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# LAND AND ENVIRONMENTAL MANAGEMENT THROUGH FORESTRY

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*Edited By*

**Abhishek Raj**  
**Manoj Kumar Jhariya**  
**Arnab Banerjee**  
**Sharad Nema**  
**Kiran Bargali**

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# Land and Environmental Management through Forestry

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# **Land and Environmental Management through Forestry**

Edited by  
**Abhishek Raj**  
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**Arnab Banerjee**  
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and  
**Kiran Bargali**



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## Preface

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Land degradation and its inappropriate uses affect soil health and other natural resources. Unsustainable land use practices, including intensive agriculture and deforestation activity, deprive soil of its quality, biodiversity and environmental services. Now, land degradation has become a global issue discussed by numerous institutions, and its management is of utmost importance for ensuring environmental sustainability. Large percentages of forest land, 20% of agricultural and 10% of grass land are under land degradation severity due to anthropogenic activities. Similarly, land degradation and desertification affect 2.6 billion people in a hundred countries which cover approximately 33% of the global land surface. Land degradation, climate change and biodiversity losses are strongly linked to poor environmental health and services. Poor environmental health, services and its sustainability are further amplified by land degradation including deforestation and intensive land use practices. Land degradation can be reversed through practicing sustainable forest management including better restoration and rehabilitation. Therefore, sustainable land use and management is a key step towards better environmental sustainability which can be possible through managing forests in sustainable ways. To address such diverse issues of land degradation and how a sustainable land management practices including forestry, agroforestry and other practices can be effectively utilized to minimize negative consequences is the central theme of the book.

This book, *Land and Environmental Management through Forestry*, covers the diverse issues of land degradation in developed and developing nations and its restoration through forestry, agroforestry and other practices. Textbooks are available in the global market that address specific issues on agriculture, its production and associated environmental consequences. The present title would integrate all the concepts into a single dimension from which various scientists, research scholars, academicians, and policymakers can benefit from updated information. New insights are

very important in this particular aspect as our very existence depends on forest sustainability and land restoration management.

The present title consists of chapters addressing the issue of land degradation, deforestation, intensive agriculture practices, sustainable intensification, soil and forest related services, land and environmental management, and overall sustainability of the land-related ecosystem. The present book consists of some specific research case studies considering geospatial technologies in monitoring land degradation and its environmental repercussions. Case studies on farmland evaluation for soil quality and land use assessment are also included. Deforestation activities, climate change risks and related consequences along with its mitigation and adaptation are presented in this book. These will provide new insights into the field of land and environmental management. Some titles update the reader about the current scenario on the issue of land/soil degradation, desertification, deforestation, erosion, afforestation activities, agroforestry, food security, sustainable intensification, resource conservation, sustainability and services, and soil and plant management. Therefore, the present title would help to address current issues and their management holistically. The objectives that will be fulfilled by the present title are as follows: (1) present context of land degradation and its problem, (2) identify the key areas of research in the field of land restoration, and sustainable land management including forestry and agroforestry for environmental management, (3) identify the land-based services and their potential role for ecosystem sustainability, (4) raise awareness around the globe in this context so that future policies can be framed from this for the betterment of human civilization, and (5) address sustainable intensification for land and environmental management and services.

This book will be a standard reference work for disciplines such as forestry, agriculture, ecology and environmental science as well as being a way forward towards strategy formulation for combating climate change. It will help academicians, researchers, ecologists, environmentalists, students, capacity builders, and policymakers gain an in-depth knowledge in the diverse field. Eminent academicians and scientists across the globe would be invited related to the theme of the book to share their scientific innovation, research outputs, views, and opinions, an experience that would enlighten the academic community. Each of the chapters has good scientific support in terms of scientific database, diagrams, tables, graphs, images, pictures, and flowcharts as per the requirement with proper recent updated citation. All the chapters would be thoroughly reviewed by the respective individual of a specific discipline which would enrich the chapter content from a future research perspective. The submission would



be reviewed by the editorial team for further upgradation. It would set a roadmap for the preparation of sustainability in forestry which ensures eco-restoration of the land degradation in the future. The editors would appreciate receiving comments from readers that may assist in the development of future editions.

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# Land Degradation and Restoration: Implication and Management Perspective

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## **Abstract**

Presently, land degradation is a global concern discussed by numerous institutions and its management is of utmost important for ensuring environmental sustainability. As per ISRO (2019), approx. 97.85 M ha of land is degraded and 3.32 M ha of degradation was reported between 2005 and 2019 (last five years) in India. Almost 30% of the country's geographical areas are under desertification, which is a major environmental problem. Thirty percent of 71 M ha forest land, 20% of agricultural and 10% of grass land are under land degradation severity due to anthropogenic activities. Similarly, land degradation and desertification affect 2.6 billion people in a hundred countries which cover approximately 33% of global land surface. These figures are enough to express a global scenario of land degradation in the world. Land degradation, climate change and biodiversity losses are strongly linked to poor environmental health and services. Poor environmental health, services and its sustainability are further amplified by land degradation including deforestation and intensive land use practices. Land degradation vulnerability (LDV) is also observed due to poor vegetations and soil quality under

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climate change that jeopardize ecosystem health and environmental sustainability. In this context, land degradation can be reversed by practicing sustainable forest management including better restoration and rehabilitation. Moreover, UNCCD also introduced the term LDN (land degradation neutrality) which represents land management for enhancing ecosystem services including soil-food quality and its sustainability. Therefore, sustainable land use and management is a key step towards better environmental sustainability which can be possible through managing forests in sustainable ways. Constructive policy and institutional supports are required to sustainable land and environmental management through better forestry practices.

**Keywords:** Afforestation, desertification, ecosystem services, land degradation, restoration

### 1.1 Introduction

Land is a key terrestrial resource that delivers uncountable ecosystem services including food, fiber and shelters. Land degradation is a continuous process propelled by natural, climatic and various anthropogenic activities. Deforestation, intensive agriculture, mining and several other developmental projects deteriorate land quality and related environmental services. Erosion, desertification, waterlogging condition, salinization, and organic matter depletions are key drivers for land quality deterioration [1]. Land degradation affects biodiversity along with ecosystem health and productivity. Land degradation alters physical, chemical and biological properties that affect biology, economy and quality of land. Soil acidity, salinization, lesser SOC, erosion, desertification, soil compactions result in unproductive land which reduces plant health and productivity [2]. Unscientific farming, urban sprawl, improper irrigation, land clearance and overgrazing are key causes of degradation. Moreover, industrial waste and quarrying of sand, stone and minerals resulted in land pollution [3]. Land degradation also affects various environmental services including regulation of fresh water quality, climate regulation, clean air quality, soil fertility, plant productions and recreational opportunities globally [4, 5]. Land degradation also affects hydrological and biogeochemical cycles [6]. Around 60% of global land area has been degraded by various natural and anthropogenic factors [7]. Land degradation deteriorates environmental health and productivity [8]. Nearly 40.0 billion USD has been lost due to annual degradation of land resource in the world [9]. Therefore, it has negative consequences on the environment and affects soil-food-climate security. Approx. 18.10 M Km<sup>2</sup> areas are reported as degraded lands of which 92% and 38% are due to

mismanagement and overgrazing of animals [10]. Similarly, 30%, 20% and 10% of forests, arable land and grasslands, respectively, have been affected negatively due to land degradation which influenced 1.50 billion people of the world [11]. A total 50% of arable land comes under moderate to severe degradation. Land degradation affects 1.50 billion people in the world. Every year approx. 15.0 billion tons of soil losses occur, whereas desertification and drought lead to 12.0 m ha<sup>-1</sup> soil degradation. Land degradation also affects biodiversity through loss of 27,000 species annually. The risk of dry land has been prevalent in 110 countries which affected approximately 250 million people globally. Moreover, a desertification cost was reported as 42 million dollars globally [10].

In this context, land restoration is an urgent need which minimizes negative consequences on our environment. Managing forests is a good weapon to manage land, soil, water and other natural resources in this climate change era. Afforestation activities, ground cover plantations, conservation agriculture, organic agricultural practices, and a sustainable land use system ensure healthy land/soil and related parameters [12]. Thus, land degradation nowadays has become a big environmental challenge which needs a scientific and holistic approach for healthy land management that ensures environmental sustainability and ecological stability on a long-term basis [13].

The present chapter will address the land degradation in developed and developing nation and its restoration through sustainable land use practices. Impacts of land degradation and desertification on soil, water, food and other resource induced environmental changes are also discussed. Land reclamation through forestry by practicing SFM and other sustainable land use system are included in this chapter. It will also focus on new insights related to updated research, development and policy-oriented afforestation activities for combating C footprints and climate change issue for better ecosystem health and productivity through sustainable land management approach.

## **1.2 Land Degradation in Developed and Developing World**

Land is lithospheric component of environment which provides many valuable direct and indirect services including food, air and water for sustaining peoples and biodiversity. Land resource is degraded continuously due to excessive pressure by intensive agricultural practices, deforestation,

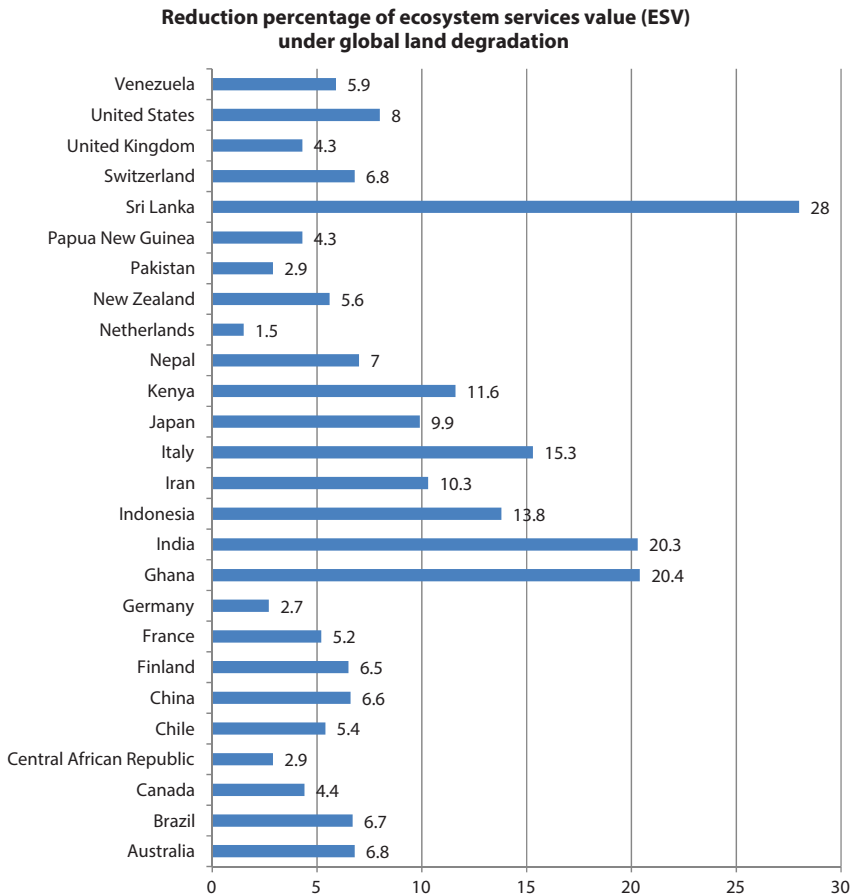
urbanization and cattle ranching beyond carrying capacity of the land. Unsustainable land use practices and its frequent changes along with its expansion put ecosystem health and its services in danger. The degradation of land and its resources is not confined in limited regions but is expanded throughout the globe, especially in developing countries. Land degradation is maximum in Asia followed by Africa and European countries. A global map has been created by the World Atlas of Desertification for assessment of land productivity and changes during the period 1999-2013 [14]. Similarly, land degradation due to desertification incurred 490 USD billion  $\text{yr}^{-1}$  of the cost which affects the health and economy of 3.20 billion people. Europe and Central Asia (ECA) countries have a diversified ecosystem for people sustenance but they are facing land degradation issues and various environmental challenges [15]. However, there is a blurred map on the severity and extent of land degradation that countries have been facing from the past [16]. IPBES has also discussed land degradation scenarios in India, Asia, Europe and other countries of the world in its recent report [17]. Approx. 10-60 million  $\text{Km}^2$  areas were reported as land degradation globally, which corresponds to ice-free land area of 8-45%. This assessment has been based on a global map sketched by experts, their opinion arrived at by using satellite observatory, biophysical models and abandoned agricultural lands database [18]. Remote sensing-based satellite data including NOAA AVHRR data has reported land degradation with approx. 22-24% of the world ice-free land area in downward trend whereas increasing trends were shown by 16% respectively in the period 1983-2006 [19]. Similarly, 29% of land area is reported as “land degradation hotspots” globally which needs serious attentions for its management. Globally, land degradation affected 3.20 and 1.33 billion people of which 95% were in developing countries [20, 21]. Also, different soil erosion model (RUSLE) was used to identify soil erosion-based land degradation in the regions of Southeast Asia, Africa and South America [22, 23].

### **1.3 Land Degradation Impacts on Biodiversity and Ecosystem Services**

Land degradation and its inappropriate uses destroy soil quality and other natural resources. Unsustainable land use practices including intensive agriculture and deforestation activity deprive soil quality, biodiversity and environmental services. It affects biodiversity and uncountable ecosystem services in extensive ways. It refers to many direct and indirect processes

that induce biodiversity losses and decline ecosystem services [24]. An ecosystem services value (ESV) and its reduction percentage under land degradation of the world is depicted in Figure 1.1 [25].

Land is an important terrestrial environmental component which supports many flora and fauna. Many drivers affect land quality which leads to 75% of land degradation globally. It has negative consequences on the well-being of 3.20 billion people along with 10% of global income loss due to poor biodiversity and ecosystem services. Land degradation minimizes the variety of ecosystem services (ES) such as timber, fuelwood and fiber [26]. Therefore, land degradation drivers should be identified for reversing



**Figure 1.1** Ecosystem services value (ESV) and its reduction percentage under global land degradation [25].

negative consequences on biodiversity which further can be controlled by effective scientific management [27].

## **1.4 Land Degradation and Restoration: A Response Framework**

There is a great link between direct and indirect responses while addressing land degradation. Appropriate indirect responses can support and enable the direct responses which tackle various parameters of land degradation [28]. Anthropogenic assets including human and physical resources, legal framework, regulatory instruments, effective policy, good governance, socio-cultural and financial instruments are indirect responses [29]. These responses include management activities which directly affect various identified degradation drivers or many biophysical processes such as land-soil-water management in sustainable ways. However, both direct and indirect responses are interlinked and dependable and comprise possible response strategies which are more or less suitable as per nature, extant and severity of land degradation [30]. Therefore, effective management of these direct or indirect responses and their proper regulation can help in achieving the goals of land restoration and maintain the resilience of socio-ecological systems [31].

## **1.5 Soil Erosion and Desertification: Problems and Challenges**

Soil erosion is major form of land degradation which becomes a global challenge. It causes loss of agricultural productivity due to heavy loss of essential nutrients. As per one figure of FAO-led Global Soil Partnership, a loss of approximately 75 billion ton (Pg) of soil from agricultural land leads to a heavy economic loss of 400 billion USD yr<sup>-1</sup> globally [32]. Sheet erosion, mass erosion, water erosion and landslides are various types of soil erosion. Landslides occur frequently due to deforestation, mining, road construction, hydropower projects and several other developmental works [33]. Soil erosion causes loss in plant productivity and surface water quality in an agricultural system [34]. It affects many ecosystem services by reducing soil health and fertility, crop productivity, water quality and overall environmental health and sustainability [35]. Inappropriate land management causes severe soil erosion on 175 million ha of the total