专家论坛

泰国土地发展部顾问 Chinapatana Sukvibool 先生论东南亚森林植被变化与土壤侵蚀管理

摘　要：[目的] 回顾和总结近年来东南亚地区森林植被变化与水土流失演变领域研究项目的成果，并探讨东南亚地区改良后的保育措施在流域尺度水土流失与产沙管理方面的成效。[方法] 根据东南亚各国不同时空尺度的数据，分析了该区森林植被的变化及采取的对策。选择泰国实施流域管理的地区为研究区，阐述了被动和主动侵蚀控制策略的有效性和实用性。[结果] ①在 2000—2005 年期间，东南亚地区的森林面积大幅减少，累计年度森林砍伐率达到 2.76×10^6 hm^2。然而，由于森林种植园的建立，该区森林覆盖率近期已经增加。②东南亚雾霾是一种定期发生的大范围空气污染问题，它在很大程度上起因于农业上的非法放火烧荒。③东南亚地区土壤侵蚀管理措施包括带状种植、等高耕作、条状种植、草障、保护性耕作、免耕种植和植物篱间作。尽管在小区尺度上，保护措施在减少径流方面发挥了良好的作用，但对大尺度而言，其作用还有待进一步的研究和验证。水土保持对产量的潜在影响可能是影响水土保持投资价值的一个关键因素。[结论] 东南亚地区森林覆盖变化的挑战既真实又迫切。我们应该建立区域防控机制减少森林火灾和雾霾，并通过保持一个可持续的林业，维护陆地生物多样性减少土壤侵蚀。为低收入小户型农民选择适当的水土保持方法，对于降低水土流失速度和提高作物产量至关重要。

关键词：森林植被；土壤侵蚀与保持；雾霾污染；东南亚

文献标识码：C　　**文章编号**：1000-288X(2019)03-0307-06　　**中图分类号**：S157，X171.4

文献参数：Chinapatana Sukvibool. 东南亚森林植被变化与土壤侵蚀管理[J]. 水土保持通报，2019，39(3)：307-312. DOI：10. 13961/j. cnki. stbctb. 2019. 03. 049；Chinapatana Sukvibool. Change of forest vegetation and management of soil erosion in Southeast Asia[J]. Bulletin of Soil and Water Conservation，2019，39(3)：307-312.

EXPERT FORUM

Change of Forest Vegetation and Management of Soil Erosion in Southeast Asia

—Commented by Chinapatana Sukvibool，
An Adviser of the Land Development Department，Thailand

Abstract：[Objective] The objectives of this paper were to review and synthesizes the research programs which were conducted in the field of change of forest vegetation and the evolution of soil erosion in Southeast Asia，and to discuss the effectiveness of improved conservation practices on managing soil erosion and sediment yield at catchment scale. [Methods] The forest vegetation change countermeasures at different spatial and temporal scales were analyzed according to data from countries in Southeast Asia. This paper focused on an extensive range of methodologies at different spatial and temporal scales. The research area was the region selected for the implementation of watershed management in Thailand. The efficacy and practicality of passive and active erosion control strategies were expounded. [Results] ① Forest loss in Southeast Asia had remained at high levels during the period from 2000 to 2005，accumulating to an annual deforestation rate of about 2.76×10^6 ha. However，forest cover has increased in the recent years due to the establishment of forest plantations. ② Southeast Asian haze was a large-scale air pollution problem that occurs regularly. The haze was largely caused by illegal agricultural fires. ③ Soil erosion control strategies for manage soil erosion in Southeast Asia include alley cropping，contouring，strip cropping，grass barriers，

收稿日期：2018-11-12　　**修回日期**：2019-02-26
第一作者：Chinapatana Sukvibool(1956—)，男，泰国人，主要从事水土保持管理工作，E-mail：sukvibool@hotmail. com。

conservation tillage, minimum tillage and hedgerow inter-cropping. Despite the role of conservation practices being well established in reducing water runoff at the plot scale, extrapolation to a large scale, it has been less understood and verified. The potential impact of soil conservation on yield may be a key factor that affects the value of soil conservation investments. [Conclusion] The challenge of forest vegetation change in Southeast Asia is real and urgent. Regional prevention and control mechanisms should be constructed to decrease forest fire and haze. To decrease soil erosion, we should keep a sustainable forestry and sustain terrestrial biodiversity. Selection of appropriate soil conservation methods for low income smallholder farmers is critical to reduce the rate of soil erosion as well as to increase crop productivity.

Keywords: forest vegetation; soil erosion and conservation; haze pollution; Southeast Asia

The forests of Southeast Asia comprise some of the world's most valuable and productive tropical forests, forming unique ecosystems of high biodiversity composition. But forest loss in Southeast Asia has remained at high levels during the period from 2000 to 2005. The continuing loss of forests in Southeast Asia is alarming not only in terms of the sustainable development of the forest resources, but also for biodiversity conservation. The economic loss suffered by countries during the haze episode was enormous. Several economic sectors, including air, water and land transport, tourism and agriculture have been severely affected.

1 Introduction to the Southeast Asia

The Southeast Asia includes 11 countries, they are Cambodia, Indonesia, Brunei, Singapore, Malaysia, Philippines, Vietnam, Laos, Thailand, Myanmar and East Timor. The Southeast Asia is divided into two parts: the islands and the mainland. The mainland is a peninsula, and the islands extend east and west between the Indian Ocean and Pacific Ocean.

1.1 Climate and vegetation of Southeast Asia

The west coast of Myanmar is a tropical humid climate, the mainland is a tropical dry and humid climate, and the southeast coast of India is a tropical humid climate covered with tropical rainforest. The summer monsoon brings a lot of rain to the area, and the rainfall reaches at least 1 524 mm per year. Southeast Asia contains the second largest tropical rain forest region in the world. Rain forests are a source of lumber, herbs, medicines, and chemicals. Rain forests once covered nearly all of Southeast Asia. But huge sections have been cut down over the years.

1.2 Agriculture and Farming of Southeast Asia

About 60% of the Southeast Asian population work in agricultural sector. People farm and live in the river valleys of the mountain. Crops include cash crops such as: oil palm, coffee, tea, and rubber. Rubber and oil palm products are the major exporters in Indonesia, Malaysia and Thailand. Soybeans, sugar cane, fruit and rice are also major agricultural products. Rice is a food crop as well as a cash crop. Indonesia, Vietnam and Thailand are the top rice-producing nations.

1.3 Haze of Southeast Asian

Southeast Asian haze is a fire-related large-scale air pollution problem that occurs regularly. These haze events have caused adverse health and economic impact on Brunei Darussalam, Indonesia, Malaysia, Singapore, and to a less degree, the Philippines and Thailand. The problem flares up every dry season in varying degrees. Trans-boundary haze in Southeast Asia has been recorded since 1972. The haze is largely caused by illegal agricultural fires due to industrial-scale slash-and-burn practices in Indonesia, especially from the provinces of South Sumatra and Riau in Indonesia's Sumatra Island, and Kalimantan on Indonesian Borneo. The burned land can be sold at a higher price illegally, and eventually used for activities including oil palm and pulpwood production. Burning is also cheaper and faster compared to cutting and clearing using excavators or other machines.

2 Forest Change in Southeast Asia

Forest cover and its annual change rate vary widely, typically as a function of country size. Forest cover of most countries in Southeast Asia is at least 50%, but forest cover in East Timor, the Philippines, Thailand and Vietnam ranges from 20% to 30%; especially in Singapore, forest cover is less than 3%.

The total annual reduction of forest cover is greatest in Indonesia and Myanmar. In fact, new

evidence from Indonesia indicates an annual loss of 1.80×10^6 ha per year (Indonesia FLB, 2001) and it is estimated that annual loss of forest cover increases at 5.00×10^5 ha over at present. The only country with a positive forest cover change is Vietnam. There is no change of the forest cover in Brunei Darussalam and Singapore. Forest loss in Southeast Asia has remained at high levels during the period from 2000 to 2005, accumulating to an annual deforestation rate of about 2.76×10^6 ha or occupying 1.3% of the region's forest area. In Indonesia alone, the moist tropical forests experienced an annual loss of almost 1.90×10^6 ha, which accounted for about 2% of the region's forest area. High forest loss is also reported in Myanmar and Cambodia, with annual deforestation rates of 4.66×10^5 ha (occupying 1.5% of the region's forest area) and 2.19×10^5 ha (accounting for 2% of the region's forest area), respectively. For the whole region, the annual net loss remained at the same level as reported for the 1990s, with annual deforestation rates of 2.79×10^6 ha.

Unsustainable cutting and burning of forests, along with diseases and insects are the crux reasons for forest vegetation change. Tropical deforestation is a potentially catastrophic issue for the change of forest vegetation. Moreover, the high rate of tropical deforestation might increasingly contribute to global warming.

3　Methods to Sustain Tropical Forests in Southeast Asia

The solution for sustainability of tropical forests in Southeast Asia involves two aspects: prevention methods and rehabilitation methods.

Methods to prevent forests from deforestation are as follows: ① To protect the most diverse and endangered areas; ② To educate settlers about sustainable agriculture and forestry; ③ To subsidize only sustainable forest use; ④ To protect forests with debt-for-nature swaps and conservation concessions; ⑤ To certify sustainably grown timber; ⑥ To reduce poverty; ⑦ To slow population growth down.

Methods to restore forests are as follows: ① To encourage regrowth through secondary succession; ② To rehabilitate degraded areas; ③ To concentrate farming and ranching in already-cleared areas.

4　Management of Soil Erosion

Soil erosion was very serious in Southeast Asia due to the high rate of tropical deforestation during 2000—2005. To control soil erosion, researchers have evaluated the efficacy and practicality of passive and active erosion control strategies. These include alley cropping, contouring, strip cropping, grass barriers, conservation tillage, minimum tillage and hedgerow inter-cropping. Selection of appropriate soil conservation measures for low income smallholder farmers is critical to reduce the rate of soil erosion as well as to increase crop productivity. The potential impact of soil conservation on yield may be a key factor that affects the value of soil conservation investments. Soil conservation strategy adoption by upland farmers is not a function of the farming system type or income. Despite the role of conservation practices being well established in reducing water runoff at the plot scale, extrapolation to a large scale, it has been less understood and verified.

4.1　Impacts of Soil Erosion in Southeast Asia

The loss of nutrients in the upper layer of soil reduces the ability of soil to retain water after erosion, resulting in decline of soil quality. Fertilizing can increase the nutrient content of soil. But it is not an option in most developing countries. The main off-site effect of water erosion is the movement of sediment and agricultural pollutants into watercourses. Sediment in watercourses can lead to the silting-up of dams, disruption of the ecosystems of lakes, and contamination of drinking water. Increased downstream flooding may also occur due to the reduced capacity of eroded soil to absorb water, and the reduced capacity of streams and lakes to hold water.

4.2　Soil and Water Conservation Measures in Southeast Asia

The research area is the region selected for the implementation of watershed management in Thailand case. The implemented varieties of soil and water conservation measures are shown in Fig. 1. Several engineering measures were adopted to prevent and control the damages caused by soil erosion in the river basin. In addition, vetiver grass is used as an effective biological measure. It is a kind of living barrier for soil erosion control (Fig. 2).

Fig. 1 Engineering measures for watershed management, Thailand

Fig. 2 Ecological restoration function of vetiver grass, Thailand

5 Solutions to Problems of Soil Erosion

The solutions to problems of soil erosion in Southeast Asia are sustainable forestry and terrestrial biodiversity. The major tree harvesting methods are selective cutting, clear-cutting and strip cutting.

5.1 Keeping a Sustainable Forestry

We should identify and protect forest areas with high biodiversity, rely more on selective cutting and strip cutting, no clear-cutting on steep slopes, no logging of old-growth forests, reduce road building into uncut forest areas, leave most standing dead trees and fallen timber for wildlife habitat and nutrient recycling, certify timber grown by sustainable methods including ecological services of forests in estimating their economic value.

5.2 Sustaining Terrestrial Biodiversity

We should adopt forests, plant trees and take care of them, recycle paper and buy recycled paper products, buy sustainably produced wood and wood products, choose wood substitutes as bamboo furniture and recycled plastic outdoor furniture, decking, and fencing, help to restore a nearby degraded forest or grassland, and landscape our yard with a diversity of natural plants.

5.3 Constructing Regional Mechanisms on Fire and Haze Prevention and Control

ASEAN (Association of Southeast Asian Nations) has signed agreement on trans-boundary haze pollution. The agreement aims to prevent and monitor trans-boundary haze pollution as a result of land and forest fires which should be mitigated, through concerted national efforts and intensified regional and international co-operation. The development of the ASEAN agreement on trans-boundary haze pollution was as follows: ① Since the early 1990s, ASEAN member states have been working together to tackle trans-boundary haze pollution problem arising from land and forest fires. ② In 1995, ASEAN Environment Ministers agreed to intensify co-operation through concrete programs spelt out in the regional haze action plan (RHAP) to prevent, monitor and mitigate land and forest fires. ③ The RHAP was adopted at the first ASEAN ministerial meeting on haze in December 1997 in Singapore. ④ In 1999, ASEAN took a further step by adopting the policy on zero-burning and banning of open burning as a long-term strategy during dry season. ⑤ The ASEAN Haze Agreement was signed by the ten ASEAN members states on 10 June 2002 during the occasion of the World Conference and Exhibition on Land and Forest Fire Hazards in Kuala Lumpur. ⑥ The agreement entered into force on 25 November 2003, following the deposit of the sixth instrument of ratification by Thailand on 26 September 2003.

6 A Major Issue for Unclear Data of Forest Resources from Different Countries

Information on forest cover in Cambodia is of high quality and up to date. It appears that the rate of loss of forest cover has slowed from a rather high rate during the 1980s. Forest degradation, however, remains a serious problem.

There is uncertainty about the data for Indonesia. Data published since these estimates were made suggest a higher rate of forest cover loss. There are some questions and concerns on how the new data were derived, but the situation in Indonesia remains serious.

Data from Lao People's Democratic Republic are probably quite reliable. The most recent data are from 1989. National data suggest that forest degradation is serious.

Malaysia has separate data for Peninsular Malaysia, Sabah and Sarawak. Secondary figures had to be relied on and periods between surveys were quite long (10 years for Peninsular Malaysia, 25 years for Sabah and 20 years for Sarawak). The secondary data are probably reliable. However, extrapolation over such long periods may have caused the overestimation of forest cover loss.

Data from Myanmar are up to date and probably reliable. It shows that Myanmar has a high annual loss of forest cover. Forest degradation is also serious.

Data sets for the Philippines are rather recent and compatible, and its reliability can be regarded as high. Loss of forest cover is high for the sub-region, which is 1.4% per year. Some innovative management initiatives to arrest this development are under way.

No major change in forest cover for Singapore should be expected. The "greening" policy and urban forest management programs are interesting examples for other large cities.

The period between the data sets of Thailand is long (17 years), but it is unlikely that this has led to overestimation of annual forest cover loss. Interesting rehabilitation and reforestation initiatives are also under implementing.

Vietnam is the only country in the sub-region with an annual increase of forest cover. Data are secondary but of rather recent date. Establishment of plantations helps offset annual loss of natural forest cover in the range of 3.00×10^4 ha.

The sub-region may cease to be a major exporter of large logs from natural forests, since accessible natural forests have mostly been depleted. The region has also undergone rapid economic development and there is a growing domestic demand for forest products. Forest industry has expanded during the last several decades and now mainly includes pulp and paper mills.

7 Conclusion

The challenge of forest vegetation change in Southeast Asia is real and urgent. The forest vegetation change is likely to amplify the environmental stresses and vulnerabilities of some of the existing urban and its urban communities, many of which are living in coastal and low-lying areas and rapid expanding mega-cities. A business-as-usual scenario is unlikely to support a sustainable Southeast Asia. Based on this situation, Southeast Asian responses to date have been largely inadequate even though several important steps have been taken and a number of essential foundations, both at country and regional levels, have been established for further action. For example, ASEAN leaders have recently signed the Declaration of Environmental Sustainability and the ASEAN cooperation in environment has established a common agenda and forged consensus on some policy goals for sustainable development as well as action to address trans-boundary haze pollution, nature conservation and biodiversity, marine and coastal environment problems.

Common issues of concerns include illegal logging, forest fires and encroachment. Stakeholders, participation, alternative ownership systems, resolution of land use conflicts and rehabilitation of degraded forests have started to play more important roles in forest management.

Forestry plantation is being practiced on an increasingly large scale to relieve the pressure on natural forests. Large plantations exist in the sub-region and many countries have major afforestation programs. It will, however, take some time for plantations to replace natural forests as a source of raw material. In the meantime, appropriate use and management of natural forests will be crucial. Natural forests in the sub-region are state-owned. There is no longer an abundance of heavily stocked natural forests to rely on.

[**References**]

[1] FAO. Global Forest Resources Assessment 2000[R]. Rome, 2001.

[2] FAO. Global Forest Resources Assessment 2005[R]. Rome, 2005.

[3] FAO. Global Forest Resources Assessment 2010[R]. Rome, 2010.

[4] FAO. Global Forest Resources Assessment 2015[R]. Rome, 2015.

[5] Land Development Department. State of Soil and Land Resources of Thailand Bangkok[R]. Thailand, 2015.

The original report of this paper was presented by Chinapatana Sukvibool at Global Soil Erosion Research Forum 2018, in Northwest A&F University, Yangling District, Shaanxi Province, China. This paper is reorganized from the PPT by Miss Lü Du, a P. H. D. student of Northwest A&F University. This paper is corrected by professor Zheng Fenli.

Chinapatana Sukvibool (Thailand), a former expert in Management of Soil and Water Conservation System, Land Development Department, Thailand. He was deputy president of the World Association of Soil and Water Conservation (WASWAC, from January 2010 to December 2016). He chaired or co-chaired about 30 international conferences. He is an adviser of the Land Development Department in Soil and Water Conservation Programs, Thailand, and also a councillor of the WASWAC.