AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/

Assessing the Context of Redd+ in Muree Hill Forest, Pakistan

[1]Waseem Razzaq Khan, [1]Muhammad Fahim Khokhar, [1]Sana Munawar, [1]Naila Yasmin, [2]Qurban Ali Panhwar, [3]Muhammad Nawaz Rajpar

[1]Institute of environmental sciences and engineering, Sector H-12, Main Campus National University of Sciences and Technology, 46000-Islamabad, Pakistan
[2]Department of land management, faculty of agriculture, University of Putra, 43400-Malaysia
[3]Recreation and Ecotourism Department, Faculty of Forestry, University of Putra, 43400-Malaysia

ARTICLE INFO

Article history:
Received 22 February 2015
Accepted 20 March 2015
Available online 23 April 2015

Keywords:
Vegetation Index, carbon stock, MODIS, REDD+, deforestation, LULUCF emissions

ABSTRACT

Reducing Emissions from Deforestation and Forest Degradation plus (REDD+) is a mechanism to cut down GHG emissions and protect threatened forest ecosystems. Forests uptake CO_2 from the air, which is constituted around 33% carbon emissions into the atmosphere due to human activities such as deforestation and degradation of forested land. Changes in land use pattern may release stored carbon into the atmosphere which is a major source of air pollution. Pakistan is facing higher deforestation rates due illegal logging, conversion into agricultural land and development of housing societies that had reduced the forest cover from 5.0% to 2.5 percent. The context of REDD+ due to deforestation in Muree Hill forest was examined from 2000 and 2012 employing MODIS vegetation indices (NDVI/EVI), land cover product MCD12Q1 and CO_2 emission inventory. Exisiting carbon stock data was used to quantify LULUCF emissions based on IPCC guidelines. The findings indicated an increase in vegetation index and an increase of forest cover by 57 percent based on MODIS land cover product. CO_2 emission results of EDGAR (Emission Database for Global Atmospheric Research) and REAS (Regional Emission inventory for Asia) highlighted an increasing trend and didn't not compare with calculated LULUCF emissions. Overall, outcomes of the study suggest that Murree hills forest is a storehouse of CO_2 and it has great potential for REDD+ implementation.

To Cite This Article: Waseem Razzaq Khan, Muhammad Fahim Khokhar, Sana Munawar, Naila Yasmin, Qurban Ali Panhwar, Muhammad Nawaz Rajpar., Assessing the Context of Redd+ in Muree Hill Forest, Pakistan. ***Adv. Environ. Biol., 9(6),*** *15-20, 2015*

INTRODUCTION

Forests cover around 3.8 billion hectares or 30% of total land area of the world [1]. They are the most important and productive ecosystem i.e., it may provide a diversity of tangible and non-tangible service for human beings. Forest plays a significant role in maintaining the natural environment such as regulate the hydrological cycle and reduced the soil erosion, regulate the micro-climate (i.e., temperature, relative humidity), harbor biodiversity and store carbon, livelihood (providing jobs and local employment), water (watershed protection, water flow regulation, rainfall generation), food, nutrient cycling and climate security etc. Standing forest hold a large carbon stock and sequester carbon from the atmosphere. Unfortunately, being highly valuable, the forest cover is decreasing day by day due to human activities such as illegal logging, conversion into agricultural fields and housing societies that ultimately has caused devastating effects on our environment. It has been stated that, around 6.8 million hectares of forest had been lost every year during the 1990 and 2005 [1]. It has been stated that the deforestation and degradation of tropical forests may contribute 12–20% of global carbon emissions in the atmosphere [3, 4, 5].

1.1. Concept of REDD+:

Reducing Emissions from Deforestation and Forest Degradation (REDD) is an effort to get financial value for the carbon stored in the forest, provide incentives for developing countries in order to halt the deforestation

Corresponidng Author: Dr. Muhammad Fahim Khokhar, Assistant Professor, Institute of environmental sciences and engineering, Sector H-12, Main Campus, National University of Sciences and Technology, 44000-Islamabad, Pakistan.
Ph: +92 -51 -90854308

Advances in Environmental Biology, 9(6) Special 2015, Pages: 15-20

and degradation to reduce the emissions of carbon from forested lands. REDD+ motivated the decision makers of the developing countries to protect the forest and get financial benefits improve the livelihood of forest-dependent communities. In 2008, United Nations initiated the REDD+ program to stop the emissions of carbon stored in the forest of developing through offering financial incentives. This program also targeted stakeholders for their capacity building to implement REDD+ mechanisms.

1.2. Pakistan's Forest Resources:

With a low forest cover of 2.5 percent relative to the international standard of 30 percent, Pakistan has a huge diversity of forests ranging from coastal mangroves to temperate conifer forests. This ecological set up is mainly due to arid and semi-arid climate prevalent in most part of the country. The total area covered by forest is 4.34 million hectares (Mha) or 5 percent. Natural forests account for 4.2 Mha whereas irrigated plantations occupy 103,000 ha. Forest area occupied by Sindh, Baluchistan, Punjab, Khyber Pakhtun (KPK), Azad Kashmir and Northern areas is 0.92, 0.33, 0.69, 1.21, 0.42, and 0.66m ha respectively. It is evident that most of the forests are distributed is in the northern part of the country with 40 percent in KPK, 15.7 percent in Northern Areas and 6.5 percent in Azad Kashmir. The Northern region of Pakistan mainly comprises of Alpine and temperate forests. Forests in Pakistan are diminishing at a rate of 27000 ha/year bringing it down from 5 to 2.5 percent.

1.3. REDD+ in Pakistan:

Pakistan is blessed with 2.19% forest area (6) which stored around 213 million metric tons of carbon. Pakistan is the member of the Coalition of Rainforest Nations and also signatory to the initial REDD+ proposal submitted by the Rainforest Coalition in 2008. To develop REDD+ readiness roadmap Pakistan joined UN-REDD Program in 2011 and has also initiated its REDD+ Preparedness phase, which is a collaboration between Climate Change Division of Pakistan, International Centre for Integrated Mountain Development (ICIMOD) and WWF-Pakistan. It is financially supported by the United Nation Development Program (UNDP) through One UN Joint Program on Environment (JPE).

MATERIALS AND METHODS

2.1. Study Area:

Murree is an exurb of Islamabad and the administrative center of Murree Tehsil, in the Punjab province in Pakistan with an area of 37977 ha. It is in a subdivision of Rawalpindi District and includes the parts of the Margalla Hills around Islamabad. It is located on the southern slopes of the Western Himalayan foothills as they ascend northeastwards at an average altitude of 2,291 meters (7,516 ft).

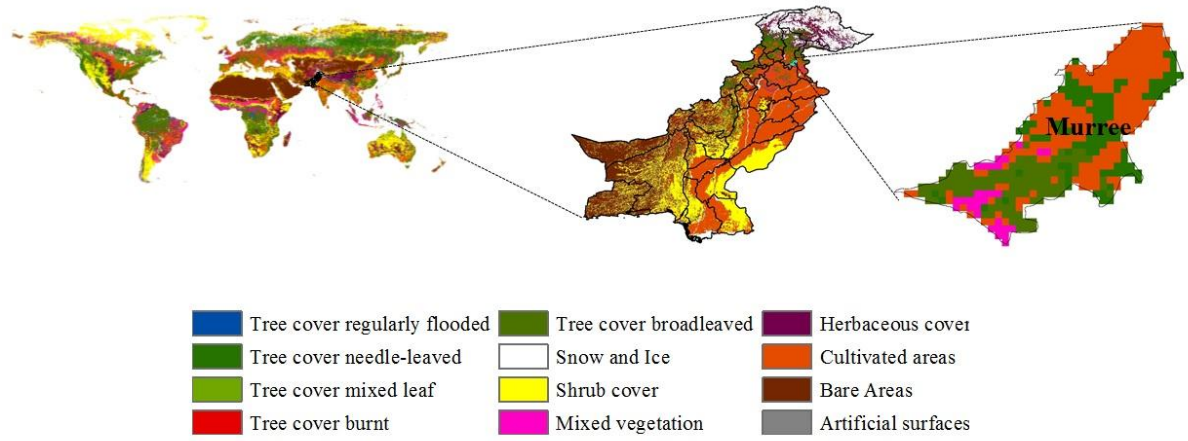

Fig. 1: Murree Hills, Pakistan.

2.2. Satellite Data:

Changes in vegetation cover were analyzed using data recorded by MODIS on-board Terra platform. MODIS product downloaded for years between 2000 and 2012, was 13Q1 Vegetation Indices (VI) and 12Q1 land cover product with tile number h24v05. MODIS products are in HDF-EOS (Hierarchical Data Format for NASA's Earth Observing System) with Sinusoidal projection. To extract information over Murree using shapefile, the tiles had to re-projected to WGS-84 using ArcMap v10.2.

MOD13Q1 dataset provides two VI layers: Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI). The first one represents the continuity with the Advanced Very High Resolution Radiometer (AVHRR) mission; the second one is a newer VI, which is known to be able to account for both background and aerosol effects (7, 8). Vegetation indices (NDVI & EVI) are used for global monitoring of

vegetation conditions and are used in products displaying land cover and land cover changes. These data may be used as input for modeling global biogeochemical and hydrologic processes and global and regional climate. MODIS products were obtained from the Land Processes Distributed Active Archive Center (LP DAAC).

Table 1: Specifications of datasets used in this study.

	MODIS Terra	EDGAR emissions	REAS emissions
Spatial resolution	250 x 250 m/ 500 x 500 m	0.1^0 x 0.1^0	0.5^0 x 0.5^0
Swath width	2330 km		
Temporal resolution	16 days/ annual (L3)	Yearly	Yearly
Temporal coverage	2000-2012	2000-2008	2000-2010
Spectral range	0.405-14.385µm		
Data quality assessment	**89.32 % accurate		

* (IIRS, 2003), ** (http://landval.gsfc.nasa.gov/ProductStatus.php?ProductID=MOD09)

Since Murree is towards north of the country where temperatures are quite low and summer time is ideal to study the vegetation due to vigorous growth and less snow cover. Therefore MODIS vegetation index was used only for the month of June. Yearly spatial maps of mixed forests (needleleaf/broadleaf) were developed for the years 2001, 2005 and 2012, along with NDVI and EVI spatial trend. Time series for NDVI and EVI were also developed over Murree Hills. Forest area was calculated using Eq.1.

Forest covered Area = (No of pixels with Forests) (Area of one pixel) Eq. (1)

2.2. Emission Inventory Data:

The yearly inventory data on Global CO_2 emission of EDGAR (European Union) and REAS (FRCGC) were downloaded and extracted over the study site by using ArcMap v10.2. Followed by this time series were developed to depict temporal trends of CO_2 emissions over Murree hills. EDGAR datasets downloaded were total emissions and land use change (LUC) emissions.

2.3. Quantifying CO_2 Emissions from LULUC:

CO_2 emissions data from land use change (LULUC) was calculated using a standard formula provided by IPCC (2003) Eq. (2).

CO_2 emissions/year = Change in Forest Area (hectare) x Carbon Stock per hector Eq. (2).

Results:

3.1. Spatial and temporal variation of forest cover:

Fig. 2 shows spatial distribution needle/broadleaf forests derived using MODIS 12Q1 product. This is a clear overall increase in the area of needle/broadleaf forests, however this increase is mainly observerd after 2005. This can be attributed to the widespread plantation scheme and the ban imposed on green felling by Government of Pakistan.

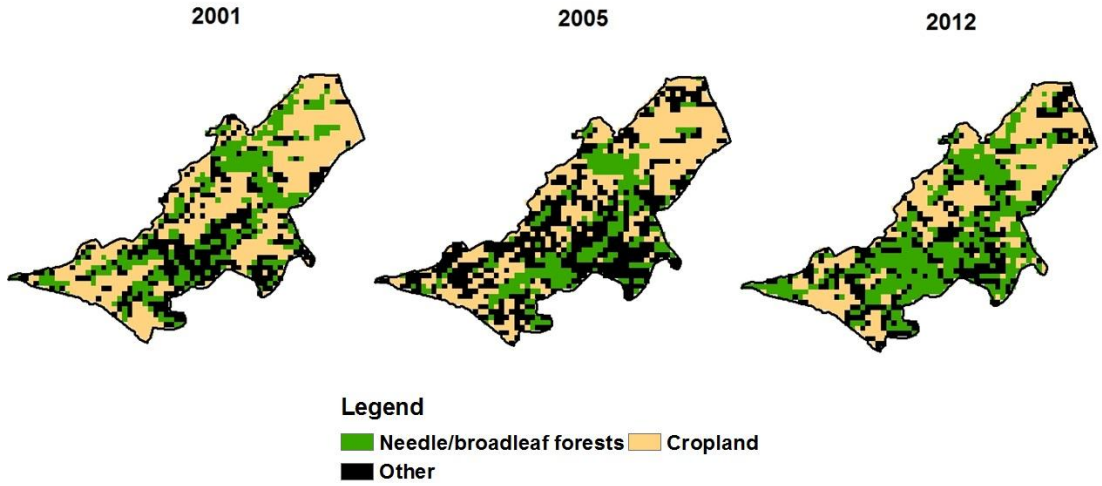

Fig. 2: Spatial and temporal variation of needleleaf/broadleaf forests over Murree Hills between 2001 and 2012.

3.2. Spatial and temporal trend of MODIS Vegetation Index:

According to fig. 3 MODIS NDVI and EVI over Murree hills has increased by 3 and 10 percent respectively. Fig 4. shows a similr trend of vegetation index variation, it also reinforces the minute increase of NDVI relative to the large increase of EVI.

Advances in Environmental Biology, 9(6) Special 2015, Pages: 15-20

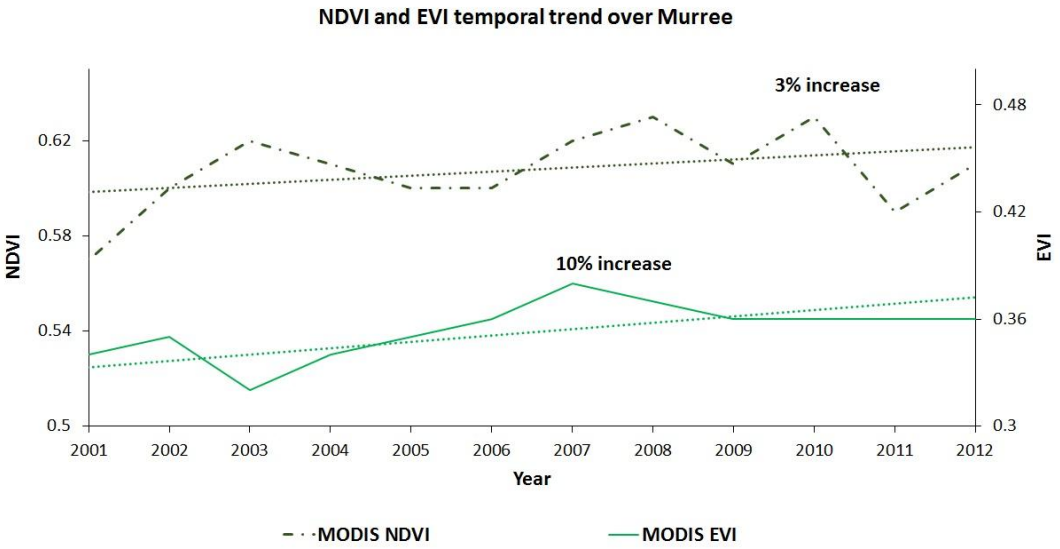

Fig. 3: Temporal viariation of MODIS NDVI and EVI.

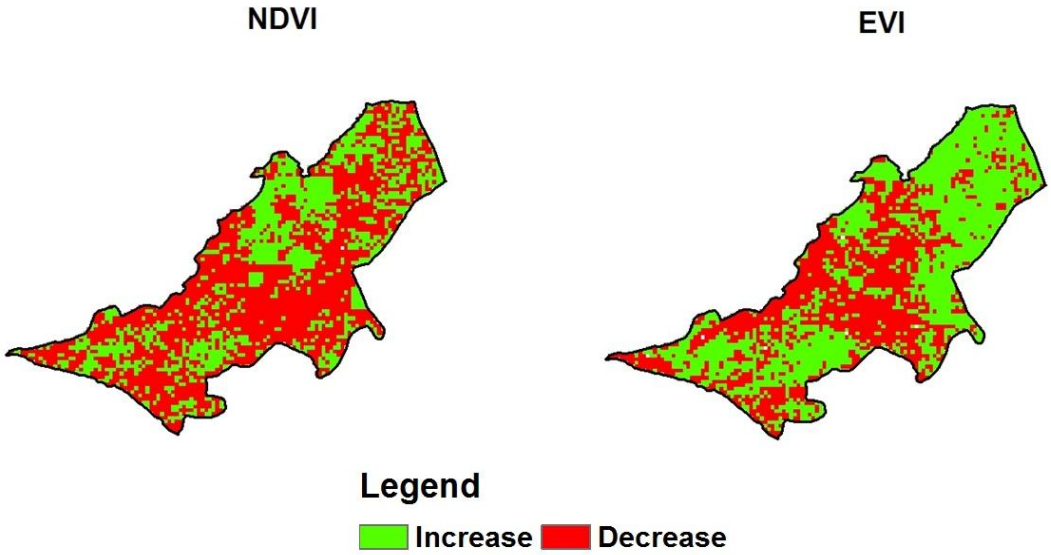

Fig. 4: Spatial variation of MODIS NDVI and EVI over Murree between 2001 and 2012.

3.3. Comparing Time Series of CO_2 Emissions with Calculated Forest Area:

EDGAR and REAS emission inventory data was extracted over study area and compared with forest area calculated using MODIS 12Q1 product (fig. 5). EDGAR and REAS anthopogenic are broadly used emission inventories, which are based on CO_2 emissions from industrial activities and land use change sectors. Based on the trend depicted in fig. 5 CO_2 emissions are increasing, which is mainly contributed by industrial sources as shown by REAS estimates. On the other hand, EDGAR LUC emissions displayed constant trend, therefore there is a poor comparison between global/ regional emission inventory and calculated forest area. Pakistan does not have any national emission inventory, especially for land use change, that's why EDGAR LUC CO_2 emission can be questionable. To more accurately quantify LULUCF CO_2 emissions, it is essential to account for the emissions from other sources as well (transport and industrial).

Murree hills are hot spots for ecotourism to attract the tourist throughout the world due aesthetic beauty, diversity of vegetation, snowfall in the winter and a variety of food. The transport sector and land use change sector can be two major contributors in CO_2 emissions at Murree Hills.

3.5. CO_2 Flux, Total Emissions and Sequestration over Murree Hills:

Table 2 shows a change in forest area each year with respect to the base year 2001, negative sign is showing decrease in forest cover and emissions while positive sign is depicting an increase in forest cover and sequestration. Land use Change (LUC) emissions were calculated in Kilo tons, employing standard IPCC formula equation 2. Carbon stock 126 +2.94 t/ha calculated by (9) is used to compute the CO_2 emission.

Advances in Environmental Biology, 9(6) Special 2015, Pages: 15-20

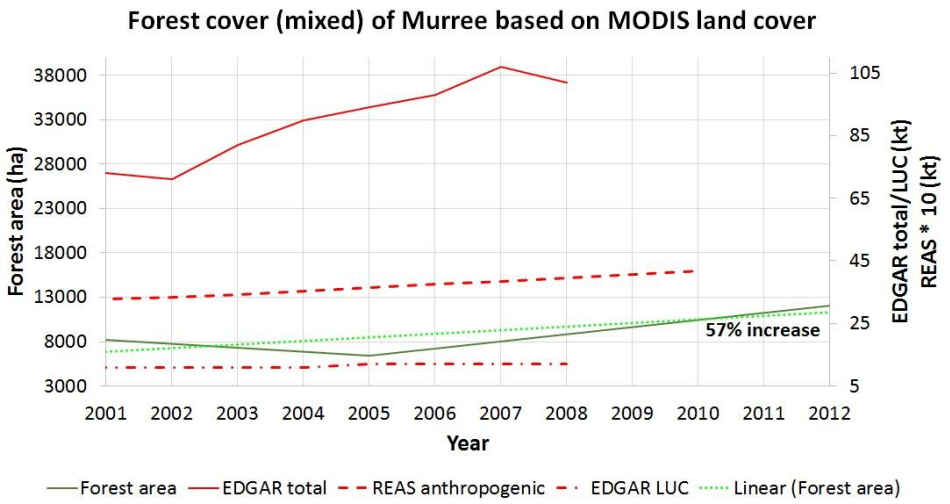

Fig. 5: Comparison of calculated forest cover with CO_2 emission inventory.

Table 2: Calculated change in forest area using IPCC Equation.

Year	Change in forest area (ha)	LULUCF emissions (kt)
2005	-1750	-221
2012	5575	482
Net sequestration (kt)		261

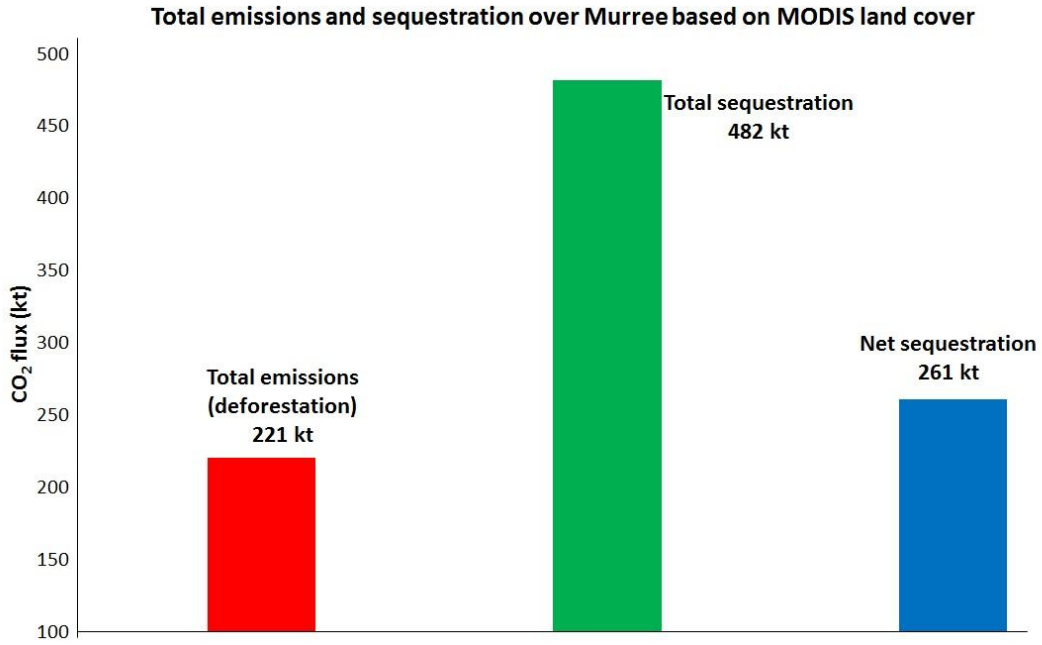

Fig. 6: Change in CO_2 Flux over Murree based on MODIS landcover product. Red color represents total emissions, green represents total sequestration blue net sequestration.

3.6. Carbon Credit Potential:

Fig. 6 revealed that the total sequestration of CO_2 (i.e., 261000 tons) has exceeded than the total emissions, thus leading net sequestration of carbon and generate the carbon credits. Selling these credits in the international carbon market at rate of $ 6.7/carbon credit will produce financial revenue worth $ 1 million.

Conclusion and Recommendations:

Spatial and temporal monitoring of forests over Murree Hills was performed by using MODIS NDVI and landcover products with respect the base year 2001. Analysis of MODIS vegetation indices and land cover product indicated a net CO_2 sequestration of 261000 tons. It illusterate that by further preservation of forests of Murree Hills will have an enormous potential of carbon credits. To accurately quantify CO_2 emissions from

selected region, it is inevitable to carry out ground-based carbon stock and forest cover assessment (ground trothing) and to constrain emissions from all sources within the study area. Overall, results highlighted that the selected site of Murree Hills has huge potential for REDD+ implementation and reasonable amount of revenue can be generated by selling the carbon credits in international market. This revenue can be utilized to provide a sustainable livelihood to forest dependent communities and for the conservation of forests of Murree Hills Pakistan. Furthermore, it is recommended that in future a detailed study should be carried out to examine the carbon stock by various forests types in Pakistan.

REFERENCES

[1] FAO, J.R.C., 2012. Global Forest Land-use Change 1990–2005, by E.J. Lindquist, R. D'Annunzio, A. Gerrand, K. MacDicken, F. Achard, R. Beuchle, A. Brink, H.D. Eva, P. Mayaux, J. San-Miguel-Ayanz and H-J. Stibig. FAO Forestry Paper No. 169. Food and Agriculture Organization of the United Nations and European Commission Joint Research Centre. Rome, FAO. ISBN 978-92-5-107399-5.

[2] Pagiola, S., N. Landell-Mills, J. Bishop, 2002. Making market-based mechanisms work for forests and people. In: Pagiola, S., Bishop, J., Landell-Mills, N. (Eds.), Selling Forest Environmentalb Services: Market-based Mechanisms for Conservation. Earthscan, London.

[3] Intergovernmental Panel on Climate Change (IPCC), 2007. "Climate Change 2007: The Physical Science Basis. Cambridge University Press, Cambridge, UK". In:http://www.meteo.bg/meteorology/SPM2feb07.pdf.

[4] Van der Werf, G.R., D.C. Morton, R.S. DeFries, J.G.J. Olivier, P.S. Kasibhatla, R.B. Jackson, G.J. Collatz, J.T. Randerson, 2009. "CO2 emissions from forest loss. Nat. Geosci", 2: 737-738.

[5] Climate Analysis Indicators Tool (CAIT) Version 7.0, 2010. World Resources Institute, Washington, DC. URL: http://cait.wri.org.

[6] Food and Agriculture Organization (FAO), 2010. Global Forest Resources Assessment, Key Findings, Rome.

[7] Huete, A., K. Didan, T. Miura, E.P. Rodriguez, X. Gao and L.G. Ferreira, 2002. Overview of the radiometric and biophysical performance of the MODIS vegetation indices. Remote Sensing of Environment, 83: 195-213. doi: http://dx.doi.org/10.1016/S0034- 4257(02)00096-2.

[8] Soudani, K., G. le Maire, E. Dufrene, C. Francois, N. Delpierre, E. Ulrich and S. Cecchini, 2008. Evaluation of the onset of green-up in temperate deciduous broadleaf forests derived from Moderate Resolution Imaging Spectroradiometer (MODIS) data. Remote Sensing of Environment, 112: 2643-2655.

[9] Nizami, M., 2012. "The inventory of the carbon stocks in sub-tropical forests of Pakistan for reporting under Kyoto Protocol". Journal of Forestry Research, 23(3): 377-384.