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INNOVATIVE SOLUTIONS TO REDUCE THREATS AFFECTING BIODIVERSITY CONSERVATION

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Abstract

Biodiversity threats are becoming much more adverse than ever been. Accordingly, the conservation tasks are becoming more difficult to achieve especially, with the worse situation of global warming and climate change. Various methods can be summarized under the major themes of conservation known as In-Situ and Ex-Situ conservation. However, everyday there are certain creative methods, that are considered very creative, but most are still listed as subdivisions of the classical methods. In this paper, some classical conservation methods are reviewed and lessons learned from nature will be introduced which might have an impact on our understanding of plant conservation. The examples of conservation will be dealing mostly with plants growing in the desert and dry ecosystem. Plants species growing under little amounts of rainfall reaching 70 mm / year, as well as shifting of the flowering behavior of other species are used as examples of innovation solutions for conservation.

Introduction

Some of us think the all biodiversity resources should be protected. Some think that biodiversity is not necessary. Some others think that conservation of biological diversity is in becoming a crisis discipline (Johnson, 1995). Therefore, it is often difficult to decide what to conserve or not to conserve, simply due to the fact that how much time, money, well trained manpower and good management is needed to achieve such goals. Understanding the function of natural ecosystem behavior in terms of the specific requirements of each component is a very difficult task. Therefore, conserving unbalanced ecosystem with lots of missing biodiversity elements is a very difficult and uncertain process. Conservation of biodiversity priority settings is based on various factors such as the importance at a global, regional or national level. Some consider the value based on economic uses, spiritual or cultural values, food, medicinal or other values.

Therefore, the need for conservation and urgency may vary from one country to another, some countries are very keen to conserve endemic species even if they have no economic value, some other think that genetic resources and crop relatives are more important to conserve in terms of importance to mankind. However, biodiversity studies have been increasing ever since the Rio Declaration on the CBD in 1992.

Various major publications have been produced in cooperation with international agencies especially, IUCN, UNEP, UNDP, WWF, FAO, UNESCO and others. Some of these major references are the Global Biodiversity Stratigy (Courrier, 1992); Global Biodiversity, Status of the Erarth's Living Resources (Groombridge, 1992); Global Biodiversity Assessment (Heywood, 1995).

The arid and dry ecosystem is a fragile system, since it is a delicate system and changes that take place can be very serious and irreversible. However, arid and dry ecosystems have proved to be very rich and containing important species of genetic, economic and medicinal value (Al-Eisawi, 2007; Oran & Al-Eisawi, 1998). Major works of region have been conducted in the dry and arid regions of the world including the Arab World.

Arid and semiarid regions account for nearly two third of Africa and Australia continents. Yet they account for one third of the desert in Asia. However, the desert of Africa is considered as a hyper-arid, while the desert of Asia is arid or semi arid. However, conservation strategies in the arid land tend to ignore the aquatic vegetation which are particularly rich (Gopal, 2003). More than 80% of the Middle East is a desert land, yet it is a very rich area in term of valuable medicinal plants and drought resistant species.

Loss of biodiversity: When natural habitats are destroyed, a few species may be able to adapt the change and most are not capable and ultimately perish. Some scientists says that extinction rates have accelerated enormously over past 50 years as many types of habitats have been damaged or destroyed. Keeping crops from diseases often depends on our ability to breed new disease-resistant strains by tapping into gene pools of wild relatives. Loss of biodiversity in an ecosystem reduces efficiency of production and nutrient use, and makes the ecosystem less resistant to disturbances.

What are the causes of biodiversity loss?: There are various causes of biodiversity loss, some of which are considered as simple and some other are complex, others have effect at global levels, while some have effect at the regional or local levels. Some biodiversity losses have direct effects or indirect effects. Some of the losses are affecting aquatic ecosystems and the species of both marine and fresh water ecosystems, while other losses affect terrestrial ecosystems of various types whether they are forests, shrubs, grasslands wet or dry ecosystem (Raven, 1992; Courrier, 1992). However, the major mechanisms of biodiversity loss where given as follows:

1. Habitat loss and fragmentation
2. Introduced Species
3. Over-exploitation of plant and animal species
4. Pollution of soil, water, and atmosphere
5. Global climate change
6. Industrial, agriculture and forestry

However, since 1992 things have changed in terms of knowledge and time, thus some consider loss of biodiversity is due to other factors including the previously mentioned ones as follows:

1. The impact of human on biodiversity
2. Population growth
3. Desertification
4. Global warming
5. Erosions
6. Aquifer depletion
7. Destruction of natural habitats and Loss of Biodiversity
8. Acid deposition
9. Water contamination
10. Hazardous waste
11. Invasive species
12. Absence of land use planning

Each of these factors can be at the global, regional or local level as the following:

Impacts of humans on plant communities: Long-lasting impacts that cause problems at the global level to:

1. Climatic changes
2. Stratospheric ozone depletion
3. Loss of biodiversity

Global warming: Human activities are accelerating the rate at which global warming is occurring. Accumulation of gases that permit radiation from sun to reach earth's surface, prevent heat from escaping back into space, leading to the known phenomenon of greenhouse effect. Gases involved are carbon dioxide, methane and others, such as chlorofluorocarbons. This global warming is resulting very unwelcome events:

1. Glaciers will shrink
2. Permafrost will disappear
3. Sea levels rise
4. Extreme storms
5. Huge swings between wet and drought years
6. Expansion of deserts
7. Dramatic drops in crop yields
8. Massive extinctions due to habitat changes

Erosion: Erosion mostly occurs as result of human activity such as urbanization, road construction, removal of green cover and overgrazing leading to serious effects such as:

1. Wind and water remove productive soil
2. Soil erosion limits sustainable agriculture productivity
3. Most affected is the fertile topsoil
4. Loss of organic matter and thus soil fertility
5. Increasing the process of water runs off
6. Removal of fertilizers and pesticides into streams and lakes
7. Direct result of overgrazing, clearing land for urbanization and roads, and plowing

Aquifer depletion: It is one of the most serious effects of human activities that trigger irreversible sequences of ecological problems. Most of the underground water is used in agriculture, mostly for non strategic production of crops of very little impact on human food needs such as tomatoes watermelon, and others. The water demand is ever increasing due to population expansion. The ratio of the underground water pumped at the international level for is as follows:

1. Irrigation - 70%
2. Industry - 20%
3. Homes - 10%

Acid deposition: Burning fossil fuels releases sulfur and nitrogen compounds into the atmosphere. Chemical reactions with sunlight and rain convert the compounds into nitric acid (HNO_3) and sulfuric acid (H_2SO_4). Acid rain adversely affects living organisms as follows:

1. Forest/tree death
2. Reduction in mycorrhizal fungi association
3. Alters soil fertility
4. Eutrophication due to nitrogen accumulation in water bodies

Effect of chemicals and pesticides and hazardous waste: The excessive use of pesticides and chemicals form exhausts and combustion cuses:

1. Loss of plant species
2. Pollution in lakes and streams
3. Dumping toxic wastes
4. Pollution of runoff water
5. Pollution of ground-water supplies
6. Accumulation of chemical and their by production in the food chain

Invasive species: The effect of Invasion and foreign species is due to their being:

1. Often aggressive weeds
2. Reproduce quickly and exclude native plants
3. Have no natural pests or herbivores, thus successful reproduction and absence of defense strategies allow them better compete with native plants
4. More phenotypic plasticity
5. More genetic differentiation (rapid evolution)

Innovative methods of reducing threats to biodiversity?: Are there innovative methods of reducing threats to biodiversity? And if they exist what are? How simple or sophisticated they? Then why they are not used? All of theses questions are justified to be asked. But how we answer such simple sophisticated questions?

Biotechnology and genetically modified species: Sometimes biotechnology can solve all our problems. This can be true in terms of electronics, communications, transports and many other fields. But natural ecosystems are not as easy to be manipulated because we are dealing with living organism and their complex life requirements. However, biotechnology can solve some of the human requirements in term of food supply, bio-fuel, medicine and others. Yes biotechnology alone cannot replace lost

species regardless of these arguments, the pros and cons of biotechnology use can be summarized as follows:

1. Benefits of Genetically Modified Organisms (GMO's)
a. Transgenic crops are environmentally friendly
b. Farmers can use fewer and less noxious chemicals for crop production

2. Drawbacks of transgenic plants (Unanswered questions)
a. Effects on non-target organisms, such as beneficial insects, worms, birds etc?
b. Effects on humans consuming transgenic crops?
c. Movement of herbicide-resistance genes into weeds?
d. Evolution of insects to be able to eat transgenic plants?
e. Encouragement of farmers to abandon sustainable agricultural farming

Other methods of conserving biodiversity: The means that can be used to reduce the loss of biodiversity and the rates of extinction are known as restoration ecology. Some other may call them solutions or innovation methods. Working in the field as field biologist, taxonomist, vegetations ecologist, and biodiversity conservationist, we can find the solutions if we can answer the following simple question:

1. Do we understand our resources?
2. Do we understand the structure and the composition of our ecosystems? Either in a country or local areas?
3. Do we know precisely the total numbers of flora and fauna?
4. Do we understand how such ecosystems work
5. Do we appreciate the role of each species within its community
6. Do we understand the effect of a species absence on the community and thus the ecosystem?
7. Do we recognize the imbalance of the ecosystem?
8. Do we know precisely what caused this imbalance?

If we can answer such questions and understand the problem, then it would be easy to find a solution. It is always true if we find the cause of a problem, the solution becomes reachable. Some of the solutions or innovations can be listed as follows:

1. Solutions are based on understanding and learning from nature itself
2. Review the causes of negative effects on biodiversity
3. Reverse negative effects to positive effects through a series of measures
4. Sustainable use of our resources
5. Applying scientific knowledge to solve or problems

The worst thing about the ecosystem scenarios, they are highly complex, sophisticated and can be irreversible or very costly to be managed after being altered or imbalanced. A group of suggested methods are based on field experience conducted in the desert and dry ecosystems of the Arab world. However, these methods of conservation of biodiversity, which we consider innovation, are simple and are often treated as classical since they are the solution that can work at the end of the day.

Underground depletion: Depletion of underground water is one of the most serious problems for ecosystems especially, desert and oasis. There are many reasons of underground over pumping out of which, two serious examples are mentioned here based on close observations and field studies and these are Azraq Oasis in Jordan and Fresh Water Spring in Bahrain (Al-Eisawi, 1995, 1996, 2004, 2008).

Azraq Oasis, Jordan: Azraq oasis used to be flooded every year forming a huge water body of few Km's in diameter. The Azraq basin is depression in the desert with an altitude of less than 500 m in height. The annual charge of the ground water as a result of rain fall on Jibal Al-Arab, southern Syria is about 22 million cubic meters. The annual water pumping exceeded 200 million cubic meters. This irrational and unsustainable use of water as drinking water in the cities of Amman and Irbid, in addition to undetermined uses for agriculture has lowered the water table enormously and the Famous Azraq Oasis has dried out (Figs. 1, 2).

Fig. 1. Showing water level and the water vegetation before, water pumping exceeding permitted levels from Azraq Oasis, Jordan.

Fig. 2. Showing lake drying due to water over pumping and lowering of water table in Azraq Oasis, Jordan.

What are the characteristics of this oasis? It is the only oasis in Jordan. It has a peculiar richness in water plants and some of the species are endemic and some others do not occur anywhere else. This was a very special ecotourism site, complementary with archeological Azraq cites such as Azraq Castle. Again this water body was one of the rare stations of the migratory birds along the track from Europe to Africa back and forth. If we want to rescue this site and conserve it, or restore it in an innovative way, then the only way is to stop water pumping from the whole basin for few years until the water table comes back to its standards. After that if we want to re-pump water then the amount should no not exceed the annual recharge.

Bahrain fresh water springs: Bahrain is a small country of about 700 km² used to have a small population with green cover of palm orchards, named as the million palm country. This country was sustained by fresh water use for both human need and agriculture using only water produced by a series of springs. However, due to over pumping and water depletion, the country now is totally relaying on desalinated water. And all of the natural springs have dried out especially, the famous Ain Athari. Most of the water is used in agriculture contains high ratios of salinity, even the tap water being supplied in houses in not useable due to high ratios of salt. Accordingly, the people do not use tap water for drinking. Following this the majority of the green cover of the country, especially, Palm orchards have been lost (Figs. 3, 4).

In this case it is very difficult to say that there is a solution except stopping pumping of ground water. But even if Bahraini people stop pumping water the effect will be there due the ever increasing water pumping from Eastern Saudi Arabia. However, the big question is that the ecosystems in both Jordan and Bahrain can ever go back to their natural status? Are the lost biodiversity species can be recovered?

Fig. 3. Showing Palm orchards in Bahrain in their normal situation in the availability of water, Manama, Kingdom of Bahrain.

Fig. 4. Showing Date Palm Orchard, completely died due to over pumping of ground water and the dryness of water spring, Manama, Kingdom of Bahrain.

Sustainable use of agriculture

Oman: A sustainable method of agriculture has been observed in part of Oman in Al-Jabal Al-Akhdar have been observed. That is cultivating the (*Wadi*) valley sides which rich with natural rain or running water with very well adapted crops such as local vegetables, grapes, pomegranate, and roses for distillation of rose water. The cultivation of such crops on terraces of steep hills have reduced very much soil erosion, produced sustainable food and made the scenery much more beautiful. This is one of rare most successful use of ecosystem in contrast with the two previously mentioned examples of Jordan and Bahrain (Figs. 5-7).

Cultivation of Marginal Land in Eastern Jordan: Eastern parts of Jordan receive annual rainfall ranging from 50 mm in the furthest eastern borders with Saudi Arabia an Iraq, increasing up to 200-250 mm at the Eastern Borders of Amman and Zarqa. Almost 100 km East of the capital Amman and almost exactly in Azraq and eastern borders at that limit the annual rainfall decreases reaching a limit of 70 mm/year (Al-Eisawi, 1996). Therefore, the region between the eastern borders of Amman up the real desert areas is severely subject to useless agriculture practices. The agriculture is mostly based on natural rain, using annual crops especially barely. In some cases there are in the northeastern parts of Jordan irrigated cultivation of cereals or fruit crops are taking place, but at the expense of the limited underground water resources that cased the dryness of Azraq Oasis. These practices of marginal land cultivation have lead irreversible sequences some of which are:

1. Destruction of the primary natural vegetation that form the main elements of the dry ecosystem components which contain highly important medicinal, genetically and grazing elements
2. Replacement of the natural palatable and medicinal plants by weedy species, which are not palatable, cause pollen allergy and act main food for Gerbils which act as a secondary host for the parasitic disease
3. Destruction of the vegetation causes erosion and in turn leads to desertification

Of course this type of land use is definitely unsustainable in comparison to the previously mentioned in Oman.

Fig. 5. Showing the use of terraces, that can reduce soil erosion and can be productive, in Oman, Jabal Akhdar.

Fig. 6. Showing terraces on steep areas and the successful use of land to conserve land from erosion and biodiversity loss, in Oman, Jabal Akhdar.

Fig. 7. Showing roses cultivated on the slopes and terraces for the production of rose water, in addition to cultivation of other crops such as grapes and pomegranate, in Oman, Jabal Akhdar.

Simple protection methods

Jordan natural reserves: Often the question is raised how we can protect biodiversity? Is it possible to conserve our plants? The answer is yes, simple fencing methods can do the job. This has been proved in almost all range land reserves as well as in reserve of natural conservation, in Jordan. The vegetation cover and the species number increase greatly using just simple method (Al-Eisawi & Hatough, 1987).

Arab world natural reserves: The same observation was recorded in Bahrain, where the rainfall is almost 70 mm/year. Yet simple fenced areas are very well protected. This was observed in terms of species cover and species richness. In Saudi Arabia the north western desert reserves and others have proved be in excellent conditions under just simple fencing and protection from grazing for few years (Al-Rowali, 2003). In Arab tradition, the past have protected the land in a system called *Hima*, means protected land were they used to graze animals in a sequential system of every other or every two to three years (Al-Eisawi & Hatough, 1987; Al-Rowali, 2003).

Desert plants adaptation: Most of the Arab World is characterized by dry and arid ecosystems. Yet such systems are very rich in plant and animal biodiversity that have acclimatized through thousands of years. To understand such adaptation and survival tactics, it is logical to subgroup the plants into following categories.

Mangrove plants: Mangrove plants grow almost around the sea water in most of Arabia in the regions of the Red Sea and the Arabia Gulf region. Most of the mangrove plants are represented by the species *Avicennia marina*. However, very few natural populations are still present in some countries such as Saudi Arabia, Oman, United Arab Emirates, Bahrain. Some of these natural populations have been entirely lost in some countries such as the Gulf of Aqaba, Jordan, Qatar. Active projects to conserve mangrove plants are carried out in Oman, Saudi Arabia, United Arab Emirates and may be others countries. The importance of such plants is the most in host dry conditions. Such plants form unique sea shore vegetation ecosystem associated by a highly complex interrelation between plant associations, root systems, various vertebrate and in vertebrate marine species and birds. It has been demonstrated that the mangrove ecosystem is critically important for the major sea shore species specially crustaceans and the various species of shrimps. It is highly important to protect such plants and even to increase their population as much as possible (Al-Eisawi, 2001).

Sand dune fixatives: Most Arab countries especially, in Arabia and some in North Africa the movement of sand dunes and the pollution of the atmosphere with the fine soil particles that cause often poor visibility, serious accidents and serious allergy and respiratory tracks diseases.

However, there is a good number of sand growing species in most countries of the Arab Word such as, *Haloxylon persicum, Calligonum cummosum, Hammada scopira, Salsola drummondii, Zygophyllum qatarense, Suaeda vermiculata* and many others. Such sand fixatives are highly precious genetic resources that should be protected and efficiently utilized to reclaim sand dunes and to reduce swiftting soil masses.

Arabian desert summer plants (desert succulents): Most plants use clod rainy season as adaptation mechanism for their growth and seed production to complete their life cycles. In the desert some herbal plants grow which live very short and complete their cycles in few weeks known as ephemerals. However, a huge group of desert succulent plants differ from the Arizona Desert succulents of cactus plants. The desert plants of Arabia are totally different succulent plants mostly, belonging to the family Chenopodiaceae, Asclepiadaceae, Zygophyllaceae, Compositae or others. Such plants grow and thrive in the heat of the summer time and produce their seeds at the beginning of the rainy season. Such plant behavior is rather different in Jordan. This plant adaptation can be successfully used for the conservation of the dry ecosystems, especially the plants useful for human and animals.

Saline plants: Dry ecosystem has often saline vegetation including unique halophytic plants, which are able to grow in dry and salt conditions. Some of these species are edible, while others are medicinal or oil producing plants, or herbs excellent for grazing various types of herbivores. In addition, these plants are important CO_2 fixators that can reduce global warming. They fix CO_2 in the biomass above and underground the soil. Such plants have adapted such habitats and accordingly developed genetic make up. Dry and desert ecosystem plants are very common in the Arab countries. Hawar Islands in Kingdom of Bahrain, have the most beautiful and natural saline vegetations that spreads in the costal zones (Al-Eisawi, 2004).

Survival technology of wild species: The previously mentioned plant groups that are adapted to grow and survive naturally in the most hostile dry and saline conditions should be very well studies. There are various studies to understand the physiology and the genetics of dry and saline plants all over the world, but very few or limited studies have been conducted on the wild natural plants of the dry and saline plants of the Arab World. Therefore, extensive studies are needed to inventory plants species, their specific physiology, genetics and adaptation. How did such plant have adapted to survive the harsh conditions, can we identify some of genes to utilize them in producing crops that can tolerate similar dry or saline conditions. Such research methods can focus on some of the following problems:

1. Seed germination technology
2. Fixation of nitrogen
3. Drought resistant mechanism and its genetic basis
4. Saline plant resistant mechanisms and its genetics basis

Shifting life cycle: Lots of desert bulbous and geophytes have shifted their life cycles and changed their flowing and vegetative growth periods. Species such as *Urginea maritime*, *Pancratium* spp., *Colchicum* spp., *Crocus* spp., *Biarum* spp., *Dipcadi* spp., and others are very good example. All such species flower in the hot summer in the desert such as Wadi (Valley) Arab in Jordan during the months of September to November. These plants produce their seeds just before the rainfall season to maximize the chance of seed germination. They use the spring season in vegetative growth and maximizing the food storage in their bulbs or corm to be ready for flowering in the due time. It would be very important to understand the flowering and vegetation mechanisms of such plants to understand the life cycle and the phenology behavior of these plants.

Land use application: Most of the countries either lack regulation to control land use or the rules are not effective or even not applied at all. Land use is one of the most important factors that can conserve limited resources, biodiversity and specific populations of key species of restricted distribution. Therefore, the important of implementation of land use regulation will be the key issue to insure the following actions:

1. Restriction of natural forest destruction
2. Planning of housing areas
3. Planning of rural expansion
4. Expansions of reforestation
5. Restriction of cultivated areas at the expense of natural habitats
6. Restriction to quarries locations
7. Remediation of mining places

Gardening the earth: The final issue of conserving biodiversity and reducing the climate change and thus loss of biodiversity is combating and reversing the negative action of climate change on green cover of our planet (Blackmoore, 2009). Therefore, intensive cultivation of forests, trees, shrubs and green cover in general should take place immediately all over and wherever possible in order to try to replace the huge loss of the green cover. Cutting forest trees should halt for few decades if possible and the concentration on cultivation should go parallel to that. If each person grow a tree yearly for few decades then billions of trees are added to nature, which in turn will improve the rain shade, restructure the ecosystem and reduce enormously the CO_2 concentration in the atmosphere and thus reduce the green house effect and the global warming.

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