Available online at www.sciencedirect.com
ScienceDirect
Environment International 33 (2007) 706–711
ENVIRONMENT INTERNATIONAL
www.elsevier.com/locate/envint

Review article

Soil erosion and its impacts on water treatment in the northeastern provinces of Thailand

Suthipong Sthiannopkao [a,*], Satoshi Takizawa [b], Jiraporn Homewong [c], Wanpen Wirojanagud [c]

[a] International Environmental Research Center, Gwangju Institute of Science and Technology, 1 Oryong-dong, Buk-gu, Gwangju 500-712, Republic of Korea
[b] University of Tokyo, Department of Urban Engineering, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan
[c] Khon Kaen University, Department of Environmental Engineering, Khon Kaen 40002, Thailand

Received 31 August 2006; accepted 29 December 2006
Available online 1 February 2007

Abstract

The economy of Northeast Thailand is mainly based on agriculture. The transformation of forestlands to agricultural areas and the encroachment of riverbanks within the Phong watershed have caused severe soil erosion. Strong storms in rainy season exacerbate the problem of soil erosion. Difficulty in getting water drives people in the upstream region to live on riverbanks. Soil erosion affects water utility by increasing the turbidity in the Phong River and also by decreasing the water storage capacity of small reservoirs for the upstream residents, as well as that of the Ubolratana Dam. The rate of siltation in the Ubolratana Dam was estimated to be 1.5 million tons/year during 1965–1990. The main source of water supply is surface water in the Phong watershed, and fluctuating turbidity makes water treatment difficult. The maximum turbidity in the upstream Phong River exceeds 5000 NTU, whereas it is reduced to be about 300 NTU at the intake point of Khon Kaen Municipal Water Treatment Plant because the Ubolratana Dam works as a huge clarifier. Khon Kaen Municipal Waterworks has a daily water supply of 72,960 m^3/day. The average amounts of alum used in the wet (May–October) and dry (November–April) periods are 42.33 g/m^3 and 28.46 g/m^3, respectively. The average costs of the amounts of alum used are 0.213 and 0.143 Bahts/m^3 during the wet and dry periods, respectively. Fluctuation of turbidity in raw water makes it difficult to adjust alum dose, resulting in treated water quality unstable, and handling of sludge disposal difficult.

Keywords: Land uses; Soil erosion; Turbidity; Water treatment; Phong watershed

Contents

1. Introduction

The northeastern region of Thailand covers 170,000 km^2 and is bounded on the north and the east by the Mekong River,

* Corresponding author. Tel.: +82 62 970 3390; fax: +82 62 970 3394.
E-mail address: suthi@gist.ac.kr (S. Sthiannopkao).

0160-4120/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.envint.2006.12.007

which is the border with Laos; on the west by the Phetchabun Mountain Range and on the south by the Dangrek Mountain Range, where there is a border with Cambodia. According to the Bank of Thailand (2004), the area and population in the northeast account for one third of the whole country's area and population, whereas their income is only about one tenth (11.2%) of the national income. Most of the population in the northeast Thailand lives on farming. The 1995 per-capita income was only 24,311 Bahts/year, which was the lowest in the country. The average income was only one ninth of the average annual per capita-income of the Bangkok residents (238,894 Bahts).

The Phong watershed (Fig. 1) is the most important watershed in the upper northeast region of Thailand. The Phong River is a tributary of the Chi River system, which flows into the Mekong River. Its catchment covers 1,518,900 ha, extending to five provinces of Chaiyaphum, Khon Kaen, Loei, Nong Bua Lumphu, and Petchaboon. The upstream watershed area is divided by the four main rivers namely the Phrom, the Choen, the Phaneng, and the upstream Phong. These rivers run into the Ubolratana Dam, which is located in the middle region of the Phong watershed. The downstream Phong River is divided into two river sections, namely sections from the Ubonratana Dam to Nong Wai irrigation weir and from the weir to Mahasarakam dam. The upper Phong watershed shares 79.59% of the total watershed area, and its land is comprised of 27.33% forest, 64.05% agriculture (mainly rain-fed paddy fields and plantations producing crops such as cassava, corn and sugarcane), and 8.62% other uses. The majority of the agricultural land has been transformed from forestland in the last few decades. This land transformation, together with farming practices without soil conservation, causes soil erosion and increased suspended solids in rivers, which silt up reservoirs, raise the riverbeds and affect water quality and water uses due to elevated turbidity levels in the rainy season.

Table 1
Slope length and steepness in the Phong watershed classified by different types of land use

Rivers	Slope length and steepness		
	Forest	Crop	Paddy
Choen	0.03–1.32	0.03–0.19	0.03–0.19
Phaneng	0.03–1.32	0.03–0.06	0.03–0.52
Phrom	0.03–1.32	0.03–0.52	0.03–1.32
Upstream Phong	0.03–1.32	0.03–0.52	0.03–1.32
Ubonratana Dam	0.03–0.60	0.03–0.06	0.03–0.19
Downstream Phong	0.03–0.60	0.03–0.52	0.03–0.06

There are two main state organizations responsible for water supply in Thailand. The Metropolitan Waterworks Authority (MWA) supplies water to three central provinces of Bangkok, Nonthaburi and Samut Prakan. The Provincial Waterworks Authority (PWA) provides services of water supply to the

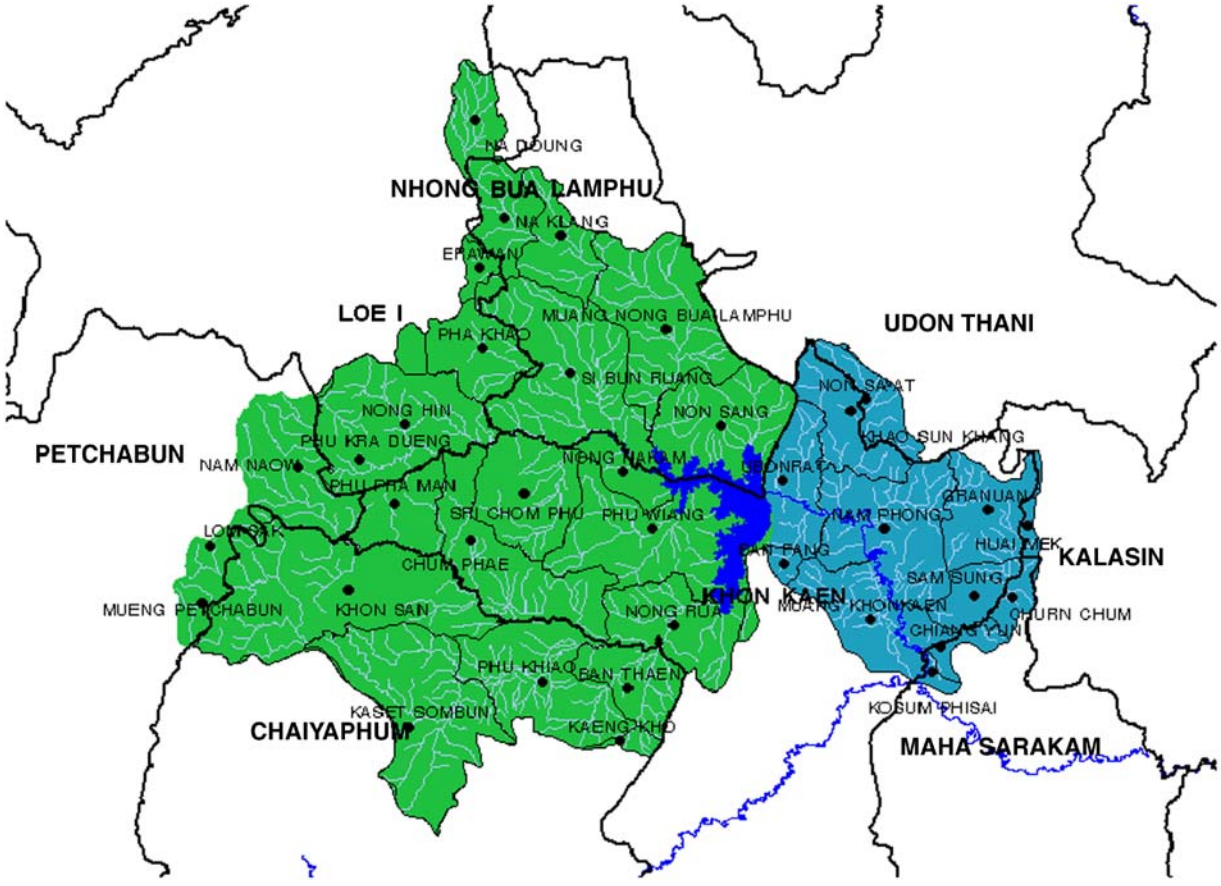

Fig. 1. The Phong Watershed Map (KKU, 1995).