Economic Valuation of Annual Carbon Sequestration Potential for Woody and Shrubby Land Cover

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ABSTRACT

The manners in which natural resources are exploited lead the conviction that such unmatched assets are about to decline. Unfortunately, humans, either consciously or unconsciously, degrade ecosystems with unsustainable rapid development and this has caused them to backslide. Obviously, lack of awareness regarding the economic values of all goods and services offered by natural ecosystems as well as non-interfering them through cost-benefit analysis will lead to choosing the options followed by destruction of environment. Indeed, knowing the economic values of natural resources for those whom decisions somehow affects the environment is absolutely essential in order to obtain the optimal decision. The current study was carried out with the aim of valuating carbon sequestration in shrubs and trees to find out their real economic role in human's life. Accordingly, Latyan Watershed was selected as a case study area. It is noteworthy that the method provided by the United States Department of Energy was applied to estimate carbon sequestration through the area. The obtained results indicated that around 3,699 tons of carbon dioxide is annually sequestered in the whole area. On this basis if the sequestering price of carbon per ton is considered $ 20, the economic role of the land cover in sequestration of carbon dioxide will be tantamount to $ 73,980 in the entire study area. Generally, it can be concluded that all forests have conceal economic values which are usually neglected by economists and decision makers.

Key words: Carbon sequestration, woodland, shrub land, valuation, Latyan dam

INTRODUCTION

Now-a-days, it has been proved that destruction of ecosystems and deterioration of quality and quantity of services offered by ecosystems has negative effects on the current economic growth (Chandra et al., 2011). Alongside, it also influences on the economic capacity toward a sustainable growth in the future (Islam and Swar, 2010). Therefore, selecting the best land use in accordance with carrying capacity as well as applying appropriate methods for utilization of land have been the main concern of planners in recent decades (Venkatachalamm, 2004; Aticho and Elias, 2011; El-Nahry and Khashaba, 2006; Sultana et al., 2000; Al-Mashreki et al., 2010). The important point is that in many cases, necessary tools to meet demands and solve problems are not covered
thoroughly by any scientific discipline. For instance, the traditional economy and ecological concepts do not have the required efficiency to deal with global and ecological issues. As a result, it is worth mentioning that there is an obvious need to achieve a new kind of studies based on the relationship between ecosystems and economic systems, with cross-disciplinary nature. Thus, the economic valuation of ecosystem services should be considered in the decision making process (Sutton and Costanza, 2002; Knauer et al., 2006). On the other hand, the most important challenge in economic valuation is to quantify ecosystem functions in such a way that it has the valuation capabilities. However, the issue faces some difficulties such as the complexity of the ecosystems, disability to quantify ecosystem services and challenges associated with integration of economic and ecological analysis (Schaeffer, 2009). It is needless to mention that lack of awareness of the values of all products and services (especially economic values) offered by natural ecosystems and its components, moreover, not being considered them cost and benefit calculations lead to selection of options which cause the nature and environment to be destructed (Bariol and Loureiro, 2010). Indeed, it is absolutely necessary for those whose decisions affect the environment to have information about the economic values of all goods and ecosystem services in order to make the best decision. Economic development experiences in different countries have demonstrated that along with the population growth and urban development, the quality and quantity of environmental resources have declined. Air pollution as one of the aspects of environmental pollution, in the regional dimension affects human health in the form of acid rain and in the global dimension causes global warming and greenhouse gas emissions (Chehregani et al., 2004; Syed et al., 2000). The consequences of decisions may impose an impact on future generations. Unfortunately, the consequences are not taken seriously. The provisions of the conventions, such as the Montreal and Kyoto and etc., not only pay serious attention but also are constantly undermined. In this respect, Russia’s unilateral action upon the withdrawal from the Kyoto protocol in the last month of 2003 can be a good example (Karami, 2003). Based on a report by the United Nations, temperature fluctuations and the rainfall affect the climate change which causes a loss equal to 400 billion dollars. The mentioned fluctuations in each region should supposedly be influenced by factors such as latitude, altitude and ocean currents. However, the excessive concentrations of greenhouse gases in the atmosphere with solar energy confinement can speed up the process of climate change. Therewith, the forenamed process can change the effectiveness of the mentioned above factors and bring undesirable consequences (Common and Sigrid, 2005). The limitation of the natural resources, human unlimited needs and the trustee for the next generation draws human attention to the fact that the right strategic decisions must be adopted for proper management of resources (Anya and Ayuk, 2011).

The undeniable fact is that the economy is not going to be sustainable unless paying enough attention to ecological issues at different scale.

Due to the climatic characteristics of Iran and low levels of forest being considered as a carbon sink, if the calculations of environmental economics do not count in decision making, the sustainable future of Iran's industrial economy will face lots of difficulties. Currently, it is estimated that the amount of carbon dioxide gas (CO₂) has increases in the atmosphere compared with before the industrial revolution and due to its long lifetime, this causes about 60% of global warming (Common and Sigrid, 2005). Carbon dioxide emissions and the consequences of its release are of great importance at international scale and the producers' supplies are different in each country.
according to their conditions. Unfortunately in the current situation, the emissions of greenhouse gases and in particular, carbon dioxide is significant in Iran due to the exhaustion of the applied technologies and high consumption rate of energy carriers. In terms of being committed to the treaty such as Kyoto, it is essential to take actions for managing the decisions properly in the country. Due to the specific features of Caspian forests, most of studies and researches have been focused on this region. In the meanwhile, in Iranian and Turanian forests which have further conservative uses and assign itself considerable area in the country, fewer researches have been done.

Unfortunately in our country the decisions are taken based on the traditional economic approaches and the environment economy is not regarded in the policy and decision making process. Hence, it is essential to make decisions in line with the country's sustainable development by the usage of the findings obtained from several studies.

The current study aims at economic valuation of annual carbon sequestration potential for woody and shrubby land cover in the watershed of Latyan Dam. As regards a vast area of the surface land cover has been drawn in water and completely destroyed, along side the remained land cover is excessively harvested, the land cover is currently deteriorated. Thereby, the findings of the research will clearly specify the importance of the land cover from protective point of view. By clearance of the economic values of the land cover, it is hoped to the accelerative deterioration status of wool and shrub land is urgently stopped.

MATERIALS AND METHODS
The study area: The watershed of Latyan Dam (study area) is located in the southern part of Central Alborz (DOE, 2001). which has a rich and varied land cover. The dominant figure of the land is mountain steppe with the presence of various species such as Astragalus, perennial Gramynh, cushion species like sainfoin and Acantholimon in the upper elevations and sagebrush, Rivas and many other species of wild flowers at the lower elevations. There are a shrub species such as mountain almond, rock spray, Cerasus microcarpa, Amygdalus lycioides, egantine, barberry etc., in the form of rangeland types. In the margins of the streams and wet areas, the dominant species usually consist of dense groups of trees such as tamarisk, willow, spruce, sea-buckthorn and they are sometimes accompanied with shrubs such as egantine, rock spray and raspberry. In addition, in some hillside, trees and shrubs become the dominant vegetation type and form the forest species. Figure 1 demonstrates the situation of the study area.

Calculation methods of carbon dioxide sequestration in plant species: Carbon sequestration is of great importance owning to this fact that it can be a way to reduce greenhouse gases in the atmosphere (Smith, 2004; Litynski et al., 2008; Lasco et al., 2002). If carbon dioxide is considered as an international business product, then monitoring the amount of carbon sequestration by projects is also a chief component in each trading system (Xu et al., 2007; De Jong et al., 2000; Cannell, 2003).

Presently, efforts in order to estimate the amount of carbon sequestration have two general aspects. One aspect is related to the studies which can be done with multiple defaults due to lack of necessary and sufficient data (Albrecht and Kandji, 2003; Benitez et al., 2007;
Fig. 1: The situation of the study area

Cantarello et al., 2011; Franzluebbers, 2005; Thomson et al., 2008) and another aspect takes very extensive researches which are so costly and require a lot of specialization (Henry et al., 2006; Rokityanskiy et al., 2007). The point that should be noted is that the carbon sequestration measurement with different methods gives different results and this case has been reported several times (Pan et al., 2008; Yadav et al., 2009; Wang et al., 2011; Palmer and Silber, 2012).

In this study, in order to calculate the sequestration amount of carbon dioxide in plant species, the method provided by the USDE (1998) was used. Here, is a brief explanation of the method.

First of all, a table with different columns is made and species name is written in column A. Column B is determiner of species growth rate and coverage types in terms of wood if the information is not available, moderate can be assumed with hardwood. In column C, the number of species is written and column D is representative of survival factor for each species. We extracted the survival factor from tables which has been formulated by the United States Department of Energy for the tree species regarding their characteristics (USDE, 1998). Column E that is the multiplication of column C and column D shows the number of surviving trees. Annual sequestration rates from the mentioned method is written in column F and eventually column G is the multiplication of columns E and F. The obtained number of column G represents the total sequestration of carbon in vegetation cover during a year and if it is aimed to determine the CO₂ level, this number should be multiplied by 3.67. Since the achieved weight is based on pounds unit, in order to convert it to metric tons, this number should be divided by 2000. The reason to use this method in this study is that using the simplified method does not require an official record from forestry according to Department of Energy. On the other hand, this method is not suitable to use in places with high densities of trees and highlands. However, this method was used due to the low density in the area and impossibility of using other methods owing to lack of information. It is notable that this method of measuring the annual carbon sequestration is able to be used for vegetation cover of in urban and suburb areas Table 1.
Table 1: Calculation of annual carbon sequestration of woody and shrubby land cover

<table>
<thead>
<tr>
<th>Species entry (A)</th>
<th>Growth rate (B)</th>
<th>Survival Number (C)</th>
<th>Factor (D)</th>
<th>No. of surviving trees (E)</th>
<th>Annual sequestration rate (F)</th>
<th>Sequestered (E×F) (G)</th>
<th>G&gt;3.67/2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pistacia-almonds</td>
<td>Average</td>
<td>17301</td>
<td>0.178</td>
<td>3079</td>
<td>83.0</td>
<td>255548</td>
<td>469</td>
</tr>
<tr>
<td>Elm</td>
<td>Average</td>
<td>15341</td>
<td>0.178</td>
<td>2730.6</td>
<td>83.0</td>
<td>220639</td>
<td>415</td>
</tr>
<tr>
<td>Cerasus avium microcarpa</td>
<td>Average</td>
<td>29766</td>
<td>0.232</td>
<td>6906.7</td>
<td>67.8</td>
<td>468206</td>
<td>859</td>
</tr>
<tr>
<td>Egglantine</td>
<td>Average</td>
<td>14863</td>
<td>0.232</td>
<td>3448</td>
<td>67.8</td>
<td>233774</td>
<td>428.9</td>
</tr>
<tr>
<td>Rhannus pallasii</td>
<td>Average</td>
<td>15032</td>
<td>0.178</td>
<td>2675.6</td>
<td>83.0</td>
<td>222074</td>
<td>407.5</td>
</tr>
<tr>
<td>and Colutea persica</td>
<td></td>
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<tr>
<td>Malus domestica</td>
<td>Average</td>
<td>15067</td>
<td>0.232</td>
<td>3495</td>
<td>67.8</td>
<td>236961</td>
<td>434.8</td>
</tr>
<tr>
<td>Tamarisk</td>
<td>Average</td>
<td>2</td>
<td>0.232</td>
<td>464</td>
<td>67.8</td>
<td>29832</td>
<td>0.067</td>
</tr>
<tr>
<td>Juniper</td>
<td>Average</td>
<td>13015</td>
<td>0.178</td>
<td>2138.6</td>
<td>70.8</td>
<td>151417</td>
<td>278</td>
</tr>
<tr>
<td>Lonicera iberica</td>
<td>Average</td>
<td>5926</td>
<td>0.178</td>
<td>1060</td>
<td>83.0</td>
<td>87993</td>
<td>161</td>
</tr>
<tr>
<td>Berberis</td>
<td>Average</td>
<td>9053</td>
<td>0.178</td>
<td>1611</td>
<td>83.0</td>
<td>133749</td>
<td>245</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3699</td>
</tr>
</tbody>
</table>

G: Total sequestration of carbon in vegetative cover during the year

Table 2: Calculation of monetary value of carbon sequestration in the study area

<table>
<thead>
<tr>
<th>Total sequestration of carbon in vegetation cover during a year A(ton)</th>
<th>Price of sequestered carbon per ton B($)</th>
<th>C = (A×B)($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3699</td>
<td>20$</td>
<td>73980</td>
</tr>
</tbody>
</table>

*multiply mark

RESULT AND DISCUSSION

Calculation of monetary value of carbon sequestration in the study area: To calculate the economic value of carbon sequestration, the amount of sequestration should be multiplied by the shadow price of carbon. Food and Agriculture Organizations (FAO) suggested a specific methodology for valuation of carbon sequestration in northern countries. Thereafter, by codifying and reviewing the methodology proposed by Intergovernmental Panel on Climate Change (IPCC) provided the estimation chance of carbon sequestration valuation for developing countries. Fankhauser (1994) estimated the monetary value of carbon sequestration 20$ based on shadow pricing (1995) for every ton of sequestered carbon with the assistance of this method. Since then, more researches and studies taken by various researchers have been referred to his estimation.

According to Fankhauser (1994), per ton of released carbon on the ground costs about 20$ for human economic activities. Consequently carbon sequestration by various factors has the same value as the above cost. On this basis if the price sequestered carbon per ton is considered $ 20, the price of sequestration of carbon dioxide will be $ 73,980 in the study area as it has been showed in Table 2.

CONCLUSION

According to the findings of this study, it can be concluded that Iranian and Turanian forests and any other forest have the value of wood production which has its own specific market. Furthermore, forests have other values including carbon sequestration which has no market base depending on the specific geographic locations. The absence of forests on a global scale can be found in synergy effects of greenhouse gases. Thereby, with destruction of each hectare of forest, not only natural wealth and its monetary value will be exhausted but also a range of ecosystem functions and services are going to be interrupted. Furthermore, the carbon sequestration and the damage dimensions should be sought in a global scale. In addition as Carbon sequestration calculations in
forest can function as an index of productivity of woodland habitat with exception of wood value. Therefore it can be considered in economic equations for sustainable forestry management. On the other hand, this study was done based on calculations of existing data and the minimum economic value in the study area. It seems that the completion of log data in study area has more value and it can have a very effective role in decisions and policies making with consideration of the study area conditions, having protected areas and communication of ecological habitat. Also it is significant to note that studying the carbon sequestration is actually a snapshot of the ecosystem at the time of getting data. Sutton and Costanza (2002) believes that understanding the operation method of regional landscape and how it’s acting and how it changes are of great significance for our decision making. So, it seems in order to achieve the goal of greenhouse gases management, it is essential to do researches in the field of ecosystem dynamics evaluation, ways to increase underground storage of carbon and optimizing land use for carbon sequestration.

REFERENCES


