Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

European Journal of Experimental Biology, 2013, 3(3):443-449

ISSN: 2248 –9215
CODEN (USA): EJEBAU

A study on carbon stoks and CO_2 uptake in natural pistachio-Amygdalus forest research in Fars, Iran

RoustaTouba[*1], Fallah Asghar[2], Amirnejad Hamid[2] and Bordbar S. Kazem[3]

[1]Young research Club, Arsanjan Branch, Islamic Azad University, Arsanja, Iran
[2]Sari Agricultural Sciences and Natural Resources University, Mazandaran, Iran
[2]Fars Agriculture and Natural Resources Researches Center, Iran

---

ABSTRACT

This study focused on estimatingof carbon sequestration and carbon stocksin the dry ecosystem of the Zagros Forest in Iran. The study was done on Pistachio atlantica, Amygdalus scoparia and soil in the Firouzabad Forest. Systematic_random sampling was done to determine numbers of Pistachioatlanticaand d.b.hwithina 2000 m^2 areaand on Amygdalus scoparia within a 1000 m^2area to determine classes for crown diameter. 30 plots of $1m^2$ were established under trees to calculate the organic carbon in leaf litter. Amount of C in these plants estimating by ash method and amounts of soil organic carbon were calculated using the Walky-Black method in the laboratory.The amount of carbon storage in soil and vegetation was 14.65 ton/ha. The amount of carbon sequestration in the total forest stand was 137329.1 ton. The economic value of C sequestration was \$418.46 (USD) and \$12.871 (USD) in each hectare for Pistachio atlantica and Amygdalus scoparia, respectively. The amount of C sequestration and its economic value in the soil was 12.78 t/ha and \$835.812 (USD) respectively. Thereforean increase of C sequestration ina dry ecosystem will be beneficial in both economic and environmental terms. Decision making for more efficient land use and conservation will be effective, on the economic value of forest service resources that are in existence and are free. This site was located in the semi-aridregion of Iran. Research on this arid site is pertinent because activities that cause C emissions are less thanother sites. So afforestation and reforestation is suitable and beneficial in these regions.

Keywords: Amygdalus scoparia,Carbon Storage, Firuzabad Forest, Fars, Iran, Pistachio atlantica

---

INTRODUCTION

Scientists have determined that global climate change is occurring as a result of increasing atmospheric concentrations of green house gases (GHGs).The most dominant GHG from human activities is carbon dioxide (CO2), both in terms of emissions and its potential to affect climate change [12]. Globally, agricultural activities and deforestation account for an estimated 31% of anthropogenic GHG emissions [10]; livestock production alone accounts for an estimated 18% [22]. Atmospheric CO2 levels are increasing at the rate of 0.4% per year and are predicted to double during the 21st century. Implications of this increase are complex and not yet well understood [7; 23]. Climate change may affect ecosystem productivity, allocation of aboveground versus belowground biomass and microbial populations[9]. Therefore Carbon sequestration should be understood as a part of many policy options in addressing global climate change.Carbon (C) storage in forest ecosystems involves numerous components including biomass C and soil C content. In an ecosystem a C stock is large and in a dynamic equilibrium with its environment. Because of the large areas involved, both regionally and globally, forest soil plays an important role in the global C cycle [6, 9]. Managing carbon stocks within a landscape is key for mitigation of atmospheric accumulation of GHGs and climate change. The cost of carbon dioxide absorption has been estimated at 0.12 \$ ton per hectare and was 2.94 $ for 25 years[21]. Carbon sequestration in the northern forests of Iran was estimated at 2.41 tons in each hectare per year therefore its economic value was 2427 US$ [3]. The rate of carbon sequestration in East Panama was 335 ton/ ha in a controlled forest; 145 ton/ha in traditional agroforestry and 46 ton/ha in pasture (Kirby & et al., 2007).Potential CO2-e above base line sequestration was determined for two forest sites on commercial eucalyptus plantations in northern Brazil (Bahia). Mean values were $8.16 (USD) and $7.19 (USD) for average and high site indexes, respectively. Results showed that carbon supply was more cost-efficient in highly productive sites [14]. Carbon sequestration in Bamu National Park, obtained 43 ton/ha and with a total value of $8600 (USD) [15]. The cost of carbon emission in Zagros forests of Iran was calculated as $4 million (USD) with a C sequestration rate of 1.11 t/ha/yr[16]. The rate of C sequestration in forest species was estimated at 1.24 t/ha and 0.027 t/ha by Ephedra sp and Amygdaluslycioides respectively. In addition the economic value of CO_2 absorption was $455 (USD) for Amygdaluslycioides[17].The benefits of C storage and sequestration were estimated in terms of monetary value, as well as the role of urban forests in offsetting C emissions from fossil fuel combustion. Results showed that urban forests in areas within the third-ring road of Shenyang stored 337,000 t C (RMB92.02 million, or $13.88 million), with a C sequestration rate of 29,000 t/yr (RMB7.88 million, or $1.19 million). The C stored in urban forests equaled 3.02% of annual C emissions from fossil fuel combustion, and C sequestration could offset 0.26% of annual C emissions in Shenyang [13]. Humid regions there are a lot of decompose and C storage is low, while in arid regions because of low decomposiotion, C storage is high. Thus these regions have a greate importance.Iran is located in an arid and semi-arid climate zone. In comparison with other countries there are severe constraints tothe density of vegetation and forest cover. However, diversity of the country's resources should not be neglected. Iran is an important country regarding plant genetic diversity. The largestareaofarid forestvegetation in Iran is betweenthe Gulf ofOmanand thesouthern domains ofIranoAlborz, North East, and East, partsofthe southeastand centralregionsofthecountry. In this zone, there are two main forest species in mountains that exist on a large scale,Pistachioatlantica and Amygdalusscoparia.Significance of these species within an ecosystem. Furthermore, introduction of the economic value of carbon sequestration and CO2 uptake can demonstrate the importance of these trees and shrubs to encourage their proper management and to preserve their existence within an ecosystem.

MATERIALS AND METHODS

Study area

The study was conducted on Pistaciaatlantica and Amygdalusscoparia in the Firouzabad Forest Research (29̊ to 29̊ 15´ N , 52̊ 30´ to 52̊ 40´E) Maximum and minimum altitudes were 2350 m and 1700 m a.s.l. respectively, with an average altitude of 2025 m. The study area bordered Zanjiran Village to the north, Shurab to the East and the western border was north of Shiraz (Firouzabad Main Road). The average annual rainfall in the forest was about 559/2 mm. Maximum and minimum temperatures were 42 ° C and -15 ° C, respectively. The evaporation rate was between 2474 to 3082 mm per annum. Its climate was semi-arid and cold semi-humid. The study area had an area of 9374 ha and the following species covered the mountains and foothills; *Pistachio atlantica, Amygdalus scoparia, Amygdalusl ycidios, Pistachio khinjuk Amygdalus haussknechtii, Amygdalus ebornea, Amygdalus Lycioides, Amygdalus eleagnifolia, Acer monspessulanum, and Amygdalus scoparia*.

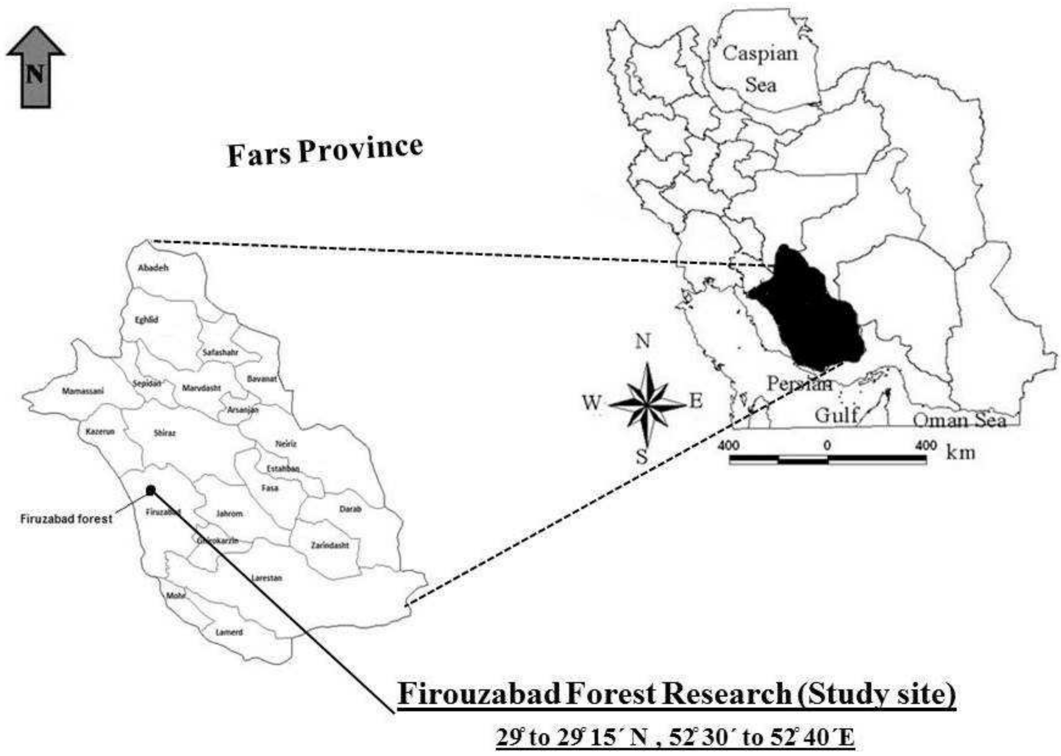

Fig 1 Location of the study area in the Fars province and Iran

iomass estimating method

Carbon sequestration in Pistachioatlantica

Systematic_random sampling was done to determine the number of Pistachio atlantic a trees using the inventory network with 1000x 400meters and plots of 2000 m^2.

Considering the sample statistics and status distribution of diameter classes of trees, three trees were randomly selected from each diameter class and tree characteristics were measured (diameter at breast height (dbh) and height).

Tree parts were taken (in accordance with thelogging embargo), at an eighth or a quarter to determine the wet weight of different tree components (leaves, branches and trunks) [1, 19, 15.]

Carbonstorage in Amygdalusscoparia

Inventory sampling – systematic network was used (1000 × 400 m) and 1000 m^2 to determine the number of shrubs in classes of crowndiameter. According to statistics results of the sampling and distribution of crown diameter, three shrubs were randomly selected for each of the 5 categories (0-1, 1-2, 2-3, 3-4 and 4-5) and they were measured for crown diameter (small and large diameter) then wet weights were measured for each sample.

Estimating organic carbon in root and litter

30 plots of 1m^2 were established under trees to calculate the organic carbon content ofleaf litter. Samples of leaf litter from these plots were collected and carried to the laboratory [14]. As direct sampling of roots is expensive and destructive, root biomass was calculated using function (1) (Hernandez & et al., 2004).

(1) Belowground biomass = 0.2 Aboveground Biomass

Conversion ratiocalculation

To determine the conversion ratioof wet weight to organic carbon in different organs, three separate samples were cut and transferred to the laboratory. Samples were burnt in an electric furnace at a temperature of 375 C̊ for 24 hours[23]. Then ash weight was measured.

Using previous weight measurements and ratio of organic carbon to organic material (function 2), tree organ conversion ratioswere calculated separately [2, 4, 23].

(2) Organic carbon = ½organic material
To estimate amounts of carbon sequestration in the soil, 4 samples from each of the four corners of micro-plots(5 x 5 meters) were taken. Plots were selected from different areas of the forest, in different geographical locations and altitudes (to consider crown affect, samples were taken from under the crown and outside it).

Samples were then mixed. In total, 15 soil samples were taken and after drying without exposure to sunlight they were transported to the laboratory.

Amounts of organic carbon were calculated using the Walky-Black method in a laboratory. Finally, amounts of carbon sequestration in soil were estimated with formula (3) [4, 23].

(3) $OC= 10000 \times \% OC \times E \times Bd$

That *OC* is organic carbonand *Bd* is bulk density

EXCEL software as a database and SPSS software were used for data analysis.

Economic evaluation
To evaluate carbon sequestration thefollowingfunction was used:

$$V_e = F_e \times P_c$$

F_e is the total amount of carbon sequestration in Pistachio, Amygdalus and soil (tons).P_c is carbon tax, which is calculated based on the average rate per ton for tax on carbon dioxide emissions based on studies in Iran and other countries.

In this study, carbon tax or the cost method of carbon emissions (carbon emissions taxes) was used. This method avoids damage costs and uses cost values applied to prevent injury and damage as a criterion for the benefits provided by an ecosystem.

Carbon tax rates in different countries were used to determine carbon tax rates for Iran. The average of carbon taxes calculated was $ 61 (USD).

RESULTS AND DISCUSSION

Carbon stocks estimation in
Pistachio atlantica.
Table 1 shows the Conversion coefficient for Pistachio component for components of *Pistachio atlantica.*

Table 1 Conversion coefficient for Pistachio component

Organ	Trunk	Shoot	Leaf	literate	Root
Conversion coefficient	31.7	32.9	18.1	39.1	28.9

Base on table 1 conversion coefficientis at least in leaf and is most for literate

Table 2 amount of organic carbon and carbon dioxide uptake in different parts of Pistachio and soil

	Trunk	Shoot	Leaf	Root	Literate	Total	Soil	Total soil & Vegetation
Organic carbon (ton/ha)	1.05	0.521	0.026	0.27	0.0012	1.87	12.78	14.65
Organic carbon in total (ton)	9842.7	4883.85	243.72	2530.98	11.9	17529.38	119799.1	137329.1
CO_2 absorption (ton/ha)	3.85	1.91	0.095	0.99	0.0044	6.86	47	53.76
CO_2 absorption in total (ton)	36118.02	17904.34	890.53	9280.26	41.24	64305.64	440578	503946.2

Table 3 Duncan test results for comparing the carbon stored in various organs such luggage in forest research Firouzabad

Organ	Reservation carbon weight average	Class
Trunk	183.8	a
Shoot	74.22	b
Leaf	3.77	c
Root	42.88	bc

Analysis of variance was done between *Pistachio components* to compare amounts ofcarbon sequestration separately for leaf, branch, trunk and root (results are shown in Tables 3 and 4).

Table4 MeanVarianceAnalysisof carbonstorageinvariousorgansin Pistachio atlanticaFirouzabad Forest Research

	Sum of Squares	Mean Square	df	F
Between Groups	807159.888	269053.296	3	28.064
Within Groups	1687357.535	9587.259	176	
Total	2494517.423		179	

Sig: 99%

Carbon Sequestration estimation in Amygdalusscoparia

Table 5 Conversion ratio (percentage), the amount of organic carbon storage and carbon dioxide absorption inAmygdalus

	Amygdalusscoparia
Conversion coefficient	7
Organic carbon (kg/ha)	0.0575
Organic carbon in total (kg)	539.005
CO2 absorption (ton/ha)	0.211
Total of CO2 absorption (ton)	1977.9

Table 6 shows Duncan test results for the mean carbon storage comparison inthe crown diameter in *Amygdalusscoparia*.

Table 6 Analysis of variance of carbon storage in *Amygdalusscoparia* in study area

	Sum of Squares	Mean Square	df	F	sig
Between Groups	2.097	0.524	4	10.786	0.000
Within Groups	0.488	0.094	10		
Total	2.583		14		

Table 7 Duncan test results for comparing the carbon stored in *Amygdalusscoparia* in Firouzabad Forest Research

Crown diameter classes	Mean Carbon sequestration	Class
<1	0.665	a
1-2	0.875	a
2-3	1.39	b
3-4	1.4	b
4<	1.68	b

Percentage of organic carbon in *Pistachio atlantica, Amygdalus scoparia* and soil are showed in figure 1.

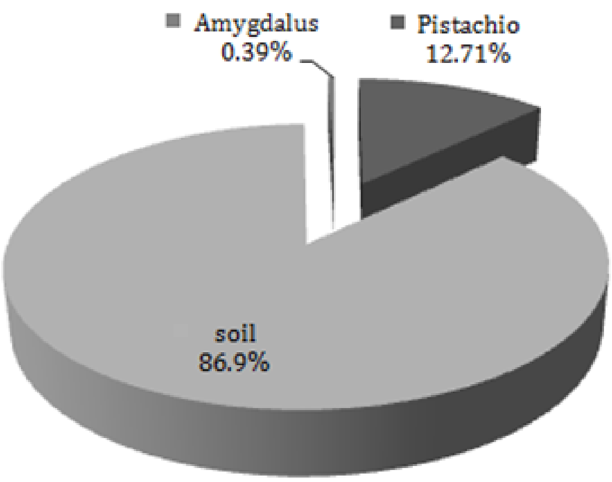

Figure 2 Percentage of organic carbon in *Pistachio atlantica, Amygdalus scoparia* and soil ***Economic value of Carbon Sequestration***

Table 8: Economical value of carbon sequestration in different parts of the forest

object	CO_2 uptake (ton/ha)	Economic value ($)
Pistaciaatlantica.	**6.86**	**418.46**
Amygdalusscoparia	**0.211**	**12.871**
Soil	**47**	**2867**
total	**54.071**	**3298.331**

CONCLUSION

In this research, we considered to estimate amounts of carbon sequestration and the economic value that can be placed on an environment. The amount of carbon sequestration in soil and vegetation was 14.65 ton/ha. The amount of carbon sequestration in the total forest stand was 137329.1 ton. The percentage of C sequestration in the soil washigh, approximately 87%, because it was an old forest standC storage is accumulated in these years in soil.C sequestration in Pistachio sp. was low (13%) because species density waslow. The economic value of C sequestration was $418.46 (USD) and $12.871 (USD) in each hectare for *Pistachio atlantica* and *Amygdalusscoparia* respectively.Results show that the C storage in*Pistachio atlantica* is very important and because of existence of old trees so these species must be protected and not be cutted.Amounts of carbon sequestration will increase by conservation by increasingdensity of *Pistacioatlantica*. The area of this forest is considerable, therefore an area could be designated for this purpose and a higher-level of carbon sequestration could be facilitated. The amount of C sequestration and its economic value in the soil were calculated 12.78 t/ha and $ 835.812 (USD) respectively. Therefore anincrease of C sequestration in a dry ecosystem would be beneficial in economic and environmental terms. Decision making for more efficient for land use and conservation can be made more effective with consideration of a forest's economic value that exists as a free resource for humans.There are factors such erosion caused by overflow from seasonal rains and firethat contribute to depletion of organic C and CO2 contents in forests. These factors need consideration in further research to address associated problems that may confound attempts to raise levels of carbon sequestration in these ecosystems. The site of this research was in the semi-aridregion of Iran. Research on such a site is useful because activities that cause C emissions are less than that of other sites therefore afforestation and reforestation are very important in these regions.

REFERENCES

[1] HR.Adl, Iranian *Journal of Forest and Poplur Research*, 15,**2007**, 417-426.
[2] N.Abdi, Estimating of potential of carbon sequestration of Stragalus Sp. (sub: Tragacanth) in Markazi and Esfahan province. Islamic Azad university Tehran Science and Research branch,**2005**,194.
[3] H.Amirnejad, S.khlilian, M.Ahmadian, MH.Osareh,the Total Economic Value Determination of North Forests Ecosystem of Iran with the Emphasis on Valuation of Environmental-Ecological and Preservation Values. A Thesis Presented for the Degree of Philosophy in Agricultural Economics,**2005**, 269p.
[4] S.K.Bordbar, S.M.MortazaviJahromi, *Iran,Pazhuhesh and sazandegi*, 70,**2006**, 95-103.
[5] A.BussoniGuitart, L.C.Estraviz Rodriguez, *Ecological Economics*, 69,**2010**, 451–458.
[6] R.P.Detwiler, C.A.S.Hall, *Science*, 239,**1988**, 42–47.
[7] R. Lal, Forest *Ecology and Management*,220,**2005**, 242–258.
[8] R.K.Dixon, J.Wisniewski, *Water Air Soil Pollute*, 85,**1995**, 101–110.
[9] E.G.Jaba´ggy, R.B.Jackson, Ecol. *Appl*, 10,**2000**, 423–436
[10] IPCC, 'Climate Change, Mitigation; Contribution of Working Group III to theFourth Assessment Report of the IPCC. In: Metz, B., Davidson, O.R., Bosch, P.R., Dave, R., Meyer, L.A. (Eds), Cambridge and NY, USA: Cambridge University Press, Cambridge, United Kingdom and New York, NY,**2007**, USA
[11] L.A.Joyce, R.Birdsey, The impact of climate change on America's forests: atechnical document supporting the 2000 USDA Forest Service RPA Assessment, USDA Forest Service No. RMRS-GTR 59,**2000**,134 p.
[12] E.Krcmar, B.Stennes, G.C.van Kooten, I.Vertinsky, *European Journal of Operational Research*, 135,**2001**, 616–629.
[13] C.Liu, Li,X, Carbon storage and sequestration by urban forests in Shenyang, China, Urban Forestry & Urban Greening, article in press,**2011**.
[14] A.MahmudiTaleghani, Gh.ZahediAmiri, E.Adeli, Kh. Saghebtalebi, *Forest and spruce*, 15 (3),**2007**, 241-251.
[15] S.H.Mesbah, M.Khorramitayyebi, M.Ansari, Gh.Diyanattalab, R.Samaniyan, Estimatin of soil and dominant vegetation carbon sequrstrationofBamu national park, Agriculture and natural resources center, Fars,**2009**, Iran.
[16] M.Moradi, Economic- Environmental Value Determination of Zagros Forests Ecosystem of Iran .A Thesis Presented for the Degree of Philosophy in Agricultural Economics, Islamic Azad University Tehran Science and Research Branch,**2008**,183p.

[17] T.Rousta, A.Fallah, H.Amirnejad, S.K.Bordbar, E.Tashakorifard, Survey of medicinal plants Ephedra spp. In the reduction of greenhouse gas.National Conference of medicinal plants, Sari Agriculture and Natural ResourcesUniversity,**2010**, Iran.
[18] T.Rousta, A.Fallah, H.Amirnejad, S.K.Bordbar, Z.Khalili, Estimating environmental value of Amygdaluslycioidesspach. National Conference of medicinal plants, Sari Agriculture and Natural Resources, Sari, **2010**, Iran.
[19] T. Satoo, H.A.I.Madgwick, Forest Biomass. *Forestry sciences*, **1982**, 152p.
[20] K.R. Kirby, C.Potvin, *Forest Ecology and Managemement*,**2007**, 208-221.
[21] D.Rodel, S. Joveno,Ma. Lales, Q. Theresa Arnuevo Ina,*Renewable Energy*, 25,**2002**, 307–315.
[22] H.Steinfeld, P.Gerber, T.Wassenaar, V.Castel, M.Rosales, Livestock's longshadow. Environmental issues & options,**2006**, Food and Agriculture Organization ofthe United Nations, Rome. Available at: http://www.virtualcentre.org/en/library/key_pub/longshad/A0701E00.pdf.
[23] S.Varamesh, S.M.Hoseini, N.Abdi, M.Akbariniya, Estimates of Carbon Sequestration in urban Forest (case study: Park Cheetgar in Tehran. Iran). MSc thesis of forestry.TarbiyatModarres University,**2009**, 150p.
[24] Document supporting the 2000 USDA Forest Service RPA Assessment. USDA Forest Service No.RMRS-GTR 59, 134 pp.