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Research Article

CARBON SEQUESTRATION POTENTIAL IN BIOMASS OF *HALOXYLON APHYLLUM* AND *STIPAGROSTIS PLUMOSA* (ARAN-O-BIDGOL DESERT, IRAN)

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ABSTRACT
Carbon sequestration in soil organic matter (SOM) is increasingly advocated as a potential win–win strategy for reclaiming degraded lands, particularly in arid regions of the developing world, mitigating global climate change and improving the livelihoods of resource-poor farmers. Vegetation management to develop the shrub or tree species in arid and semi-arid regions is one of the inexpensive and multi-purpose methods to decrease CO2. Afforestation in desert regions is one of the most practical and advantageous methods of desert management. This research was done in Saxaul (*Haloxylon aphyllum*) stands as the afforested area and the surrounding native vegetation *Stipagrostis plumosa* (Control area) in Aran-o-Bidgol desert of Iran. In both areas, the amounts of aboveground and underground biomass of the species were calculated by cutting and weighting the aerial parts (leaves, stem) and roots in both species. Ash method was used to determine carbon sequestration coefficient of the studied species. The amounts of soil carbon sequestration were measured too by using of wacky black method. The comparison of carbon sequestration of *H. aphyllum* in the unit of the measuring surface and control areas (*S. plumosa* biomass) showed the difference of this ability between two areas ($p<0.01$). The results indicated that total soil carbon sequestration of *H. aphyllum* (24.31 mg/ha) was significantly ($p<0.01$) more than *S. plumosa* (11.2 mg/ha).

***Keywords**: Carbon Sequestration, Afforestation, Haloxylon Aphyllum, Stipagrostis Plumosa, Iran*

INTRODUCTION
Widespread concern about global climate change has led to interest in reducing emissions of carbon dioxide (CO2) and, under certain circumstances, in counting additional carbon absorbed in soils and vegetation as part of the emissions reductions. Researchers generally believe that the main factor of increasing the temperature of earth CO_2 (Komer, 2003). Climate changes and the global warming are generated by the density in the greenhouse gases found in the atmosphere of the Earth (Brooks, 1998); and carbon is one of the major causes of the greenhouse gases (Lal, 2004). From the time of beginning industrial revolution in 19th century, the viscosity of carbon dioxide in atmosphere has reached from 280 to 365 section in million and its considered that in 21th century it would be reached to 600 section in million which this cause increasing medium annual temperature of the earth at the rate of 1Cº to 4Cº (Komer, 2003). However main part of carbon is holed by oceans and is kept as reserves , but studies show that the source of oceans are not so big that can reserve additional carbon in themselves and its residue should be reserved in land (Kenneth and Michael, 2000). The main resources for reserving carbon are plants particularly forests. Forest ecosystems of the world in case of activity in order to reserve carbon, can hold about 2.3 gig ton carbon annually (Thompson and Matthews, 1989). It's estimated that average rate of distributed CO_2 from fossil fuels and change of the use of farms during 1980 by now is about7.6 milliard ton in a year (Dixon *et al.*, 1994). Refining carbon by artificial methods such as filtration and etc. include a lot of charges so that this expense in America has been measured about 100 to 300 $ for each ton carbon (Finer, 1996). In this direction, industrial countries, have predicated prolonged programs in order to decrease the viscosity of carbon dioxide that in Kyoto conference, this problem was pronounced seriously and countries were obliged to reserve carbon by using particularly natural and artificial forests in different ecological condition like desert area. Over time, forests can grow on lands that were in other

uses (e.g., croplands), and vice versa. Deforestation is the conversion of forests to pasture, cropland, urban areas, or other landscapes that have few or no trees. Afforestation is planting trees on lands that have not grown trees in recent years, such as abandoned cropland. Deserts and semi deserts occupy approximately 22 percent of the earth's land surface (Janzen, 2004), yet because of their low productivity, they are generally assumed to be relatively minor players in the global carbon cycle and afforestation is an important methods for carbon sequestration in desert area. Article 3.3 of the Kyoto Protocol allows counting the carbon effects (both sequestration and release) of afforestation, reforestation, deforestation, and other forestry and land use changes that have occurred since 1990, if the change in carbon stock is verified. Verification requires a system for estimating the carbon effects because a census of carbon changes on every forested acre is infeasible and for reporting the carbon effects.

MATERIALS AND METHODS

Maranjab desert located in the northern city of Kashan in Isfahan province Aran Bidgol functions (Figure 1). Average height of Maranjab Desert in the open sea is about 850 meters. Much of the desert is covered with sand dunes and Sabulous. The annual precipitation is generally 100 mm in the plains, and about 150 mm in the mountain areas. About 70–80% of the annual precipitation is concentrated in the months from September to March, while less than 5% occurs in the summer months. The average annual temperature is 19.4 °C but there are wide variations. Temperatures are very high in summer, the hottest month being July.

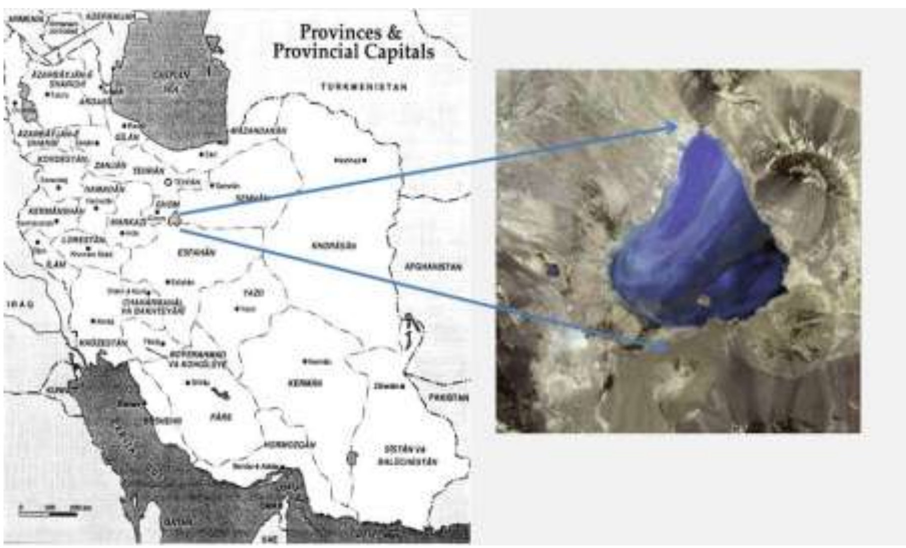

Figure 1: Maranjab desert location Isfahan province

The aforementioned area was divided into two sites: *Haloxylon aphyllum* stands as the forest planting for ten years and the surrounding native vegetation *Stipagrostis plumosa* (Control area). This research was done in *Haloxylon aphyllum* stands as the forest planting and the surrounding native vegetation *Stipagrostis plumosa* (Control area) in Aran-o-Bidgol desert of Iran. Leaves, branches, stems and roots were sampled from randomly selected samples in each plot (20m^2 and 2m^2) for measuring C concentrations. In both sites, the amounts of aboveground and underground biomass of the species were calculated by cutting and weighting the aerial parts (leaves, stem) and roots in both species by 30 repetition. Effective depth for root sampling in *Haloxylon aphyllum* and *Stipagrostis plumose* were 150 and 30 cm respectively. All the plant samples (leaves, stems, branches, roots, and litter) were oven-dried to a constant mass at approximately 65° C for 48 h, and then stored in desiccators until use. Ash method was used to determine carbon sequestration coefficient of the studied species. The soil sampling was conducted randomly on each site. For each of the selected site representing vegetation type 30 sampling ditches were dug. Soil bulk density was determined using a soil corer (stainless steel cylinder of 100 cm^3

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in volume) and soil samples were collected from 0.0 to 30 cm depth. Gao *et al.*, (2007) argued that the changes in the soil organic carbon in the depths greater than 30 cm are quite small. 30 soil samples on each area and 60 soil samples in total were drawn out and moved to the laboratory. They were dried out in the open air and sifted through a sieve of 2mm meshes. Soil organic carbon (SOC) was measured by the $K_2Cr_2O_7$–H_2SO_4 oxidation method of Walkey and Black (Grunzweig *et al.*, 2003). Regarding the goal of study, the mineral layer thickness, carbon accumulation and bulk density of soil were specified as the variables. In order to determine the amount of the sequestrated carbon by the gram per meter square, the formula (1) was employed:
Formula (1): $Cc = 1000 \times C(\%) \times Bd \times e$,
In this formula, Cc refers to the amount of the sequestrated carbon weight per meter square. C signifies the percentage of the accumulated carbon in the calculated depth of soil. Bd represents the bulk density of the soil, and e denotes the thickness of the soil depth by the centimetre. Total system carbon was defined as the sum of the woody biomass, herbaceous biomass, root, litter, and soil carbon

RESULTS AND DISCUSSION

Results

There is a clear difference between two areas from carbon stock point of view (Figure 2).

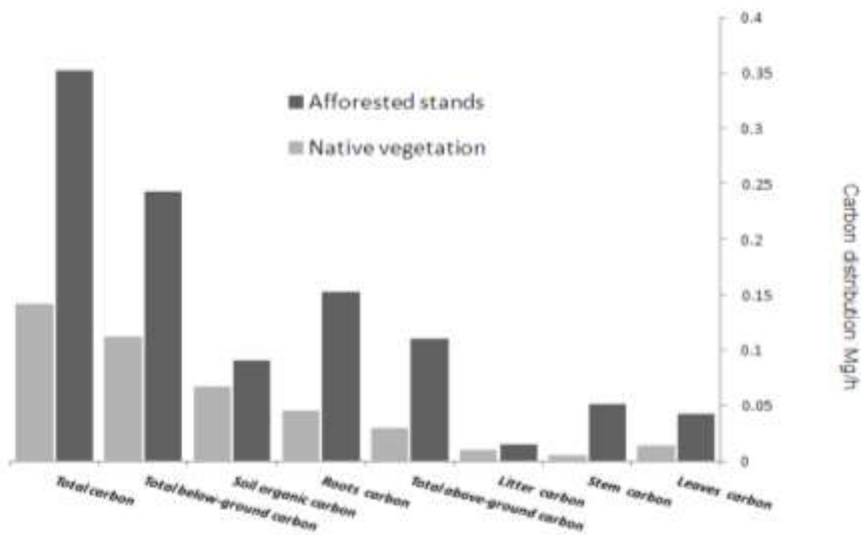

Figure 2: Carbon distribution in different part of afforested and native vegetation stands

Afforested stands presented significantly higher carbon storage compared to the adjacent control area (Table 1). Every part shows this difference.

Table 1: Carbon distribution (Mg/ ha) among Native vegetation and afforested stands

Parts of C storage	Afforested stands		Native vegetation		Number of sample	T test
	Mean	S.E	Mean	S.E		
Leaves	4.25	±2.25	1.45	±0.25	30	2.25*
Stem	5.2	±1.65	0.55	±0.12	30	2.45*
Litter	1.56	±0.05	1.03	±0.23	30	2.14*
Total above-ground carbon	11.01	±1.03	3.03	±0.02	30	2.45*
Roots	15.25	±2.55	4.52	±0.36	30	2.49*
Soil organic carbon	9.06	±1.56	6.68	±0.23	30	2.48*
Total below-ground carbon	24.31	±4.23	11.20	±3.45	30	2.61*
Total carbon	35.23	±3.21	14.23	±1.52	30	2.55*

After 10 years since trees were planted, afforestation added twice more C to the initial ecosystem carbon pool. Annual C sequestration rates averaged 1.31Mg/ha/ year.

Discussion

Our study clearly demonstrates that the afforestation of desert in the study area has the potential of sequestering atmospheric C. Aboveground and belowground C stocks differed depending on plant species. The average carbon sequestration rate of plantations that we observed (24.31MgC/ha) matched observations from other afforested systems in semi-arid regions (Nelson and Sommers, 1982) and evidenced the potential of afforestation for carbon sequestration programs in strongly water-limited ecosystems. The sequestration rate that we estimated was based on young Saxaul plantations (10 years of age), characterized by high initial growth rates. Considering that plantations are clear cut 35–40 years after planting (Laclau *et al.*, 1999), growth and C sequestration rate decay could be expected as plantations get older (Binkley *et al.*, 2002). Changes in carbon pools after tree planting were mainly due to tree biomass and litter increases. Finally these results showed in spite of rain shortage and harsh condition in central deserts of Iran these areas can support atmospheric carbon as a big container and this means every effort for vegetation improvement can be economical activities.

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