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Investigation on Above-Ground and Soil Carbon Sequestration in Poplar Plantations of Guilan Province

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1. Abstract

Forests are regarded as an economically viable solution to reduce greenhouse gas emissions and mitigate climate change. Carbon sequestration in forests is accomplished through surface and underground biomass as well as soil, which are interconnected and important sources of carbon storage. This study models and estimates the stand stock and soil carbon sequestration potential in *Populus deltoides* plantations in Gilan province, Iran, using direct calculations based on stem analysis and plant biomass. Four poplar plantations were selected, and a one-hectare plot was sampled in each plantation. DBH and total height of all trees were measured in each plot, and two poplar trees were randomly selected and cut for analysis. Stem analysis, wood biomass determination, and carbon measurement were conducted. In each plot, soil profiles were dug, and samples were taken to measure the physiochemical properties. The results showed that Shaft had the highest density (N/ha) (326), followed by Siahkal (216), Langrud (129), and Talesh (190), respectively. Stand tree stem carbon content (tons per hectare) was the highest in Talesh with 52 tons per hectare, followed by Shaft (38.7), Siahkal (28.3), and Langrood (24.16). Allometric equations were established based on the highest correlation coefficient (r^2) and the lowest standard error value (SE) between age as the independent variable and carbon as the dependent variable. Calculation of carbon sequestration in plantation stand stock and soil can provide insights into species function and their responses. Furthermore, comparing carbon sequestration in different sites can aid in the restoration of degraded lands and the conversion of such lands into high-yield plantations, which can be an effective measure in managing carbon sequestration using fast-growing species.

Keywords: Carbon Sequestration, Climate Change, Modeling, Stem Analysis

Introduction

Carbon capture and storage is a vital process in the global fight against climate change. By absorbing and storing carbon dioxide emitted from fossil fuels from various industries and power plants in the atmosphere, the greenhouse effect is prevented, this process is called carbon sequestration. Forests are known to be the least expensive method from an economic point of view to reduce greenhouse effects and climate policies related to carbon balance. Carbon sequestration in forests is carried out by above-ground and underground biomass as well as soil, which are important sources of carbon storage. Therefore, in order to reduce carbon in the atmosphere, the policy of developing forests through afforestation can be used. The Kyoto Protocol and the Paris Agreement have emphasized forestry activities to reduce greenhouse gases during the Clean Development Mechanism. The potential of carbon sequestration to contribute to climate goals depends not only on the size of carbon stocks but also on the comparative costs of using fossil fuels, so that studies have shown that the marginal cost of increasing carbon stocks is significantly lower than the cost of measures to reduce carbon emissions in the atmosphere. Nowadays, the issue of carbon sequestration and bioenergy production against fossil fuels is of great concern to governments, and many efforts have been made to reduce or control carbon dioxide emissions in this way. In this regard, it is necessary to pay attention to the optimal management of forests in order to preserve and store carbon (Assmuth & Tahvonen, 2018).

2. Materials and Methods

2.1 Study area

Four poplar plantations were selected from east to west of Guilan Province in North of Iran. The areas located in Siahkal, Langrud, Shaft and Talesh.

2.2 Methods

A single plot with area of 1 ha was sampled in each district (Arora et al., 2014; Mohammadi et al., 2017) after study of planning of the plantations that prepared by Department of Natural Resources and Watershed Management. The location of the plots determined randomly, because the plantations were homogenous. The diameter at breast height (dbh) and height of all trees were measured in each plot. In total, 30 trees were destructively sampled, with regular distribution in diameter classes (Wang, 2006; Segura et al., 2006). In order to estimate the stem volume, discs are chosen from different height of each tree. Stems were cut into 2.3 m sections. At the end of each stem section, 8 cm thick disc was cut and taken to the laboratory for analysis. The surface of each disc was sanded smooth in order to reveal the growth rings. The rings were analyzed for annual increment (Metsaranta and Bhatti, 2016). Annual diameter increment of tree-ring data are used to estimate the annual increment of tree.

The sampled discs were weighted and taken to the laboratory where square sub-samples of 4 cm×4 cm ×4 cm were oven-dried at 100 ◦C to constant mass and the dry mass determined with an electronic balance (Henry et al., 2010). The percentage of organic carbon of disc samples was determined by combustion in an electric oven (Arora et al., 2014). The amount of CO_2 sequestrated when the biomass increased by one unit per age (t CO_2/t).

In order to check the soil in detail, a soil profile was also dug in each of the sample pieces. After removing the litter layer, soil samples were taken from the depths of 0-20, 20-40, 40-60 and 60-80 cm.

3. Results

The results showed that Shaft had the highest density (N/ha) (326), followed by Siahkal (216), Langrud (129), and Talesh (190), respectively. Stand tree stem carbon content (tons per hectare) was the highest in Talesh with 52 tons per hectare, followed by Shaft (38.7), Siahkal (28.3), and Langrood (24.16). Allometric equations were established based on the highest correlation coefficient (r^2) and the lowest standard error value (SE) between age as the independent variable and carbon as the dependent variable.

The calculation of the amount of carbon in tree stems and soil showed that Talash region had the highest amount (trunk carbon 52 and soil carbon 54.88 tons per hectare), followed by

shaft areas (38.7 and 36.14 tons per hectare). hectare), Siahkol (28.3 and 12.79 tons per hectare) and Langrod (24.16 and 19.8 tons per hectare).

4. Discussion

Calculation of carbon sequestration in plantation stand stock and soil can provide insights into species function and their responses. Furthermore, comparing carbon sequestration in different sites can aid in the restoration of degraded lands and the conversion of such lands into high-yield plantations, which can be an effective measure in managing carbon sequestration using fast-growing species.

Using the method of biomass estimation in terms of allometric equations will be much more economical in terms of cost and time than direct measurement, and allometric relationships for estimating the carbon storage in the wood tissue of the trunk are much stronger than Other non-wooden organs were determined to be more accurate. Because the biomass of the stem is more stable than the dynamic changes of the habitat.

A study on carbon sequestration in tree stems and forest soil will lead to conclusions about the mode of action and the effect of species. Also, the comparison of carbon sequestration in different habitats can be a significant help in rehabilitating degraded and eroded lands, turning them into productive forestry and preventing carbon wastage, and is an effective step in managing carbon sequestration with Forestry will be used with fast growing species. It is suggested that similar studies be conducted in natural habitats and the field of comparison with hand-planted species and their effectiveness should be defined and reported more in advance.

Conflicts of Interest

The authors declare no conflict of interest.