



RESEARCH PAPER

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The review of fire condition in Zagros forest and estimate carbon sequestration of plantation by endemic species in Northern Zagros forest (Marivan Region: West of Iran)

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Abstract

Fire, as a natural ecological disturbance factor in forest, this project located Jashniabad village in the Marivan region, Northern Zagros forest, and western Iranian state of Kurdistan. To this project visited the forest and interviewed to Forest communities detected the major forest destruction in the study area. To afforestation of burned area used the native species (*Quercus* spp., *Pistacia atlantica* Desf, *Amygdalus communis* L, *Cercis griffithii* Boiss, *Celtis tournefortii* Lam, *Romex* sp. and *Juglans regia* L.) Two estimate of Carbon sequestration in the project of plantation in the first year used the sampling the in the seven plantation species. Seedlings were collected and their weights were measured by scales (gr carefully). For estimate the carbon sequestration used this formula (Carbon sequestration (kg) = 1.63× weight (kg)). The results of this study showed that the main forest destruction element in the Marivan and Zagros are fire, grazing, farm operation in forest, fuel wood and timber, mining, semi-parasite plant and non-wood forest production, but fire is a major element of forest destruction in the marivan region. Results showed that the quantity Carbon sequestration this (1 hectare) in the first year in one hectare is 97.3 kg. Overall results showed that the fire are a major element for forest destruction in the Marivan region and plantation by native and endemic species are suitable methods for rehabilitation of burned forest area, and one hectare of plantation absorbed the near 100 kg of carbon from air and soil. Authors suggestion to use the plantation by native and endemic species for rehabilitation of burned forest in Marivan and others region from Zagros forest.

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Introduction

With due attention to climate conditions of Iran that 65% area includes arid and semi-arid and degradation rapid of north and west, because of degradation of natural resources will cause to degradation agricultural lands and human environmental (Dastmalchi, 1998, Zabihollahii *et al*, 2012, Haidari *et al*, 2012, Haidari *et al*, 2013a and Askari *et al*, 2013a). Forests cover about 12 million ha in Iran (Forest and Rangeland Organization, 2002; Haidari *et al*, 2013b, Haidari *et al*, 2013c), including 5 million ha in the mountainous Zagros region. The major element of Zagros forest destruction include: fire, grazing, farm operation in forest, fuel wood and timber, mining, semi-parasite plant and non-wood forest production (Jazirei and Ebrahimi Rastaghi, 2003, Haidari *et al*, 2013d, Haidari *et al*, 2013e, Bazyar *et al*, 2013a, Parma and Shataei, 2013). Increasing population, low level of development and high dependence of local communities on forests for their primary livelihood needs, are the main reasons of this destruction. The lack of regeneration in these forests is a major concern (Fattahi 1994, Jazirei and Ebrahimi Rastaghi, 2003, Bazyar *et al*, 2013b, Rezaei *et al*, 2013, Askari *et al*, 2013c, Haidari *et al*, 2012b, Haidari *et al*, 2012c).

Fire review in Iran and Zagros region

Recurrent fires have seen an enormous increase in frequency over the recent decades and they are the main disturbances to this ecosystem (Luis-Calabuig *et al*, 2000). Disturbances such as fire, windstorms, floods, and grazing play a role in the maintenance of species diversity that has become well recognized in ecological theory (Mackey and Currie, 2000). Effects of Fire on vegetation are usually the most obvious impacts of burning. Fire affects natural ecosystems by consuming plants, altering successional patterns, and changing vegetative resources such as timber, forage and wildlife habitats (DeBano *et al*, 1978). Burning alone can result in increased forb abundance (Wienk *et al*, 2004) grained abundance and under story species richness (Laughlin *et al*, 2004).

Many studies have been carried out on plant biodiversity indices in Iran and around the world. The Zagros where fire occurs in 300-400 ha annually (Anonymous, 2002).

Author proclaimed that fire increased herbal species cover in burned area but did not effect on biodiversity indices in temperate forest of northeast of Iran (Atrakchaiee, 2000).

The researcher studied effect of fire on herbal layer biodiversity in a temperate forest of northern Iran and results showed the biodiversity indices and coverage percent of shade tolerant species in unburned area were higher than burned area (Banj Shafiei *et al*, 2006).

The researcher investigated on the preliminary results of post fire re sprouting of manna oak (*Quercus brantii* Lindl.) in Zagros forests and results showed that post-fire re sprouting is positively related to the number of pre-fire sprouts and the fire intensity (Pourreza *et al*, 2009).

The researcher studied the effect of forest fire on diameter growth of beech (*Fagus orientalis* Lipsky) and hornbeam (*Carpinus betulus* L.) and results showed that the surface fire didn't effect on beech but hornbeam ring growth was increased significantly. The correlation within ring growth width and climatic data had been recognized before fire but there was no correlation with years after that. Thus, other factors excluding climate such as fire could be considered as the change reasons (Banj Shafiei *et al*, 2009).

The researcher studied the Fire influence on vegetation changes of Zagros mountainous rangelands and results showed that in burned sites density, cover percentage and forage production of perennial grasses significantly increased while, in contrast density and cover percentage of shrubs and annual grasses decreased. Percentage of bare soil increased in burned sites. The Species diversity reduced in initial years after burning but a gradual

increase was observed at the end of study period (Fattahi and Tahmasebi, 2010).

The researcher studied the effect of fire on some soil chemical properties of oak forests in Marivan region and results showed significant effects of fire on most chemical attributes of surface soil including: pH, available phosphorous, electrical conductivity and available potassium increasing. The fire caused increasing of total nitrogen and cation exchangeable capacity in surface soil. All of chemical properties of subsurface soil were measured higher in burned area than control however; these differences were not significant, statistically (Hemmatboland *et al*, 2010).

Most of soil physical, chemical, mineral and biological attributes are changed by forest fires. Fire is one of the most important factors of forests destruction in Marivan region and considerable area of the region are annually exposed to fire. Depend on environmental conditions and also fire intensity, different effects will impose on ecological conditions of the environment (Hemmatboland *et al*, 2010).

The researcher investigation the Ecological Factors Affecting Fire Spread in Forest Ecosystems and results of this study showed that vegetation and moisture in fuel materials are the main factors affecting fire spread in forest ecosystem (Biranvand *et al*, 2011).

In pine/oak forest USA, most post fire under story dominants were previously inconspicuous or absent from the wetter communities and these species increased significantly more than others (Plocher, 1999).

The burned plots in ponderosa pine/Douglas-fire forest had reduced species richness and cover of the under story in early years after fire, however after three years, richness increased to the level of the unburned plots. Simpson evenness increased in subsequent years (Metlen and Fiedler, 2005).

In another research that was conducted by sanghoon *et al* (1997) cited that richness and evenness indices were higher in burned area than unburned area on year after burning in mixed broad leaves oak forest. Also richness index in burned pine/oak forest was higher compare with control (Mehta *et al*, 1997).

These are mostly surface fire and effect mainly undergrowth and young trees. Despite such fires, there are unfortunately limited scientific studies or published papers about investigation of fire effects on temperate forests in Iran. In this study we evaluated the fire condition in Marivan region, Kurdistan province, Northern Zagros forest.

Carbon sequestration review in Iran and Zagros region

Carbon sequestration in planting new species, in view point of economics, is one of the practical ways to reduce CO₂ concentration in the atmosphere (Sheidai Karkaj *et al*, 2013).

Totally it could be said that the process of carbon sequestration is important for water and soil quality, fertility increment, Hydrology system of soil improvement and also preventing the erosion and wasting the nutrients. Therefore the forest ecosystem should be managed in order to increase the carbon sequestration potential (Varamesh *et al*, 2011).

The several study focused on the Carbon sequestration in the Iranian forest include:

The researcher assessment of carbon sequestration in soil layers of managed forest and results showed that there is significant difference between Deldareh and Tooskachal districts in term of the amount of carbon sequestration. Over 283 ton/ha carbon sequestration in Deldareh shows that this forest ecosystem is active. Compared to other districts, Deldareh with 312 m³/ha has the highest stocking volume. There is a direct relationship between volume per hectare and forest biomass, contributing more carbon storage (Mahmoudi Taleghani *et al*, 2007).

The researcher estimation of carbon sequestration in Astragalus rangelands of Markazi province and results showed that the total carbon sequestration per hectare was 32.95 ton and 87.43 % of total carbon sequestration was soil organic carbon. The results of biomass carbon distribution showed that the carbon content in aerial biomass was higher than underground biomass (Abdi *et al*, 2008).

The researcher studied the increment of soil carbon sequestration due to forestation and its relation with some physical and chemical factors of soil and results indicated that soil carbon sequestration of *R.Pseudoacacia* (78.19 mg/ha) was significantly ($p < 0.01$) more than *P.eldarica* (57 mg/ha) and barren land (10.8 mg/ha). Their economic values for mentioned species were computed 2.790 and 3.741 million dollar's respectively (Varamesh *et al*, 2011).

The researcher comparison of the soil carbon sequestration in hardwood and softwood monocultures and Results showed that the amount of soil carbon sequestration in Norway spruce stand (124.27 ton/ha) was significantly ($P < 0.05$) higher than Black pine (94.67 ton/ha), Common ash (87.58 ton/ha) and oak (78.11 ton/ha). Results of stepwise regression showed that nitrogen percentage and C/N ratio were the most important factors affecting soil organic carbon content (Varamesh *et al*, 2011).

The researcher studied the cost comparing of soil carbon sequestration in rangeland reclamation practices through plantation of *Agropyron elongatum* and *Atriplex lentiformis* and that reclamation of rangeland by *Atriplex lentiformis* and *Agropyron elongatum* have sequestered 21.974 and 12.872 ton carbon per hectare in soil respectively. The cost of sequestering carbon in soil of *Atriplex lentiformis* and *Agropyron elongatum* sites were 17,056,172 and 20,115,109 Rials respectively. Therefore *Atriplex lentiformis* is more suitable and low-cost species in reclamation of rangeland in view point of soil carbon sequestration and continuing reclamation of this region by planting *Atriplex*

lentiformis would contain low cost for sequestration carbon in soil (Sheidai Karkaj *et al*, 2013).

Forest ecosystems contain a large part of the carbon stored on land, in the form of both biomass and soil organic matter (SOM). The long-term fate of C in forest ecosystems depends on whether it is stored in living biomass or soils. Forest trees also control the major terrestrial bidirectional transfer of C between the atmosphere and the soil: forests take up large amounts of CO₂ from the atmosphere through photosynthesis, and return large amounts through respiration by vegetation and decomposers in the soil. Carbon stocks in soil exceed that in vegetation by c. 2:1 in northern temperate forests to over 5:1 in boreal forests (Dixon *et al*, 1994; Schlesinger, 1997). Thus changes in soil C stocks can be more important than changes in vegetation C stocks for forest C budgets (Medlyn *et al*, 2005). Increasing atmospheric carbon dioxide concentration [CO₂] with subsequent changing climate, increased nitrogen deposition, and changing land use have changed (and will change) the forest C stocks.

The aims of this study are an evaluation of fire condition in Northern Zagros forest, and estimate of carbon sequestration by plantation of endemic species in the Marivan Region in the first years.

Material and methods

Site description

This project was located in the Jashniabd village in Marivan region, Northern Zagros forest, and western Iranian state of Kurdistan (Figure 1). Mean annual precipitation is 909.5 mm, ranging from 590.8 to 1422.2 mm, Mean annual temperature is 13.3° C, and the length of dry season is 4 month (based on embrothermic curve) from June to August. Type of climate is sub humid with cold winters in the basis of Emberger's formula (Pourbabaei and Navgran, 2011). For this study, the Fire event occurred in 2010 where and selected the 1 hectare of Jashniabd village territory, plantation the endemic tree species by 700 N/ha density in the winter of 2012.

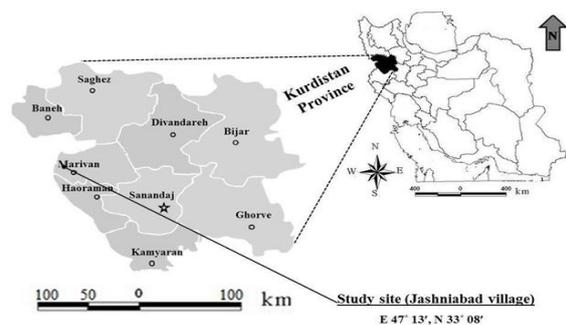


Fig. 1. Study site location in the Kurdistan Province, Zagros region, Western Iranian state of Iran.

Methods

To this project visited the forest and interviewed to Forest communities detected the major forest destruction in the study area. Studied the time and location frequent of forest in the Marivan region and detection the best method for rehabilitation of burned forest area. To afforestation of burned area used the native species (*Quercus* spp., *Pistacia atlantica* Desf, *Amygdalus communis* L, *Cercis griffithii* Boiss, *Celtis tournefortii* Lam, *Romex* sp. and *Juglans regia* L.) in the Marivan Region (Plantation of Nalli in the Jashniabad village territory) in the one hectare are.

Two estimate of Carbon sequestration in the project of plantation in the first year used the sampling the in the seven plantation species. Seedlings were collected and their weights were measured by scales (gr carefully). For estimate the Carbon sequestration used the below formula (Equation 1)

Carbon sequestration (kg) = $1.63 \times \text{weight (kg)}$.

Results

Forest destruction element in the Marivan region

The major element of Zagros forest destruction include: fire, grazing, farm operation in forest, fuel wood and timber, mining, semi-parasite plant and non-wood forest production Most of soil physical, chemical, mineral and biological attributes are changed by forest fires. Fire is one of the most important factors of forests destruction in Marivan region and considerable area of the region are annually exposed to fire. Depend on environmental conditions and also fire intensity, different effects will impose on ecological conditions of the environment (Hemmatboland *et al*, 2010).

Table 1. showed that the quantity Carbon sequestration of plantation by this species in the first year in one hectare is 97.3 kg.

No	species	Number of seedling	Average weight (kg)	Total weight (kg)	Carbon sequestration (kg)
					$\text{weight (kg)} \times 1.63$
1	<i>Quercus</i> spp.,	180	0.05	9	14/67
2	<i>Pistacia atlantica</i> Desf,	180	0.035	6.3	10/26
3	<i>Amygdalus communis</i> L	200	0.12	24	39/12
4	<i>Cercis griffithii</i> Boiss,	50	0.06	3	4/9
5	<i>Celtis tournefortii</i> Lam	20	0.05	1	1/63
6	<i>Romex</i> sp.	30	0.13	3.9	6/35
7	<i>Juglans regia</i> L	50	0.25	12.5	20/40
Total		700		59.7	97.3

The farm operation is the major elements of forest destruction in the Marivan region and distracted the vegetation and forest cover in the future. Waste burning in forest leads to deforestation and environmental pollution.

Plantation the major element for rehabilitation of destructed forest

Commonly, two terms are used relative to establishing plantations of forest trees. The term reforestation involves planting trees to replace those in areas that have been recently harvested. The other term used is afforestation, which involves planting trees on areas such as brush fields, grasslands, severely burned stands and forest stands where useful trees are not now present. Afforestation relates to a conversion of land from other uses to forest plantations (Zobe, 1997). Plantation forestry at a global or semi-global scale has been the subject of a number of recent reviews (Pandey, 1995).

This project (Climate change projects in the Zagros) supported by SGP and UNDP (IRA/SGP/OP5/STAR/CC/12/13/ (152) and plantation in the burned and area by used the native species (*Quercus* spp., *Pistacia atlantica* Desf, *Amygdalus communis* L, *Cercis griffithii* Boiss, *Celtis tournefortii* Lam, *Romex* sp. and *Juglans regia* L.) in the Marivan Region (Plantation of Nalli in the Jashniabad village territory) in the one hectare are.



Fig. 2. fire, grazing and farm operation condition in Zagros forest (Marivan region).



Fig. 3. fire condition in Zagros forest (Marivan region).

The most tree and shrub species used for plantation in the project area (Jashniabad village territory) are *Quercus* spp., *Pistacia atlantica* Desf, *Amygdalus communis* L, *Cercis griffithii* Boiss, *Celtis tournefortii* Lam, *Romex* sp. and *Juglans regia* L. For protection this plantation from livestock and human distract used the fence (figure 13).

Carbon sequestration in the Zagros climate change project (plantation by used the native tree and shrub species)

Emission of carbon dioxide via human activities is known as the main cause of global warming. Appropriate forest management practices can have effective role to mitigate carbon emission as well as adsorb atmospheric carbon (Varamesh *et al*, 2011).

Discussion

Disturbances such as fire, windstorms, floods, and grazing play a role in the maintenance of species diversity that has become well recognized in ecological theory (Huston 1994, Mackey and Currie 2000). Fires have negative impacts on native plant diversity, with varying effects on species and ecosystems, including the potential for localized extinction (Franklin *et al.*, 2005). Fire was historically a major influence on landscape patterns and species diversity in the forests (Delcourt and Delcourt, 1997). One of the serious threats to most of the Iranian ecosystems is drought, because much of Iran lies in the arid or semi-arid regions. The other threats for plants are: fire, overgrazing, fuel wood extraction, conversion of forest and other wild lands for agriculture, road construction, overexploitation, and

unscientific extraction of plant resources for medicine and food.



Fig. 4. farm operation condition in Zagros forest (Marivan region).

The results of this study showed that the main forest destruction element in the Marivan and Zagros are fire, grazing, farm operation in forest, fuel wood and timber, mining, semi-parasite plant and non-wood forest production, but fire is a major element of forest destruction in the marivan region. In the report of Marivan Natural Resources Office accrued the more 60 fire in the Marivan forest. Fire is one of the most important factors of forests destruction in Marivan region and considerable area of the region are annually exposed to fire. The afforestation involves planting trees on areas such as brush fields, grasslands, severely burned stands and forest stands where useful trees are not now present. This project showed that the fire have a negative effect on forest parameters and Hemmatboland *et al.* (2010) emphasis this results.



Fig. 5. Burning Trash in Zagros forest (Marivan region).



Fig. 6. the location of Climate change projects in the Jashniabad village (Marivan region).

For rehabilitation of burned forest used the plantation by native and endemic species are suitable methods. In the in Zagros climate change project used the *Quercus* spp., *Pistacia atlantica* Desf, *Amygdalus communis* L, *Cercis griffithii* Boiss, *Celtis tournefortii* Lam, *Romex* sp. and *Juglans regia* L. species for afforestation.

Results of first year of plantation showed that this species are suitable species for Marivan region and Northern Zagros forest.



Fig. 7. the view of the reforestation in Zagros climate change project.



Fig. 8. the view of the plantation by used the *Quercus* spp in Zagros climate change project

Emission of carbon dioxide via human activities is known as the main cause of global warming. Results

showed that the quantity Carbon sequestration of plantation by this species in the first year in one hectare is 97.3 kg (Table 1).



Fig. 9. the view of the plantation by used the *Pistacia atlantica* Desf in Zagros climate change project.



Fig. 10. the view of the plantation by used the *Amygdalus communis* L in Zagros climate change project.

Overall results showed that the fire are a major element for forest destruction in the Marivan region and plantation by native and endemic species are suitable methods for rehabilitation of burned forest area, and one hectare of plantation absorbed the near 100 kg of carbon from air and soil. This research emphasis the negative effect of fire on forest and Importance of Carbon sequestration by forest (Banj Shafiei *et al*, 2006, Pourreza *et al*, 2009, Fattahi and Tahmasebi, 2010, Hemmatboland *et al*, 2010, Sheidai Karkaj *et al*, 2013, Varamesh *et al*, 2011 and Abdi *et al*, 2008).



Fig. 11. the view of the plantation by used the *Romex* sp. in Zagros climate change project.

In the base of this project authors suggestion to use the plantation by native and endemic species for rehabilitation of burned forest in Marivan and others region from Zagros forest.



Fig. 12. the view of the plantation by used the *Juglans regia* L. in Zagros climate change project.



Fig. 13. the view fence used for protection of plantation in this project

Conclusion

Fire, as natural ecological disturbance factors in forest, and have negative effect on the qualities of forest and for this forest use the afforestation by native tree and shrub species in Marivan region.

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