

中国森林生态系统定位研究网络(CFERN)系列丛书

大岗山森林生态系统研究

王 兵 聂道平 等著
郭泉水 夏良放



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前 言

森林生态系统是维持生物圈、地圈动态平衡的重要陆地生态系统类型。森林覆盖面积约占地球陆地面积的 1/3, 森林的生物总量约为整个陆地生态系统的 90%, 森林生产的有机物每年约占整个陆地生态系统的 70%。森林对太阳辐射的吸收、分配、利用和转化过程, 直接影响地球的能量收支、转换, 而且也影响大气中的 CO_2 、 O_2 和水汽的动态平衡。森林的养分循环、水分循环参与整个地球的生物化学循环过程, 在全球物质循环代谢方面起着重要作用。同时, 森林的生产力和经营水平也直接关系到全球人类的社会生活。森林不仅能为人类提供木材、林副产品和能源, 而且在调节气候、涵养水源、保持水土、减免和抗御洪涝灾害、保护和美化环境等方面, 都具有独特作用和巨大效能。

森林生态系统研究的目的在于阐明森林生态系统的结构与水热条件, 物质与能量循环, 生物量与生产力以及不同树种的种内和种间关系, 为森林合理经营利用提供指导, 也为经济发展和环境建设提供科学依据。

大岗山森林生态系统研究始于 20 世纪 60 年代, 主要是结合当地自然条件 and 生产实际开展森林资源的专项调查与观测, 而后开始吸收欧美等国的生态系统理论和观测方法, 开展系统水平的物流、能流定位研究。其主要目的是调查研究我国中亚热带用材林基地的森林群落一系列自然生态系统和社会经济系统的背景、森林生态系统结构和功能规律, 以及森林经营管理(包括造林、采伐、抚育、科技示范)和林业可持续发展等。

为了更好地进行大岗山森林生态系统研究, 1984 年创建了中国林业科学院生态环境与保护研究所, 是国家林业局科技司管辖的 15 个森林生态系统定位站的主要台站之一。

大岗山国家级森林生态系统定位研究站地处江西省分宜县境内, 位于东经 $114^{\circ}30'$ ~ $114^{\circ}45'$, 北纬 $27^{\circ}30'$ ~ $27^{\circ}50'$, 面积 9339.9hm^2 。属罗霄山脉北端的武功山支脉, 地质构造属华夏系, 地势起伏较大, 相对高差达 1000m, 最高峰海拔 1091.8m。属亚热带湿润气候区, 具有四季分明、日照充足、雨量充沛等特点, 特别适合林木生长。土壤属长江中下游低山丘陵红壤、黄壤类型。地带性植被为亚热带常绿阔叶林, 代表种是青冈栎、刺栲、大叶锥栎、甜槠、苦槠、木荷、红楠等。植被类型主要有常绿针叶林(杉木林、马尾松林)、常绿阔叶林、落叶阔叶林、混交林(杉阔混交、杉竹混交)、毛竹林、油茶林等。植物种类为 1888 种, 常见的陆生野生动物有 7 目 15 科 38 种。

该站区自然条件优越, 水热资源丰富, 生物资源及矿产资源也极为可观, 工农业具有一定基础, 经济发展具有巨大潜力。但是, 由于植被破坏严重, 森林资源量下降, 农业不合理开垦, 矿区不合理开发, 导致生产能力偏低, 商品率不高, 区域内水土流失严重, 生态环境趋于恶化, 生物群落类型及物种多样性减少。与此同时, 人工林结构单一, 经营粗放, 天然林破坏严重, 地力衰退

加剧。

大岗山森林生态系统定位研究站建有完备的野外观测设施和先进的观测分析仪器,现有集水区测流堰 5 座,坡面径流观测场 15 个,光合生理观测铁塔 5 座,设固定标准地 20 块,自建野外观测试验楼 2 栋(建筑面积 800m²),海拔 300m 和 800m 标准常规气象观测场 2 个,并配备了先进的 Delta-T 自动气象站,以及植物光合测定仪 2 台,植物茎流水势仪 1 台,土壤中子水分仪 1 台。此外,尚设有野外分析实验室和化学分析中心。

近年来,大岗山森林生态系统的研究围绕森林群落演替、结构与功能、生产力及生态环境变化和动态演替、生态系统物质循环(养分、水、碳循环等)、能量传输途径及能量平衡、森林与区域气候的相互作用、森林水文生态效益、天然林的生态系统经营及退化等方面展开,取得了一系列具有较高学术价值的成果。

经多年对大岗山两个主要土类——红壤、黄壤在各个研究林型下的理化性质、生物化学活性、水文性质等方面的定位研究,取得了丰富的资料数据,对林地土壤水分含量与主要气象要素进行了多元回归分析,效果良好。

通过对大岗山森林生态系统观测数据的分析比较,对杉木人工林的光合、呼吸、气孔导度和水分利用效率等生理生态特性;生产力(生物量)、生长过程的差异以及养分吸收和养分循环状况进行了详细的分析总结并与不同地带不同林木进行对比分析,取得一系列有价值的研究成果,为今后大岗山森林生态系统的科学经营提供了理论依据。

径流是森林水文生态功能的重要体现形式之一,径流的流量和特点决定着林区河流的水文特征。总体来讲,大岗山森林生态系统不同森林类型对径流的影响有显著差异,与人工杉木林、人工马尾松林以及人工针阔混交林相比,天然常绿阔叶林更具有涵养水源、减少坡面径流、防止水土流失以及减少土壤侵蚀的良好森林水文生态效益。依据 2000 年以来的长期观测、试验数据,本书对典型集水区及天然常绿阔叶林的水量平衡和水文生态功能进行了分析研究,与当地的人工杉木林、马尾松林和毛竹林的水文特征进行了比较并与我国其他地区亚热带常绿阔叶林生态系统的水文生态功能进行了对比分析。

大岗山森林生态站设置了杉木不同密度幼林的试验,开展了密度管理、杉木经营、杉木速生丰产林技术等多项森林经营管理技术研究。在对大岗山林区立地条件调查分类的基础上,分析了杉木林的生长规律、经营技术以及经营对策等并构建了杉木人工林的经营模型,以便采取合理技术措施,寻求优化栽培模式的方法和手段。

另外,还对毛竹林复合经营模式进行了详细的研究,分别就竹林—药用植物复合经营、毛竹林区竹荪栽培、荪竹两用林的培育、“竹—牛—草”复合经营等多种类型进行分析评价,建立了大岗山林区毛竹林复合经营的优化模式,提出了具体的经营方法与经营对策,对当地的经济的发展起到了积极的促进作用。

大岗山森林生态站以亚热带常绿阔叶林、杉木人工林、毛竹人工林和人工针阔叶混交林作为研究对象,以野外观测指标体系的数据集为基础,采用具有强大的分析、查询,检索、决策等功能的 ARCVIEW 和 ARC/INFO 系统软件,建立了大岗山森林生态系统野外观测信息管理系统和数据共享平台,开发了基于 GIS 的大岗山森林生态站观测数据库及信息管理系统,完善了数据管理方法和管理制度;建立了基于互联网的大岗山森林生态站主页,将大岗山资源环境信息上

网共享,提高了数据的使用效率。

根据 2000~2010 年发展战略,我们将大岗山森林生态站的研究定位在以下三个方面:

(1)为中亚热带山区扭转森林资源下降、发展速生丰产林、提高林分生产力和集约经营水平,提供营林技术和经营管理模式。

(2)充分利用生态系统水热资源及生物资源,提高森林生态系统的多样性、稳定性,探索立体林业、农林复合经营、混交造林模式等可持续发展道路。

(3)为中亚热带山区及长江中下游地区在森林集约经营基础上提供改善生态环境的生态经济发展示范,实施天然林保护工程,提供天然生物群落的对照区,控制并改善由于矿产资源开发造成的环境污染,提高环境质量。

本书对国内外森林生态系统研究现状做了综述,对江西大岗山森林生态系统中的森林植物资源与群落演替、森林生态系统能量平衡与光合生产力对比研究、养分循环、水量平衡以及森林生态系统管理等方面的研究成果进行了概括与总结,为中亚热带森林生态系统的研究提供了科学指导和理论依据。

参加本书撰写的人员有:前言(王兵、李海静、崔向慧、赵广东);1.1 节(王兵、崔向慧);1.2 节(王兵、李少宁);1.3 节(王兵、刘世荣、崔向慧);1.4 节(王兵、崔向慧);1.5 节(聂道平、徐德应、王兵);1.6 节(聂道平);2.1 节(郭泉水、夏良放、陈艾、郭景华);2.2 节(张家城、陈力);3.1 节(王兵、崔向慧、李海静);3.2 节(赵广东、聂道平、张家城);4.1 节(郭玉文、戴伟);4.2 节(聂道平);5.1 节(王兵、崔向慧);5.2 节(王兵、崔向慧);6.1 节(聂道平);6.2 节(聂道平);6.3 节(王兵、李少宁);6.4 节(王兵、李少宁);6.5 节(聂道平)。

此版本为《大岗山森林生态系统研究》一书的最终正式版本,与本书内容不符的其他版本予以废止。

由于时间仓促以及著者水平等原因,书中难免疏漏,恳请各位不吝赐教。

Preface

As a type of terrestrial ecosystem, forest ecosystem is rather important in maintaining the dynamic balance of biosphere and geosphere. Roughly speaking, forest covers one third of the total terrestrial area on the earth, with its total biomass accounting for 90 per cent of that of the whole terrestrial ecosystem. In addition, annual amount of organic matter produced by forest appropriately accounts for 70 per cent of that by the terrestrial ecosystem as a whole. Forest directly affects energy's budget and transformation on the earth through absorbing, allocating, utilizing and transforming solar radiation, which also exerts influence on the dynamic balance of carbon dioxide, oxygen, and water vapor in atmosphere. Forest's nutrient cycle and water cycle are two key links of the earth's biochemical cycle, playing a significant role in the material cycle and metabolism around the world. In the meantime, forest's production capacity and management level also directly influence people's several life all over the world. Forest can not only provide timber, forest by products and energy to human being, but has great importance in adjusting climate, conserving water and soil, preventing floods, as well as protecting and beautifying environment.

Research on forest ecosystem is aimed at illustrating forest ecosystem's structure, water-heat condition, material and energy cycle, biomass, production capacity, as well as intraspecific and interspecific relations between different tree species, so as to guide the reasonable management and utilization of forest, and provide scientific proof for economic development and environmental construction.

Initiated in 1960s and combining the local natural condition and practical production, the study of Dagangshan Forest Ecosystem stressed on the research and observation of forest resource. By and by, absorbing the theories of ecology and the ways of observation and record from Europe and America etc; and improved the study and have a series of integrated systems of research.

In order to research the Dagangshan forest ecosystem, we built Dagangshan State Forest Ecosystem Station, which is one of stations that was put up in the year of 1986 and had wide observing contents since its foundation. Its main purpose is to 1) illustrate the characteristics of structure and function of nature and man-made ecosystem in middle sub-tropical zone and the relationship between them; 2) do research on the effects of man-made managing measurements; 3) bring up the management methods that are reliable in theory and are feasible in reality for the economical, ecological and social improvement.

Dagangshan State Forest Ecosystem Station is located in Fenxi county, Jiangxi Province ($114.30^{\circ} \sim$

114.45°E, 27.30° ~ 27.50°N). The area of site is 9839.9hm² and the altitude of Dagangshan is 1091.8m. The station is belonging to subtropical climatic region. The average yearly temperature is 15.8℃, average yearly sunshine time 1656.9 hours, average precipitation 1590.9mm. The type of soil there is red and yellow soil at low hills of the Yangtze River's middle-lower reaches. According to the statistics of 1997, amounts of wild animal have got to 7 orders, 15 families, 38 species; 4 orders, 38 families (4 sub-families), 16 species birds were found. Cover plant is subtropical evergreen broad-leaved forest, whose representative species and so on. Main plants are evergreen coniferous forest, evergreen broad-leaved forest, deciduous broad-leaved forest, mingled forest, bamboo, tea-oil tree and so on.

The natural geography and economic development background of Dagangshan Forest Ecosystem is as follows: superior natural conditions, abundant water-heat resources, spectacular biological and mineral resources, industry and agriculture on the certain basis, low productivity, low commodity rate and high economic development potential. In this region, there are abundant forest reserves and superior growth conditions and the management of artificial forest there has historical convention, but is rough. The structure of artificial forest is monotonous, Natural forest is seriously damaged, and the regression of land capability is aggravating.

Dagangshan State Forest Ecosystem Station built the self-contained observation establishment and a series of analyzed instrument, V-notch weir in the catchments (3); Overland runoff observation station (7); Iron tower for photosynthesis measurement (5); Building for observation (2); Micro-climate observing station [300m altitude (1), 800m altitude (1)]; LI-6200(1); LI-6400 (1); TDR (1); Water potential instrument for stem flow measurement (1). We also built the analysis laboratory and the center of chemistry analysis.

During the past fifteen years, the main achievements in Dagangshan forest ecosystem station are as following.

The researcher in the Dagangshan Forest Ecosystem investigate the vegetation types in Nianzhu forestry center and Shangcun forestry center and divide them into different types by the way of naturalness and intensity degree.

By the comparison of observation data in Dagangshan Forest Ecosystem, the biomass, net productivity, the difference during the growth, the uptake and cycling of nutrients. Forests gain the energy from the sun and the consume of energy includes heating up the underlying surface, transpiration, evaporation and photosynthesis. From the setting up of Dagangshan State Forest Ecosystem Station, the researchers observe and compute the weight of energy for a long time.

From 1986, the researcher in Dagangshan State Forest Ecosystem Station begin to study the hydrologic effects of the forests, including *Phyllosachya pubescens* forests, *Pinus massoniana* forests, Chinese fir

forests and so on. The emphasis of research is as following, ①the redistribution of precipitation in vegetation layer, ②the physical character of forest soil, ③the effects of forests on the runoff.

During the "8th five-year project period", on the classification basis of the site quality in Dagangshan forest areas, the growth rule, management technology and management countermeasure were analyzed and the management model of Chinese fir plantation were set up. The research purpose was to find out the available methods and means of planting models.

On the basis of monitoring index database and with the usage of Arcview/Info system software, the information management system and data sharing platform of Dagangshan State Forest Ecosystem Station were established and its purpose was to improve data management methods. The website of Dagangshan State Ecosystem Station which was on the basis of Internet was built up. With our efforts, the monitoring and research in the Dagangshan State Ecosystem Station become more typical and more scientific.

With the increase of population and the economic development in the Southern China, some crude vegetation had been destroyed and the ecological environment became more and more exasperate. The long-term monitoring data and the original information is the basis of drawing the corresponding important management measurement and the forest constructing policy.

According to the Development Strategy for 2000—2010, the main research in Dagangshan State Forest Ecosystem Station is as following.

At present, the forest resource in the mid-subtropical mountain area has decreased. In order to improve the stand productivity and develop high-yielding timber plantation, the forest management technology will be studied.

The technology and methods, which can improve the biodiversity, stability of forest ecosystem, will be illuminated. The purpose of this research is to explore the sustainable development way of three-dimensional forestry, agroforestry and so on.

On the basis of forest intensive culture in mid-subtropical mountain area and middle and lower valley of Yangtze River, we will put up the experimental area of ecological economics and carry out natural forest conservation program. Our aim is to control environmental pollution and improve the environmental quality in the station areas.

This book introduce the study on the Dagangshan forest ecosystem form summarizing the forest ecosystem, succession situation for forest community, energy balance and photosynthesis, nutrient recurrence, balance of water, forest ecosystem management and so on. It also affords the gist of the theory and practice for the study on forest ecosystem in the future.

The personnel of compiling this book: Preface (Wang Bing, Li Haijing, Cui Xianghui, Zhao Guangdong); Section1.1 (Wang Bing, Cui Xianghui); Section1.2 (Wang Bing, Li Shaoning); Section1.3

(Wang Bing, Liu Shirong, Cui Xianghui); Section1.4(Wang Bing, Cui Xianghui); Section1.5(Nie Daoping, Xu Deying, Wang Bing); Section2.1(Guo Quanshui, Xia Liangfang, Chen Ai, Guo Jinghua); Section2.2(Zhang Jiacheng, Chen Li); Section3.1(Wang Bing, Cui Xianghui); Section3.2(Zhao Guangdong, Nie Daoping Zhang Jiacheng); Section4.1 (Guo Yuwen, Dai Wei); Section4.2(Nie Daoping); Section5.1(Wang Bing, Cui Xianghui); Section5.2(Wang Bing, Cui Xianghui); Section6.1(Nie Daoping); Section6.2(Nie Daoping); Section6.3(Wang Bing, Li Shaoning); section6.4(Wang Bing, Li Shaoning)Section6.5(Nie Daoping).

This edition is the finally formal edition for the Research On Dagangshan Forest Ecosystem .No other edition against this is prohibited.

Without enough time and labor, there may be mistakes. And we wish we could get suggestion from you.

目 录

前言

Preface

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