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Reducing emissions from deforestation and forest degradation implementation in northern Pakistan

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ABSTRACT

Reducing emissions from deforestation and forest degradation (REDD) is a mechanism to cut down GHG emissions and to protect the threatened forest ecosystems. Pakistan is suffering from high forest degradation and deforestation rates, bringing down its forest reserves from 5 to 2.5%. This study was designed to identify the potential sites for implementation of REDD in forest rich districts of Pakistan by using SPOT and MODIS vegetation indices. Change in forest cover was assessed during the time period of 2000–2012 in addition to the amount of carbon dioxide (CO_2) released and/or absorbed over the study area. Results showed an increase in NDVI (normalized difference vegetation index) by 9.7 and 11.6% based on SPOT and MODIS observations, respectively. On the other hand CO_2 emission inventory data from EDGAR (Emission Database for Global Atmospheric Research) and REAS (Regional Emission inventory for ASia) showed an overall increasing trend which is mostly due to anthropogenic sources. Finally, CO_2 emissions calculated using carbon stock data and forest cover change exhibited a net sequestration of atmospheric CO_2 with huge potential of REDD implementation in the selected district of Dir, Pakistan.

Introduction

Forests uptake CO_2 from air worth 33 percent of anthropogenic carbon emissions (Parry et al., 2007). Due to land use change activities carbon stored within forests is released back into the atmosphere. International panel on climate change estimated that deforestation adds 17 percent to the global anthropogenic greenhouse gas (GHG) emissions (IPCC, 2007). However, recent estimates state that AFOLU (agriculture, forestry and other land use) sector contributes around 25% to the global total anthropogenic emissions (Smith et al., 2014). In order to meet global emission reduction targets, IPCC has recommended that the focus of climate change mitigation strategies must not be only on lowering fossil fuel consumption but also on the forest degradation and land use changes. Furthermore, such strategies cannot be successfully implemented without taking developing countries onboard because deforestation and forest degradation is rapid and dominant in the developing part of the world. One of leading causes of deforestation, besides agricultural expansion, is the increasing demand for wood products mainly in pulp industry, furniture and renewable energy sector and exerting additional stress on availability of forestry goods and services (FAO, 2001). Another type of forest loss is degradation and can be caused by forest fires, climate change, and pests and/or diseases. For instance, substantial loss of *Dalbergia sissoo* (known as shisham or tally) in Pakistan is an example of biodegradation of tropical forests during the recent decades. Several studies (e.g. Khan et al., 1965; Khan and Bokhari, 1970; Khan, 1993; Bakshi, 1995; Gul and Mughal, 1999 etc.) have been conducted in order to identify the pathological symptoms or signs of ill health of Sisso in Pakistan. They found the following pathogens: *Fomes lucidum*, *Poria ambigua* and *Polyporus gilvus* cause die-back and canker diseases, while *Fusarium oxysporum* caused the Wilt disease in *Dalbergia sissoo*. It can be prevented by avoiding the root injury and haphazard use of pesticides and chemical fertilizers with proper cultivation management (Khan, 1993).

Forest wood being resistant to bio-deterioration by microbes, parasites, fungus and termites without the application of

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preservatives, makes it desirable to use (Taylor et al., 2002) and vulnerable to over exploitation. Moreover higher cellulose content and purer form of hemicellulose found in forest wood adds to its commercial and economical value. Rapid Deforestation, especially in Southeast Asian tropical forests, for paper plantations will lead to net loss of forest biomass and its carbon sequestration potential (Liao et al., 2010).

Forests and other vegetation types have a crucial contribution in maintaining the balance of carbon cycle. As a result of photosynthesis forests convert the absorbed carbon dioxide from atmosphere into biomass. Therefore mature forests act as a major carbon sink by storing carbon as both above and below ground biomass. In fact, forests hold more volume of carbon than the atmosphere (Stern, 2006). According to Parry et al. (2007) about 77 percent of terrestrial carbon is accumulated in the earth's forest alone. With efficient forest management systems global carbon sequestration by forests can be increased up to 100 Giga tons (Gt) that is of worth of about 30 years of atmospheric carbon build up by anthropogenic sources (IPCC, 2001).

REDD initiative

REDD is being developed as a climate change mitigation strategy by United Nations Framework Convention on Climate Change (UNFCCC). Initially focus was on providing financial benefits to developing countries in order to curtail the deforestation rates while protecting the rights of forest-dependent communities. Later on, conserving carbon stock through sustainable use and management of the forests was also included in the agenda of REDD. For an effective emission reduction program, it is important to measure and verify changes in carbon stock of a particular forested area through MRV (measuring, reporting and verification) system under the framework of REDD. Changes in forest cover, carbon stock, emission factors and land use land use change (LULUC) are identified with the help of high resolution satellite imagery and ground trothing. Forest inventory accounts for changes in carbon stock caused by deforestation and/or forest degradation (UNFCCC, 2013). The ultimate output of MRV system is national inventory of the carbon emissions from land use, land use change and forestry (LULUCF).

Pakistan's forest resources

Pakistan has low but a diversified forests ranging from coastal mangrove and riverine ecosystem to Alpine Chir and Pine forests. This ecological set up is mainly due to arid and semi-arid climate in large parts of the country. Total area of forests in the country is 4.34 (about 5%) million hectare (Mha) with Sindh, Baluchistan, Punjab, Khyber Pakhtunkhwa (KP), Azad Kashmir and Northern Areas having forest cover of 0.92, 0.33, 0.69, 1.21, 0.42, and 0.66 Mha, respectively (GoP, 2003). It is evident that most of the forests are located in the northern parts of the country mainly with 40 percent in the KP province. Northern regions of Pakistan mainly comprises of Alpine and temperate forests. Forests in Pakistan are diminishing at a rate of 27,000 ha/year bringing it down from 5 to 2.5 percent (FAO, 2005, 2010).

Various studies have mentioned the deforestation is prevalent in Pakistan. For instance, Ahmad et al. (2012) indicated a decline in Coniferous forests from 1992 to 2010 in all provinces of Pakistan. A study carried out by Ali et al. (2005) determined the change in forest cover in Basho valley by comparing Landsat images of 1976 and 2002. They also mentioned that deforestation is caused by mismanagement of forests and illegal harvesting instead of over population. Siddiqui et al. (2004) and Abbasi et al. (2011) reported a loss of 21,590 ha of riverine forests along the plains of river Indus. Especially 85 percent loss has been observed in the Sindh province from 1977 to 2009.

Pakistan and REDD

Pakistan is an active member of the Coalition of Rainforest Nations (CRN). Pakistan has joined UN-REDD Program in 2011 and is receiving targeted support funds to develop REDD readiness roadmap and national forest monitoring system. Pakistan has already launched a Mega-Carbon Sequestration project in order to fulfill REDD objectives in the longer run.

In order to assess a country's potential for REDD implementation, its historic pattern of forest cover and CO_2 emissions have to be quantified. The aim of this study was to select a pilot site, assess the changes in forest cover using satellite observations, and calculate the CO_2 emissions using carbon stock and global emission inventory data (e.g. EDGAR, REAS) over the selected site. For this purpose District of Dir (Fig. 1) from Khyber Pakhtunkhwa (KP) was selected.

Materials and methods

Moderate Resolution Imaging Spectroradiometer (MODIS – Hui et al., 2014) and Satellite Probatoire d'Observation de la Terre (SPOT – Neuberg and Wahr, 1991; Nerem et al., 1994) are widely

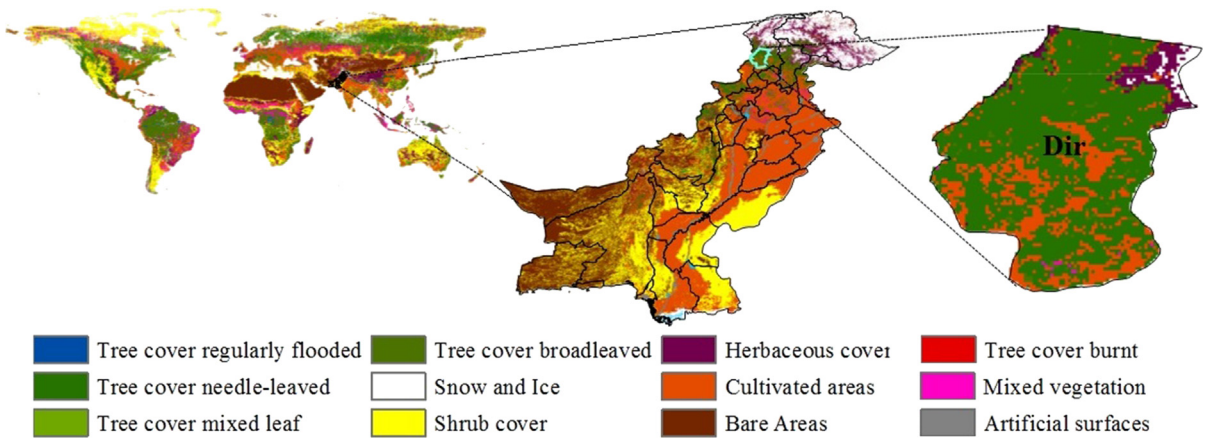

Fig. 1. "Study site": study site shown in green with an area of 419,825 ha (ha). Global and Pakistan's land cover maps obtained from a merge between data from the GlobCover project (Version 2.2, released 10.12.2008; Bicheron et al., 2008), and the McGill University M3-Cropland data (Ramankutty et al., 2008). The land cover classes were aligned to correspond to the specifications of the REDD project. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)