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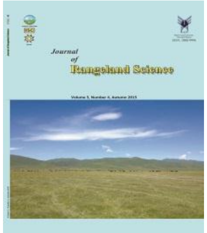

Research and Full Length Article:

Identifying Carbon Sequestration Hotspots in Semiarid Rangelands (Case Study: Baghbazm Region of Bardsir City, Kerman Province)

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Abstract. Carbon sequestration in rangeland ecosystems has been identified as a suitable strategy to offset greenhouse gas emissions and information on carbon sequestration hotspots is a good tool to improve rangeland management. Objectives for this study were to assessment potential carbon sequestration in various rangeland types, to identify carbon sequestration hotspots and to study the effective factor on hotspots in semiarid rangeland of Kerman province. The content of above and underground biomass and litter carbon by Ash method and soil carbon by Walcky-Black method were determined in 300 plots 2m×2m scattered randomly in rangeland types in 2014. Results showed that rangeland types had significant effect on carbon sequestration as *Zygophyllum eurypterum-Artemisia sieberi*, *Artemisia sieberi-Pteropyrum aucheri*, *Astragalus microcephalus –Stipa barbata*, *Artemisa sieberi* and *Artemisia sieberi- Salsola brachiata* respectively with 65.84, 53.92, 43.32, 33.17 and 24.77 (T/ha) regarding the highest and lowest carbon sequestration amounts. Carbon sequestration hotspots and coldspots were mapped by using hotspots analysis. *Zygophyllum eurypterum-Artemisia sieberi* and small parts of both types *Artemisia sieberi-Pteropyrum aucheri* and *Astragalus microcephalus–Stipa barbata* with 65.34 (T/ha) were carbon sequestration hotspots. Majority of *Artemisia sieberi-Salsola brachiata* and small parts of *Artemisa sieberi* with 23.78 (T/ha) included carbon sequestration coldspots. PCA analysis also showed that life form, clay and vegetation cover were the most important factors influencing on the hotspots. It was concluded that soil characters also play effective roles to stock carbon in semiarid rangeland ecosystems although rangeland types demined with Phanerophyte species had a greater probability of being identified as carbon sequestration hotspots.

Key words: Hotspots analysis, Carbon, Soil, Phanerophyte, Kerman

Introduction

Climate change is a result from emission of greenhouse gases in the past century that will cause atmospheric warming (IPCC, 2007). Climate change has profound effects on livelihood vulnerability in the world (Davidson and Janssens, 2006). Carbon is the most important greenhouse gas (Su, 2007). The rate of increase in atmospheric carbon concentration can be reduced through the process of carbon sequestration (IPCC, 2001). More specifically, carbon sequestration can be defined as the transfer and secure storage of atmospheric carbon into other long-lived sinks that would otherwise be emitted or remain in the atmosphere (Lal, 2004). Carbon stocks are located in the ocean, biosphere, pedosphere and geosphere. Rangelands can be introduced one of the most important ecosystem to sequestrate carbon because of some features, such as its large area (Bahrami *et al.*, 2013). Dregne and Choun (1992) found that more than 70% of rangelands are already suffering from moderate to very severe degradation due to land use and land-cover changes. In the degraded rangeland, soil carbon is lost to the atmosphere (Schuman *et al.*, 2002) so wind and water erosion accelerate in the loss of organic carbon (Brown *et al.*, 2006). Losses of inorganic carbon may also be significant sources of CO_2 flux to the atmosphere (Monger and Martinez Rios, 2001). The greatest potential for increasing rangeland soil carbon is the restoration of degraded land (Follett *et al.*, 2001). Unfortunately, in arid and semiarid areas where land degradation is most pronounced, there are few reliable techniques for restoration (Bird *et al.*, 2001) so conservation and maintenance of existing rangeland is very essential in this area. Maintenance of existing ecosystems will require application of practices based on understandings of the ecological site capacities (Sayre, 2004). In general, realizing the potential of rangelands to provide carbon sequestration requires for managing ecosystems identifying priority area to conserve, avoiding large and significant losses of carbon to degradation, and restoring depleted and degraded rangelands (Walker and Janssen, 2002). Abdi et al. (2008) examined the rate of carbon sequestration of *Astragalus* in Markazi province, their results showed that the total carbon sequestration was 32.95 (T/ha) and soil carbon was contained 43-87 percent of the total carbon sequestration and stored carbon in aboveground biomass was more than underground biomass. Bai *et al.* (2009) compared soil carbon sequestration in grasslands and shrub lands and revealed that the amount of soil carbon in shrub land was more than that in grassland and the soil texture was more effective than rangeland types in soil carbon. The results of Singh *et al.* (2003) showed that soil carbon had positive correlation by rangeland types in India. They believed that the economic value of carbon is based on biomass. Ahmadi (2009) in south Salt lake, found that the highest rate of carbon sequestration belonged to Haloxylon and the lowest rate of carbon sequestration has occurred in litter surface. Bahrami *et al.* (2013) examined carbon sequestration in the rangeland types. Their results showed that the carbon sequestration ability of species was different so that *Pteropyrum aucheri-Astragalus microcephulus*, *Astragalous microcephalus-Acanthophyllum microcephalum* and *Pteropyrum aucheri- Prangus uloptera* respectively produced 10.96, 84.73 and 85.52 (T/ha) carbon. They also concluded that the amount of carbon sequestration was significantly reduced by increasing the slop. Yang *et al.* (2014) founded that carbon sequestration capacity increased after establishing new vegetation in the Tengger desert of China and carbon storage in soil represented the largest carbon stock, it included 65-80 % total carbon stock.

Ecosystem hotspots have been used for identifying the areas where high values for a variable of interest occur (Timilsina *et al.*, 2013). Analysis of the pattern and structure of value hotspots in the landscape, as with biophysical landscape patterns, is necessary for understanding the dynamics between landscape pattern and process. Ecosystem hotspots, known to be ecologically and economically important, are often the focus of conservation efforts (Worm *et al.*, 2003) and previously been applied in biology and conservation literature (Mittermeier *et al.*, 2011) and for mapping distinct, localized areas affected by biological invasions (Drake and Lodge, 2004). Ecosystem hotspots have been determined through different ways (Hoekstra *et al.*, 2005). Wu *et al.* (2013) used ranked layers and overlap analyses to identify ecosystem hotspots base on ecosystem services in the northeastern coast of Mainland China. Hotspot analysis also is used to cluster data and to determine hotspot border (Anselin, 1995). Karimi *et al.* (2015) used hotspots analysis to identify and to map social and ecological hotspots in Queensland, Australia. Timilsina *et al.* (2013) used hotspots analysis for mapping carbon hotspots in forest types in Florida, USA.

Due to climate change, identifying carbon sequestration hotspots has the potential to accumulate complex information of the ecosystems and can be used by decision makers as a powerful tool for conservation assessments (Swetnam *et al.*, 2011; Daily and Matson, 2008). Unfortunately, there is a clear lack of information relevant to decision making (Turner and Daily, 2008). Our objectives for this study were to assess the potential carbon sequestration in various rangeland types and ecosystem hotspots based on carbon sequestration and study the effective factor in hotspots in semiarid rangelands.

Materials and Methods

Study area

The study was conducted in rangelands of Baghbazm located about 8km from Bardsir city of Kerman province in 56° 21´ to 56° 31´ eastern longitude and 29° 45´ to 30° north latitude. It covers an area of 26332.6 ha and elevation is between 1987-3567 m above sea level. According to Lalezar station data (1991-2001), the mean rainfall is 202 mm with irregular distribution and the climatic conditions of semiarid region base on Domarten method. TWINSPAN (Two Way Indicator Species Analysis) method was applied for determining vegetation classes (Torri *et al.*, 2013) then vegetation map was created with compilation geomorphology unites and vegetation classes (Tatian, 2001). Rangeland types were included *Zygophyllum eurypterum-Artemisia sieberi* (*Zy-Ar*), *Artemisia sieberi* (*Ar*), *Artemisia sieberi-Pteropyrum aucheri (Ar-Pt), Artemisia sieberi- Salsola brachiata (Ar-Sal) and Astragalus microcephalus –Stipa barbata (As-St)* (Fig. 1).

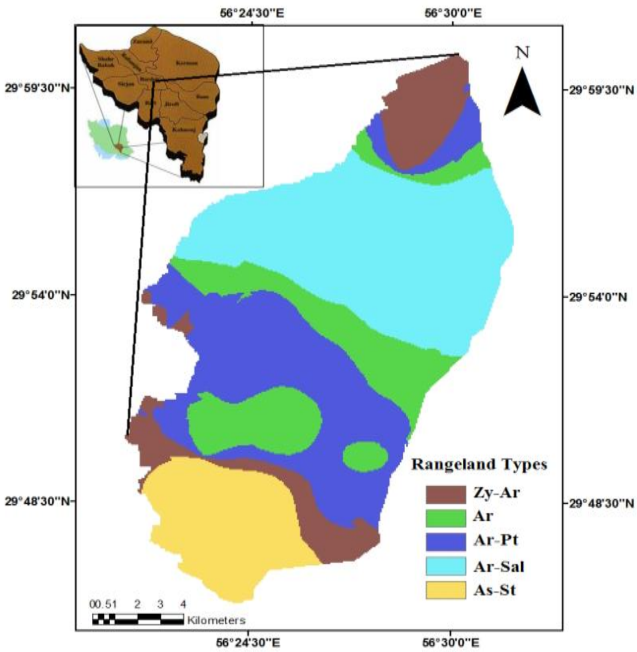

Fig. 1. Vegetation map of Baghbazm region of Bardsir city

Sampling

Plot number was determined 60 plots for each rangeland types by using Cochran (1977) method so 300 plots 2m×2m were scattered randomly in five rangelands types in May 2014. There were 24 vegetation species in plots. For annual species (Therophytes) together and other species separately, Double Weight Sampling was used to estimate aboveground biomass (Reid *et al.*, 1990). In this method, estimated biomass was corrected by clipped biomass base on regression equation (Table 1). 15 individual shrubs (standard shrubs for each species) were harvested and the roots were gathered by excavating to determine the root/shoot ratio (Abdi *et al.*, 2008). In each plot, all plant litter was collected from the soil surface and soil samples were taken from depth 0-30 cm (Mac Dicken, 1997).

Table 1. Regression equation between estimated and clipped aboveground biomass of vegetation species in Baghbazm region of Bardsir city

Species	Family	Life Form	Regression Equation	R^2
Achillea wilhelmsii L.	Compositae	Hemicryptophyte	0.86x+38.98	0.84
Aelleni subaohylla(C.A.M.)Botsch	Chenopodiaceae	Chamaephyte	0.73x+42.03	0.82
Alhaji camelorum Boiss. et Bh.	Fabaceae	Hemicryptophyte	0.76x+34.2	0.93
Amygdalus scoparia Spach.	Rosaceae	Phanerophyte	0.86X+250.72	0.84
Artemisia siebri Asso.	Compositeae	Hemicryptophyte	0.89X+22.87	0.94
Astragalus microcephalus	Leguminoseae	Hemicryptophyte	0.43X+58.35	0.85
Boissiera squarrosa (Banks & Sol.)	Poaceae	Therophyte	0.58x+65.21	0.83
Bromus tectorum L. var. tectorum	Poaceae	Therophyte	0.58x+65.21	0.82
Acanthophyllum macrodon J.D	Caryophyllaceae	Chamaephyte	0.63x+97.34	0.8
Eremurus persicus J.et. Sp.	Liliaceae	Therophyte	0.58x+65.21	0.83
Eruca sativa Miller	Compositae	Therophyte	0.58x+65.21	0.83
Ferula assa-foetida L.	Umbelliferae	Hemicryptophyte	0.79x+75.65	0.96
Mentha longifolia (L.) Hudson	Lamiaceae	Cryptophyte	0.42x+61.05	0.8
Peganum harmala L.	Zygophylaceae	Hemicryptophyte	0.68x+88.93	0.84
Pteropyrum aucheri Jaub .et. Sp.	Poligonaceae	Phanerophyte	0.87x+290.95	0.85
Salsola brachiata Pall	Chenopodiaceae	Therophyte	0.58x+65.21	0.83
Salsola kali L.	Chenopodiaceae	Therophyte	0.58x+65.21	0.83
Salvia macilenta Boiss.	Lamiaceae	Chamaephyte	0.81x+40.43	0.95
Scariola orientalis L.	Chenopodiaceae	Hemicryptophyte	0.42x+71.53	0.8
Stipa barbata Desf.	Poaceae	Geophyte	0.73x+59.84	0.93
Ziziphora capitata L. subsp. capitata	Lamiaceae	Therophyte	0.58x+65.21	0.83
Zygophylum eurypterum Boiss. et.Bh.	Zygophylaceae	Phanerophyte	0.71x+176.54	0.86

Laboratory and statistical analyses

Litter, above and underground biomass samples were dried, weighed and analyzed for organic carbon content by using Ash method. Soil samples intended for carbon analyses were passed through a 2-mm screen to remove plant crowns and visible roots and root fragments. Samples were air dried and analyzed for total carbon by the Walkley-Black dichromate oxidation procedure (Nelson and Sommers, 1982) then the amount of soil organic carbon was estimated by using Equation 1. Hydrometer, pH meter and EC meter were used to determine soil texture, pH and EC. Bulk density also was assessed on separate soil cores (Blake and Hartge, 1986) (Equation 1).

$$Cc = \%OC * Bd * E \quad \text{(Equation 1)}$$

Where Cc is amount of organic carbon (T/ha), %OC is percent of organic carbon, Bd is Bulk Density (gr/cm^3) and E is soil depth (m).

Hotspots

To determine hotspots, we used the spatial statistics extension of the Arc GIS 10 software to compute the Gi* statistics in hotspot analysis (Getis and Ord, 1992). This statistic was calculated as the sum of the product of weight and the attribute value (total carbon) of neighbors divided by the sum of the attribute value of all plots (Equation 2).

$$G_i^*(d) = \frac{\sum_j W_{ij}(d) X_j}{\sum_j X_j} \quad \text{(Equation 2)}$$

Where G_i^* is the statistics calculated for each target plot, d is the distance that defines the neighbors, wij is spatial weight, xj is the total carbon value for all plots. Plots with a higher G_i^* shows clusters of higher total carbon values (hotspots) and plots with lower G_i^* shows clusters of lower total carbon values (coldspots). In this analysis, Z-score was used to test the statistical significance of G_i^* (Equations 3 and 4).

$$Z(G_i^*) = \frac{G_i^* - E(G_i^*)}{\sqrt{(VarG_i^*)}} \quad \text{(Equation 3)}$$

$$E(G_i^*) = \frac{\sum_j W_{ij}(d)}{n-1} \quad \text{(Equation 4)}$$

Where E (G_i^*) is expected G_i^* and n is number of plots.

Carbon sequestration in different rangeland types was analyzed by Duncan. Principal Component Analysis (PCA) was used to investigate the relationship between vegetation and environmental parameters with classes derived from hotspots Analysis.

Results

Results showed that carbon sinks had significant difference in rangeland types (Table 2). Carbon aboveground biomass in Zy-Ar and *Ar-Pt* respectively with 8.73 and 8.46 (T/ha) wasn't significant deference. Aboveground carbon in *Ar* and *Ar-Sal* respectively with 3.59 and 4 (T/ha) wasn't significant deference also aboveground carbon in *As-St* with 5.89 (T/ha) had not significantly difference with mentioned two groups. For underground carbon, *Zy-Ar* with 11.17 (T/ha) was significantly different from other types. *Ar-Sal* and *As-St* respectively with 1 and 2.42 (T/ha) were significantly different from *Ar-Pt* and *Zy-Ar*. also *Ar* and *Ar-Pt* respectively with 3.92 and 6.46 (T/ha) were not significantly different together. Litter carbon in *Zy-Ar*, *Ar-Pt*, *Ar-Sal* and *As-St* respectively with 1.82, 4.40, 0.4 and 2.98 (T/ha) were significant difference and Ar with1.25 (T/ha) wasn't significantly different from *Zy-Ar* and *Ar-Sal*. For soil carbon, *Zy-Ar*, *Ar*, *Ar-Pt*, *Ar-Sal* and *As-St* respectively with 44.12, 24.4, 34.59, 19.35 and 31.19 (T/ha) were significantly different. Also for total carbon, *Zy-Ar*, *Ar*, *Ar-Pt*, *Ar-Sal* and *As-St* respectively with 65.84, 33.17, 53.92, 24.77 and 43.32 (T/ha) were significantly different (Table 2).

Hotspots analysis classified plots to three hotspots, intermediate and coldspots classes base on carbon sequestration (Fig. 2). Carbon in hotspots and coldspots was respectively 65.34 and 23.78 (T/ha). Hotspots analysis also showed hotspots were located in *Zy-Ar* (78%), *Ar-Pt* (11%) and *As-St* (11%) and coldspots were located in *Ar* (12%) and *Ar-Sal* (88%) (Table 3).

Effect of the canopy cover, life form, slope, elevation, aspect, EC, pH, clay, silt and sand on hotspots (G_1), intermediate (G_2) and coldspots (G_3) were studied by using PCA. The plot distribution in the first and second axis of PCA showed that hotspots, intermediate and coldspots were different for mentioned characters. There is strong direct relationship between hotspots and the first axis of PCA and indirect relationship with the second axis of PCA. Coldspots had indirect relationship with the first axis of PCA and direct relationship with the second axis of PCA (Fig. 3).

The first axis of PCA that expressed 57.01 percent data changes was reflection of life form and clay. The second axis of PCA that expressed 19.48 percent data changes was reflection canopy cover (Table 4).

Table 2. Means aboveground, underground, litter and soil carbon sinks in rangeland types

Rangeland Types	Aboveground Biomass (T/ha)	Underground Biomass (T/ha)	Litter (T/ha)	Soil (T/ha)	Total (T/ha)
Zygophyllum eurypterum-Artemisia sieberi	8.73±0.72a	11.17±2.98a	1.82±0.11a	44.12±0.41a	65.84±3.32a
Artemisia sieberi	3.59±0.62b	3.92±0.35bc	1.25±0.11ac	24.49±0.29b	33.17±1.03b
Artemisia sieberi-Pteropyrum aucheri	8.46±0.54a	6.46±0.59b	4.40±0.48b	34.59±0.32c	53.92±1.56c
Artemisia sieberi- Salsola brachiata	4.00±3.13b	1.00±0.12c	0.40±0.52c	19.35±0.22d	24.77±3.18d
Astragalus microcephalus –Stipa barbata	5.89±0.36ab	2.42±0.12c	2.98±0.23d	31.91±0.31e	43.32±0.73e

Means of column with the same letter are not significantly different (ρ<0.05)

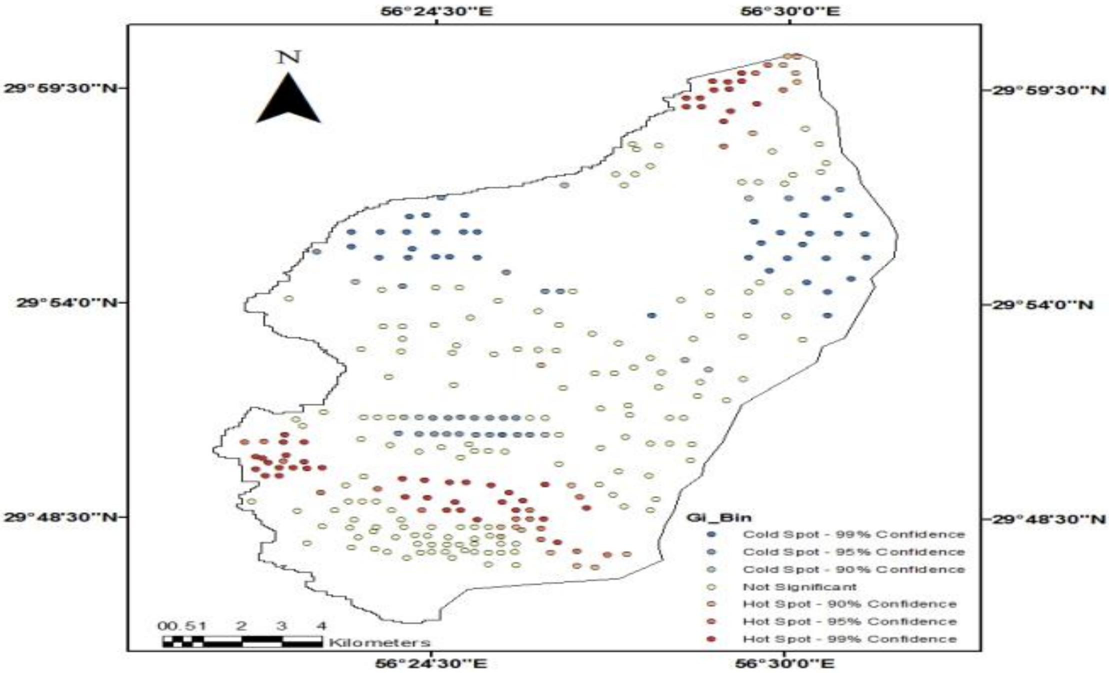

Fig. 2. Ecosystem hotspots (red circles) and coldspots (blue circles) base on carbon sequestration in Baghbazm region of Bardsir city

Table 3. Mean of carbon in hotspots and coldspots and their plots distribution (%) in rangeland types

Class	Carbon (T/ha)	*Zy-Ar*	*Ar*	*Ar-Pt*	*Ar-Sal*	*As-St*
Hotspots	65.34±34	78	0	11	0	11
Coldspots	23.78±13	0	12	0	88	0

Table 4. PCA for defining effective factors in hotspots

Factors	Eigenvector	
	Axis1	Axis2
Life form	**-0.396**	0.126-
Slop	0.243	-0.132
Elevation	0.287	-0.265
Clay%	**0.388**	0.164-
Vegetation cover	0.210	**0.312-**
Sand%	0.214	-0.221
EC	0.121	0.176-
pH	-0.134	0.176-
Aspect	0.137	-0.143
Silt%	0.123	0.102-
Eigenvalue	3.89	1.04
% Variance	57.01	19.48

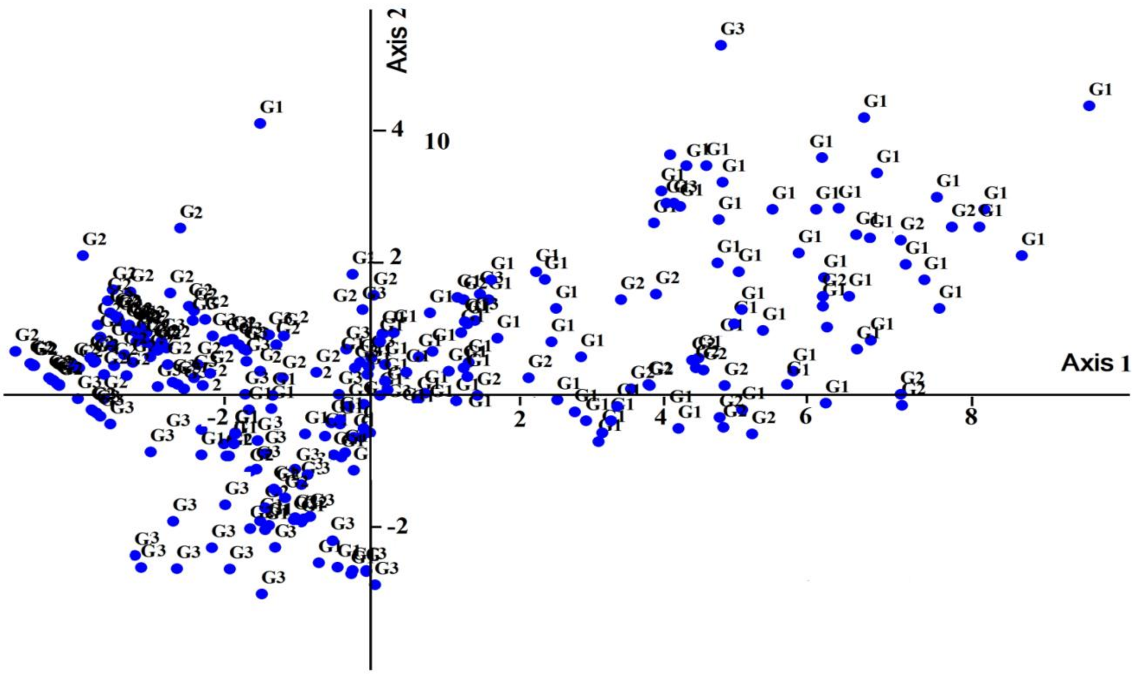

Fig. 3. Scatters of hotspots (G_1), intermediate (G_2) and coldspots (G_3) in PCA axis 1 and 2

Discussion and Conclusion

Rangeland types had significant effect on carbon sequestration as *Zygophyllum eurypterum-Artemisia sieberi*, *Artemisia sieberi-Pteropyrum aucheri*, *Astragalus microcephalus –Stipa barbata*, *Artemisa sieberi* and *Artemisia sieberi- Salsola brachiata* contained from the highest to the lowest carbon sequestration. Soil carbon included almost 70 percent of the total carbon sequestration. Bahrami *et al.* (2013) also concluded that rangeland types provided different carbon sequestration. Abdi *et al.* (2008) founded that soil carbon included more than 94 percent of the total carbon and introduced soil as the most important carbon storage in the *Astragalus* community. Snorrason *et al*. (2002) reported that the amount of carbon sequestration was 157 (T/ha) in a grazing pasture over a period of 32 years and soil carbon had the largest carbon in carbon sinks. Bai *et al.* (2009) showed that shrubland is more capable than grassland to sequestrate carbon. Shrubs with their root systems and shading canopies can create high nutrient patches and can alter the environment nearby, thus affecting arid and semiarid land functions (Ehrenfeld *et al.,* 2005). Eldridge *et al.* (2011) also reported that shift in ecosystem structure from grassland to shrubland changes the spatial distribution of soil resources and shrub covers enhance soil carbon by making fertile islands especially in ecosystems that experience high temperatures and evapotranspiration.

According on results, *Zygophyllum* eurypterum-Artemisia sieberi has the most valuable for carbon sequestration hotspots also small parts both *Astragalus microcephalus –Stipa barbata* and *Artemisia sieberi-Pteropyrum aucheri* as hotspots are valuable area to conserve and to attention in rangeland management. Majority of *Artemisia sieberi-Salsola brachiate* and small parts of Artemisia sieberi were coldspots and need special attention because by investing exclusively in hotspots and ignoring coldspots the risk is to lose large, natural and ecologically important areas that contribute too many ecosystem services (Kareiva and Marvier, 2003). PCA showed that the life form, clay and vegetation cover are the most important factors in determining carbon hotspots.

Zygophyllum eurypterum-Artemisia sieberi and Artemisia sieberi-Pteropyrum aucheri had the largest carbon content;we can conclude that rangeland types demined with phanerophyte species have more successful than other rangeland types to sequestrate carbon. Although carbon above and underground biomass in both Zygophyllum eurypterum-Artemisia sieberi and Artemisia sieberi-Pteropyrum aucheri are same amount and litter carbon even in *Artemisia sieberi-Pteropyrum aucheri* is more than Zygophyllum eurypterum-Artemisia sieberi, but Zygophyllum eurypterum-Artemisia sieberi has been more successful than Artemisia sieberi-Pteropyrum aucheri to sequestrate carbon because of soil carbon. Soil organic carbon formation and dynamics is complex and might not necessarily be increased by increasing the total biomass stock, because it is dependent on multiple interactions between climate, soil biological and physical factors such as, in arid and semiarid ecosystems with high levels of solar radiation, low litter inputs, and low levels of microbial activity, the direct abiotic mineralization of litter to carbon may be a major mechanism for litter decomposition (Gallo *et al.*, 2006). Previous studies on carbon also illustrated the importance of soil texture on carbon soil (Galantini *et al.*, 2004). Due to, heavy soil texture more than light soil texture has a positive impact on soil carbon storage. Clay particles as physical protections can improve composition of organic matter but decomposition rate in sandy soil is lower (Van veen *et al.*, 1991). Bahrami *et al*. (2013) founded clay is the important effective factor for soil carbon in arid and semi-arid rangeland. Although results of Abdi et al. (2008) indicated in Astragalus community the carbon content raised with increasing the percentage of rock and gravel in soil because of Astragalus adaptation to this kind soil texture. It was concluded although rangeland types demined with phanerophyte species had a greater probability of being identified as carbon sequestration hotspots, soil characters also play effective role to stock carbon in semiarid rangeland ecosystems.

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تعیین مناطق مهم ترسیب کربن در مراتع نیمه خشک (مطالعه موردی: منطقه باغبزم شهرستان بردسیر، استان کرمان)

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چکیده. ترسیب کربن در اکوسیستم‌های مرتعی به عنوان یک راهکار مناسب برای خنثی کردن انتشار گازهای گلخانه‌ای است و آگاهی از مناطق مهم ترسیب کربن یک ابزار خوب برای بهبود مدیریت اکوسیستم‌های مرتعی است. در این مطالعه به بررسی پتانسیل ترسیب کربن در تیپ‌های گیاهی مختلف، شناسایی مناطق مهم ترسیب کربن و تعیین فاکتورهای محیطی موثر بر مناطق مهم اکوسیستم مراتع نیمه خشک استان کرمان پرداخته شده است. در ۳۰۰ پلات ۲m×۲m که به صورت تصادفی در تیپ‌های مرتعی در سال ۱۳۹۳ پراکنده شده‌اند، میزان کربن در بیوماس هوایی، زیرزمینی، لاشبرگ با استفاده از روش احتراق و کربن خاک با استفاده از روش والکی-بلاک تعیین شد. نتایج نشان داد که تیپ‌های مرتعی تاثیر معنی داری بر میزان ترسیب کربن دارند به طوریکه ***Zygophyllum eurypterum-Artemisia sieberi*** ، ***Artemisia sieberi-Pteropyrum aucheri*** ، ***Astragalus microcephalus –Stipa barbata*** ، ***Artemisia sieberi*** و ***Artemisia sieberi- Salsola brachiata*** به ترتیب با ۶۵/۸۴، ۵۳/۹۲، ۴۳/۳۲، ۳۳/۱۷ و ۲۴/۷۷ تن در هکتار، محتوی بیشترین تا کمترین میزان ترسیب کربن بودند. مناطق مهم و کم اهمیت ترسیب کربن با استفاده از آنالیز مناطق مهم ترسیم شدند. به طوری که تیپ ***Zygophyllum eurypterum-Artemisia sieberi*** و بخش‌هایی کمی از دو تیپ ***Artemisia sieberi-Pteropyrum aucheri*** و ***Astragalus microcephalus –Stipa barbata*** با میانگین ۶۵/۳۴ تن در هکتار، جزء مناطق مهم ترسیب کربن بودند. اکثر قسمت‌های تیپ ***Artemisia sieberi- Salsola brachiata*** با بخشهای کمی از تیپ ***Artemisia sieberi*** با میانگین ۲۳/۷۸ تن در هکتار، جزء مناطق کم اهمیت ترسیب کربن بودند. آنالیز مولفه‌های اصلی نشان داد که فرم رویشی، رس و درصد تاج پوشش از مهمترین فاکتورهای موثر در شناسایی مناطق مهم ترسیب کربن می‌باشند. به طوری کلی می‌توان چنین نتیجه‌گیری کرد اگر چه تیپ‌های مرتعی با غالبیت گونه‌های فانروفیت احتمال بیشتری دارند که جزء مناطق مهم ترسیب کربن باشند، اما خصوصیات خاک هم نقش موثری در میزان ذخیره کربن اکوسیستم‌های مرتعی نیمه خشک دارد.

کلمات کلیدی: آنالیز مناطق مهم، کربن، خاک، فانروفیت، کرمان