

## Approaches to sustainable development of arid regions (A case study in arid regions of Iran)

A. Estelaji<sup>\*</sup>

*Associate Professor, Islamic Azad University, Shahre-Rey branch, Tehran, Iran*

Received 5 December 2007; Received in revised form 1 March 2008; Accepted 5 May 2008

---

### Abstract

Interest in arid ecosystems as a source of food supply for rapidly increasing population of the world, on the one hand, and the problems pertaining to the climatic characteristics, water shortages and soil sensitivity for the inhabitants in such areas, on the other have prompted efforts at both national and international levels to develop a better understanding of these problems as well as to find proper ways for the optimized utilization of the available natural resources. Iran is characterized by arid and semi-arid ecosystems for most parts (around 90%). Despite climatic problems in arid areas; there is also a great potential whose optimal management could decrease the problems. This article is an attempt to provide a model for sustainable development in arid areas and ecosystems of Iran. The focus of research and analysis has been as follows: The factors affecting dry weather in arid ecosystems, The problems and limitations in arid ecosystems, The potentials in arid ecosystems, Approaches to the environmental management and sustainable development in arid ecosystems.

*Keywords:* Sustainable development; Environmental management; Arid region; Utilization of resources; Touristy attractions.

---

### 1. Introduction

Arid ecosystems tend to limit human activities such as farming, animal husbandry, and the likes for a further or better utilization of natural resources (soil, water, vegetation coverage, etc.). Arid areas are characterized by rapid loss of vegetation cover and soil erosion. In arid areas, thus, appropriate models for environmental management in arid ecosystems need to be taken into consideration prior to any measure is taken for utilization purposes.

### 2. Materials and Methods

The scope of the survey covers arid lands and the interior deserts of Iran surrounded by

the Alborz and Khorasan mountains in the north, Central mountains in the west and the eastern mountains in the east of the country. The highlands per se are divided into several areas.

The greatest area is called Dashte Kavir and the other, being in the south, is called Kavir-e-Loot. (Rabiee, Badiee, 1993)

The statement of the problem of the survey determines the research to be applied type and the approach and concept to be analytical-descriptive type.

The geographical facts embraces ecological elements, botanical and zoological societies, urban and rural residential areas as well as tourist attractions of the study region.

Maps, satellite pictures, airborne pictures, field and library researches have been utilized in compiling the related data.

---

<sup>\*</sup> Corresponding author. Tel.: +98 912 5130274;  
fax: +98 21 22646963.  
E-mail address: [al\\_estelaji@yahoo.com](mailto:al_estelaji@yahoo.com)

### 3. Results and Discussion

The findings of the research can be presented under the headings below:

#### 3.1. The factors affecting dry weather in arid ecosystems

The factors responsible for dry weather are as follows:

- High regional temperature caused by radiation of sunshine;
- High pressure caused by pressure centers (especially subtropical high pressure);
- Oceanic coastal streams;
- High mountain ranges and high plateaus;
- Lack of exposure to the marine impacts (distant from marines and oceans); and
- Absence of upward movement of air even in the moist air and weather turbulences.

One of these factors or more can be responsible for dry weather in an area. In the selected area for this study, however, subtropical pressure is the major factor for this phenomenon. That is to say, warm moist air in the equator moves upward and releases its humidity in the form of rain. Then at the same altitude it moves towards poles (i.e. north and south). Rotation of the earth causes a major part of the air to sink in 30 degrees Meridian. Here, the air is distributed, without being allowed to move upward. The result is an arid area, where Iran lies for most part. Accordingly Iran is located in an arid and semi-arid area with consequent arid and semi-arid ecosystems (Estelaji, 2002).

#### 3.2. The problems and limitations in arid ecosystems

The current problems and limitations may fall into two categories:

- a. Natural limitations inherent in arid ecosystems; and
- b. Problems or constrains created due to inadequate understanding of appropriate utilization of arid ecosystems.

Precipitation pattern in the area is characterized by both low average annual (less than 50mm) and disproportionate distribution. Poor vegetation coverage, scarcity of water resources, and saline soils are other natural limitations. This holds true to the extent that no water resource can be found in many parts with Loot desert (Kavir-e-Loot) in eastern Iran as a distinctive instance.

In terms of temperature, dry weather coupled with dry soils and air, causes intensive soil erosion by occasional winds and storms. It also leads to the movement of sand-dunes and emergence of new shapes or landscapes (Estelaji, Shariat Panahi, 2003).

Also, human being creates problems in this regard, merely because he does not know how to deal appropriately with arid areas for utilization purposes. In the selected area, for instance, some irrational acts such as excessive use of saline water for irrigation, cultivating steep lands, plowing in wrong direction, over-grazing, burning plants and the residues, as well as cutting trees and collecting soil humus, have resulted in the loss of vegetation coverage and intensified soil erosion. Also, excessive use of chemicals along with inappropriate waste disposal (land fill) and sewage systems have infected or polluted soils in some regions.

As far as water resources are concerned, irregular digging of deep wells and lack of adherence to defined boundaries, have decreased groundwater levels in many regions.

#### 3.3. The potentials in arid ecosystems

In spite of climatic limitations in arid areas, there are also a variety of potentials that need to be identified and utilized. Studies in the study area revealed the following potentials as currently available capacities: (Kardavani, 1999)

- Solar energy;
- Wind energy;
- Salt pits;
- Coal mines;
- Uranium mines;
- Sand and gravel pits;
- Copper, zinc and lead mines;
- Clay soil and China clay mines;
- Natural touristic attractions such as appealing landscapes in arid areas, including landscapes created through blowout, desert rock-revetments, eroded features, dunes, dried salt domes, water catchments, salt lakes, wild life, uncommon and scare ground cover (plantation coverage), etc; and
- Practicing irrigated agricultural and horticultural activities (providing that appropriate utilization methods in arid areas are adequately taken into consideration).

These potentials may well provide proper setting for investments in research, industrial, manufacturing, and tourism activities.

### 3.4. Approaches to the environmental management and sustainable development in arid ecosystems

According to field studies in the selected area, as far as management and sustainable development in arid areas is concerned, the following approaches can be well applied to diminish limitations for optimized utilization of resources in such areas all over the world:

#### 3.4.1. Modifying saline and alkaline soils

It is not advisable to develop lands in arid areas where shortage of water is common, or no adequate facilities are available for canal construction or conveyance of fresh water. However, mineral resources can be appropriately utilized where irrigable water or adequate facilities for conveyance of water are available (Kardavani, 2001).

In this regard, measures have been taken in the selected area as follows:

- A. Constructing drainage systems;
- B. Removing alkaline top soil;
- C. Leveling and plotting out farmlands;
- D. Leveling farming plots and removing bulky clods;
- E. Applying minerals to modify alkaline soils;
- F. Surface washing with fresh water;
- G. Improving land with mineral and organic fertilizers;
- H. Planting saline-resistant plants on due time; and
- I. Adopting appropriate methods for plantation and irrigation.

#### 3.4.2. Controlling soil erosion (soil conservation)

The mentioned studies also reveal that every year a huge amount of high quality soil is eroded in the area (Kardavani, 1996). To scale down the effects of this process, successful measures have been taken in the selected area that can be used in other similar areas as well. These measures are stated hereunder.

A. Controlling soil erosion through following watershed management practices

- Direct practices: building bench traces and trace systems as well as loose rock dams; and
- Indirect practices: creating and improving vegetation coverage coupled with pasture reserving;

B. Stabilizing sand-dune

This is done through creating vegetation coverage, building shelter belts, and applying oil mulch;

C. Protecting and improving vegetation coverage

D. Complying with appropriate farming principles

crop rotation, plugging in correct direction, terracing, constricting diversion channels for spilled over water, and making use of animal manure to improve both soil and yields.

#### 3.4.3. Decreasing soil loss

Considering the previously mentioned factors that cause soil loss, measures have been taken in this regard in the selected area. These measures are mainly as follows:

- A. Improving soil with manures or a combination of manures and fertilizers;
- B. Using chemicals with low durability in plants and soils for controlling pests and weeds;
- C. Reducing harmful pests through biological controls;
- D. Building channels for collecting waste water and sewage; and
- E. Making compost out of waste materials and litters.

#### 3.4.4. Optimizing water uses

As a major problem, arid areas suffer always from shortage of water. However, studies in the selected area have provided this area and other similar areas with useful measures to catch up with this ever lasting problem. These measures may fall into following categories:

A. Controlling surface water for further uses through

- Constructing storage dams;
- Using motor pumps for lifting up water from valleys and rivers;
- Detaching fresh water tributary streams from those with saline water; and
- Shifting channel line towards places that need water.

B. Utilizing and enhancing groundwater resources through

- Constructing underground aqueducts (Qantas) in arid areas and conveying water from water-abundant regions to water-dearth regions via underground canals;
- Constructing deep and semi- deep wells in compliance with the defined boundary for well-digging;

- Making greater use of springs or fountains as water resources; and
  - Making greater use of carestic and underground water resources.
- C. Softening (desalinating) saline water;
- D. Collecting rainwater through:
- Land modifying and clearing, constructing suitable canals and gutters, condensing soils, and making flat lands uneven;
  - Sprinkling chemicals like silicon, latex, sodium salt, and tar;
  - Covering top soils with synthetic materials;
  - Covering land with asphalt, concrete, mosaics, etc.
- E. Promoting drip irrigation and other low-input methods (Kardavani, 2001).

#### 3.4.5. Utilizing natural resources available in arid areas

In spite of the susceptible and fragile ecosystem as a natural constraint in arid areas, there are also a variety of potentials for utilizing natural resources that may well compensate for the problems. The authors' studies in the selected area have revealed many useful approaches or measures in this regard that can be well workable in other areas with the same climatic conditions. These measures are as follows:

- A. Taking advantage of wind and solar energies for different agricultural and industrial uses;
- B. Utilizing sandy regions as sand or gravel pits;
- C. Making use of sandy regions for artificial nourishment of underground waters;
- D. Building industrial sites in sandy regions;
- E. developing sandy regions as farmlands through following processes:
  - Leveling land;
  - Plotting land and preparing it for irrigation;
  - Irrigating prepared lands with flood water; and
  - Cultivating land and improving it with humus and organic materials.
- F. Utilizing clay soil pits;
- G. Amending clay soils for agricultural purposes;
- H. Utilizing sand pits;
- I. Utilizing salt pits; and
- J. Making investment on other mineral resources and establishing the related industries. (Estelaji, 2002, 47)

#### 3.4.6. Taking advantage of tourist attractions

While living in areas with fragile ecosystems seems to be difficult to some degrees, arid areas are, in turn, provided with many unique natural and man-made attractions. Natural landscapes and relief such as dunes, salt domes, bad lands, salt lakes, fresh and saline fountains, and animals adapted to live under vehemently arduous conditions are just few instances that one can find in arid areas as matters of wonder. Halophytes and xerophilous species in deserts, from small bushes to shrub trees as tall as 6 meter, are another unique manifestation of nature that can be offered only in arid areas.

Man-made or human attractions like ancient relics, production methods, nomadic livelihood patterns, the type of architecture and materials used, the way people challenge and adapt to water scarcity or drought are also other eye-striking sceneries available to tourist in arid areas (Shariat Panahi, Estelaji, 2003).

Accordingly, following approaches are proposed as necessary measures for taking better advantage of tourist attractions in arid areas.

- A. Establishing through site- surveys, touristic residential complexes in the neighborhood of desert villages, marshes and fountains;
- B. Constructing appropriate access roads to connect marginal cities to desert and the inside;
- C. Establishing reserved wildlife parks;
- D. Building museum specific to the ancient relics or remnants of the arid areas.
- E. Providing tourists with facilities for air visits;
- F. Providing appropriate services in terms of eating, drinking, and guides for tourists; and
- G. Securing the safety of tourists during their visits.

#### 3.4.7. Developing and changing coordinated development projects for poverty alleviation and improvement of living standards

Current livelihood conditions and the way resources are used in the areas endangered by drought and desertification, fail to meet adequate living standards. In addition, traditional livelihood pattern is based mainly on pasture farming. Managerial measures, thus, need to be taken for both poverty alleviation and environmental protection in the area as follows:

- A. Strengthening and reinforcing rural organizations for managing rural affairs and rangelands;

- B. Developing industrial activities according to the potentials and capacities of arid areas in terms of energy and mineral resources;
- C. Promoting and encouraging natural resources participatory management, with emphasis on using modern technology for conservation on of the environmental and natural resources; and
- D. Establishing periodical credit funds for rural investors so as to facilitate initiation of rural industries or businesses.

*3.4.8. Improving awareness aspects (including socio-economic aspects of arid ecosystems) along with developing information and monitoring systems for drought-prone areas susceptible to desertification*

Raising mere basic knowledge dose not suffice to deal with desertification process in arid areas. Thus, managerial activities need to be taken in to consideration for pertinent information and monitoring systems. Some of managerial activities needed for this issue are: (Taravati, 1992).

- A. Creating and enhancing an environmental information system at national level;
- B. Improving rural infrastructures, and conducting national, provincial and local assessments to ensure network-wise cooperation between existing environmental information and monitoring systems;
- C. Raising the capacity of national institutions for environmental data analysis so as to practice close control over biological changes;
- E. Encouraging public collaboration and education on environmental protection with emphasis on anti-desertification efforts.

#### 4. Conclusion

The arid area's fragile and sensitive ecosystem is evidently an important ecosystem with exclusively unique resources and characteristics. It has, thus, prompted many efforts at national, regional and international levels for a better understanding of problems in arid areas and how to utilize optimally their resources. Iran is mainly (about 90%) located in an arid and semi-arid area. The findings and results of the studies made in the selected area may work in other areas with the same characteristics around the world as well. This area can, thus, serve as a strategic model for other similar area's as far as below-mentioned research findings are concerned.

Studies in the selected area well reveal that more than one factor can be responsible for

emergence of an arid area. In the selected area, however, the effect of sub-tropical high pressure has been the major factor for arid ecosystem. The area challenges with two distinctive limitations or constrains: a) natural limitations inherent in arid ecosystems; and b) constraints or problems created by man due to the lack of adequate understanding to adopt to arid ecosystems conditions. For instance, irrational practices such as over-using saline water for irrigation purposes, cropping in slope lands, plowing in wrong direction, over-grazing, cutting trees and burning the residues as fuel, over-using fertilizers and chemicals, using inappropriate landfill systems; etc. have all caused arid areas to face difficult challenges. In spite of natural constraints in the selected area, there are also many potentials and capacities available for investment in industrial, research and tourism sectors. Many resources such as wind and solar energies, mines of salt, clay, sand, gravel, coal, copper, zinc, lead..., as well as attractive landscapes and sceneries in arid areas for tourism purposes are just few instances to be mentioned in this regard.

Studies in the selected area have suggested a number of approaches to sustainable development and management in arid areas for alleviating limitations and optimizing resource utilization in the area. These approaches that may work well in other similar areas around the world are as follows:

- A. Improving (amending) saline and alkaline soils.
- B. Controlling soil erosion (soil conservation).
- C. Decreasing soil infection (soil pollution).
- D. Optimizing utilization of water resources.
- E. Utilizing natural resources.
- F. Taking advantage of tourist attractions.
- G. Developing and enhancing coordinated development projects for poverty alleviation and improving awareness aspects along with developing information and of living standards.
- H. Monitoring systems for drought-prone areas susceptible to desertification.

#### References

- Alizadeh Amini, 1998. Quality of Water for Irrigation, Astan-e-Qods Publisher, Mashhad.
- Arnon I, 1986. Principles of Farming in Arid Areas; Astan-e-Qods Publisher, Mashhad.
- Estelaji A.Reza, 2003. Area Planning: Principles and Methodologies, Shahr-e-Rey Azad Islamic University Publication, Tehran.
- Estelaji A.Reza and Shariatpanahi M.Vali, 2003. Natural tourist Attractions in Desert and Semi-Desert Areas, Shahr-e-Rey Azad Islamic university publications, Tehran.

- Estelaji A.Reza, 2002. Sustainable Development, Ministry of Jihad-Agriculture (MOJA), Tehran.
- Forests Organization, 1997. Soil Erosion in Loot Desert ..., Forest Organization, Tehran.
- Iranian Center for Desert Research Studies, 1977. The Roles of Human and Nature factors in Further Progress of Loot Desert, Desert Research Center, Tehran.
- Jafarpour Ebrahim, 1996. Climatology, University of Tehran Publications, Tehran, Iran.
- Jafarpour Ebrahim, 1986. Reasons of Dryness, Zeytoun Journal; Vol. 56, Tehran.
- Jedari E. Jamshid, 1986. Geography of Desert Regions, Zeytoun Journal; Vol.57, Tehran.
- Kardavani Parviz, 2001. Geography of Soils, University of Tehran Publication, Tehran.
- Kardavani Parviz, 2001. Water Resources and Problems in Iran, University of Tehran Publications, Tehran.
- Kardavani Parviz, 1999. Arid Areas, University of Tehran Publication, Tehran.
- Kardavani Parviz, 1996. Soil Conservation, University of Tehran Publication, Tehran.
- Mahdavi Massoud, 1987. A review of Weather in Desert Margins, Center for Research on Iranian Desert Regions, Vol.18, Tehran.
- Mahmoodi Frajollah, 1971. An Overview of Natural Sciences: Loot, Vol.7, Geography Institute, Tehran.
- Paul Jakof and Mey Brogil, 1987. Studies on Ecology of Halophyte, Desert Research Center, Vol.21.
- Rabiee, Badiiee, 1993. Geography of Iran, University of Tehran.
- Tarvati H. and Ayafat, 1992. S.A. A Sustainable Development Agenda for the 21<sup>st</sup> Century, Rio de Janeiro, Brazil.