



高等学校“十一五”规划教材

土地复垦与生态重建

Land Reclamation and Ecological Restoration

胡振琪 等编著

中国矿业大学出版社

China University of Mining and Technology Press

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内 容 提 要

土地复垦与生态重建是对人为活动和自然灾害损毁的土地和环境采取整治措施,因地制宜地恢复到期望状态的行为或过程。本书介绍了土地复垦与生态重建的概念、内涵与发展历史,阐述了采矿对土地与环境的影响,介绍了相关的基础理论知识,详细讨论了土地复垦与生态重建的十大技术:工矿区环境破坏的动态监测与评价技术、土地复垦管理技术、土地复垦规划设计技术、采煤沉陷地复垦与生态重建技术、露天矿土地复垦技术、煤矸石山绿化技术、矿区重金属污染土地的修复技术、土地复垦与生态重建的信息技术、土地复垦与生态重建的评价与验收技术和微生物复垦技术。最后,对矿区土地复垦与生态重建中的测量工作也给予了介绍。

本书是一本关于土地复垦与生态重建方面的教材,内容全面,适宜于高等学校、科研与规划设计单位有关土地资源管理、环境、生态、测绘、地质、采矿、水土保持、土壤等专业的师生和工程技术人员使用,也可供相关领域的行政与事业单位的工作人员参考。

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前 言

土地是人类之母,是人类生存与发展的基础,是宝贵的自然资源。但自从有了人类以来,采矿、修路(铁路、公路)、水利工程等人类活动就不断地扰动和破坏着土地。我国人多地少,采矿等人为活动破坏了大量土地,加剧了人地矛盾。伴随着土地的破坏,引发了大量的生态环境问题,如水土流失、土地沙漠化、盐渍化、滑坡、泥石流、大气污染、水污染等。

20 世纪初,人类为了自身的生存发展,开始对土地所遭受破坏及其引发的环境问题采取补救措施,土地复垦与生态重建便应运而生,并逐渐被各国所重视。土地复垦与生态重建产生于 20 世纪初的工业发达国家,大都是针对采矿破坏的土地和环境问题所采取的治理措施,且大都是以在矿山废弃地上恢复植被为主要治理工作。

土地复垦常常用“Restoration”、“Reclamation”和“Rehabilitation”三个词进行描述,且越来越多的专家认为这三个词具有相同的含义。国外土地复垦的定义是:将破坏的土(场)地(Site)恢复到破坏前的原状、近似状态或与破坏前制订的规划相一致的形式和生产力,其主要目标是重新建立永久稳定的景观地貌,这种地貌在美学上和环境上能与未被破坏的土地相协调,而且采后土地的用途能最有效地促进其所在的生态系统的稳定和生产能力的提高。我国 1989 年 1 月 1 日生效的《土地复垦规定》将土地复垦定义为:对在生产建设过程中,因挖损、塌陷、压占等造成破坏的土地,采取整治措施,使其恢复到可供利用状态的活动。近年来,根据我国的实际情况,土地复垦的内涵进一步扩展,它是对人为和自然损毁的土地,因地制宜地采取整治措施,使其恢复到可供利用的期望状态的行为或过程,其主要目的是再生利用土地、恢复生态平衡,使生产建设得到健康发展的同时,土地资源和环境也得以保护和持续利用。

生态重建(Ecological Restoration 或 Ecological Reconstruction)是将人类所破坏的生态系统恢复成具有生物多样性和动态平衡的本地生态系统,其实质是将人为破坏的区域环境恢复或重建成一个与当地自然界相和谐的生态系统。生态重建更侧重于强调生态系统的恢复。土地复垦在恢复土地利用价值的同时,也是对土地生态系统的恢复。因此,土地复垦与生态重建有非常紧密的联系和一致性。

随着我国经济的持续快速稳定发展,采矿业和道路建设得到了飞速发展,对土地和环境的破坏也达到了非常严重的程度。以煤炭开采为例,我国煤炭年

产量已突破 20 亿 t,是世界第一产煤大国,1949~2006 年累计煤炭产量约 376 亿 t,按万吨煤塌陷 0.2 hm² 计,我国因采煤塌陷破坏的土地面积已达 75.2 万 hm²,而且每年还以 4.6 万 hm² 的速度递增。土地破坏、环境恶化、失地农民增多等生态环境问题和社会问题已成为区域和国家可持续发展的重要制约因素,而土地复垦与生态重建正是解决这一问题的有效途径。因此,土地复垦与生态重建已得到越来越多的关注和政府的高度重视。

从《土地复垦规定》生效至今已近 20 年,我国土地复垦在理论和实践上取得了很大的进展,许多高校也试图开设这门专业课,但一直没有一本系统全面的教材,为此我们几所院校的教师共同编写了这本教材。本书由中国矿业大学(北京)胡振琪教授构思设计和组织编写。全书共有 14 章,具体参加人员和撰写分工是:中国矿业大学(北京)胡振琪(第一章、第三章部分、第五章部分、第七章部分、第九章部分)、赵艳玲(第十二章、第五章部分、第七章部分)、李晶(第十四章),中国矿业大学卞正富(第六章),中国地质大学(北京)付梅臣(第八章),山东科技大学成枢(第二章、第十三章、第三章部分),辽宁工程技术大学杨帆(第三章部分),黑龙江科技学院杨秀红(第十章),河南理工大学陈秋计(第十一章),安徽理工大学郑礼全(第四章)和太原理工大学阳泉学院陈胜华(第九章部分)。

土地复垦与生态重建在我国还是一个新的领域,新理论、新技术不断涌现,我们希望呈献给大家的是一本比较系统而全面的教材,但由于我们水平所限,错误之处一定不少,欢迎批评指正。

胡振琪

2008 年 2 月

Preface

Land is the most precious natural resources for human survival and development. But with the appearance of human, the land began to be disturbed and destroyed by human activities such as mining, road construction (railway and highway), hydraulic engineering and so on. China has a large population and scarce land resource, so the human activities results the conflicts between people and land. Many eco — environmental problems have been caused by land destruction such as soil erosion, land desertification, soil salinization, landslide, debris flow, air pollution, water pollution and so on. At the beginning of 20th century, people began to take remedial measures to solve the environmental problem caused by land destruction, thus land reclamation and ecological restoration appeared and been emphasized by many countries.

Land reclamation and ecological restoration originated in the developed countries at the beginning of the 20th century, most of them are remedial measures according to land destruction and environmental problems, and the main task is revegetation of abandoned mined land.

Restoration, Reclamation and Rehabilitation are three popular words in this field. Now, more and more experts have recognized that the three words have synonymous meaning. The concept of land reclamation overseas is: the site will recover to the exact or approximately conditions of the site before disturbance, or a form and productivity in conformity with a prior use plan, the main purpose of land reclamation is to reestablish a permanent and stable landscape which is coordinated with the surrounding undisturbed land in the view of aesthetics and environment, the land use can effectively promote the stability and productivity of the ecosystem. In the Stipulation of Land Reclamation which became effective on Jan 1st, 1989, the conception of land reclamation is described as the activities to recover the land damaged by production activities such as excavation, subsidence or occupation to a useable state with remedial measures. In recent years, many experts thinks that the meaning of land reclamation should become the activity or process to recover the disturbed land destructed by natural disaster or human activities to an expected state with remedial measures based on its suitability. The main task of land reclamation is to reuse the land and restore the ecological balance, which results the good environment with the economic development.

Ecological restoration or ecological reconstruction means that reconstructing the ecosystem destructed by human activities to the ecosystem with biodiversity and ecological balances. It is the reconstruction of the destructed ecosystem to the one which can coordi-

nate with the local nature. Ecological restoration emphasizes the restoration of the ecosystem. Land reclamation also restored the ecosystem while recovering the value of land utilization. Therefore, land reclamation and ecological restoration has a tight link and consistent with each other.

With the continuously rapid and stable development of national economy in China, the mining industry has a high developing speed, which results over 2 billion tons of the coal production. Thus China becomes the largest coal production country in the world. With the excavation of coal, a lot of lands were serious damaged. During the year 1949~2006, the coal production accumulated to 37.6 billion tons, and the subsidence land is achieved 0.75 million hm², and grow 0.04 million hm² per year. Many farmers lost their land, thus cause employee problem, and do harm to the social stability. Many problems such as land destruction, environment pollution and farmland losses have become the main restraint factors for regional and national sustainable development. Land reclamation and ecological restoration is an effective way to solve these problems. Therefore, many governments pay much attention on land reclamation and ecological restoration.

The Stipulation of Land Reclamation has been put effect for nearly 20 years in China. A great progress of land reclamation has been achieved. Many universities have established this specialized course, but there is no systemic and comprehensive textbook, so some teachers from 9 universities wrote this book. Professor Hu Zhenqi (China University of Mining and Technology, Beijing) design the structure of the book and organized the writing of the book. This book has 14 Chapters: Chapter 1 is Introduction, written by Hu Zhenqi (China University of Mining and Technology, Beijing); Chapter 2 is Mining influence on land and environment, written by Cheng Shu (Shandong University of science and Technology); Chapter 3 is Basic theory of land reclamation and ecological restoration, written by Yang Fan (Liaoning Technical University), Cheng Shu and Hu Zhenqi; Chapter 4 is Dynamic monitoring and evaluation technology of environmental destruction in industrial and mining area written by Zheng Liquan (Anhui University of Science and Technology); Chapter 5 is Land reclamation management, written by Hu Zhenqi, Zhao Yanling (China University of Mining and Technology, Beijing); Chapter 6 is Technologies of land reclamation planning and design, written by Bian Zhengfu (China University of Mining and Technology); Chapter 7 is Land reclamation and ecological restoration technology in coal mine subsidence land, written by Hu Zhenqi, Zhao Yanling; Chapter 8 is Land reclamation in open pit mine, written by Fu Meichen (China University of Geosciences, Beijing); Chapter 9 is Coal waste pile reclamation, written by Chen Shenghua (Taiyuan University of Technology Yangquan College), Hu Zhenqi; Chapter 10 is Remediation technology of heavy metal polluted land in mining area, written by Yang Xiuhong (Heilongjiang Institute of Science and Technology); Chapter 11 is Information techniques of land reclamation and ecological restoration, written by Chen Qiuji (Henan Polytechnic University); Chapter 12 is Evaluation and acceptance techniques of land reclamation and ecological res-

toration, written by Zhao Yanling; Chapter 13 is Survey in land reclamation and ecological restoration in mining area, written by Cheng Shu; Chapter 14 is Microorganism reclamation techniques, written by Li Jing(China University of Mining and Technology, Beijing).

Land reclamation and ecological restoration is still a new field in China. As the planned textbook for the mining science in the 11th five-year plan, we hope this book can be a systemic and comprehensive one in the field of land reclamation and ecological restoration. But restricting our ability and time, there must be many mistakes in this book, we really appreciate it if you could kindly point out and correct it.

Hu Zhenqi

Feb. 15th ,2008

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第一章 绪 论

第一节 土地复垦与生态重建的产生

任何一门学科的产生,都有一定的历史背景和历史环境,都是社会和生产力的发展到一定阶段,为人类的某种需要而产生的,土地复垦与生态重建的产生也不例外。

众所周知,土地是人类之母,是人类生存与发展的基础,是宝贵的自然资源。但自从有了人类以来,人类的活动就不断地扰动和破坏着土地。原始社会,由于人口数量少,生产工具简单,人类对土地的破坏并不严重,但随着人口的增加,特别是随着 18~19 世纪的三次工业革命的兴起和采矿业的迅速发展,大量的土地因城市化和工业化而被占用或因矿藏开采而遭受了巨大的破坏。到 21 世纪初,人类对土地的破坏已远远超过了土地的自我恢复和调节能力,同时世界范围的人口膨胀,使人均占有耕地面积明显减少,人地矛盾已经达到了前所未有的尖锐程度。伴随着土地的破坏,水土流失、土地沙漠化、盐渍化、滑坡、泥石流、大气污染、水污染等自然灾害在世界范围内频繁发生,人类已经饱尝了自然界的惩罚。为了人类自身的生存发展,人类开始对土地所遭受的破坏及其引发的环境问题采取补救措施,土地复垦与生态重建便应运而生,并逐渐被各国所重视。由于各国社会生产力发展水平的差异,土地复垦与生态重建在各国产生与重视在时间上也有明显差异,美国 1911 年提出土地复垦,1918 年在伊州丹维尔附近的煤矿进行种植复垦,同年在印第安纳州进行复垦试验;德国和前苏联对土地复垦始于 20 世纪 50 年代末;英国在 1951 年颁布了复田法;我国早在古代开山取石中就注重生态重建,浙江绍兴东湖风景区原先是一处采石场,从汉代起开山取石,隋代扩建绍兴城时,大规模开采,由于长年累月的开凿,形成千奇百怪的峭壁和深邃的小塘,构成了东湖的雏形,至清代,东湖筑堤分界,外为河,内为湖,并经长期的改造,形成了山水交融、洞窍盘错的风光旅游胜地,在国内外享有盛名。我国于 20 世纪 80 年代正式提出土地复垦与生态重建问题。

图 1-1 是土地复垦与生态重建产生示意图,从图中可以看出,土地复垦与生态重建的产生需要三个条件:

- ① 土地与生态问题已达到一定的危害程度——足以引起人们的注意。
- ② 公众有关心生活质量(环境意识)。
- ③ 社会有一定的经济发展水平(实力)。

综上所述,我们不难发现,土地复垦与生态重建不是学者们突发奇想、心血来潮的产物,它是社会生产力发展到一定阶段,人类与土地的关系以及与环境的关系陷于深刻危机的严峻时期,在人类社会发展的阵阵痉挛和频频剧痛中兴起的。它的兴起,意味着人类和土地以及环境都遭受了巨大的创伤。

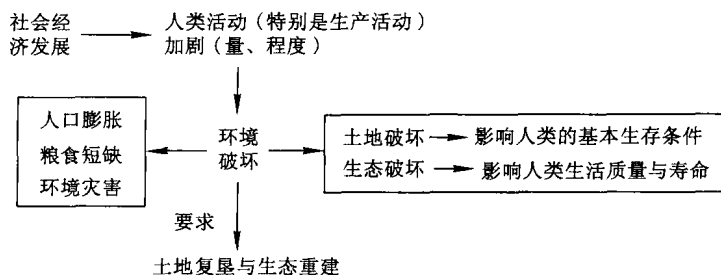


图 1-1 土地复垦与生态重建产生示意图

第二节 土地复垦与生态重建的定义与内涵

关于土地复垦与生态重建的内涵及其两者的关系,人们一直有不同的理解,导致现在存在很多不同的说法。例如,同是针对矿区破坏土地的治理工作,矿山、土地、农业等的研究人员称其为“土地复垦”;环保研究人员有时称其为“土地复垦”,有时称其为“生态建设”;生态研究人员常称之为“生态恢复”或“生态重建”。甚至有人统称之为“土地复垦与生态重建”,或“生态重建/土地复垦”。虽然名称各异,方向也各有所侧重,但从近年的研究和实施工程来看,其总目标在逐渐趋向于更综合的生态环境问题。

那么,土地复垦与生态重建的定义和内涵究竟有无区别,二者之间有何关系呢?本节重点介绍该内容。

一、土地复垦的定义与内涵

“土地复垦”,顾名思义,往往理解为土地的恢复耕种,这是我国不少人的理解。我国新近颁布的《土地管理法》的英文版中,将“土地复垦”翻译为“Land Recultivation”,即土地重新耕种。但也有专家将土地复垦的定义表述为:对采矿等人为破坏的土地,采取整治措施,因地制宜地恢复到可供利用的期望状态的行动或过程。其目的是:再生利用土地、恢复生态平衡,使生产建设得到健康发展的同时,土地资源和环境也得以保护和持续利用。另外一种表述为:土地复垦是对地球表层的陆地部分(包括海洋滩涂和内陆水域)中由于人为或自然营力原因遭到直接或间接破坏而丧失了原有利用价值的部分,采取各种技术和相关措施,使之恢复到可供人类持续、高效利用状态的行为。而我国 1989 年生效实施的《土地复垦规定》,将土地复垦定义为:对各种破坏土地“恢复到可供利用状态的活动”。

(一) 土地复垦概念的来源

在《新编说文解字》中对复、垦的解释是:“‘复,行故道也’,其本义是‘返回、回来’,引申为‘恢复’”;“‘垦,耕也’,本义是翻土,开垦。”复、垦两字组合在一起的字面意思则是:“重新开垦、恢复可耕。”所以,在我国“土地复垦”一词最早称之为“造地覆田”、“复田”、“垦复”、“复耕”、“复垦”、“综合治理”等,直到 1988 年 11 月国务院颁布了《土地复垦规定》,“土地复垦”一词才被我国确定下来。

“复垦”一词来源于国外,应在对国外原始定义理解的基础上加以翻译。欧美常用 Res-