A GEOGRAPHICAL PERSPECTIVE ON SUSTAINABLE LANDSCAPE DESIGN IN ARID ENVIRONMENTS

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It is useful to situate the case studies of arid landscape design in this volume within a geographic context that can facilitate analysis, comparison, and evaluation. This chapter offers a brief introduction to arid environments and to processes of desertification that can undermine sustainable development.

The term “arid” has a range of connotations that vary by culture and historical period. For some, it implies barren wastelands while for others it evokes landscapes of biological, cultural, and aesthetic richness (Wescoat 1990). From a scientific standpoint, aridity refers to a scarcity of moisture, in which precipitation is exceeded by potential evapotranspiration (i.e., the amount of water that would be consumed by plants and evaporation when unlimited water is available). Aridity and drought indexes have been developed to analyse water scarcity. These varied climatic patterns of water deficit interact with physiographic conditions to produce a variety of arid and semiarid environments (figure 1). Five major causes and contexts of aridity may be distinguished:

1. **Subtropical Latitudes.** Subtropical zones, around latitudes 30 degrees north and south, are more likely to be arid than other belts because they are dominated by high pressure systems of descending air that inhibit convective precipitation. These climatic processes account for the broad arid and semi-arid belts of the southwestern U.S., northern Africa, northwestern India and Pakistan, Australia, southern Africa, and the Sahara desert.

2. **Rain Shadow Effects.** When moist air masses encounter mountains, they ascend and cool, which leads to condensation and precipi-
tation on the windward side of the mountains. Downwind, dry descending air masses create a “rain shadow”. This effect produces the sharp climatic boundaries found along mountain ranges and escarpments of the northwestern U.S., southern India, and some Pacific Islands like Hawaii whose windward areas have humid subtropical climates while their leeward slopes are semiarid.

3. Continental Interiors. As air masses move across the large continents of the world, they lose moisture through precipitation, and then pick up little additional moisture by evaporation. Thus, they become increasingly dry, which helps explain the gradual transitions from sub-humid to sem-arid and arid conditions in the interior regions of the American Great Plains, Central Asia, and western China.

4. Cool Current Coasts. Cool ocean currents extend the arid conditions of subtropical regions into the middle or lower latitudes by reducing convection and precipitation. Such conditions occur on the western coasts of California, northern Mexico, South America, and southern Africa.

5. High Altitudes and Polar Latitudes. Although generally perceived as moist snow-covered landscapes, some polar and alpine regions have little precipitation and little water in a liquid state.
These five phenomena give rise to seasonal and annual moisture deficits. Their complex interactions in and with the landscape yield an enormous variety of environmental and ecological conditions. Some deserts, such as the Sonora in the southwestern U.S., have highly diverse flora and fauna while others, like the nearby Mojave, have a more limited range of native species. Human uses of arid regions also vary enormously. Land uses range from pastoralism, rainfed and irrigated agriculture to mining, manufacturing, urban settlement, and recreation. Deserts are places of movement ranging from transportation to religious pilgrimage. They are also places of wilderness conservation and military testing. As technologies and patterns of desert occupancy change, so do trends in environmental design. Settlement on the humid margins of a desert shape the use, condition, and perceptions of the desert (e.g., Heathcote, 1983; and Sharma, 1972).

Perceptions are important in leading groups to settle in or avoid an arid region. The erroneous belief that “rain follows the plow... or the tubewell” has led many farmers to try to cultivate semi-arid lands (Glantz, 1995). They often hope that irrigation and shelterbelts will increase regional rainfall as well as local microclimates. Other groups, both in the U.S. and Middle East, have viewed deserts as promised lands, paradise gardens, or reclamation frontiers that will “bloom as a rose” when properly irrigated and tended by an upright society - perceptions and beliefs that are sometimes fulfilled and at other times dashed.

This diversity defies simple classifications of arid landscape problems and solutions. On the one hand, every desert area presents a different situation that changes as economic, political, technological, and cultural conditions unfold. On the other hand, experience gained in one arid environment can sometimes be successfully adapted for applications elsewhere.

What are the lessons and limits of landscape design in arid environments of the world? This was a key question for the roundtable dis-
Discussion. Case studies were selected from Iran, Saudi Arabia, Egypt, Sudan, Morocco, and the United States. Although varied in geographic scope, these cases do not encompass all of the arid regions of the world (e.g., China, Central Asia, northwest India and Pakistan, southern Africa, and South America, not to mention some important areas of experimentation in the Middle East, Maghreb, and Sahara).

At the same time, the case studies do encompass an enormous variety of conditions: climatically, they range from the hyper-arid deserts of Saudi Arabia to sub-humid foothills of Iran; physiographically, from the sand dunes of northern Sudan to Mediterranean coasts of California; economically, from local orchards and herding communities of the Sudan to high-tech export marketing in Morocco; and socially, from urban children of Cairo and farmers in the Sahel to pre- and post-revolutionary urban life in Iran. These topics invite comparison and contrasts: universities in Iran and the U.S.; parks in Egypt and Iran; plant nurseries in the Sudan, Saudi Arabia, and the U.S.; and office complexes in Morocco and Saudi Arabia to name a few.

These case studies also reflect the problems of unsustainable development, or “desertification”, where environments become “desert-like”. Processes of desertification include deforestation, overgrazing, waterlogging, salinisation, accelerated erosion, and biodiversity reduction which lead to the degradation of vegetation, soils, ecosys-
tems, economies, and cultures. Although often associated with arid regions, they can occur in any environment, reminding us that the successes and failures of arid zone landscape design may also have broader relevance for humid regions of the world.

The theme of desertification also reminds us that the concerns of this symposium have salience for international efforts to negotiate a Convention to Combat Desertification (CCD), which entered into force in December 1996. The Convention is a priority of AGENDA 21, the action plan of the 1992 U.N. Conference on Environment and Development (UNCED). The draft convention provides for multilateral and regional arrangements to mitigate desertification with a special emphasis on vulnerable regions of Africa. It creates a “global mechanism” to stimulate funding for these efforts. The United Nations Environment Programme (UNEP), Food and Agriculture Organisation (FAO), and other international organisations sponsor desertification research and policy analysis (UNEP, 1995; UNEP/FAO, 1992; SCOPE, 1995; Stiles, 1995; Wass and Hutchinson, 1995; and FAO, 1993). An international network of non-governmental organisations concerned with desertification and drought, RIOD, actively monitors and participates in debate over these policies and programs (http://riod.utando.com).

Environmental designers have had relatively limited influence on these negotiations and programmes, and it seems vital that stronger link-
ages be forged between landscape design and international environmental policy.

The current round of desertification negotiations builds upon previous generations of arid zone research in which landscape designers have had a role and which should therefore be briefly reviewed. Indeed, societies have experimented with medicinal, architectural, food, and forage aspects of desert landscaping for thousands of years. In antiquity, these experiments found expression in the literatures of natural history, agronomy, and medicine (Butzer, 1993). In the Islamic realm, they were advanced by al-Kindi (c. 795-870 CE), al-Dinawari (d. 895), ibn Wahshiya (fl. c. 903-30), and others in Persia and Nabatea, not to forget the agronomic treatise of Ibn al-Awwam of Seville (Butzer, 1994; Watson, 1983). The mediaeval period also yielded agronomic treatises and landscape architectural experiments in Yemen, Ottoman Turkey, Persia, and Mughal India (Petruccioli, 1997; Subtelny, 1997; Varisco, 1994; and Wescoat and Wolschke-Buhlmann, 1996).

In the 19th century, major centres of experimentation arose in the U.S., European colonies, and Australia. In 1902, the American Forestry Association went so far as to rename its journal American Forests as Forestry and Irrigation to pursue the exciting conservation programmes emerging in the arid West. Geographers, soil scientists, and ecologists in Europe, America, and Russia made breakthroughs in large-scale environmental and evolutionary modelling. Colonial re-
gimes initiated research on heat stress in humans, plants, and animals; on desert flora, agriculture, and horticulture, famine relief; and energy flux in buildings and building materials (e.g., Heffernan, 1996).

Also around the turn of the century, ideas emerged about the links between regional policy and landscape design. John Wesley Powell published a Report on the Lands of the Arid Region in 1878, which included innovative proposals for land and water management. H.W.S. Cleveland wrote Landscape Architecture as Applied to the Wants of the West, and although it referred to the midwestern U.S., it clearly asserted that different regions had different landscape design requirements (cf. Lewis, 1993).

These advances did not, however, prepare arid zone occupants for the disastrous drought, soil erosion, and economic depression of the 1930s. Those disasters gave rise to the U.S. Soil Conservation Service, to shelterbelt programmes, and to the expansion of irrigation. U.S. soil scientists such as Max Lowdermilk drew upon earlier experience in other parts of the world, such as Palestine and China. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia developed an interdisciplinary framework for arid zone research.

Comparative international arid zone research advanced more rapidly in the 1950s in large measure through programmes of United Nations
agencies, such as the arid zone research programme of UNESCO. UNESCO supported publications, scientific conferences, and research centres. Soviet research centres in Ashkhabad and Repetek were reported in an influential journal, Problems of Desert Development, which was paralleled by initiatives of the Chinese Academy of Sciences and arid zone research centres such as Jodhpur, India, that conducted research on sand dune stabilisation, soil erosion, and salinity.

Despite these growing international and national efforts, disasters continued in the 1960s and 1970s, most devastatingly in the semi-arid Sahelian region of Africa. While disaster relief programmes tried to cope with the consequences of desertification, other programmes of agricultural intensification and settlement aggravated them. Some modernisation programmes (e.g., roads and railroads) helped alleviate food crises while others increased drought vulnerability. The worst disasters, then as now, occurred in areas of political and civil conflict (Glantz, 1995). African food crises led to an expanded U.N. desertification control programme in the 1970’s (EROS, 1995; UNEP, World Atlas of Desertification; and OSS-UNITAR spatial database).

Modest but increasing emphasis was placed on landscape design in arid environments, most notably at the University of Arizona’s Office of Arid Land Studies and International Arid Lands Consortium (e.g., Miller, 1978). Efforts to combat desertification were paralleled by three other movements that shaped landscape design in arid regions: 1) the economic growth of OPEC countries which stimulated demand for landscape design and heritage conservation in the Middle East; 2) increasing historical research on arid landscapes; and 3) international and local environmental movements.

Increased oil revenues in the 1970s stimulated large-scale landscape construction in Kuwait, the United Arab Emirates, and Saudi Arabia. Landscape architecture also grew as a profession in these years in Iran, Iraq, Turkey, and India. Landscape designers in these countries
faced fundamental questions that persist today: rising demand for plants; plant propagation and protection; irrigation water supplies and technologies; and unclear social, cultural, and aesthetic aims (Miller, 1978; Cochrane and Brown, 1978; Goodin and Northington, 1979; Kelly and Schnadelbach, 1976). Golany’s (1983) works on design in arid environments were influential in addressing these issues.

The fields of landscape and garden history also grew during this period in the American, European, and Islamicate realms (e.g., Environmental Design: Journal of the Islamic Environmental Design Centre, 1986; Hussain, Rehman and Wescoat, 1996; Petruccioli, 1994, 1997; Ruggles, 1991; Wescoat, 1996; Wescoat and Wolschke-Bulmahn, 1996). The Aga Khan Award for Architecture and programmes rec-
ognised historical and contemporary excellence in landscape design (Serageldin, 1989; Steele, 1994). These efforts were also complemented by a longer record of research on the history of agriculture, horticulture, and agronomy (Watson 1983; Butzer, 1994; and al-Hassan and Hill, 1986).

Environmental activists and scientists have been more effective in challenging modern development trends and impacts (Hester, 1990). They have struggled to reduce irrigation, increase use of native and drought-adapted plant species, and shift to wastewater and “grey water” for tertiary water treatment and landscape irrigation. Their criticisms have been translated into creative design solutions by groups such as the Center for Regenerative Studies at California Polytechnic University at Pomona, the Arid Lands Studies programmes at the University of Arizona, and Xeriscape organisations (Lyle, 1994; Phillips, 1995; Denver Water, 1997; and Sunset Books, 1988).

These trends continued in the 1980s and 1990s as horticultural and land development industries and government agencies sought to catch up with changing public demands for low input, low-water, and naturalistic styles of landscape design. During the 1990s Arizona has sponsored an annual desert horticulture conference that combines ecological, technological, and design issues (Desert Horticulture, 1996). Arizona’s Arid Lands Newsletter focused on “Desert Architecture” in its issue of Fall/Winter 1994. Other current newsletters and journals include the RIOD Circular on Desertification, the UNEP Desertification Control Bulletin, and the International Arid Lands Consortium Newsletter (http://ag.arizona.edu/OALS/IALC).

While landscape design preferences and practices seem to be changing as new emigrants to arid regions find beauty in xeric flora, old patterns of arid land and water development die hard, and the connections among landscape design, landscape history, and environmental policy in arid environments remain weak. Theses, monographs,
and dissertations on arid zone landscape design have not received the attention they deserve (e.g., Joma, 1991). Landscape design projects that explore the contours of sustainability in arid regions also warrant closer attention, and it is to such projects that we now turn.

REFERENCES


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