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LANDSCAPE LEARNING; XERISCAPING DESIGN TECHNIQUES: THE CASE OF JORDAN UNIVERSITY

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ABSTRACT

Xeriscape landscapes are defined as "quality landscaping that conserves water and protects the environment."

Xeriscape landscape design is a challenging new field in Jordan as well as in the Middle East. The role of the landscape designer in Jordan is little different from his/her role in any country in the world. His/her role is to understand, design, supervise, and advise on the management of the landscapes his/her clients wish to create. Therefore, we must try to avoid, as much as possible, untried technology, but spend time in acquiring a deep understanding of the climate, soils, the plants, local materials, water management, local craft, and management skills and above all, of the people. With the escalating water scarcity problem in Jordan, the promotion of such concepts is essential for the sustainability Jordanian urban landscaping. The document at hand proposes a curriculum for a 1-credit hour course to be instructed at the University of Jordan as a summer session course for architecture and agriculture students. Considering its low load (i.e., 1-credit hour), and the importance of the issue, it is highly recommended that such course be mandatory for such students.

In addition, and being a newly applied concept in Jordan, it is also recommended that such course be offered to non-students through the University's Center for Consulting and Technical Studies. Target audiences for such course will include landscape architects, agriculturalists, and nursery owners. So, any successful course in Xeriscaping must cover the following basic areas

1. Planning and Design
2. Plant Selection
3. Turf Areas
4. Soil Improvement
5. Efficient Irrigation
6. Mulches
7. Maintenance

Considering the inter-disciplinary nature of those areas, it is highly recommended that such course be instructed via a joint effort between the Department of Architecture and the Faculty of Agriculture.

KEYWORDS: Xeriscaping Landscape, Environment, Soil Improvement, Plant Selection

INTRODUCTION

THE SEVEN PRINCIPLES OF XERISCAPE

Whether old or new, your landscape can be made much more water efficient by applying the principles of water conserving gardens. Xeriscape means low-water-using. It does not mean dry or barren looking. Applying the seven

principles of xeriscape enables you to use natives and non-native drought tolerant plants for lovely, colorful, and shady outdoor spaces around your home.

XERISCAPE'S SEVEN PRINCIPLES ARE

1. **Water-wise Planning and Design**

Begin by making a plan for your site. Determine how you intend to use areas around your home. Identify shady and sunny areas, sloped and flat areas, and how air moves on your site. Next, divide your property into oasis-type, moderate, and low-water-use areas. The Oasis area should be next to your house, where use is the most intense, to provide shade and coolness, as well as aesthetic appeal. The lowest-water-use area will probably be at the outer edge of your property, and may include native plants already growing on the site. Once the plants in this zone are established, they need little or no water. The middle zone is a transition zone between the other two areas and uses a moderate amount of water. Plants that have a similar need for water, sun, and maintenance should be grouped together to increase irrigation efficiency and reduce maintenance time.

2. Low-Water Using Plants

There are plenty of plants that use little water (figure 1). A wide selection of such plants is provided in the plant lists included in this web site. Tree selection is very important because trees can provide you with years of luscious shade. They can be chosen and located to provide shade to your home in summer months and allow the winter sun in. Use groundcovers and wildflowers to add color and texture in your landscape, and use shrubs for accent or as a screen for privacy.

Figure 1: Selecting Low Water Use Plants

Take the time to look at good xeriscape examples in your area. A good example in Amman is the Darat al-Funun garden in Jabal al-Luweibdeh (figure 2).

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Figure 2: Darat Al-Funun Garden In Jabal Al-Luweibdeh, Amman

3. Limit Grass Areas

Grass uses more water than anything else in the garden and also requires more maintenance, so use it only where it provides functional benefits. If you want grass just to look at, perhaps a good groundcover could better provide you that mat of green. Use grass in high-use areas, but do not use it on slopes or in hard-to-irrigate and maintain areas. A good alternative for low-use areas is seeded wildflowers or native grasses or other drought tolerant ground covers.

4. Water Harvesting Techniques

Incorporate water-harvesting techniques into your landscape design. This means simply channeling runoff from rain to planted areas or to a container for later use (figure 3). A few simple methods that direct runoff to where it is needed include sloping sidewalks and terraces, collecting roof water, contouring lawns or other sloped areas, and the use of rock "river" channels. By constructing earth mounds or berms at the edge of your property you can also hold water on your site. Locate plants where they can take advantage of this extra water.

Figure 3: Incorporating Water Harvesting Techniques

Jordan features a number of distinctive historical examples that incorporate effective water harvesting systems. These include the cut-stone reservoirs of the Nabatean city of Petra, as well as the underground cisterns found in the country's Umayyad desert palaces, Crusader castles, and traditional village houses.

5. Efficient Irrigation System and Design

Match your irrigation method to the type of plant being irrigated - drip irrigation for individual plants and spray irrigation for grass. Drip is the most efficient way to irrigate because it puts water where it is needed and reduces evaporation. Use a timer or controller to schedule irrigation and change schedules often - whenever the weather changes, especially when it rains. Put plants with similar water needs and similar rooting depth on separate valves.

Then you are not wasting irrigation water on shallow-rooted plants such as groundcovers to accommodate deep-rooted plants such as trees. Most soils cannot absorb water as fast as a spray irrigation system puts it out, so use low volume spray heads to avoid runoff. And most important, water wisely. Too much water is as bad as not enough, and in many cases is worse. Use deep widely spaced irrigations. This will encourage deeper rooting and more drought tolerance in plants. Water in the early morning to reduce water loss from evaporation.

6. Mulch

Apply mulches at the base of plants to retain moisture, keep weeds down, and control erosion. Mulches can also reduce soil compaction and salt buildup. Typical mulches include compost, bark chips, and inert materials such as decomposed granite and river run rock (figure 4).

Figure 4: Using Mulches

7. Proper Maintenance

Your xeriscape will not only reduce your water use, but also minimize your maintenance efforts. But some pruning, weeding, and fertilizing will still be needed. Without good maintenance you will not achieve the water savings and appearance you want. Go easy on the fertilizer and use a slow-release type. Remember that many xeriscape plants do

not need any or very little fertilizer. Aerate and de-thatch your lawn once a year to improve infiltration and reduce runoff. Pull up weeds because they use valuable water and fertilizer. Establish a regular maintenance program for your irrigation system to check for leaks and damaged equipment. Be sure and fix any problems immediately or turn your system off until you can.

Water is a most precious natural resource. Through its wise use in water efficient landscaping, you preserve and protect this resource and at the same time you can have beautiful and enjoyable yards and gardens.

Remember, xeriscape means low-water-using, it doesn't mean dry and barren looking. Applying the seven principles of xeriscape enables you to use natives and desert-adapted plants for lovely, colorful, and shady outdoor spaces around your home.

WATER SECTOR

Water resources are vital to socio-economic growth in Jordan. Any shortage or decrease of water supply is bound to have a negative effect on the overall development effort. Therefore, the development and prudent management of the water sector is crucial for growth in the other sectors of the economy especially agriculture, industry, and tourism.The water sector is managed by the Ministry of Water and Irrigation which sets water policies and coordinates the various activities through two implementing agencies, the Water Authority and the Jordan Valley Authority (figure 5)..

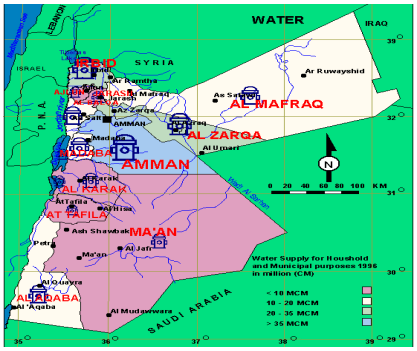

Figure 5: Household Water Supply in Jordan

Sources of Water Use in Jordan in 1998

SOURCE	USES IN MCM				Total
	Municipal	Industrial	Irrigation	Livestock	Uses
1. Surface Water	**53.200**	**1.802**	**282.355**	**4.000**	**341.357**
- Jordan Rift Valley	33.726	1.802	204.922	0.000	240.450
- Springs	19.474	0.000	30.000	0.000	49.474
- Base & Flood	0.000	0.000	47.433	4.000	51.433
2. Groundwater	**182.808**	**36.303**	**258.351**	**7.735**	**485.197**
-Renewable	173.163	32.031	208.171	6.635	420.000
-Nonrenewable	9.645	4.272	50.180	1.100	65.197
3. Treated Wastewater	**0.000**	**0.000**	**70.989**	**0.000**	**70.989**

SOURCE	USES IN MCM				Total
	Municipal	Industrial	Irrigation	Livestock	Uses
-Registered	0.000	0.000	65.989	0.000	65.989
-Not Registered	0.000	0.000	5.000	0.000	5.000
Total	**236.008**	**38.105**	**611.695**	**11.735**	**897.543**

* Estimated figures.

Projection of Supply and Demand

As shown below the quantities of water consumed in Jordan for all purposes in 1995 were estimated at 950 Million Cubic Meter (MCM). VS the demand of 1400 MCM. The deficit was reflected in lesser quantity of water allocated for agriculture and in the rationing of municipal supplies.

Assuming a reasonable growth rate in both population and industrial/agricultural production, total water demand is expected to reach about 1700 MCM/year by the year 2010. These estimates represent double the total available resources, even when all resources are utilized. The figures clearly show that demand far exceeds supply and that the gap is widening as time goes by.

	1990	1994	1995	2000	2005	2010
Population (Million)	3,452	4,139	4,291	5,107	6,035	7,033
Drinking*	252	302	313	373	441	513
Industry**	43	43	50	78	96	119
Agriculture	800	1000	1088	1088	1088	1088
Total Demand	1095	1345	1451	1539	1625	1720
Actual Consumption	870	940	950	980	1050	1100
Safe Yield	700	700	710	843	970	1070
Deficit	225	405	501	559	575	620

Note

* Consumption = 73 m^3 per person per year.

** Including private industrial wells, network, and surface water.

Sector Strategies and Policies

The foundation on which water policy will be built is the public ownership supported by a stable system of water rights and clear allocation policies.

Consistent with public ownership, the allocation and use of water will be determined to promote the public interest. Rights to the use of water by public and private entities, and by individuals, will be subjected to clear and stable criteria designed to harmonize these requirements with national policy.

The system of water rights will acknowledge traditional and existing rights; provide for clear rules that govern the appropriation, expropriation, and reallocation of rights; and allow for transferability in such a way to meet the objectives of the national policy.

With these broad guidelines, the Government of Jordan, in its 1993-1997 Economic and Social Development Plan, adopted specific policies aimed at:

a) Optimizing the utilization and conservation of water resources;

b) Managing the use of ground and surface water for various purposes (figure 6);

c) Improving the quality of the water while maintaining good environmental standards;

d) Raising the efficiency of water saving practices at the user level; and

e) Promoting public awareness of the importance of water conservation.

Figure 6: The Yarmouk River, the Main Source of Surface Water in Jordan

The Government's Program

The Government's large investment program in the water sector will represent one third of the total public expenditures. The program has been recently given a full review by the Government in close collaboration with the World Bank. It is intended to proceed in stages, seeking to address the most urgent needs first. Among these priorities is water loss reduction in major urban areas, protection of the King Talal Dam outflow from saline spring intrusion, augmentation of supply from the Jordan Valley, and securing adequate water supply to meet the increasing demand for the tourism sector in Petra and the Dead Sea areas (figure 7).

Figure 7: The King Abdullah (East Ghor) Canal in the Jordan River Valley

While these are being implemented, new projects are being prepared so that they could be launched as soon as technical, financial and institutional arrangements are agreed. These include projects for augmenting supply, particularly the Disi-Amman Water Supply Project and for enhancing irrigation efficiency.In addition, the government is working to repair leakage of water from distribution networks. The government has been actively promoting water conservation through public awareness campaigns, decreasing water pollution, recycling water, and improving water technologies.The government introduced a range of measures to save water and to support the struggling agricultural sector. The government

took a major step recently with the awarding of a contract to a French water company “Suez lyonnaise des eaux”, for the private management of the Greater Amman Water and Wastewater Networks. The company is expected to improve both distribution and revenue collection, and tackling chronic problems of water losses in the system, which is generally estimated at about 50% of total supply.

SOIL IN JORDAN

General Information (figure 8)

Area:

89500 Sqkm;

Land Regions:

18

Altitude:

400 – 1800 Masl

Rainfall:

50-600 Mmy

Soil Moisture Regime:

Xeric/ Ustic-Aridic/ Aridic/ Torric

Soil Temperature Regime: (figure 9)

Thermic/ Hyperthermic/ Mesic

Parent Rock Materials: (figure 10)

Limestone/ Limestone & Basalt/ Granite/ Sandstone

Figure 8: Soil Types in Jordan

Soil Type	Estimated Coverage	Landuse	Location
Typic Chromoxererts Fine	4.0%	Annual & Tree	H. Land
Entic Chromoxererts Fine		Crops	Plains
Typic Xerochrepts Fine			
Vertic Xerochrepts Fine-Medium			
Cacixerollic Xerochrepts Medium			
Lithic Xerocrepts Medium	0.7%	Forest	H.Land
Lithic Xerorthents Medium			
Ustocreptic Camborthids Fine	0.7%	Irrigated	J.Ualley

Soil Type	Estimated Coverage	Landuse	Location
Typic Camborthids Fine	0.6%	Irrigated	Desert
Typic Calciorthids Medium	92%	Range Land	Desert
Typic Camborthids Medium			
Cambic Gypsiorthids Medium			
Lithic Camborthids Medium			
Lithic Calclorthids Medium			
Typic Torriorthents Coarse			
Lithic Torriorthents Coarse			
Typic Torripsamment			
Typic Torrifluvents			
Rocky Lands			
Others	2.0%	Urban Areas, Roads…Etc.	

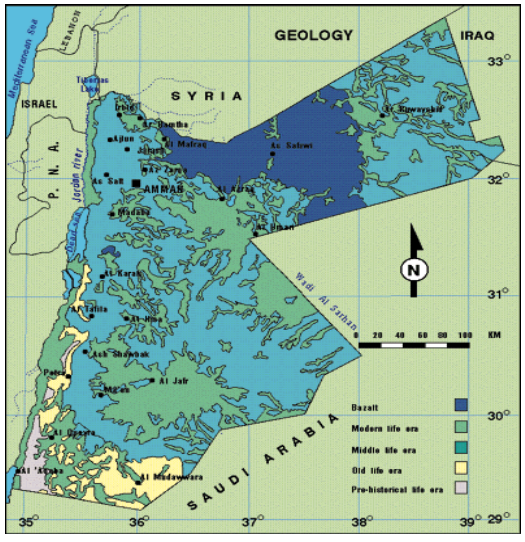

Figure 9: Jordan Geological Map

Figure 10: Jordan Agricultural Areas Map

IRRIGATION TECHNIQUES

It generally is difficult to devise accurate formulas specifying the water needs of a given plant. Such needs are determined by a number of variables that include climatic factors such as sun exposure, as well as changes in temperature, humidity, and wind speed, all of which affect the evaporation rate of the water given to the plants.

Other factors affecting a plant's need for water are the depth of its root system, the stage of its growth, soil composition, and maintenance procedures such as fertilizing and pruning.

A number of irrigation techniques are available for watering plants. Each has its own distinctive characteristics, and certain procedures need to be followed to ensure that each irrigation method is used optimally to allow for the growth of healthy, low-water consuming plants.

IRRIGATION METHODS

Flood Irrigation

This method is simple and easy to implement. However, half of the water provided using flood irrigation might be lost as a result of evaporation, runoff, or wind distortion.

Flood irrigation also might give plants more than their needs of water and faster than their ability to absorb it. To minimize water runoff resulting from flood irrigation, it is advised to flatten the irrigated area and to create a ditch around each plant.

Spray Irrigation

This method does not require much effort and is suitable for irrigating areas of various shapes, whether rectangular or circular. However, it requires constant maintenance, and about a third of the water provided by spray irrigation is lost before it reaches the plant as a result of wind distortion or evaporation.

Therefore, limit the use of spray irrigation to lawns, which require the equal distribution of water over relatively wide areas. Also, spray the water as close as possible to ground level to reduce water loss due to wind distortion.

Drip Irrigation

In most cases, this is the most effective and water-saving irrigation method. It involves moving water in plastic pipes connected to the water source. The pipes are placed above the ground, or buried under the soil near the plants' root systems. Water slowly flows out of the pipes through openings or valves that control the rate of water output, and these openings and valves are placed near the plants so that the water easily reaches the plants' root systems.

The slow rate of water output gives the plants adequate time to absorb the water.

One of the most important advantages of drip irrigation is that it saves water. Very little of the water administered by drip irrigation is lost to runoff, evaporation, or wind distortion. It is the most suitable method for irrigation in arid areas, or ones characterized by high winds or strong slopes. Another advantage of drip irrigation is its flexibility.

The number and location of openings and valves on the irrigation pipes, as well as the rate of water output can be adjusted whenever the need arises. Drip irrigation also does not require much effort, but the components of drip irrigation systems need regular maintenance.

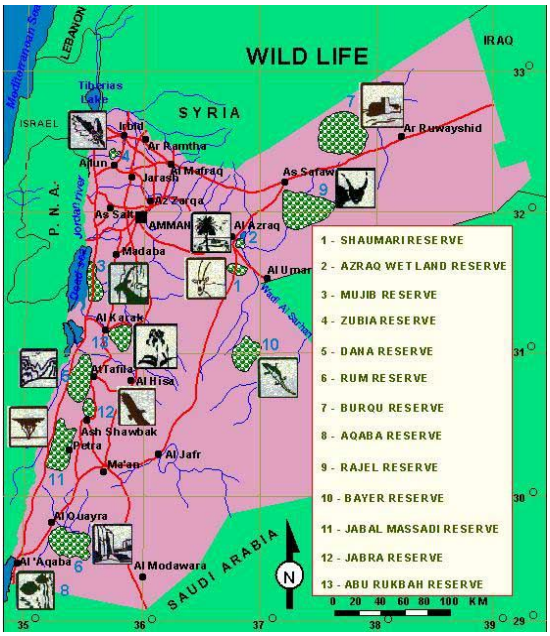

Figure 11: Map of Wild Life in Jordan.

Figure 12: Dana Wildlife Reserve

Figure 13: Mujib Wildlife Reserve.

General Guidelines

When designing your garden, place plants with similar water needs in proximity to each other so as to irrigate them using the same drip irrigation line. Also, develop a schedule that trains your plants to consume less water. This usually consists of widely spaced but deep applications. Such a schedule encourages the roots to expand and extend deeper into the soil in search of water, and therefore increases the plant's drought tolerance. Generally, irrigate trees with generous amounts of water given at widely spaced time intervals, but irrigate ground covers and plants that have shallow root systems with smaller amounts of water given at more tightly spaced time intervals. Also, irrigate so that water reaches a soil depth of 50 - 60 cm for trees, 35 - 40 cm for shrubs, and 15 cm for ground covers.

Irrigate during the early morning hours since the temperatures are lowest at that time of the day and evaporation therefore is minimized. If that is not possible, irrigate in the evenings, when temperatures begin to decrease.

Modify your irrigation schedule as the seasons change and your plants grow. Since plants need less water in the winter, decrease the amounts of water given to them - and possibly even stop irrigation - during that season. Also, keep in mind that drought tolerant plants need less water as they mature.Pay attention to the quality of the soil in your garden and make sure that it includes a mixture of topsoil and organic fertilizers. Such soils retain moisture and provide plants with their nutritional needs. Also consider the use of moisture-retaining materials to minimize the need for irrigation.

These can be placed either on top of the soil or mixed in it. One such material is pumice stone. This material is extracted in Jordan - where it is known as "touf" stone - and can be obtained in various sizes. It contains cavities that hold moisture and also provide breathing space for the soil. Other moisture retaining materials include polymers that absorb water when coming into contact with it to form a gel-like substance. This water consequently is stored in the soil for extended periods of time.It generally is difficult to predetermine the amounts of water that a plant requires. Consequently, one needs to inspect the plants and the soil in which they are located on a regular basis to ensure that each plant receives its exact needs of water.

Plant Lists

There are many water conserving plants from various regions of the world. Contrary to popular belief, they are not confined to cacti and succulents, but also include a wide variety of beautiful trees, shrubs, vines, perennials, and groundcovers. Many have outstanding characteristics that include distinctive flowers, fruits, and leaf texture.The following lists provide visual and textual information on native and non-native drought tolerant plants. These plants already are available at commercial nurseries in Jordan.

Native Plants

Jordan is blessed with a variety of beautiful native plants that are intrinsically tolerant to drought conditions. Because of their adaptability to arid regions, they are ideal for use in water conserving gardens and in the larger landscape context. They also provide other benefits such as affording habitat for native fauna.

Moreover, native plants provide color throughout the year since their various species have different blooming seasons.The following list provides a small selection of Jordan's rich and diverse native flora (figure 14).

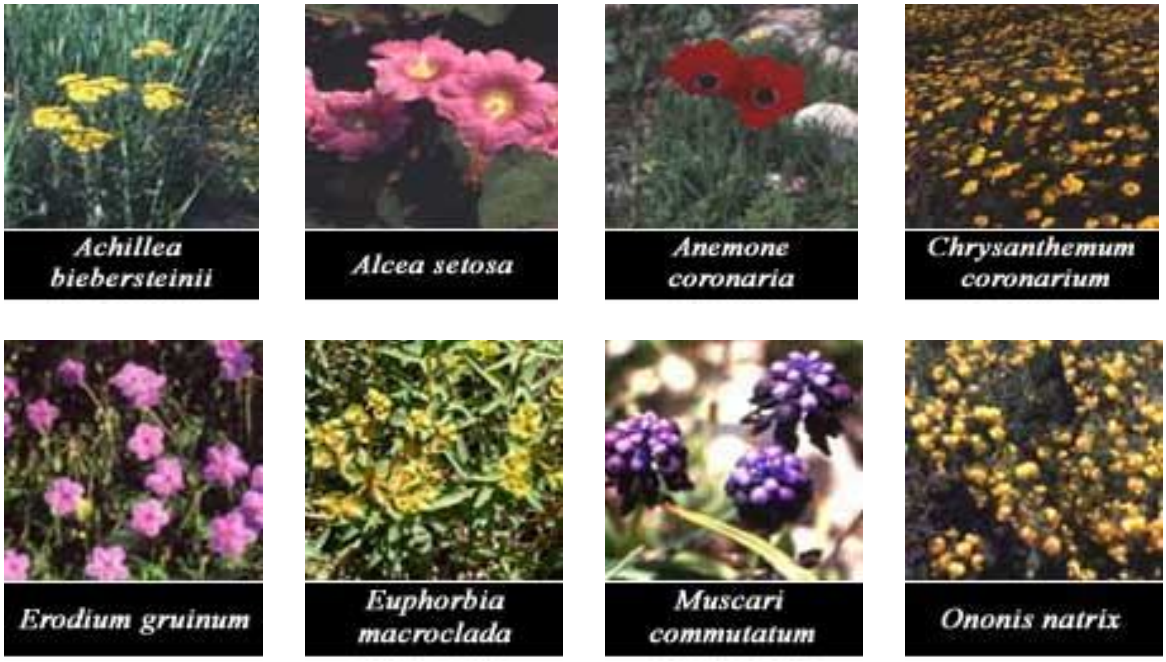

Figure 14: Some Jordan's Plants

Ornamental Plants

One of the most effective ways of saving water in gardens is to choose plants with low water needs. This section provides a list of some drought tolerant ornamental plants available in nurseries around Jordan.

These plants include shrubs, vines, groundcovers, perennials, and succulents that have attractive flowers or fruits, and that are suitable for both small and large gardens.

Ornamental plants serve a variety of uses in gardens. They reduce dust and control erosion.

They also provide green cover, and add an element of visual interest through their colors, textures, and forms. Large shrubs and vines also serve to define outdoor spaces and to provide shelter or shade.

Remember to group plants with similar water needs together to allow for more efficient irrigation. Also, when choosing plants for a garden, it is advised to use plants with different flowering seasons so that the garden would be in bloom throughout the year.

In addition, one can take advantage of what is known as accent plants. These are plants with special characteristics that attract attention due to their flowering color, leaf texture, height, or form, and usually are used to provide a focal point to a particular grouping of plants (figure 15).

Figure 15: Some Jordan's Ornamental Plants

Trees

Trees are essential elements in water conserving gardens. They provide shade, screen areas for privacy, and create microclimates with lower temperatures. Different trees serve different functions.

For example, plant trees with large canopies in outdoor living spaces to provide adequate shade. On the other hand, use evergreen trees to provide effective windbreaks and screens for privacy.

Trees also can serve to reduce summer heat in buildings when planted along the building's western façade, where they block the harsh afternoon summer sun. Moreover, planting deciduous trees along southern facades filters sunrays during the summer, but lets the sun in during the winter.

There are trees with particularly impressive characteristics embodied in their flowers, leaf texture, or form. These trees are known as specimen trees and can be planted alone or in-groups, usually in the most important areas of the garden.

The trees included in the following list are suitable for both small and large gardens, as well as in parks and along roads (figure 16).

Figure 16: Some Jordan's Trees

OURSE OUTLINE

The following report attempts to provide a description of the materials that would be covered under each of the seven aforementioned areas.

PLANNING AND DESIGN

Considered to be the most important step in Xeriscape landscaping due to the significant effect of regional and microclimatic conditions of the site, existing vegetation and topographical conditions, the intended use and desires of the owner, and the zoning of plant materials according to their water needs. Not only does Jordan have problems in planting design but also problems do exist in site planning and hard landscaping. And to be remembered that in landscaping design every element, small or large, has a relationship to it's neighbors.

This part of the course will focus on the phasing of landscaping, with initial phase installation and future phasing plans to be established as part of the proposed buildings' packages.

The main concepts that will be covered in the course are:

Site Planning

- Design of floor plans and foundations depending on site topography.
- Split level plans.
- Terracing.
- Selection of building orientation with respect to solar exposure.

Preservation of Existing Vegetation

- Incorporation of existing trees during the processes of locating structures and power lines.
- Estimating future space requirements for such vegetation.
- Tree surveys.
- Tree protection from construction (fencing and other protection measures).
- Handling tree root areas during construction.
- Paving around existing trees.
- Paints and chemicals' handling near trees.

Preserving Topsoil

- Soil formation process.
- Stockpile the topsoil for future use on the site.
- Erosion control measures (dikes and silt fences).

Soil Areas Stabilization

- Methods of stabilization (vegetation, terracing, dry stack limestone, rubble, rip-rap, etc.).
- Erosion control fabrics (jute netting, shredded mulch).

Energy Conservation

- Locating trees with respect to structure with relation shade and resulting temperatures.
- Deciduous trees and their ability to warm and light a home during winter.
- Shade provision through combinations of landscape features.
- Locating trees to channel southeasterly summer breezes to provide natural cooling.

Windbreaks

- Principles of wind breaking.
- Wind breaking trees' spacing from structure.

APPROPRIATE PLANT SELECTION RESPECT TO WATER CONSUMPTION

Plant Selection According to Supplemental Watering

- Supplemental irrigation and watering.
- Plants' establishment periods.
- Water needs grouping.
- Irrigation zoning.

Diversifying of Plant Species

- Monoculture and associated problems.
- Year-round coloring.

Suppliers and Nurseries Requirements and Qualifications

- How to select a supplier.
- Plant acclimation.

PRACTICAL TURF AREAS

Design of Turf Areas

- Curving borders of plant beds.
- Use of mowing strips can make mowing and edging easier.
- Locating turf areas close to the house.

Irrigation Separation of Turf Areas

- Irrigation system zoning.
- Efficiency of sprinklers.
- Watering times requirements for plant varieties.

Turf Selection

- Drought tolerant turfs.
- Types of grass.

Grade Concerns when Planting a Turf

- Mowing concerns.
- Terracing of slopes to slow down water.

Grass Areas

- Mulch beds.
- Children's play areas.

SOIL IMPROVEMENT

Soil Analysis and Compatibility of Plants

Enhancing Plant Health Through Organic Matters

- Soil texture and moisture retention.
- Compost and composted sludge products.

Other Soil Amendments

- Soils characteristics in Jordan.
- Fertilizers, gypsum, and sand.

Topsoil Selection

- Quality of topsoils.
- Weeds and other pests.

EFFICIENT IRRIGATION

Efficient Irrigation Systems

- Types of watering equipment.
- Integrating irrigation design with landscape design.

Automated Irrigation Systems

- Irrigation scheduling.
- Multi irrigation cycling to avoid runoff.
- Shut-off devices.
- Soil moisture sensors.
- Trajectory nozzles and pressure-compensating devices.
- Irrigation technique zoning.

Low-Flow Irrigation Equipment

- Minimizing evaporation losses.
- Drip irrigation systems.
- Retrofit of existing landscapes.
- Filters and sediment removal.

Systems' Maintenance

- Annual irrigation systems' audit.
- Irrigation schedules adjustments.
- Flushing of irrigation lines, heads, nozzles, and/or emitters.

When to Irrigate

- Developing drought tolerant root systems through infrequent deep soaking.
- Evaporation losses and wind drift minimization.
- Nighttime watering.

- Recognizing signals of a thirsty landscape.
- Seasonal irrigation tapering.

Winter Irrigation

MULCHING

Use Mulch in Planting Beds

- Retaining moisture.
- Preventing runoff through mulching on sloped areas.
- Organic mulch materials.

Inorganic Mulches

- Stone mulches and effect on glare.
- Choosing stone mulch color.

Sources of Mulches

MAINTENANCE

Composting Areas

- Yard waste recycling.
- Locating composting areas.
- Clearance of composting areas.

Mowing

- Clippings composting.
- Mowing Heights for different grasses.

Fertilizers

- Identification of needs.

Insect and Disease Control

- Integrated Pest Management (IPM).
- Natural methods of control.
- Soil contamination.

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