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Carbon Stock Change Between 1970 And 2009 In Mixed Fir Forests (A Case Study - Saraycık Forest Management Chiefdom)

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Abstract

In recent days, climate change is a main global problem which concerns the scientists. Climate change is defined as the change of global mean temperature. While the reasons for global climate change were investigated, the effect of CO_2, which is the most important greenhouse gas, was found. In the world the oceans and forests are the biggest carbon sinks. So the forests are very important for climate change and carbon storage. 75% of carbon was stocked by plants in the forests.

In this study, we aimed to determine the carbon stock change between 1970 and 2009 in Saraycık Forest Management Chiefdom using the carbon conversion coefficient calculated for Turkey's forests by Asan (2002). The stand type maps and forest management plans produced in 1970 and 2009 were digitized for calculating the carbon stock. In addition the carbon stock maps were produced with ArcGIS 10.0 software.

Keywords: Carbon stock change, Stand type maps, GIS

Introduction

Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. It may be a change in average weather conditions, or in the distribution of weather around the average conditions (i.e., more or fewer extreme weather events). Climate change is caused by factors that include oceanic processes (such as oceanic circulation), variations in solar radiation received by the Earth, plate tectonics and volcanic eruptions, and human-induced alterations of the natural world; these latter effects are currently causing global warming, and "climate change" is often used to describe human-specific impacts (URL-1).

Scientists actively work to understand past and future climate by using observations and theoretical models. Borehole temperature profiles, ice cores, floral and faunal records, glacial and periglacial processes, stable isotope and other sediment analyses, and sea level records serve to provide a climate record that spans the geologic past. More recent data are provided by the instrumental record. Physically based general circulation models are often used in theoretical approaches to match past climate data, make future projections, and link causes and effects in climate change (URL-1). While the reasons of global climate change were investigated, the effect of CO_2, which is the most important greenhouse gas, was found. In the world the oceans and forests are the biggest carbon sinks.

Forest ecosystem carbon sequestration is of particular interest to researchers and policy makers because, at global scales, forest account for 80-90% of terrestrial plant carbon and 30-40% of soil carbon (Harvey, 2000; Landsberg & Gower, 1997). Estimating large-scale forest ecosystem carbon budget is complicated because of the difficulty of quantifying the impacts of both natural environmental variability and human disturbances (Sivrikaya et. al., 2006). Humans beings are accelerating the rate of increase in atmospheric CO_2 concentration through fossil fuel burning, land use, land use changes and forestry activities resulting in global warming and climate change during recent times. The direct effects of land use and land use changes have been estimated to cause a net emission of 1.7 +-0.8 Gt carbon/year and 1.6 Gt carbon/year during the 1980s and 1990 (Houghton, 1999; Houghton et al., 2000)

In this study, we aimed to determine the carbon stock change between 1970 and 2009 in Saraycık Forest Management Chiefdom.

Materials and Methods

Study Area

This study covered the forested area in Kastamonu Regional Directorate of Forestry, Saraycık Forest Management Chiefdom, Turkey. Almost all forest area in Saraycık Forest Management Chiefdom has been covered by pure black pine, mixed black pine-Scots pine, mixed black pine-Scots pine-fir, mixed-Scots pine-fir, pure fir and pure beech forests.

Materials

For this study the 1970 and 2009 editions of forest management plans, stand maps, topographical maps were digitized using ArcGIS 10.0 software. After that a database was generated and forest management plans data (e.g. stand volumes, stand types, etc.) were saved on this database. Stand type map for the forest management plan of 1970 is shown in Fig 1 and stand type map for the forest management plan of 2009 is shown in Fig 2.

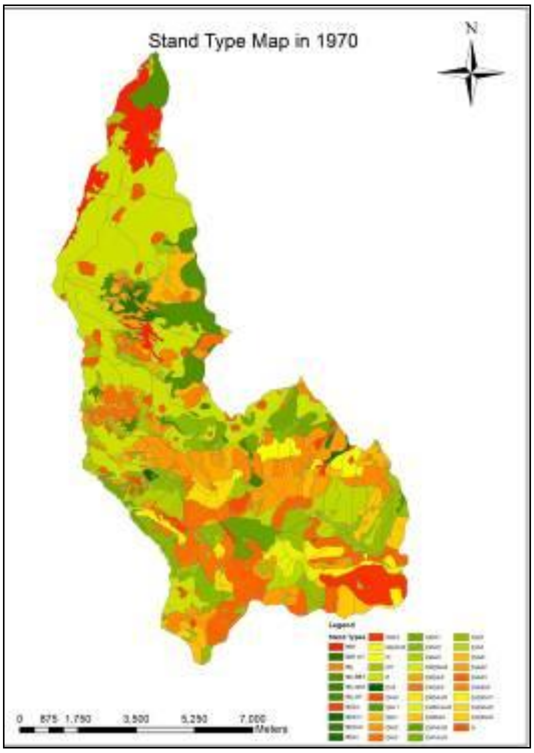

Fig. 1. Stand type map for 1970

Methods

In this study, carbon storage capacities of broadleaved and coniferous species were estimated separately. Biomass and carbon storage capacity for each stand types was calculated using allometric equations from Asan (2002):

Aboveground Biomass (deciduous) = Stand volume x 0.640 x 1.25

Aboveground Biomass (conifers) = Stand volume x 0.473 x 1.20

Belowground Biomass (deciduous) = Aboveground Biomass (deciduous) x 0.15

Belowground Biomass (conifers) = Aboveground Biomass (conifers) x 0.20

Aboveground litter and weed Biomass = (Aboveground Biomass + Belowground Biomass) x 0.40

Aboveground and belowground General Biomass = (Aboveground Biomass + Belowground Biomass + Aboveground litter and weed Biomass)

Carbon Amount of Total Biomass = Aboveground and belowground General Biomass x 0.45

Carbon Amount of Forest Soil = (Aboveground and belowground General Biomass x 0.45) x 0.58

Total carbon = Carbon Amount of Total Biomass + Carbon Amount of Forest Soil

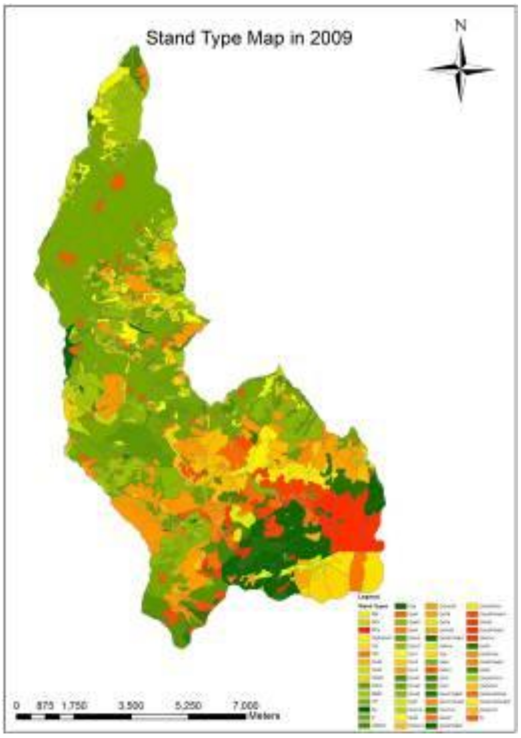

Fig. 2. Stand type map for 2009

Results and Suggestions

The total carbon storage was 527,790.11 t in 1970 and 1,006,527.581 t in 2009. Stand types and their total carbon storage capacity in 1970 is shown in Table 1. Carbon storage capacity map of stands in 1907 and 2009 is shown in Fig. 3 and 4. Stand types, their areas and total carbon storage capacity in 2009 is shown in Table 2.

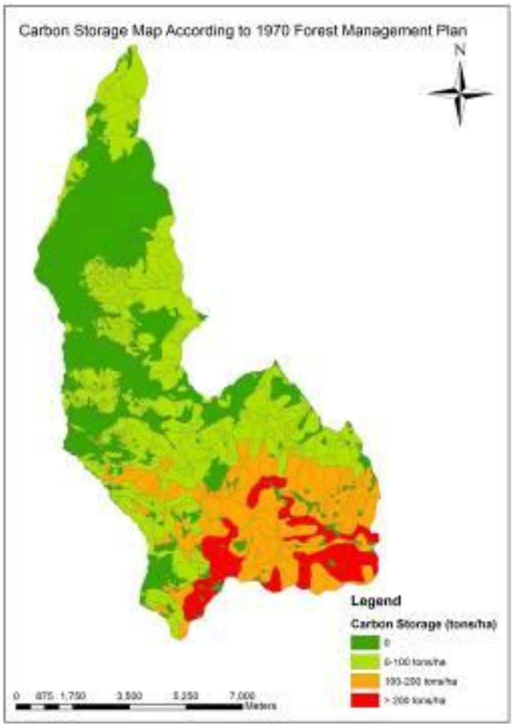

Fig. 3. Carbon storage capacity map according to the 1970 Forest Management Plan

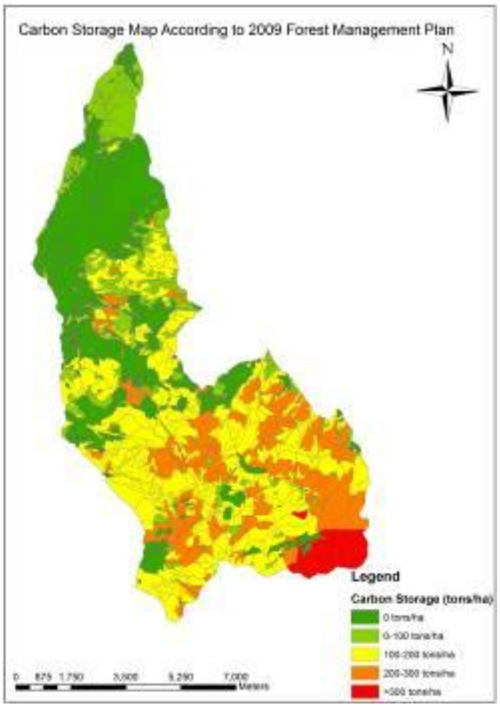

Fig. 4. Carbon storage capacity map according to the 2009 Forest Management Plan

Table 1. Stand types and their carbon storage capacity in 1970

Stand Types	Total Carbon (t)	Area (ha)	Stand Types	Total Carbon (t)	Area (ha)
Settlement	0	130.16	Çkbd2	33090.91	351.52
O	0	1.67	Çkbd3	14073.83	92.50
Forest soil	0	437.46	ÇkÇsb2	4241.301	57.75
Agricultural	0	2221.33	ÇkÇsb3	24706.84	173.31
BBT	536.74	329.86	ÇkÇsbd2	5111.885	51.33
BBT-OT	101.58	62.43	Çsb2	29551.7	284.00
BÇ	2178.89	155.88	Çsb3	49505.9	283.75
BÇ-BBT	1134.11	405.81	Çsbd1	3877.804	83.14
BÇKn	1822.97	52.74	Çsbd2	33630.95	310.38
BÇKn1	0.00	10.24	Çsbd3	97278.07	443.11
BÇKn2	0.00	6.36	ÇsÇkb2	17383.91	224.46
BÇ-NNT	36.27	12.98	ÇsÇkbd1	6738.87	131.22
BÇ-Forest S.	224.66	86.41	ÇsÇkbd2	8336.905	103.06
Ça3	0.00	7.95	ÇsÇkbd3	1211.298	8.37
Çka3	0.00	41.67	ÇsGbd3	27432.89	167.17
Çkb 1	289.73	9.41	ÇsGKnbd3	16467.79	92.67
Çkb1	9445.73	306.66	ÇsKnbd2	18896.32	122.25
Çkb2	25534.04	352.94	ÇsKnbd3	412.7996	2.85
Çkb3	23546.94	249.50	GÇsbd3	22687.29	114.25
Çkbd1	8800.25	192.34	Gdb3	39500.94	179.79
			Total	**527790.11**	**8350.68**

Table 2. Stand types and their carbon storage capacity in 2009

Stand Types	Total Carbon (t)	Area (ha)	Stand Types	Total Carbon (t)	Area (ha)
Settlement	0.00	924703.51	Çkcd3	107984.30	469.8967
BÇk	2253.69	3328938.87	ÇkÇsc3	29909.75	143.0163
BÇs	344.83	424147.07	ÇkÇscd3	40912.73	176.2766
BM	866.19	1351311.27	Çkd1	893.61	11.1085
Çka	0.00	211988.89	Çkd1/a	1324.87	50.24886
Çka3	0.00	90869.41	Çkd2	2963.98	15.81029
Çkab3	5700.66	1663874.27	ÇkMa3	0.00	37.71867
Çkb3	2261.94	393436.52	Çsa	0.00	14.70686
Çkbc2	25024.61	1807372.91	Çsa3	0.00	18.64168
Çkbc3	37597.71	2219146.84	Çsbc3	5066.21	41.61342
Çkc1	6525.72	1040622.80	Çsc2	1992.41	12.8113
Çkc2	17780.01	1379906.85	Çsc3	33546.72	181.1939
Çkc3	116643.22	6529511.68	Çscd1/Gab3	13380.87	794333.2526
Çkcd1	7533.63	978449.17	Çscd1/Knab3	5610.59	416760.2923
Çkcd2	72311.22	4579801.44	Çsd3	12065.55	477825.7362
Çscd2	19045.31	1176328.76	ÇsGa	0.00	509349.7608
Çscd2/Gab3	90301.99	4774641.65	ÇsGB	8164.38	284454.5054
Çscd2/Kna	18519.21	1067353.36	ÇsGcd3	11276.79	405698.2577
Çscd2/Knab3	6218.66	494181.13	ÇsGd1/Gab3	13067.77	443465.3235
Çscd3	36430.11	1648133.18	ÇsKna	0.00	301426.7806
Çscd3/Gab2	69913.99	2732762.63	DyGnKnd1	281.48	85379.26739
ÇsÇkcd2	5559.16	402945.34	GA	39748.55	1016746.329
ÇsÇkcd2/Kna	6960.20	456364.38	Gcd3	3128.95	86912.75687
ÇsÇkcd2/Knab2	14001.23	746226.17	GÇsB	44157.51	1150609.026
ÇsÇkcd3	19940.08	962096.67	GD	16008.26	474016.1678
ÇsÇkKnbc3	1590.72	121652.71	Gnb3	250.49	46281.675
Çsd1/a	1396.98	151555.97	Knb3	6095.74	521546.4498
Çsd2	10680.43	455096.11	Mab3	1733.89	615294.6023
Çsd2/Kna	7408.96	437382.61	Forest soils	0.00	1376253.047
Çsd2/Knab2	2407.27	180617.19	Water	0.00	298527.2379
Çscd1/a	1744.45	121910.04	Agricultural	0.00	19618190.47
			Total		**8350.68**

Different management regimes and silvicultural applications affect the sequestered carbon of forest. This subject is important for investigating the best way to mitigate green house and global warming effects. This study shows that the carbon stored in above and belowground biomass has increased with 478737.471 t between 1972 and 2002. The result is the increase of productivity and stand volume in these productive forests.

We generally use generated equations to calculate the carbon storage capacity. Nowadays, regression models generated for each tree species are used to calculate the carbon storage capacity. These models determine the carbon storage capacity more accurate than equations so they should be generated for each tree species.

Otherwise, new satellite images which were sensitive for the carbon maybe used to calculate carbon storage capacity.

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