

CONSERVATION OF NATURAL ECOSYSTEMS IN JORDAN

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Abstract

This study reports different types of natural ecosystems in Jordan subjected to human interference. Mediterranean forest and shrub land ecosystems are severely affected by cutting and fragmentation into farm lands or housing areas, leading to a great loss in biodiversity, especially, rare species, and causing soil erosion and desertification. The second type of system is a unique desert oasis, which is undergoing change by pumping ground water for the past 20 years. It is causing dryness of such unique aquatic system and thus sequentially contributing to loss of precious ecosystem. The third ecosystem is a marginal land area, classified as steppe land belonging to the Irano-Turanian biogeographic vegetation region subject to cultivation under a little rain water. It caused destruction of vegetation, soil erosion and weed spreading. The fourth is a fresh water ecosystem also badly altered by mixing of sewage water effluent. It is causing disappearance of many edible and prominent aquatic plant species. Mitigation measures are needed to overcome these negative alterations.

Introduction

Jordan is a small country with a total area of about 90,000 Km², yet it is highly diversified in terms of variation in biogeographic regions and richness in biological diversity elements (Al-Eisawi, 1996, Al-Eisawi *et al.*, 1998; Anon., 1998.). Jordan is divided into four biogeographic zones, Mediterranean, Irano-Turania, Saharo-Arabian and Sudania (subtropical penetration) (Al-Eisawi, 1985). Such regions vary in their geophysical and biological characteristics. Accordingly, richness in biodiversity in general is one of the important characteristics of Jordan especially, plant biodiversity (Al-Eisawi, 1982).

Generally, Jordan is classified as belonging to the Mediterranean region, since typical Mediterranean characteristic prevail, where typical changes in season are very clear, with long dry summer, short autumn, long winter and short spring. Although, Jordan is a Mediterranean region, but it is also classified as arid or semiarid region, since the majority of Jordan (80%) is receiving almost less than 100 mm of natural rainwater. Accordingly, biodiversity and conservation in the dry region have received some attention and some serious studies (Amr *et al.*, 2011; Barakat, & Hegazy, 1997; Cope, & Al-Eisawi, 1998; Cordova, 2007; Dutton *et al.*, 1998; Dutton & Shahbaz, 2008; Hegazy, 1999).

There are contradictory reports on biodiversity of the country, some of which are made at the national level (Anon., 1998; Anon., 2003) and others at international level (Gopal, 2003; Groombridge, 1992; Heywood, & Watson, 1995; Johnson, (1995; Lemons *et al.*, 2003). The present paper presents the current status of biodiversity in Jordan and conservation strategies to preserve such diverse ecosystems.

Mediterranean forests: Jordan is a small country with less than 1% of the total area is covered by forest. At present, the forest area is estimated as only 0.08% equally divided into natural forest and man made reforested land. Therefore, the little forest area left in Jordan is critically endangered. Only the composition, characteristics, threats and conservation of only natural forest are discussed this paper.

Natural forest types: According to the leading species of the forest type, the natural forests in Jordan are subdivided into following four main types (Al-Eisawi, 1966).

Pine forest: This type of natural forest is restricted to the northern parts of Jordan. *Pinus halepensis* (Aleppo pine) is the most commonly used species for reforestation. This species has a high rate of success and it grows quite fast. However, the remaining areas of the natural forest are restricted and limited to the soft light yellow clayey to calcareous soils of northern Jordan. The forest usually grows at altitudes above 1000 m. There are few patches of this forest in Zai, Salt Governorate, Dibbeen National Park and Sakib, Jerash Governorate and a small patch in Ajloun city, Ajloun Governorate.

The rainfall requirement is the highest in the country, ranging from 500-600 mm per year. The temperature is the least recorded mean annual in the country. However, in association with the leading species i.e. Aleppo pine, some other low trees and shrubs grow. These include *Arbutus andrachne* (strawberry tree) *Crataegus azarolus* and *Pistacia palaestina* in and some lower shrubs such as *Calycotome villosa*. The dominant bushes are *Cistus creticus* and *C. salviifolius*. Under this pine forest, the best populations of orchids are found. Some times in the open areas, *Sarcopoterium spinosum* makes the dominant or partial coverage.

The importance of this forest lies in the strategy of holding most of the 26 rare orchid species of Jordan. Thus, any loss of this particular type of forest is associated with the loss of orchid species as well as the associated pollination vectors and their parallel evolution.

Juniper forest: This type of forest formation is restricted to the southern parts of Jordan, at high altitudes of 1200-1700 m above sea level. The temperature is the lowest in the country with the low chances of snowfall. This forest stretches on the mountain range in southern Jordan from Tafila to Ras An-Naqab and Wadi Rum. This forest is seriously reduced due excessive cutting in the past. In some studies, it was shown that wood of juniper was used for the smelting of copper during the Nabteian period. This postulation is strengthened by the fact that copper deposits are still apparent in the vicinity of copper mines.

The leading species of this type of forest is *Juniperus phoenicia* (Phoenician Juniper). In association with this species, there is frequent growth of *Pistacia atlantica*, *Quercus coccifera*, *Crataegus aronia* and in rare cases *Ceratonia siliqua* especially, on sand soil rocks. In specific cases of this association, wild (*Cupressus sempervirens*) cypresses trees are still growing in Dhana area in Tafila, Jordan. The stand now is conserved within Dhana reserve in Tafila district at an altitude ranging from 1600-1700 m a.s.l. This distribution of cypresses is considered the southern limit in the Northern Hemisphere.

Evergreen oak forest: This type of forest cover is the most common in the high range of mountains that reach more or less 1000 m above sea level. Sometimes the distribution range extends from 600 to 1600 m a.s.l. The lowest distribution range can be recorded in the western mountains of the capital Amman at their descent south of Mahes and the highest are at the limit exceeding 1600 m in the Area of Tafila at the northern borders of Dhana reserve, near the cement factory in a particular place called Al-Ellami.

The best formation of forest type is in the region of Ajloun governorate. The leading species is the evergreen Mediterranean oak *Quercus coccifera*. This oak is the basic element of the Mediterranean scrubland known as Maquis. In association with this leading species is a mixture of shrubby to a tree type of *Arbutus andrache*. In addition, few other species such as *Pyrus syriaca*, *Crataegus azarolus* and *Pistacia pallaetina* are also found. Some shrubs and low bushes such as *Calycotome villosa*, *Cistus creticus*, *Cistus salviifolius* and many more species of herbs and perennial herbaceous plants especially orchid also associated with this type of vegetation.

Deciduous oak forest: This type of forest occurs in Jordan at a lower altitude, usually at the lower limits of distribution of evergreen oak forest where it form almost mixed borders of the two types. In general the distribution limit may vary from 200-900 m above sea level with best formation in Alouk area at the northern borders of Amman governorate extending to Jerash governorate, at altitude of about 500-700 m. The second site of distribution is the low western heights of Ajloun and Irbid governorates extending to the northern borders of Um Quies. A third limited distribution is found at the lower western heights of Amman governorate, especially in Albath area, Bader Area, Mahes and Fuhais reaching up to Wadi Shuaib.

Threats to these ecosystems

Private ownership of forests: The total area of the natural forests in Jordan is about 0.004% of the total area and the man made forest is almost the same 0.004%. The natural forest are always under threat from villagers living in the vicinity, since they always try to clean forests to claim ownership based on the old mandate, i.e., a piece of land is considered "owned" if it is under cultivation for a certain period of time (10-15 years). However, although this practice has not been anymore acceptable, still some people try to impose this tradition by cutting one tree and

planting an olive tree. Next year they clean one or two more and cultivate the same. After few years they have a small area with mixed forest of cultivated olive within the wild area. Once they reach the ten year border they clear the entrance from the wild trees showing a whole cultivated farm within this forest. Now for them this part of the forest is part of their property. Since in the past most of the land was not registered, they can claim that this land to be "owned" by them. Since many people in each village do the same practice, they then testify in the court with each others that this land is a private property owned from grandparents.

Due to this practice, a reasonable part of the natural forest is known to have private ownership. This land is becoming very precious now a day and worth a lot of money especially, to be used for rich people to build huge houses or palaces.

Mitigations for conservation:

- Stopping illegal activities
- Reclamation of land by buying or swapping with other pieces of lands outside forests
- Re-plantation (reforestation) of the type of forest species
- Putting heavy penalty on illegal activities

Cutting trees: There is always a group of people who cut trees for the production of coal. Most of them are clever they work on cutting sporadic trees that does not show clearance of forest at one time, but this will be realized at later stages when parts of the forest becomes very thin and rather empty. Other workers, very fast and mostly during the night, use modern cutting tools to cut trees. This cutting is made in a systematic method that shows the forest as if it was untouched, due to the fact, that they use only wide thin layer of the forest. And repeat this action in different parts or sides of the forests.

Negative effects of cutting trees

- Life becomes more expensive
- Vehicles have facilitated the quiet movement and fast escape
- Some people who are employed in forest department, use their job as a source of income
- High demand on coal for Nargila (Hubbly bubbly) since it is becoming a fashion among young generations
- A small part is based on cooperation between corrupt ranges and people who cut forests

Mitigations

- Production of by other means such as the remnant of olive seeds (Bio fuels)
- Solve causes of poverty and unemployment
- Put heavy fines and penalties on breaking law
- Reforest cleared areas

Overgrazing: Overgrazing is a habit that is often used by shepherds in protected areas. Forests in Jordan are protected from grazing under present law. However,

grazing still takes place in many forest parts of Jordan. Often people spend the whole season under forest canopy even spending the resting time of their animals in specific hides in the forest. In some cases it was observed the people are living with their animals in the forest milking and producing dairy product such as cheese, ghee or yogurt in the same place. Based on this part of the low trees, shrubs and herbs are heavily grazed.

Negative effects of grazing

1. Reducing Biodiversity in general and loss of genetic diversity
2. Threatening rare and endangered species
3. Reducing seed productions
4. Introduction of weeds and alien species
5. Effecting seedling counts and regeneration
6. Browsing basal parts causes unusual tree and shrub shapes

Mitigations

1. Rangers should have sufficient knowledge of indigenous vegetation
2. Legal rules should be employed and if not present should be formulated
3. Heavy fines should be applied for breaking laws
4. Establishment of new rangelands
5. Animal feed supply during dry times should be supplied at low prices in market

Rural expansion: Population expansion is one of the most challenging problems faced by mankind at present. Accordingly, homes, food supply, medication, education, and other rural services should be expanded to fulfill their needs (Al-Eisawi, 2004). In Jordan particularly, it was pointed out that 95% of the population is living in only 5% of the total area of country (Al-Eisawi, 1994) that is mountainous range which stretches from the northern borders with Syria to the South in Ras An-Nagab in Jordan. This area contains the best arable land in Jordan, which receives the best amount of annual rainfall and contains the best natural vegetation cover especially the limited natural forest area.

Negative effects of rural expansion

1. Loss of the majority of fertile arable land
2. Loss of the green natural vegetation
3. Reduction of the green forest and replacement by roads and house
4. Decrease of O₂ and Increase CO₂ emission
5. Increase of relying upon imported food recourses especially, wheat as a major food security element.

Mitigations

1. Minimize reduction in forested land
2. Increase reforestation areas with the same type of natural forest species
3. Shifting the rural pressure to none fertile land

4. Stopping private land owners from using forest land for building

Agriculture: Population increase leads to increasing food demand. This increase in food demand can be solved by two ways. Either by increasing in cultivated area; or increasing production per unit area. Since Jordan is developing country, it is more likely to go for increase in cultivated area at the expense of rich fertile soil which is only found in the mountains ranges where the limited forest cover is present. Thus, whatever actions have been taken to conserve forest, some forests have been cleared for food production.

Negative effects of agriculture on forest conservation

1. Reduction in natural forest area
2. Alteration the landscape of natural forests
3. Introduction of pesticides to the natural ecosystem
4. Increased access to the forest for grazing and extra damage
5. Sometimes, abandonment of agriculture land and increasing weed species

Mitigations

1. Reducing the use of forest for crop productions
2. Charging high penalty for clearing forest for crop cultivation
3. Increased public awareness

Desert oasis: In Jordan there is only one desert oasis named Azraq Oasis. This oasis historically, is subdivided into two parts the northern Azraq (Druze) and the southern Azraq (Shishan) due to the fact that there were two communities of Jordan inhabitants living in each side sharing the water resources (Al-Eisawi, 1995). The importance of this place is its abundance of fresh water supply that for local people as well as major cities of Jordan. The annual water recharged is estimated to be 20 mcm (Million Cubic Meters). In the 1950-1985 the annual discharge from the ecosystem was balanced. Often the near by Qa (Playa, Bajada) forms a big lake that attracts migratory birds coming from Europe to Africa. Therefore, it was an important RAMSAR site for bird watching. In addition to that Azraq wetland reserve (12 Km²) has offered for aquatic and rare species in Jordan of 135 vascular plant species (1995). Five new species to the flora of Jordan were only found in this location in addition 1 or 2 new taxa to science have been located.

The increased demand of water for the major cities of Jordan especially, the capital Amman and the city of Irbid in the north., has caused remarkable lowering in the water-table which reduced floods and disappearance of the seasonal lakes. This phenomenon is worsened due to the presence of hundreds of aquifer wells for the use in the ever increasing desert. Finally, such activities have destroyed this unique site and have made the place drying out except of small pools regenerated by water re-pumping.

Negative effects on desert oasis

1. Loss of the only desert wet ecosystem in Jordan
2. Loss of many rare and unique plants species
3. Loss of a beautiful site for migratory birds
4. Loss of natural laboratory for studies of both undergraduate and postgraduate students
5. Loss of a great revenue from ecotourism
6. Increase of soil salinity
7. Desertification and soil erosion

Mitigations

1. Reduction of water pumping to be balanced by natural recharge to restore the balance to the ecosystem
2. Restriction of unregulated water pumping for agriculture use
3. Supplying all well with measuring gages to restrict water over pumping
4. Make sure to imply necessary measures restore these ecosystems
5. Government involvement is essential for the success of these measure

Irano-turanian vegetation (marginal land): Almost 10% of Jordan Land is classified as Marginal land. This land does not receive enough rainwater to support natural cultivation. The annual rainfall in this region ranges from 100-250 mm annually. Thus the natural rain is not sufficient enough for crop cultivation; however, it is very good to support primary natural vegetation for supporting a natural zone of a grazing land.

Recently due to the shortage of fertile land, natural expansion of the population as well as industry, the Irano-Turanian desert in Jordan is under pressure. In addition, often unorganized or organized agriculture often aggravate the problem. Often just plowing large areas of the land takes place for cultivation of barely or sometimes just to show that the land is used for claiming ownership.

This new attitudes of moving to the eastern parts has participated and lead to the development of some eastern parts of Jordan. Due to the development in communication system and the availability of water pipes and electricity to serve almost 95% of Jordan, this has encouraged lots of people to move back to the rural areas especially, the marginal land of the eastern desert. This movement has released some of the pressure on the productive and forest region to a certain level, but it has started to affect the natural ecosystems in the marginal (Irano-Turanian) areas in the country in the most negative effects.

Negative effects on marginal lands in Jordan

1. Irregular and unplanned use of land
2. Destruction of the natural primary natural vegetation
3. Loosening soil texture through land plowing
4. Crop production is always poor that cannot be harvested and thus used for grazing
5. Altered ecosystem natural association

6. Introduction of a huge number of weed unpalatable species
7. Weed species produce allergenic pollen that cause health problem
8. The weeds increase certain rodents species that feed on them which act as a secondary host for Leishmania disease in the eastern side of Jordan

Mitigations

1. Land use plans are essential for development of this part of Jordan
2. Plowing land should be forbidden in this type of land since it has a limited capability for crop production
3. The idea of using this land for organized grazing works best
4. Destruction of such vegetation will lead to the disappearance of a wild set of species adapted to such specific conditions.

Fresh water ecosystems: Jordan has only one river well known as the baptism place for the Holly Jesus Christ. This river has been totally or partially diverted to by Israel. It is running on a very shallow level with increasing situations in the winter times. In the old days before 1965 the river used to flood and forms sort of shallow seasonal swamps. These conditions have formed a beautiful (riparian) hydric vegetation dominated by shrubs and low trees of *Populus euphratica*, *Salix alba*, *Arundo donax*, *Phragmites australis*, *Typha domengensis*, *Nerium oleander*, *Prosopis farcta*, *Tamarix jordaica* in addition to other species of *Tamarix* spp. However, many valley (*Wadi* in Arabic use) formations are running from east of Jordan to west of Jordan according to the main slopes leading to the Rift Valley of Jordan. These valleys where at one time are considered as small rivers due to the quality of water flow. Now-a-day, most of these valleys have slow running water.

Most of these running resources have almost natural water quality with minor alteration of its properties. Now-a-day most of the valley systems have polluted water with various types of influxes. The worse affected are those valleys which have mixed sewage treated water. This sewage water sometimes is well treated but often the quality of the running water became very dangerous for uses. Due to this, edible water plants or even ornaments water plants that grow on good quality of fresh water have disappeared totally. Some of these species are *Mentha longifolia*, *Apium graveolens*, *Apium nodiflorum*, *Nastortium officinarum*, *Veronica aquatica* and *Nerium oleander*.

The worst examples among those are Zaraq River due to the fact that about 50 mcm are let into the river altering totally the quality of the natural water. Very often during winter time, some of the rain water reaches the sewage station, where the amount of received water become more than the station capacity of treatment. In this case the coming mixed water in released as it is the river without any treatment (Al-Eisawi, 2004). In such cases the situation becomes dangerous, especially when we know that the end flow of the river is collected in one of the largest dams in Jordan. Another dangerous behavior is the use of this water in irrigation.

Negative effects of water pollution

1. Absence of many plant and animal species
2. Absence of pollinators and parallel evolution
3. Altering the natural quality of the water flowing in such important resources
4. Absence of edible species
5. Fish species used as food for people have disappeared or became highly polluted and inedible
6. Mixing such bad quality with the dam water produces a low water quality for irrigation
7. Sometimes the water is pumped directly from river for irrigation of various crops

Mitigations

1. Make sure that quality of mixing water is sufficiently treated water
2. Make sure to stop mixing of untreated water
3. If treated water quality cannot be altered then it should be diverted for other uses
4. Biodiversity loss should a critical point of conservation indication
5. Water should be tertiary treated to match the natural water quality, where it can be used for various aspects

Conclusion

The projected examples are representing a few examples of the negative aspects affecting conservation of biodiversity in Jordan. However, it is clear that population explosion is the main cause of most of human pollution problem. It is very well demonstrated that degradation of green cover is automatically linked with increase of atmospheric CO₂ as a result of decrease in the CO₂ sink. Human population increase is coupled with increase in vehicles exhaust and gas emission. Also increase of animals for domestic uses is associated thus with increases of greenhouse gases.

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