture, utilizing brackish water.

The tolerance of plants to salinity is not absolute, but should be tested on a relative basis. Establishing the salt-tolerance of plants is usually appraised by: " 1) the ability of a plant to survive on saline soils, 2) the absolute plant growth or yield, and 3) the relative growth or yield on saline soil as compared with that on nonsaline soil " (Mass 1986, p. 12).

The Middle East is a large geographic area which varies in landform, climate, proximity to the sea, elevation and latitude. Within these variations, there are some similar plant palettes, but consideration should be made to a specific area's water supply, climate, soil and plant availability.

CHAPTER 6

THE INFLUENCE OF ISLAM, ARID LANDS
AND WATER ON BOTANICAL GARDENS IN THE MIDDLE EAST

"There is very little else to be said for the Persian garden, except to say the same thing over and over again."

Victoria Sackville-West

(Moynihan 1979, p. vii)

Perhaps Ms. Sackville-West is correct in her perception of the Persian garden for we have seen, through this research, a sense of repetition of the essential elements of the Middle Eastern garden: the garden as paradise, the 'chahar bagh', the geometry of the square, the delight in plants and their forms and the careful and essentially simple use of water. Today, various types of gardens can be found in the Middle East: traditional, formal, natural, native desert and food producing. The traditional Islamic garden reflects the religious teachings of Islam and the Arab culture. The gardens are hospitable but private, and often a spiritual refuge (Moore 1986) (Figure 6.1).

Modern day botanical gardens and parks have some similarities of use and function. A look at previous research about parks in the Islamic world offers some general characteristics that reflect Islamic influences. A Muslim's view of the correct use of plants and design elements in a park influenced by Islam might consider; plants for food, privacy, economy, native plants, ways of sitting, recreation for health and rules of

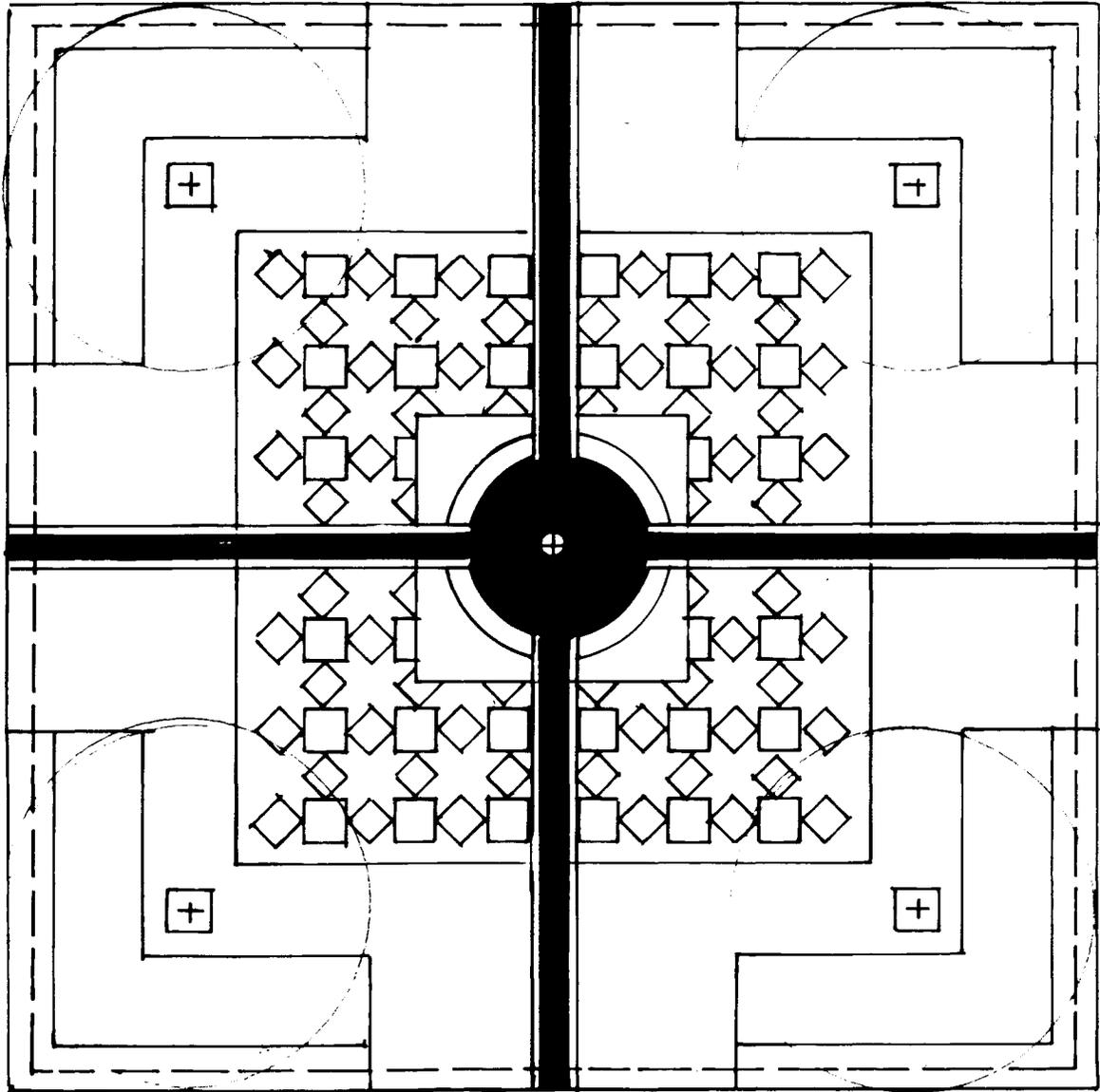


Figure 6.1 Geometric Patterns Used in Islamic Garden Design

public behavior (Al-Awais, 1986). Al-Awais, a practicing Muslim, evaluated parks in Saudi Arabia according to the following Islamic principles; privacy, rules of public areas, planting rules, thinking concept, seating arrangement, economic concept and social interaction.

For centuries, Islam has persevered in arid lands where water availability was limited and the ecological conditions severe. More ancient than the formation of Islam is the concept of the botanical garden. The earliest botanical gardens were physical expressions of the ideas of the Garden of Eden and the paradise garden. These gardens, even if constructed in non-arid climates, retained some of the original design elements for arid climate gardens.

The influence of Islam, arid lands and water on botanical gardens is: 1) A botanical garden in the Middle East should be horticulturally and ecologically sensitive to the local climate (i.e.; native plants, agriculture, arboretum). 2) A botanical garden in the Middle East should have some representation of the ancient idea of Eden and the paradise garden. 3) A botanical garden in the Middle East should be designed for limited, brackish and fresh water use, incorporating both ancient and modern methods of irrigation. 4) A botanical garden in the Middle East should be compatible with the plan of the city, urban form and the projected future stresses of arid lands.

There is a diversity of existing written information and research available about the main topics of this study: botanical gardens, Islam, arid lands and water. Unanswered questions fall into the category of synthesis of these topics into a conclusive whole, which is design. Also, available information may be outdated or not specific to the topic. What

can be concluded is a general program and analysis about what a botanical garden might be if it were to include aspects from the influence of Islam, arid lands and water. This chapter and Appendix A of this study, present a Program for a Botanical Garden in the Middle East, based on the influence of Islam, arid lands and water.

It is this author's opinion, from living and working in the Middle East, that if a botanical garden were to be constructed in a middle eastern site (taking Kuwait as an example), it might have the following general characteristics for public recreation, plants and conservation.

The Arab people appreciate their gardens, parks and areas of open space. Their bedouin heritage provokes a sense of open-space as being important and one to which is desired to be returned. As cities are built and the open desert diminishes, the need for preservation for recreation of the open land and the desert increases. An example of this desirable quality might be the winter camping tents which prevail around the open areas of Kuwait in January and February when parents and children, who are on the winter school holiday, camp. Thus, a botanical garden might be located as the central focus area of a large, recreational campground.

In Kuwait, the bedouin have traditionally lived off a land with few trees. Introduction of a botanical garden or an arboretum offers the potential for reforestation, economic yield of trees and instruction about tree growth and maintenance.

Family life is very important to the Arab people. Thus, a botanical garden would have public facilities appealing to people of all ages. As well, in the Arab world, public separation of men and women is often

encouraged. A botanical garden would necessarily allow for area discrimination based on gender and family aspect.

Historically, Islam and the development of the Muslim civilizations have been concentrated in areas of the world south of 40 degrees latitude and north of the equator. This horizontal expansion has resulted in much of the modern Islamic world being in arid or desert climates. Nearly one third of the earth's surface lies in an arid zone. As well, "world water use is expected to triple by the early twenty-first century if projected population and per capita trends materialize " (Golany 1983, p. 306). The study of Islam and arid lands merit observation because of this reoccurring pattern of population growth in the Islamic world and the requirement of designers to enable built landscapes that are culturally and environmentally correct.

A botanical garden which is the collection of plants for human use and comfort may provide practical examples of the best plants for the local climate and soils, suitable irrigation techniques for various design situations and a display of historical and religious plants and landscape design features which represent the cultural and spiritual nature of the area.

CHAPTER 7

CONCEPT FOR A BOTANICAL GARDEN; KUWAIT

A design concept for a botanical garden is shaped by the parameters of: site, functional requirements, design principles, cultural elements and plants. A botanical garden to be located in the Middle East requires the additional analysis of the influences of Islam, arid lands, and water. Appendix A of this report includes a preliminary program for a botanical garden for Kuwait.

Certainly, a complete design concept for a new botanical garden cannot be concluded from the information in this report. There are many unanswered practical questions: Is it needed? Where will it be located? Where are existing botanical gardens and what is the present nature of their work? What are the specific site requirements? How can it be funded? What will it be like? Who will manage and maintain it? What is the current state of the art in transmitting knowledge of plants and the plants themselves world-wide, and what function do botanical gardens play in that activity? What can be concluded is an initial analysis which answers these questions in the format of a preliminary program.

Site Requirements

Site planning for a botanical garden in an arid land in the Middle East requires specific criteria. Harsh climatic conditions, availability of water and maintenance are critical factors for site selection, size, and

composition. In Kuwait, choice of a site either inland or on the coast of the Arabian Gulf is a consideration. Both circumstances are arid, but the Gulf location would have special criteria due to soil and humidity.

Functional Requirements

Functional requirements depend on the scope of the project. The modern functions of botanical gardens are primarily scientific, educational and recreational. A garden could provide all these functions or specialize in one or two areas within the botanical garden framework. In Kuwait, an example of specialization could be halophytic plants for food crops or ornamentation.

Design Elements

Design elements which are closely aligned to religious, Islamic aspects of the garden include: garden as a place of quiet and contemplation, garden as public territory, planting for the public enjoyment, garden as food (i.e. the date palm), privacy in public and recreation (swimming, soccer, horseback riding, fishing and walking are the most common and encouraged sports in Kuwait). The formal principles take the shape of the square, with intricate wall and ground patterns of geometric design.

Cultural Elements

Application of cultural elements to the design of a Middle Eastern botanical garden is extremely complex. Although there are conclusions that can be made about the Arab people, these generalizations can vary. Islam is an intricate part of the life and work of the people. Thus, a botanical garden should have elements of the traditional garden which has

been shaped by both the tradition of the religion and the best selection of modern technology.

Plants

The selection of plants, their type and quantity is important. Botanical gardens usually have a variety of non-native plants, a herbarium and native plants or plants uniquely adapted to the climate and growing conditions of the area. Botanical gardens may also include arboretums which are reserved for trees and woody shrubs. Appendices E, F and H list various plants suitable for the growing conditions of Kuwait.

CHAPTER 8

CONCLUSION

Botanical gardens developed in response to specific needs of people: plants for food, shelter, medicine, spiritual fulfillment, art and recreation. The first known aspects of gardens in the category of botanic were practical, usually for the growing of plants for the body (medicine) or soul (earthly re-creations of the garden of paradise or the garden of Eden).

The pursuit of the garden of Eden is documented in literature, poetry and travel. Research assumes its location as being in the Middle East region. What can be generally concluded about Islamic gardens is that they were environmentally orientated, horticulturally aware and artistically sensitive.

The first contemporary botanical garden, Padua (1545) consolidated the ancient ideas about plants with the new idea of botanical science. The ideas of the 'garden as paradise', the 'garden as orchard' and the 'chahar bagh' are represented in many modern botanical gardens; spiritual satisfaction, food, and historical design features are available in these collections of plants for human use and comfort.

Features common to arid lands are usually dictated by the conditions of water availability, water content, soils and high temperatures. Designers of landscapes which include a botanical garden or arboretum should be aware of these primary conditions. They will shape

decisions about hard landscape design, plant choice and plant location (eg. zoning for water use and salt tolerance of plants).

A new botanical garden to be located in the Middle East, in Kuwait, requires that the design follow the specific information identified in this study; criteria in terms of the public benefits of recreation, education, conservation and enhancement of religious experience. The criteria for a botanical garden most suitable to the conditions of the Middle East in general and Kuwait in particular, identified in these terms are: 1) A combination of recreational activities for physical health (i.e. walking) combined with the other functions of a botanical garden. A botanical garden could be in conjunction with a park or arboretum, allowing gathering areas for eating and desert camping. 2) A botanical garden could have educational, instructional and historical displays of various types of gardens and native and introduced species of plants and horticultural technology (i.e. drip irrigation). 3) Conservation of plants and water could be part of the design and function of a botanical garden. 4) Provisions for the enhancement of religious experience could be incorporated into the overall purpose of a botanical garden; a Mosque may be located in or near a garden, principles of traditional Islamic garden design could be identified, and a botanical garden could be designed to respect the social and cultural aspects of Islam. A botanical garden that considers all these criteria is feasible once the specific factors are identified and described.

APPENDIX A

PROGRAM FOR A BOTANICAL GARDEN IN KUWAIT

What is a Botanical Garden ?

A botanical garden is a living museum. It is a museum where plants are grown, researched and arranged in landscape architectural displays. It is a place for the collection of plants for human use and comfort.

Modern botanical gardens provide facilities for major research for the preservation of the world ecology, and offer a way for people to renew their understanding of nature as it relates to their social, spiritual and economic life.

Why is a Botanical Garden Needed ?

_____To operate and maintain an outdoor and indoor educational institution fostering study and evaluation of the botanical and horticultural sciences, ecology, and landscape architecture.

_____To develop and execute programs for improvement of conditions and perpetuation of plants native to or found in the Kuwait desert.

_____To operate and maintain greenhouses and a conservatory.

_____To develop a plant-based industry on the site of the botanical garden.

_____To operate and maintain a facility which is available to the public year-round.

Why in Kuwait ?

Kuwait is a major city located in the central Middle East. Census estimates indicate that by 1990, Kuwait will have a population of 2.1 million (Kuwait Ministry of Information 1986). There is evidence that a botanical garden could be supported physically in Kuwait. In the infrastructure of Kuwait there are over 300 kilometers of modern roadways and expressways to grant access to almost any chosen site. There is a network of water, both brackish and fresh produced by the Ministry of Electricity and Water that, if allocated, could potentially support a large botanical garden. There is a government agency, the Agricultural Affairs and Fishes Resources Authority, to oversee the development of goals, objectives, funding, physical design and planning, construction and maintenance of such a facility.

Other factors in support of a botanical garden include: 1) There are presently over 29 municipal parks and gardens in the final design stages and going to tender (bid) for construction; 2) There are presently 5 District Parks which are being master planned and are expected to be out to tender within 3 years; 3) There are presently 3 Regional Parks in the same sort of development; 4) There is presently a national agenda for the 'Greening of Kuwait', incorporating tenders for the design and construction of landscape for the entire freeway system, independent agencies (National Housing Authority, Kuwait Municipality) building their own parks system, and a massive landscape project being planned for the new Amiri Diwan and Council of Ministers Project; 5) There are presently more than 10 landscape contractors operating in Kuwait, where 3 existed only 4 years ago; 6) The success of the Conference Center Project both

as a political coup for the country and the grounds being popular with the people has spurred the development of landscape projects; 7) From the perspective of educational value, there is justification for a botanical garden to be established in Kuwait (Sellers 1987).

How Much Will it Cost ?

- I. Preliminary Planning.....\$
- II. Master Planning.....\$
- III. Building
 - A. Construction Cost (\$ /sf x# sf)...\$
 - B. Fixed Equipment (8% of A).....\$
 - C. Site Development (30% of A),(\$/sf x # sf).\$
 - D. Total Construction (A+B+C).....\$
 - E. Site Acquisition (Govt. or Univ.)...\$ 00.00
 - F. Moveable Equipment (20% of A).....\$
 - (includes furniture,displays & plants @ \$20/sf)
 - G. Professional Fees (6% of D).....\$
 - H. Contingencies (15% of D).....\$
 - I. Administrative Costs (1% of A).....\$

Total Budget Building.....\$

other;

Mode of Operation

Operation Expenses

POE Costs

Inflation costs (8% change per year)

conversions;

1 hectare (ha) = 2.471 acres

1 sq meter = 1.1960 sq yard

3.40 U.S. Dollar = 1 Kuwaiti Dinar (KD), approx.

How Can it be Supported ?

In a project such as a botanical garden, because the initial investment is great, careful planning and organization is required. It is recommended that funding for programming and planning for the garden be allotted at the beginning of the project. A grant of 50,000.00 dollars (approx. 17,000.000 Kuwaiti dinar) to determine funding feasibility, site selection requirements and the plan for the botanical garden is recommended.

There are a number of ways that a botanical garden can be supported. They include: 1) non-profit corporation with a board of directors: 2) membership and entry fees: 3) research grants: 4) endowed funds: 5) funds from private corporations: 6) educational grants: and 7) state/country funds. In the long-term, many botanical gardens become financially self-supporting.

What Would it be Like ?

Facility Goals - Image

Functional Goals

Site Selection Criteria

Area Efficiency Study

(Programming and cost estimate format from Cherry, 1982)

APPENDIX B

NOTABLE BOTANICAL GARDENS AND ARBORETUMS IN THE MIDDLE EAST

Egypt (U.A.R.):

- 1) Alexandria: Botanic Garden, Botany Department, Faculty of Science, University of Alexandria.
- 2) Aswan: The Plant Garden.
- 3) Cairo: Orman Botanic Garden.
- 4) Cairo: Zohria Trial Gardens.
- 5) El Saff: El Saff Botanic Garden.
- 6) Qubba: Qubba Botanic Garden.

Turkey:

- 1) Adana: Cukurova University Botanical Garden Ziraat Fakultesi Peyzaj Mimarisi Kursusu.
- 2) Istanbul: Istanbul Universitesi Botanik Bahcesi.
- 3) Izmir-Bornova: Ege Universitesi Fen Fakultesi Sistematik Botanik Enstitusu.

Iraq:

- 1) Baghdad: Zaarfaraniyah Arboretum.

Iran:

- 1) Karadj: Botanical Garden.
- 2) Tehran: Ariamehr Botanical Garden.

Pakistan:

- 1) Karachi: Zoological Garden.

Israel:

- 1) Beer Sheva: Ben Gurion University of the Negev, Research and Development Authority.
- 2) Holon: Botanical Garden "Mikveh-Israel".
- 3) Jerusalem: The Botanical Gardens of the Hebrew University.
- 4) Ruppin: Havath-Noy Garden.
- 5) Tel Aviv: Botanic Garden of Tel Aviv University.

Libya:

- 1) Tripoli: Sidi Mesri Experiment Station.

Tunisia:

- 1) Ariana: Service Botanique et Agronomique de Tunisie.

Sudan:

- 1) Khartoum: Soba Arboretum, Forest Research Institute.

(Henderson and Prentice 1977)

APPENDIX C

NOTABLE BOTANICAL GARDENS AND ARBORETUMS IN THE WORLD

- 1) Royal Botanic Garden at Edinburgh, Scotland (35,000 plants).
- 2) Botanical Garden of the University, Tübingen, Federal Republic of Germany (35,000 plants).
- 3) National Botanical Gardens, Dublin, Ireland (25,000 plants).
- 4) Royal Botanic Gardens, Kew, England (25,000 plants).
- 5) Institute for Plant Culture, Berlin, Germany (21,500 plants).
- 6) Montreal Botanical Gardens, Canada (20,000 plants).
- 7) Royal Botanic Gardens, Australia (20,000 plants).
- 8) Botanical Gardens, Zurich, Switzerland (18,000 plants).
- 9) Royal Veterinarian and Agricultural High School Garden, Copenhagen, Denmark (15,000-20,000 plants).
- 10) Arnold Arboretum of Harvard University, U.S.A., (6,000 plants).

(Henderson and Prentice 1977)

APPENDIX D

PLANTS OF PERSIA

Following is a list of plants and some general terms which appear in poetic descriptions of gardens and garden imagery of Persian 'earthly gardens'. The Persian name and the literal or English translation is given for each plant. The list is published in "The Islamic Garden", by MacDougal and Ettinghausen 1976, pages 64-67. The list, by William Hanaway Jr. is titled " The Vegetation of the Earthly Garden".

PERSIAN NAME/ENGLISH/FIGURATIVE MEANING

abnus/Ebony/the breasts

anar/Pomegranate/the breasts

angur/Grape

'ar'ar/Juniper/beloved's figure

arghavan/Judas tree/the face

baddam/Almond/the eye

bahar/Ox-eye; a flower in general/the face

ban/Benjamin/beloved's figure

banafshih/Violet/hair; down on the cheek or upper lip

bid/Willowbih,bihi/Quince/the chin

bih danih/Quince seed/mole or beauty spot

bihisht/(Garden of) Paradise/the face

bustan/garden/the face

bustan afruz/Amarinthus
 chindar/Plane-tree/its leaf is likened to the human hand
 danih/any seed/mole or beauty spot
 dirikht-i kafur/Camphor tree/the neck
 gaz/Tamarisk
 ghunchih/bud/the breast,lips
 gul/Rose; any flower/breast or bosom; cheek,face
 gulbun/Rose bush/the nose
 gulistan/garden; rose garden/the face
 gulnar/Pomegranate flower/the face; cheek
 gulshan/garden/the face
 gulzar/garden/the face
 isfand (see also sipand)/wild Rue/mole or beauty spot
 jannat/Garden of Paradise/the face
 jauz/nut, in general
 khadang/white Poplar
 khairi/Wallflower
 khaizuran/Bamboo; reed
 khujastih/Marigold
 lalih/Tulip/the face,cheek
 limu/Lemon/the breasts, chin
 marzanjush/forget-me-not/hair,down
 mihrgiah/Mandrake/down
 mina/Aster
 murd/Myrtle/hair
 mnabat/plant, in general/down

nai, also nai/reed, Bamboo/loved's figure
 naishakar/Sugarcane/loved's figure
 nakhl/Date palm/loved's figure
 nar (see also anar)/Pomegranate seed/the lip
 naranj/Orange
 nargis/Narcissus/the eye
 narvan/Elm/loved's figure
 nashk/a kind of Cypress/loved's figure
 nasrin/white Rose/face, chin, bosom, teeth
 nastaran/Eglantine/the face
 nil/Indigo/down
 nilufar/Waterlily
 pistih/Pistachio/the mouth, lip
 raihan/Basil/down
 raz/Grapevine
 sabzih/greenery/down
 saj/Teak/loved's figure
 saman (see also yasmin)/Jasmine/face, hair, bosom
 sanaubar/Pine/loved's figure
 sandal/Sandalwood
 sarv/Cypress/the beloved; the beloved's figure
 sib/Apple/the chin
 sipand (see also isfand)/wild Rue/mole or beauty spot
 sisanbar/Thyme
 sunbul/Hyacinth/hair, cheek, down
 susan/Lily

shahasparam, or shasaparam/Basil
 shamshad/Box/beloved's figure, hair
 shanbalid/Fenugreek
 shaqayiq/Poppy
 shaqayiq-i nu'man/Anemone
 shikufih/blossom/the teeth
 tuba/a tree of Paradise/beloved's figure
 turanj/Citron/the breasts, chin
 tut/Mulberry
 `ud/Aloe/down
 `unnab/Jujube/the lips
 yasim (see also saman)/Jasmine/face,hair,bosom
 za'faran/Saffron
 saimaran/a kind of Basil
 zarir/yellow Dyer's weed

APPENDIX E

PLANT LIST FOR KUWAIT; SALT TOLERANT

Plants successfully grown in Kuwait under brackish water (containing 4000 ppm of TDS) and/or treated sewage water irrigation. (Source; AAFRA - Agricultural Affairs and Fisheries Resources Authority, List compiled by Head, Forestry and Fodder Crops Section during December, 1970)

TREES AND SHRUBS

1. *Acacia aneura*
2. *Acacia arabica*
3. *Acacia cambagei*
4. *Acacia farnesiana*
5. *Acacia forestiana*
6. *Acacia ligulata*
7. *Acacia implexa*
8. *Acacia mellifera*
9. *Acacia oswaldi*
10. *Acacia pendula*
11. *Acacia salicina*
12. *Acacia seyal*
13. *Acacia tortillis* var. *raddiana*
14. *Acacia tortillis* var. *tortillis*
15. *Acacia victoriae*
16. *Albizia lebbek*
17. *Albizia procera*
18. *Atriplex nummularia*
19. *Atriplex vesicaria*
20. *Azidarachta indica*
21. *Balanites aegyptiaca*
22. *Calligonum comosum*
23. *Caesalpinia gilliessi*
24. *Callistemon lanceolata*
25. *Casuarina cumminghamiana*
26. *Casuarina glauca*
27. *Casuarina lehmanii*
28. *Casuarina stricta*
29. *Cordia myxa*
30. *Dalbergia sisso*
31. *Dodonea viscosa*

32. *Dodonea attenuata*
33. *Eucalyptus brockwayi*
34. *Eucalyptus calcicultrix*
35. *Eucalyptus camaldulensis* var. *obtusa*
36. *Eucalyptus clelandi*
37. *Eucalyptus intertexta*
38. *Eucalyptus kondinensis*
39. *Eucalyptus largiflorens*
40. *Eucalyptus melliodora*
41. *Eucalyptus microtheca* var. *coolabah*
42. *Eucalyptus oleosa*
43. *Eucalyptus oleosa* var. *transcontinentalis*
44. *Eucalyptus sargenti*
45. *Eucalyptus spathulata*
46. *Ficus religiosa*
47. *Ficus carica*
48. *Ficus laurifolia*
49. *Ficus macrophylla*
50. *Haloxylon aphyllum*
51. *Ipomea* sp.
52. *Justica alba*
53. *Lawsonia inermis*
54. *Melia azedarach*
55. *Nerium oleander*
56. *Nitraria retusa*
57. *Olea europea*
58. *Parkinsonia aculeata*
59. *Pithecelobium dulce*
60. *Prosopis glandulosa*
61. *Prosopis juliflora*
62. *Prosopis velutina*
63. *Ricinus communis*
64. *Sesbania aegyptiaca*
65. *Tamarindus indica*
66. *Tamarix aphylla*
67. *Tamarix florida*
68. *Tamarix jordanis*
69. *Tamarix passerinoides*
70. *Tecoma stans*
71. *Thespesia populneum*
72. *Thevetia peruviana*
73. *Terminalia catappa*
74. *Terminalia bellerica*
75. *Terminalia arjuna*
76. *Vitex angus castus*
77. *Washingtonia* (*Pritchardia filifera*)
78. *Zizyphus spina christi*
79. *Zizyphus jujuba*

HEDGE PLANTS

1. *Clerodondron inerme*
2. *Dodonea viscosa*

3. *Inga dulcis*
4. *Lantana camara*
5. *Myrtus communis*

CLIMBERS

1. *Antigonum leptopus*
2. *Bougainvillea* sp.
3. *Clerodendrum inerme*
4. *Ipomea* sp.
5. *Lufa aegyptica*

FIELD CROPS

1. Barley
2. Corn
3. Wheat

FODDER CROPS

1. Alfalfa
2. Fine Sorghum
3. *Sativum*
4. Sudan Grass

VEGETABLES

Summer:

1. Cucumber
2. Eggplant
3. Jew's mallow
4. Melons
5. Okra
6. Pepper
7. Snake cucumber
8. Squash
9. Tomato
10. Watermelon

Winter:

1. Beet
2. Cabbage
3. Carrot
4. Cauliflower
5. Coriander
6. Endive
7. Garden rocket
8. Kholrabi
9. Leek
10. Lettuce
11. Mustard
12. Onions
13. Parsley
14. Peas
15. Radish
16. Spinach

17. Swiss chard
18. Turnip

FRUIT TREES

1. *Cordia myxa*
2. *Phoenix dactylifera* (Dates)
3. *Zyzyphus* sp.

GRASSES

1. *Cynodon dactylon* sp. - perennial lawn
2. *Lolium perenne* - winter annual

BULBS

1. *Canna*
2. *Dahlia*
3. *Fresia*
4. *Gladiolus*
5. *Iris*

FLOWER PLANTS

Summer:

1. *Amaranthus tricolor*
2. *Celosia argentea*
3. *Cosmos bipinnatus*
4. *Gomphrena globosa*
5. *Helianthus annuus*
6. *Impatiens balsamina*
7. *Kochia tricophylla*
8. *Portulaca grandiflora*
9. *Tagetes erecta*
10. *Zinnai elegans*

Winter:

1. *Ageratum mexicanum*
2. *Althaea rosea*
3. *Alysum maritimum*
4. *Anthriscum majus*
5. *Aster*
6. *Calendula officinalis*
7. *Calliopsis bicolor*
8. *Callistephus hortensis*
9. *Centaurea cyanus*
10. *Cheiranthus annuus*
11. *Cineraria*
12. *Clarkia elegans*
13. *Delphinium ajacis*
14. *Dianthus caryophyllus*
15. *Dimorphotheca awianthiaca*
16. *Gaillardia pulchella*
17. *Godetia* sp.
18. *Helichrysum bracteatum*
19. *Linaria cymbalaria*

20. *Linnum* sp.
21. *Lobelia erinus*
22. *Mathiola incana*
23. *Mesembryanthemum tricolor*
24. *Penstemon* sp.
25. *Petunia hybrida*
26. *Phlox drummondii*
27. *Salvia splendens*
28. *Saponaria calabrica*
29. *Scabiosa caucasica*
30. *Statice sinuata*
31. *Tropaeolum majus*
32. *Verbena hybrida*
33. *Viola tricolor*

APPENDIX F

PLANT LIST FOR KUWAIT; LANDSCAPE

The state of the art of plant selection and availability is constantly changing in Kuwait. Following is a list of plants which were considered for planting for the Kuwait Conference Center, which was completed in 1987. The majority of the plants listed were actually planted for the project. Irrigation of the plants was by brackish and/or fresh water.

BOTANICAL NAME

PALMS:

Phoenix dactylifera
Washingtonia robusta

TREES:

Acacia farnesiana
Acacia salicina
Acacia stenophylla
Albizia lebeck
Callistemon viminalis
Casuarina cunninghamiana
Casuarina equisetifolia
Cercidium floridum
Cordia myxa
Dodonaea viscosa
Dodonaea viscosa "purpurea"
Eucalyptus microtheca
Eucalyptus polyanthemos
Ficus altissima
Parkinsonia aculeata
Pithecellobium dulce
Prosopis alba
Prosopis chilensis
Prosopis velutina
Rhus lancea
Tamarix aphylla
Thevetia peruviana
Ziziphus spina-christi
Delonix regia

SHRUBS:

Agave vilmoriniana
 Aloe saponaria
 Asparagus densiflorus 'Sprengeri'
 Bougainvillea 'Crimson Jewel'
 Carissa grandiflora
 Cassia artemisioides
 Clerodendrum inerme
 Cortaderia selloana
 Hibiscus rosa-sinensis
 Lantana camara
 Larrea tridentata
 Leucophyllum frutescens
 Nerium oleander 'Algiers'
 Nerium oleander 'Casablanca'
 Nerium oleander 'Petite Pink'
 Nerium oleander 'Petite Salmon'
 Nerium oleander 'Sister Agnus'
 Santolina chamaecyparissus
 Tecoma stans
 Yucca elata

GROUNDCOVERS:

Alternanthera versicolor
 Arctotheca calendula
 Carissa grandiflora 'prostrata'
 Carissa grandiflora 'Prostrata Tuttlei'
 Carpobrotus edulis
 Ipomoea palmata
 Ipomoea pes-caprae
 Lantana montevidensis
 Lampranthus spectabilis
 Osteospermum fruticosum
 Phyla nodiflora
 Vinca rosea 'Dwarf Red'

VINES:

Bougainvillea 'Barbara Karst'
 Bougainvillea 'San Diego Red'
 Ficus pumila
 Ipomoea palmata
 Ipomoea pes-caprae
 Macfadyena unguis-cati

LAWN:

Paspalum vaginatum

ANNUALS:

Alyssum
 Antirrhinum
 Aster

Calendula
Chrysanthemum
Daffodil
Dahlia
Dutch Iris
Geranium
Gomphrena
Marigold
Pansy
Petunia
Tulip
Viola
Zinnia

APPENDIX G

CLIMATE ZONES IN THE MIDDLE EAST REGION

The following information refers to Figure 5.1, 'Climate Map of the Middle East Region'. The description of each zone is quoted from "Gardening in the Middle East" by Eric Moore (1986), pages 10 through 12.

ZONE 1: The humid African and Arabian coastal areas of the Red Sea, extending to the nearby foothills. In Egypt this zone extends up to the Mediterranean coast including the Nile delta, and west to the Libyan border.

Average high temperatures: 40 to 45 degrees C (104 to 113 degrees F)

Average low temperatures: 11 to 15 degrees C (52 to 59 degrees F)

Average humidity: 80% (winter), 92% (summer)

Average annual rainfall: 45 mm to 64 mm (2 to 2.5 in)

ZONE 2: The mountains and higher elevations of Saudi Arabia's southwestern Asir Province and Oman's Akhdar mountains. Characterized by heavy annual rainfall influenced by monsoon winds, and winter temperatures below freezing.

Average high temperatures: 32 to 38 degrees C (90 to 100 degrees F)

Average low temperatures: 0 to -5 degrees C (32 to 23 degrees F)

Average humidity: 40% to 60%

Average annual rainfall: 160 mm (6in) in Taif; 564 mm (22.5 in) in Jabal Salah, Saudi Arabia

ZONE 3: The arid central and north central regions of the Arabian peninsula extending up to the eastern areas of Jordan. Also includes the regions of Egypt and north Sudan from the Red Sea foothills to the Nile. Elevations from 150m to 1000m (500-3,000ft). Mild winters and occasional frost, and hot, dry summers with moderate to heavy winds.

Average high temperatures: 41 to 46 degrees C (106 to 115 degrees F)

Average low temperatures: 8 to 2 degrees C (46 to 36 degrees F)

Average humidity: 45% (winter), 18% (summer)

Average annual rainfall: 35mm to 100mm (1.5 to 4in)

ZONE 4: Semi-arid northern and north-western higher elevations, including the populous areas of Jordan. Not as cold as Saudi Arabia's Asir Province, and nowhere near the same level of rainfall. Although the average rainfall is comparable to the central areas, the extended period of frost and higher humidity make this a distinct zone.

Average high temperatures: 30 to 41 degrees C (86 to 106 degrees F)

Average low temperatures: 2 to -7 degrees C (36 to 10 degrees F)

Average humidity: 35% to 55%

Average annual rainfall: 78mm to 120mm (3 to 5in)

ZONE 5: The humid coastal area of the Arabian Gulf, from Kuwait to the straits of Hormuz, including Bahrain and Qatar, then south and west along the Omani coast.

Average high temperatures: 42 to 47 degrees C (108 to 117 degrees F)

Average low temperatures: 13 to 10 degrees C (56 to 50 degrees F)

Average humidity: 75% (winter), 90% (summer)

Average annual rainfall: 50mm to 100mm (2 to 4in)

ZONE 6: The harsh desert areas of the Sahara and Saudi Arabia's Rub Al Khali, which have very high summer temperatures, cold winter nights, and harsh winds. These regions are estimated to have the lowest rainfall in the Middle East. Some areas may not have rain for years.

Average high temperatures: 42 to 47 degrees C (108 to 117 degrees F)

Average low temperatures: 7 to 1 degrees C (45 to 34 degrees F)

Average humidity: 40% (winter), 15% (summer)

Average annual rainfall: 20mm to 40mm (1 to 2in)

ZONE 7: The Qara mountains in south-western Oman which experience heavy monsoon rains blowing off the Indian Ocean from June to September. The mountains are the natural barrier that prevents these summer rains from reaching southern Saudi Arabia and the Red Sea coast of Africa.

Average high temperatures: 26 to 32 degrees C (79 to 90 degrees F)

Average low temperatures: 2 to -4 degrees C (36 to 25 degrees F)

Average humidity: 40% to 80%

Average annual rainfall: 250mm to 625mm (10 to 25in)

The above figures are approximate averages, and are based on data

obtained from Saudi Arabia's Meteorological and Environmental Protection Administration.

APPENDIX H

SALINITY TOLERANT PLANTS

The following list is based on general salinity figures and is quoted from "Technical Considerations on Salinity in Hot Territories" by Adams and Adams, page 28.

SALINITY-TOLERANT PLANTS:

30,000 ppm:

Avicennia marina
Prosopis juliflora
Sueda spp.

25,000 ppm:

Atriplex nummularia
Nitraria retusa
Phoenix dactylifera
Prosopis tamarugo
Tamarix passerinoides
Washingtonia filifera

20,000 ppm:

Casuarina equisetifolia
Kochia indica
Tamarix aphylla

9,000 ppm:

Acacia farnesiana
Acacia pendula
Acacia salicina
Callistemon lanceolatus
Casuarina glauca
Eucalyptus camaldulensis
Eucalyptus sargentii
Nerium oleander
Parkinsonia aculeata
Prosopis chilensis
Zizyphus jujuba
Zizyphus spina-christi

8,000 ppm:

Acacia arabica
Acacia cyanophylla
Acacia nilotica
Carpobrotus edulis
Clerodendrum inerme
Haloxylon salicornicum
Sesbania aegyptiaca
Sesbania grandiflora

7,000 ppm:

Dodonaea viscosa
Melia azedarach
Punica granatum
Thevetia neriofolia

6,000 ppm:

Albizia julibrissin
Albizia lebbek
Ficus carica
Ficus nitida
Ficus religiosa
Ricinus communis
Santolina chamaecyparissus
Thespesia populnea
Vitex agnus-castus

5,500 ppm:

Calligonum comosum
Caesalpinia gilliesii
Caesalpinia pulcherrima
Dalbergia sissoo

4,500 ppm:

Brachychiton acerifolia
Ficus bengalensis
Ipomea pes-capre
Prosopis spicigera
Schinus molle
Schinus terebinthifolius
Terminalia catappa
Yucca gloriosa

3,000 ppm:

Arundo donax
Lantana camara
Pistacia lentiscus
Tamarindus indica
Tacoma stans

2,000 ppm:

Acacia tortilis

1,500 ppm:

Cassia fistula

Delonix regia

Duranta plumieri

Lavandula spica

Myrtus communis

Plumbago capensis

Tecomaria capensis

600 ppm

Bougainvillea spp.

Citrus spp.

Hibiscus rosa-sinensis

Jacaranda mimosiaefolia

Jasminum spp.

Mangifera indica

Plumeria acutifolia

Psidium gayava

LIST OF REFERENCES

- AAFRA, 1970. Agricultural Affairs and Fisheries Resource Authority. Safat, Kuwait. Unpublished paper.
- Al-Awais, S.A. 1986. Parks for Saudi Arabia. The University of Arizona, Tucson, Arizona, 152 pages. (Unpublished Master's Thesis).
- Adams R. and Adams M., Techniques no.24: technical considerations on salinity in hot territories. LFI 11.72,CI/SfB (91), UDC 626.84. pages 27-30.
- Calvery, E.E 1974. Islam: An Introduction. American University Press, Arab Republic of Egypt, 97 pages.
- Cherry, E. 1982. Programming Procedures. Section reprinted by Ms. Cherry courtesy of Cahner Books International and with the approval of CRS. Unpublished paper.
- Cochrane, T. (ed.) 1987. Landscape Design for the Middle East. RIBA Publications Ltd., London, 160 pages.
- Duval, M. 1982. The King's Garden. The University Press of Virginia, Charlottesville, VA, 214 pages.
- Girouard, M. 1985. Cities and People. Yale University Press, New Haven and London, 397 pages.
- Golany, G. 1983. Design for Arid Regions. Van Nostrand Reinhold Co., N.Y., U.S.A.
- Grubb, E. and Clabby C. 1982. Botanical Garden, A Program. Report for a Comprehensive Botanical Garden for New Mexico, University of New Mexico School of Architecture and Planning. Unpublished report, 38 pages.
- Henderson, D.M. and Prentice H.T. (eds.) 1977. International Directory of Botanical Gardens II. Scheltema and Holkema, Utrecht-Netherlands, 270 pages.
- Hepper, N. F. 1982. Kew Gardens for Science and Pleasure. Stemmer House Publishers, Inc., Owings Mills, Maryland, 195 pages.
- Jellicoe, G. and Jellicoe, S. 1975. The Landscape of Man. Viking Press, N.Y., 383 pages.

- Jellicoe, G., Jellicoe S., Goode, P., Lancaster, M. 1986. The Oxford Companion to Gardens. Oxford University Press, London, 635 pages.
- Kuwait Ministry of Information 1986. Kuwait Facts and Figures. Ministry of Information, Safat, Kuwait, 239 pages.
- Lehrman, J. 1980. Earthly Paradise, Garden and Courtyard in Islam. Stinehour Press, Thames and Hudson, London.
- MacDougall, E.B. and Ettinghausen R. (eds.) 1976. The Islamic Garden. Stinehour Press, Dumbarton Oaks, Trustees for Harvard University, Washington, D.C., U.S.A., 135 pages.
- Mass, E.V., 1986. Salt tolerance of plants. Applied Agricultural Research, Vol. 1, No. 1, pp 12-26.
- Moore, E. 1986. Gardening in the Middle East. Stacey International, London, 144 pages.
- Moynihan, E.B. 1979. Paradise as a Garden in Persia and Mughal India. George Braziller Inc., N.Y., U.S.A., 168 pages.
- Newton, N. 1971. Design on the Land. Belknap Press of Harvard University Press, Cambridge, MA, U.S.A., 715 pages.
- Oldham, J., Oldham, R. 1980. Gardens in Time. Lansdowne Press, Sydney, Australia, 288 pages.
- Patai, R. 1973. The Arab Mind. Charles Scribner's Sons, N. Y., U.S.A., 435 pages.
- Prest, J. 1981. The Garden of Eden. Yale University Press, New Haven, U.S.A. and London, UK, 122 pages.
- Ruthven, M. 1984. Islam in the World. Penguin Books Ltd., England, 400 pages.
- Sellers, G. 1987. personal interview.
- Stein, J. (ed.) 1981. The Random House Dictionary of the English Language. Random House, N.Y., U.S.A., 2059 pages.
- Stephenson, J.W. 1960. The Gardener's Directory. Hanover House, N.Y., U.S.A., 454 pages.
- Titley, N.M. 1979. Plants and Gardens in Persian, Mongol and Turkish Art. Oxley Press, London.
- Van-Ollenbach, A. 1978. Planting Guide to the Middle East. The Architectural Press Ltd., N.Y., U.S.A., 154 pages.

Wickens, G.E., Goodwin, J.R. and Field, D.V. (eds.) 1985. Plants for Arid Lands, Kew International Conference on Economic Plants for Arid Lands. George Allen & Unwin Ltd., London, UK, 452 pages.

Wilbur, D.N. 1979. Persian Gardens and Garden Pavilions. Charles E. Tuttle Co. , Rutland Vt., 239 pages.

Wyman, D. 1947. The arboretums and botanical gardens of north america. Chronica Botanica. 10:5/6 398-482.

Figure Citations:

Figure 1.1 Cochrane 1987, p. i.

Figure 2.1 MacDougall and Ettinghausen 1976, p. xiii.

Figure 2.2 Prest 1981, p. 44.

Figure 4.1 Ministry of Information 1986, p. 10-11.

Figure 5.1 Moore 1986, p. 10 -11.

Figure 5.2 Cochrane 1987, p. 9.