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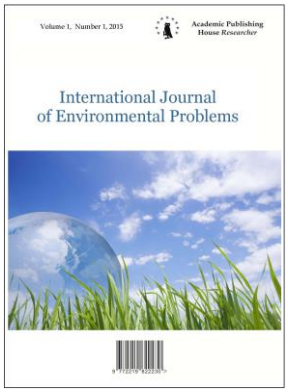

Articles

Homegardening as an Option in War-Affected Syria: A Mini Review of Homegardening and Its Potential to Promote Sustainability

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Abstract

The war and the economic sanctions imposed on Syria have resulted in economic hardship. In this context, the review on homegardens of this study provides an insight of the potential role that homegardens can play to reduce the economic burdens, improve environmental quality and cope with sustainable development objectives. The review highlights the serious lack of data on homegardens in Syria and emphasizes the need to conduct extensive research on Syrian homegardening and its optimization. The benefits of homegardening mentioned in this review present some real reasons for promoting homegardening wherever feasible in the country.

Keywords: Syria, war, homegardening, agroforestry, sustainable development, food security.

1. Introduction

Homegardens are agroforestry systems, shrub and herbaceous species are usually associated with livestock and managed deliberately by household labour (Fernandes, Nair, 1986). Many researchers studied homegardens, each for different goals and from different angles, and that is why there are many definitions of homegardens. However, typically, these systems are established in close proximity to households and have well-defined boundaries (Hoogerbrugge, Fresco, 1993). Having anciently evolved as a result of gradual cropping intensification in correspondence to the increased human pressure and reduced cultivable lands, homegardening is believed to be the oldest land use practice second only to shifting cultivation (Kumar, Nair, 2004). Most of the homegardens in the world are in Asia (Hoogerbrugge, Fresco, 1993), and for centuries, they have changed the life of millions of people by providing means for subsistence and sometimes means for prosperity (Nair, 2001). Torquebiau (1992) noted that homegardens have the potential to combine the main elements of sustainability i.e. production and conservation. War and economic sanctions have significant impacts on the three pillars of balanced sustainability: economic, environmental, and social. UN Mission (2013) reported that Syrian agricultural sector is subjected to massive destruction and huge losses in different arenas because of the war and the sanctions imposed on the country. According to the report, it is hard for the Syrian people to cope with the dramatic devastation of irrigation system and other agricultural infrastructure that severely affected the

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production of major Syrian crops and livestock. Hence, the intention of the present review is to derive a possible common conception from literature regarding the implications of adopting homegardening strategy in Syria on both the economic and ecological dimensions of sustainability.

2. Discussion

Homegardening: Ecological Dimension

Biological storage of carbon is an ecosystem service that has an important role in climate change mitigation policies (Davies et al., 2011). Intensive agricultural practices have provided more food but at a cost of many ecosystem services including CO_2 sequestration (Tilman et al., 2002). Modern agriculture was found to be contributing to the elevation of the atmospheric CO_2 concentration through reducing carbon inputs and increasing carbon losses from the soil (Paustian et al., 1997). Generally, agroforestry was found to have an important role in carbon sequestration because of its considerable potential in storing carbon in various tree species and soil (Montagnini, Nair, 2004). Mattsson et al. (2013) reported the storage of significant amount of carbon in above-ground biomass pool of homegardens. Substantial amount of carbon is stored in agroforestry systems as compared with other non-forest land use (Palm et al., 2000; Kirby, Potvin, 2007; Henry et al., 2009; Bdoor, 2018). Described as "oases of carbon" in a degraded karst landscape, homegarden land use was found to have the potential to store substantial amount of carbon per unit area in its above-ground biomass pool comparable to that of a disturbed forest (Bdoor, 2018). Besides their direct contribution as potential carbon sinks, agroforestry systems can enhance carbon sequestration by lessening the pressure on forests. In any case, the way the agroforestry systems are managed determines their capacity as carbon sinks (Montagnini, Nair, 2004). Different agricultural practices such as cropping of annuals, growing perennials, or animal farming lead to significantly different carbon sequestration (Dale, Polasky, 2007). Carbon stocks can be increased significantly by shifting from lower-biomass land use systems (e.g., permanent shrub lands, agricultural fallows and grasslands) to tree-based systems (Roshetko et al., 2007). Moreover, it is believed that perennialization generally leads to wider range of goods and services (Asbjornsen et al., 2013). In addition to their potential in climate change mitigation, homegardens can promote climate resilience at the local level; for example, through strengthen farmer seed systems (Sthapit et al., 2010). Agroforestry systems are looked at as an option that combines both climate change adaptation and mitigation (Murthy et al., 2013). Besides increasing carbon stock, agroforestry also have the potential to reduce soil erosion (Tilman et al., 2002). Murthy et al. (2013) pointed out some of the other environmental benefits of agroforestry to be: improved soil fertility; reduced insect pests and associated diseases; moderated microclimates; better utilization of solar energy; and enhanced biodiversity.

Homegardens are microenvironments possess genetic, agronomic, and cultural diversities (Watson, Eyzaguirre, 2002). Homegardens can be the sources of great diversity of food and medical plants (Chambers, Momsen, 2007). Kumar and Nair (2006) argued that homegarden agrobiodiversity is generally a result of socio-economic and ecological factors and farmers' choice, which is usually based on expected services. Homegarden land use has the potential to conserve plant diversity (Gajaseni, Gajaseni, 1999; Wezel, Bender, 2003; Kehlenbeck, 2007), even on a degraded landscape (Bdoor, 2017).

Homegardening: Economic Dimension

Production of food is believed to be the main function of most of the homegardens (Nair, 2004). Homegardens are traditional land use of marginal input (Hoogerbrugge, Fresco, 1993) that has the potential to improve food security (Talukder et al., 2000; Chadha, Oluoch, 2003; Yiridoe, Anchirinah, 2005; Bdoor, 2017). Homegardening supply households with diverse fresh foods that improve nutrients available to the family on both quantity and quality levels (Marsh, 1998). Imbruce (2007) considered homegardening to be a sort of "alternative agriculture" that has strong connections with conventional agriculture. The traditional knowledge accumulated through homegardening makes homegardens perform like reliable test labs for selecting better performance species (Watson, Eyzaguirre, 2002; Alhamidi et al., 2003). Despite the fact that conventional agriculture provides more profits with higher returns per unit of monetary or energy input as compared to traditional agroforestry, it does not match the latter regarding sustainability and compatibility with environment (Nautiyal et al., 1998). The composition and structure of

homegardens help in reducing resource deterioration that is usually one of the side effects of conventional agriculture (Nair, 2004).

Maikhuri and Ramakrishnan (1990) studied homegarden system in a village in northeast India and found the system to be highly efficient in energy and economic terms. Moreover, homegarden system was considered to be an important land use especially in areas where shifting cultivation is widely practiced, as homegardens can provide an alternative income and therefore reduce the dependence on shifting cultivation (Ramakrishnan et al., 1992). For many households, savings in food and medical expenses along with income derived from sale of surplus plant and animal products make up a substantial share of total income (Marsh, 1998).

Homegarden land use is a time-tested system (Nair, 2001) that can positively contribute to sustainable livelihood as it improves food quality, and enhance social, political, and financial status (Mitchell, Hanstad, 2004). Marsh (1998) listed the potential economic benefits of homegardening to be: Higher returns to land and labour as compared to field agriculture; source of income and fresh food; source of fodder, fuel-wood and hand-crafted items; year-round food availability and additional income through processing plant produce; the easy engagement of the income-poor in the activity; and strengthening women by providing a source of independent income. Homegardening has the potential to meet many of farmers' needs without imposing negative consequences on the resource base. In fact, it is likely to have positive impact on the resources besides improving various ecological, economic and social conditions (Torquebiau, 1992) and therefore promote sustainable livelihood.

Homegardening: The Case of Syria

Syria is located in southwest Asia, on the eastern coast of the Mediterranean Sea, and hence the country has a Mediterranean influenced climate. The area of the country is about 185,180 km^2. Farming and cattle breeding appeared for the first time in the world in Syria where it was the Centre of the Neolithic culture (Jaghayef et al., 2016). There is, accordingly, no wonder that agriculture sector in Syria is of special status. The sector is considered as one of the primary driving forces of the Syrian economy (Ali, 2010).

The multiyear drought (2006-2011) in Syria caused food insecurity for more than one million people and increased unemployment (Gleick, 2014). Following the drought disaster, a catastrophic war was erupted in Syria. Besides resulting in unprecedented humanitarian situation, the war is reversing Syria's development progress and leading to a development challenge that is the largest of our time (UNDP, 2015). It gets worse. The sanctions imposed on Syria by part of the international community have further weakened food and agriculture sectors. For instance, the sanctions are hampering the importation of the animal feed and veterinary drugs, and therefore compromising the survival of the Syrian livestock (UN Mission, 2013). Actually, the sanctions have undeniable effect on all aspects of Syrian economic performance and on the livelihoods of the Syrian poor in particular (Nasser et al., 2013). Sanctions, severe economic recession, greatly weakened national currency, rising prices for goods and services, and disrupted markets have contributed to exposing the Syrians to suffering (UNDP, 2016).

Syria has population amounting to 20 million people, about 6 million of which are food insecure and in need of food assistance (FAO, 2018). Pregnant and nursing women in Syria are at high risk of malnutrition because of the hike in food prices and limited accessibility to fresh food such as vegetables and dairy. A nutrition survey conducted in 2015 and 2016 showed that anaemia is widespread among both children under the age of five and women with a prevalence of 25.9 % and 24.5 % respectively (Kern, 2017). In order to treat malnutrition in Syria, community-based management programmes is found to be very critical (Tull, 2017). Homegardens can greatly enhance both food security and health status of households in developing countries (Yiridoe, Anchirinah, 2005). Actually, homegardening might be one of the "last frontiers" in the battle against hunger and malnutrition (Ninez, 1985).

The relationship between women and homegardening is well established. Women were found to play principal role in maintaining homegardens in different countries around the world (Marsh, 1998; Talukder et al., 2000; Finerman, Sackett, 2003; Vogl, Vogl-Lukasser, 2003; Mitchell, Hanstad, 2004; Ibnouf, 2009), including Syria (Galié, 2013). Syrian women are participating in agricultural activities and their role was increasing before the crisis. FAO (2011) noted that in Syria, female share of economically active population in agriculture increased from 31.7 % in 1980 to

60.7 % in 2010. Hence, even with the relatively high number of Syrian men involved in military activities, the success of homegardening programmes, those may rely heavily on women labour, is still anticipated.

Boyd et al. (2007) noted that small-scale CDM A/R (Clean Development Mechanism, Afforestation and Reforestation) projects such as agroforestry can enhance the livelihood among the low income rural communities. Considering that about 46 % of the Syrian population lives in rural areas (UN Mission, 2013), Syrian homegardening projects would be beneficial. In addition, homegardening is not only suited for rural areas, Sanyal (1985) described homegardening in urban areas with limited financial resources as an innovative response by the urban poor. In Zaire, a result of the civil and economic crisis during the last two decades of the twentieth century was the expansion of urban farming. It was found that during times of economic and political crises, private vacant or abandoned land in Africa was converted to a sort of farming systems (Smit et al., 2001).

Even if the economic sanctions lifted and the war ended now, the humanitarian crisis in Syria would remain for quite some time. There is some evidence that the multi-year drought that started in the mid-2000s in Syria is an indicator of expected climatic changes for the area (Gleick, 2014). According to all scientific projections, the Mediterranean is among the regions of the world where temperature will keep rising and rainfall diminishing throughout the coming decades (IPCC, 2013). The current situation in Syria is characterized with high levels of food insecurity (Tull, 2017) and undermined resilience capacities of households (UNOCHA, 2016; Calvet-Mir et al., 2012) noted that besides promoting food security, homegardens can enhance community resilience to environmental conditions.

Investing in sustainable solutions is the option that can enhance stability in Syria (UNDP, 2015). Homegardens that are well adapted to local circumstances represent a sustainable strategy that the unfortunate can enter without difficulty (Marsh, 1998). However, since the income-poor tend to have poor homegardens (Seeth et al., 1998), assisting them in establishing and optimizing their homegardens is needed. Successful homegardening projects can be found around the globe. Bangladesh homegardening programme resulted in providing micronutrient-rich foods to the households (Talukder et al., 2000). Omohundro (1985) described homegardening in the North Atlantic to be a survival strategies and recommended that governments should promote homegardening. As one of the options to enhance food security for the poor, (Marsh, 1998) noted that homegardening should be part of national strategy of food security. Understanding the traditional gardening system is critical in the success of homegardening projects (Chakraborty, Basu, 2018). In projects that promote homegardening it is very important not to replace the plants used by the people by marketable plants and to maintain homegarden diversity which would provide food security (Soekartadiredja, Ramlan, 2015). In addition, involving the poor in deciding how to optimize homegardens is fundamental for the success of a homegardening strategy (Mitchell, Hanstad, 2004). In 2016, the Syria Ministry of Agriculture and Agrarian Reform launched a pilot project to support family farming in selected households in some villages of five Syrian governorates. The outcome of the project has not yet been concluded. Although homegarden land use can offer multiple services, Syrian homegarden land use was neglected in agronomic and economic research. Only few studies were conducted on Syrian homegardens. Kywan (2016) compiled a checklist of Syria's cultivated plants and reported that many of the medical plants were cultivated in homegardens and used mainly for preparing traditional medicines in poor areas. Kywan (2016) noted that homegarden is an important location in Syria for conserving plant genetic resources particularly species that are neglected from research or economically under-utilized. For a countryside near Damascus, Alhamidi et al. (2003) explored the links between farmers' non-materialistic culture on the sustainability of their traditional farming systems/gardens and found that religion played a role in determining some of the tree species. Alhamidi et al. (2003) noted that farmers were engaged in diverse crop production to overcome the consequences of possible low prices on one or more types of their crops. No economic and agro-ecological studies were found at the scale of Syrian homegardens. The lake of comprehensive data on homegardens in Syria was not surprising, Vogl and Vogl-Lukasser (2003) highlighted similar lack in non-tropical climates. Comprehensive study of the indigenous agroecosystems which are highly site-specific systems is very important for insuring sustainable development (Chandra et al., 2011). The ecological benefits and other ecosystem values provided by homegardens necessitate conducting scientific researches on their potentials and optimization (Nair, 2001).

3. Conclusion

This review illustrates that homegardening can provide several economic and agro-ecological services that contribute to sustainable livelihoods, making homegardening especially relevant to a war-affected country such as Syria. Homegardening contributes to household food and nutritional security and can be an important part of the national food security strategy. Probing literature about Syrian agroforestry revealed that although homegarden land use constitute a part of the Syrian agricultural setup, it has been neglected in the economic and agro-ecological research. Qualitative and quantitative studies on the present status of Syrian homegardens, their optimization, and the costs and benefits of adopting homegardening strategy would be important.

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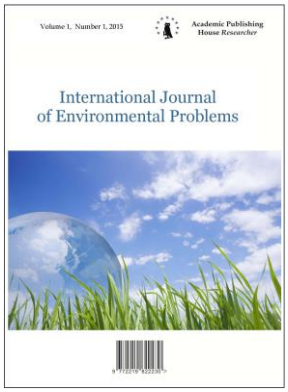

Global Warming Impact on Ecosystems

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Abstract

Climate is an important environmental influence on ecosystems. The impact of climate change on a particular species can ripple through a food web and affect a wide range of other organisms. Climate change and shifts in ecological conditions could support the spread of pathogens, parasites, and diseases, with potentially serious effects on human health, agriculture. Climate change, along with habitat destruction and pollution, is one of the important stressors that can contribute to species extinction. For many species, the climate where they live or spend part of the year influences key stages of their annual life cycle, such as migration, blooming, and reproduction. Boreal forests are invading tundra, reducing habitat for the many unique species that depend on the tundra ecosystem. It has been established that the most vulnerable system is the Black Sea coastline, which has a strategic importance for the rehabilitation of the country's economy and development of foreign trade.

Keywords: global warming, ecosystems, climate resources, population, habitat, food.

1. Introduction

Climate change affects the living world, including people, through changes in ecosystems, biodiversity, and ecosystem services. Ecosystems entail all the living things in a particular area as well as the non-living things with which they interact, such as air, soil, water, and sunlight. Biodiversity refers to the variety of life, including the number of species, life forms, genetic types, and habitats and biomes (which are characteristic groupings of plant and animal species found in a particular climate). Biodiversity and ecosystems produce a rich array of benefits that people depend on, including fisheries, drinking water, fertile soils for growing crops, climate regulation, inspiration, and aesthetic and cultural values. These benefits are called "ecosystem services" – some of which, like food, are more easily quantified than others, such as climate regulation or cultural values. Changes in many such services are often not obvious to those who depend on them.

2. Materials and methods

The study used materials from the meteorological database of the Institute of Hydrometeorology of the Georgian Technical University and published data (Berdzenishvili, 2012, 2018, 2020). Cartographic and statistical methods for processing observations were used.

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3. Discussion and results

Ecosystem services contribute to jobs, economic growth, health, and human well-being. Although we interact with ecosystems and ecosystem services every day, their linkage to climate change can be elusive because they are influenced by so many additional entangled factors. Ecosystem perturbations driven by climate change have direct human impacts, including reduced water supply and quality, the loss of iconic species and landscapes, distorted rhythms of nature, and the potential for extreme events to overwhelm the regulating services of ecosystems. Even with these well-documented ecosystem impacts, it is often difficult to quantify human vulnerability that results from shifts in ecosystem processes and services. For example, although it is more straightforward to predict how precipitation will change water flow, it is much harder to pinpoint which farms, cities, and habitats will be at risk of running out of water, and even more difficult to say how people will be affected by the loss of a favorite fishing spot or a wildflower that no longer blooms in the region. A better understanding of how a range of ecosystem responses affects people – from altered water flows to the loss of wildflowers – will help to inform the management of ecosystems in a way that promotes resilience to climate change.

The impact of climate change on a particular species can ripple through a food web and affect a wide range of other organisms. For example, the figure below shows the complex nature of the food web for polar bears. Not only is the decline of sea ice impairing polar bear populations by reducing the extent of their primary habitat, it is also negatively impacting them via food web effects. Declines in the duration and extent of sea ice in the Arctic leads to declines in the abundance of ice algae, which thrive in nutrient-rich pockets in the ice. These algae are eaten by zooplankton, which are in turn eaten by Arctic cod, an important food source for many marine mammals, including seals. Seals are eaten by polar bears. Hence, declines in ice algae can contribute to declines in polar bear populations (CCSP, 2008).

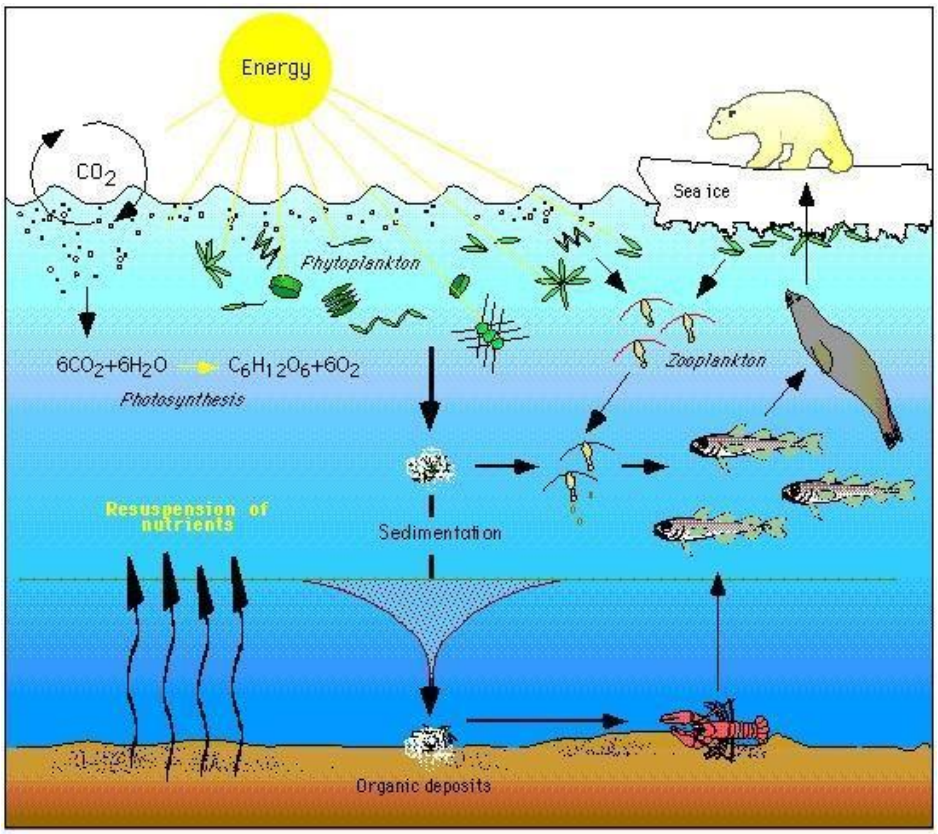

Fig. 1. The Arctic food web is complex. The loss of sea ice can ultimately affect the entire food web, from algae and plankton to fish to mammals. Source: NOAA (2011)

Climate change and shifts in ecological conditions could support the spread of pathogens, parasites, and diseases, with potentially serious effects on human health, agriculture, and fisheries.

For example, the oyster parasite, Perkinsus marinus, is capable of causing large oyster die-offs. This parasite has extended its range northward from Chesapeake Bay to Maine, a 310-mile expansion tied to above-average winter temperatures. For more information about climate change impacts on agriculture, visit the Health Impacts page.

Climate is an important environmental influence on ecosystems. Changing climate affects ecosystems in a variety of ways. For instance, warming may force species to migrate to higher latitudes or higher elevations where temperatures are more conducive to their survival. Similarly, as sea level rises, saltwater intrusion into a freshwater system may force some key species to relocate or die, thus removing predators or prey that are critical in the existing food chain.

Climate change not only affects ecosystems and species directly, it also interacts with other human stressors such as development. Although some stressors cause only minor impacts when acting alone, their cumulative impact may lead to dramatic ecological changes (Settele et al., 2014). For instance, climate change may exacerbate the stress that land development places on fragile coastal areas. Additionally, recently logged forested areas may become vulnerable to erosion if climate change leads to increases in heavy rain storms.

For many species, the climate where they live or spend part of the year influences key stages of their annual life cycle, such as migration, blooming, and reproduction. As winters have become shorter and milder, the timing of these events has changed in some parts of the country:

1. Earlier springs have led to earlier nesting for 28 migratory bird species on the East Coast of the United States (Settele et al., 2014);
2. Northeastern birds that winter in the southern United States are returning north in the spring 13 days earlier than they did in a century ago (CCSP, 2008);
3. In a California study, 16 out of 23 butterfly species shifted their migration timing and arrived earlier (CCSP, 2008);
4. Because species differ in their ability to adjust, asynchronies can develop, increasing species and ecosystem vulnerability. These asynchronies can include mismatches in the timing of migration, breeding, pest avoidance, and food availability. Growth and survival are reduced when migrants arrive at a location before or after food sources are present (CCSP, 2008; Horton et al., 2014).

As temperatures increase, the habitat ranges of many North American species are moving north and to higher elevations. In recent decades, in both land and aquatic environments, plants and animals have moved to higher elevations at a median rate of 36 feet (0.011 kilometers) per decade, and to higher latitudes at a median rate of 10.5 miles (16.9 kilometers) per decade. While this means a range expansion for some species, for others it means movement into less hospitable habitat, increased competition, or range reduction, with some species having nowhere to go because they are already at the top of a mountain or at the northern limit of land suitable for their habitat (Groffman et al., 2014; USGCRP, 2009).These factors lead to local extinctions of both plants and animals in some areas. As a result, the ranges of vegetative biomes are projected to change across 5-20 % of the land in the United States by 2100 (Groffman et al., 2014).

For example, boreal forests are invading tundra, reducing habitat for the many unique species that depend on the tundra ecosystem, such as caribou, arctic foxes, and snowy owls. Other observed changes in the United States include a shift in the temperate broadleaf/conifer forest boundary in the Green Mountains of Vermont; a shift in the shrubland/conifer forest boundary in New Mexico; and an upward elevation shift of the temperate mixed/conifer forest boundary in Southern California.

As rivers and streams warm, warm water fish are expanding into areas previously inhabited by cold water species (USGCRP, 2009). As waters warm, coldwater fish, including many highly-valued trout and salmon species, are losing their habitat, with projections of 47 % habitat loss by 2080 (Groffman et al., 2014). In certain regions in the western United States, losses of western trout populations may exceed 60 percent, while in other regions, losses of bull trout may reach about 90 percent (USGCRP, 2009). Range shifts disturb the current state of the ecosystem and can limit opportunities for fishing and hunting. See the Agriculture and Food Supply Impacts page for information about how habitats of marine species have shifted northward as waters have warmed.

Climate change, along with habitat destruction and pollution, is one of the important stressors that can contribute to species extinction. The IPCC estimates that 20-30 % of the plant and animal species evaluated so far in climate change studies are at risk of extinction if

temperatures reach the levels projected to occur by the end of this century (Settele et al., 2014). Global rates of species extinctions are likely to approach or exceed the upper limit of observed natural rates of extinction in the fossil record (Settele et al., 2014). Examples of species that are particularly climate sensitive and could be at risk of significant losses include animals that are adapted to mountain environments, such as the pika; animals that are dependent on sea ice habitats, such as ringed seals and polar bears; and coldwater fish, such as salmon in the Pacific Northwest (Groffman et al., 2014; USGCRP, 2009).

As a result of activities, conducted within the first National Communication, the systems most vulnerable to climate change in Georgia have been identified. It has been established that the most vulnerable system is the Black Sea coastline, which has a strategic importance for the rehabilitation of the country's economy and development of foreign trade. The second important vulnerable system in Georgia is agriculture, where special attention is paid to wheat in Eastern Georgia. Also, in spite of a sufficient supply of water resources, appropriate attention is being paid increase the efficiency of water utilization.

Georgia occupies the southeastern part of Europe, to the South of the watershed of Great Caucasian Range, in Transcaucasia, lying between the Black and Caspian Seas. Total area of the country is 69,700 km 2, 46 % of which is located at the altitude of 0-1000 m a.s.l. The Likhi Range, crossing the country almost meridionally in the middle of territory, divides the country into 2 different regions that is reflected mainly in the climate.

Western Georgia is rich in rivers, the biggest of which are Rioni and Enguri. The biggest river in Eastern Georgia is Mtkvari with its several confluents flowing down from the Great Caucasus. There are tens of lakes in Georgia. The biggest of them is Paravani with the area of its water plane of 37.5 km 2. Over 20 regulating water reservoirs are constructed on a number of rivers. Swamps occupy approximately 600 km 2 of the country's territory, and glaciers occupy the area of 511 km 2.

3. Conclusion

Almost all types of climate are presented over Georgian territory except savanna and tropical forests. The Black Sea coastal zone has humid subtropical climate. Mean annual temperature here is 14-15 0C and annual precipitation sums range from 1500 to 2500 mm. On the Plains of Eastern Georgia the climate is dry-subtropical with average annual temperatures in the range of 11-13 0 C and annual precipitation sums between 400-600 mm. In mountainous areas this value reaches 800-1200 mm.

In the cold period of the year stable snow cover does not form in both regions of Georgia up to the altitude of 400 m a.s.l. Duration of bright sunshine over the most part of the country's territory ranges from 1900 to 2200 hours. Warming period with 10 0C threshold value on the plains comprises 120-160 days, while in a mountainous zone it reaches 220-320 days.

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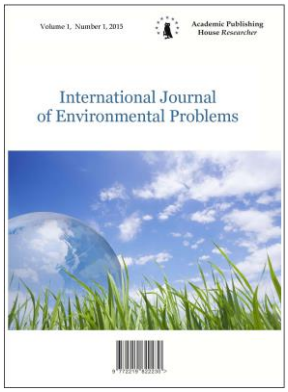

The Impact of Natural and Anthropogenic Factors on Biodiversity of Arid and Semi-Arid Zones of Eastern Georgia

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Abstract

The biodiversity of Georgia, as well as the whole Caucasus, is under the extreme threat. Most of the forests are modified by human influence. Due to overgrazing, the natural vegetation is almost destroyed and the erosion process is taking place. Natural vegetation is preserved in just a little part of its historic area. Current threats to Georgia's biodiversity are: poaching, cutting down the forests, overgrazing, illegal trading of species of plants and animals, and etc. As a result, the living habitat of living organisms is degraded, the number of species is decreased and ecological processes are disruption – all of them lead to the destruction of biodiversity.

Natural and anthropogenic factors are well expressed on large areas of the ecosystem of arid and semi-arid areas in the east of Georgia. A large part of arid and semi-arid ecosystems itself is rare biotope for Georgia, that is why some species are found only here in Georgia.

The negative impacts of natural and anthropogenic factors affect the flora and fauna diversity, resulting in a possible degradation of plant communities, semi-desert and desert plant characteristic species – Salsola spp, Artemisia fragans, Gamantus pilosus et al. and the expansion of the plant communities Artemisietum, Artemisieto-salsoletum, Botrichloeto-artemisietum. Also, the impoverishment of animal composition – disappearance of some insectivorous and rodents, for example, Crocidura leucodon, the vole Microtus socialis, Sorex volnuchini, the expansion of hares Alactaga spp, which is typical to a desert landscape.

The current level of negative impact of Natural and anthropogenic factors goes beyond the boundaries of the resistance of the ecosystem, and therefore, more or less irreversible degradation processes have been developed. All of this might cause irreparable harm to Georgia's biodiversity.

Keywords: biodiversity, arid and semi-arid ecosystems, natural and anthropogenic factors.

1. Introduction

Georgia is located in the Caucasus, on the boarder of Europe and Asia. Almost every type of the subtropical climate zone is developed here. Georgia, as eco-region of the Caucasus, is rich in endemic plant species and is involved in list of the planet's 34 most diverse and endangered hot spots.

The geographic location of Georgia caused its natural diversity. Peculiar natural characteristics of the region results in the existence of characteristic flora and fauna. There are different types of vegetation: the desert and semi-desert vegetation, arid light forests, steppes and deciduous forest elements. In addition, there are rocky xerophytes, riparian forests along the rivers

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and foothill bushes. Such diversity of vegetation within small areas is generally typical to the Caucasus region (Gvarishvili, 2013).

Caucasus' arid and semi-arid ecosystems are characterized by a dry climate, long and hot summers and mild and relatively short winters. The wettest period is short spring. The region's two main rivers are the Alazani, and the Iori. On both sides of the river Iori there are dry steppes, while on the banks of the Alazani there is moderately humid climate. The region is rich in endemic plants and endangered species.

2. Results and discussion

The natural and anthropogenic factors greatly influence biodiversity of arid and semi-arid areas. Natural factors include frequent aridity, during which, rate of precipitation is low, but air temperature is high, and therefore, moisture reserves in soil are declining, and unfavorable conditions for normal growth and development of the plant are created. Decrease of soil fertility in semi-desert areas of Georgia, are caused by salinization and solonetz processes. Salinization processes of the soil may be related to erosion processes of saline rocks, mineralized ground water, and some other factors. In addition, there is a contamination of the soil caused by the use of fertilizers (organic and mineral) and unsustainable use of pesticides in agriculture, heavy metals appearing in soil, as well as soil polluted by household and industrial waste, which causes serious damage to the ecosystem (Mchedluri, Vefxvadze, 2018).

The semi-arid zone of Eastern Georgia – from front slopes of Gombori range down to the Alazani-Iori mouth historically has been the winter pasture of Georgia. During the winters of the last decades, economic activity of the territory doubled. Negative impacts of sheep's extensive grazing causes the following: the impoverished, modified in many places and declined grass cover, a projective cover, effects of erosion and salinization of soil are observed. Almost disappeared Incense tree arid sparse forest fragments, riparian forests are oppressed, phyto-cenosis structural formation is violated, the vitality of plants is extremely weakened, and etc. The picture of soil erosion is catastrophic, which is reflected in the destruction of upper layers, increasing the content of minerals causing the soil salinity. In turn, it has great influence on the vegetation in these areas and in accordance with the output of the biomass. For these reasons there is the tendency whereabouts of the sheep towards the river bank. In "unbreakable" cenosis such as Botriochloeta soil cover is often degraded.

We should take special note of the negative impact of grazing during the spring, when the plant begins new vegetation. During this period, the sheep do not graze wormwood (Artemisia fragrans – desert and semi-desert type of vegetation dominant edificatory) and Bolriochloa ischaetum (steppe type of vegetation dominated edificatory) and fully feeds on the new green vegetation. The combined vegetation cover is mostly damaged, which have a special value for melioration of pasture, as well as for improvement of structural formation of vegetation. After the transfer of cattle to summer pasture, plants full annual life cycle can not go on. Both their vegetative and generative renewal is very limited and therefore, the phyto-cenosis are too poor and simple. The process is annually repeated, and finally begins irreversible process of vegetation digression (Mchedluri, 2020; Mchedluri, Vefxvadze, 2018a).

Grazing negatively affects the ornitofauna. It puts a particularly huge damage to ground nesting birds, such as e.g. Pheasant, because during their breeding period sheep is not yet withdrawn from the region, leading to the destruction of grass cover.

The small mammals survey showed that characteristic to the field species is rare – the vole, which indicates degradation of the study area, but there are a lot Ammodytidae colonies, which inhabit only in wormwood which in itself is an indicator of degradation.

The eastern part of the study area is full of elements semi-desert, indicators of which are hares (Allactaga williamsi, Allactaga elater). It is noteworthy that natural factors determining vulnerability become especially acute on the anthropogenic pressure background. The current level of the negative impact of human activities (sheep breeding, agriculture, excessive and unsystematic mining of natural resources, deforestation, wrong melioration, and etc.) go beyond the ecosystem resistance (self-capacity) limits, therefore, more or less irreversible process of degradation is developed: productivity of ecosystems and plant vitality is reduced, desertification processes are evident (the elements of desertification are observed in riparian forests), there has been soil erosion and salinization. Various components of the ecosystem, including species and individual

cenosis, vulnerability are the result of some particular anthropogenic factors or their combined activities. For example, riparian forest degradation is caused by cutting down the trees and grazing. The main reason for the vulnerability of many animal populations is poaching and the lack of food base. The influence of natural and anthropogenic factors is well expressed on fairly large areas of the ecosystem of the arid and semi-arid areas (Mchedluri, Vefxvadze, 2018).

A large part of the arid and semi-arid ecosystems itself is rare biotopes for Georgia (arid light forests, deserts and semi-desert elements), because of which some species are found only here in Georgia such as viper, francolin, striped hyena, gazelle. Among the spread insects 24 species were included in the Red Book, including: *Papilio machaon, P. alexanor orientalis. Inphichlides podalirius. Utethesia pulchera. Arctia caja. Coenonimpha saadi, and so forth* (The second National..., 2014–2022).

Other noteworthy vertebrate rare species from the Red Book include: *Pelobates syriacus, Eryx jaculus, Eumeces scheineri, Elaphe longissima, Haliaeetus albicilla, Aythya nycora, Perdix perdix, Mesocricetus brandti, Suncus etruscus, Nyctalus leisleri, Lutra lutra, Hyaena hyaena, Lynx lunx, Gazella subgutturosa, Cervus elaphus.*

Rare and endangered species of small mammals also include: *Sorex volnuchini. Crocidura leucodon. Allactaga elater. Cricetulus migratorius. Allactaga willamsi, and so forth.*

Some species of birds and small mammals are rare globally and are included in the World Conservation Union (IUCN) Red list. For example: *Phalacrocorax pygmeus – LR; Aegypius monach – LR; Haliaeetus albicilla – LR; Aquila heliaca – VU; Tetrax tetrax – LR; Aythya nyroca – VU; Rhinolophus ferrumequinum – LR. cd; Rhinolophus hipposideros – VU.A2c; Barbastella barbastellus – VU.A2c; Driomys nitedula – LR.nt, and so forth* (The second National..., 2014–2022).

Negative impact of natural and anthropogenic factors negatively affects the diversity of arid and semi-arid ecosystem that could lead to impoverishment of floristic composition of the vegetation, degradation of plant communities. The expansion of plant species characteristic to desert and semi-desert (Salsola spp, Artemisia fragans, Gamantus pilosus et al.) and plant communities (Artemisietum, Artemisieto-salsoletum, Botrichloeto-artemisietum) and others.

Also, the impoverishment of animal composition – disappearance of some insectivorous and rodents, for example, Crocidura leucodon, the vole (Microtus socialis), Sorex Volnuchini (Sorex volnuchini), existence of hares (Alactaga spp), which is typical to the desert landscape.

3. Conclusion

Particular part of Georgian territory is located within the arid and semi-arid zone. On the Caucasian background discussion of the Georgian landscapes shows that aridity is the least characteristic to our country. However, this does not mean that Georgia is not facing drought and aridity problems. On the background of global warming, favorable natural factors for aridity become more intense, resulting in the increase of natural aridity. This is evidenced by the frequency of droughts, which took place on the territory of the latter period.

Vulnerable to desertification regions in Georgia were determined Kakheti and Kvemo Kartli. The number of areas vulnerable to climate change and anthropogenic impacts is even higher.

Natural and anthropogenic factors on the biodiversity represent a serious problem. The main natural factors are: climatic, hydrological, morpho-dynamic, soil and others. Anthropogenic impacts on ecosystems regard overgrazing, reduction of forest areas, agriculture, urbanization and more.

Cutting down the forest, burning pasture, and overgrazing cause serious harm to the biological diversity and cause impoverishment of fauna. The forests lose function of the habitats of large mammals, which causes them to disappear, or migrate. Burning pasture has a very negative impact on the hilly pastures hillsides and on the density of bushes in the ravines, that is why they face their degradation and destruction. In turn it leads to increased evaporation of moisture from the soil, the disappearance of bushes and enhancement of desertification effect. Especially natural landscapes are dramatically changing as a result of burning pasture areas on the territory, where erosion caused by overgrazing is obviously expressed.

Cultivation of grasslands and riparian forests affects the natural landscape change. The territories which are covered with steppe plants become weedy; unique riparian forests are destructed and replaced with gardens. Most of the arable land in such areas is used today, which

excludes the possibility of restoring the natural grove here. The remaining abandoned places were degraded and weedy. As a result of cultivation of grove forests, their function of keeping away winds and bank protection is reduced, which contributes to desertification considering the climate change trend. Deforestation has a very negative impact on the biodiversity of arid and semi arid zone. In the second half of the last century, there were reports of various species of animals and birds in the river Alazani and Iori groves, which are virtually disappearing after the destruction of grove forests.

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