Catena 123 (2014) 225–235

Contents lists available at ScienceDirect

Catena

journal homepage: www.elsevier.com/locate/catena

Sediment yield of a forest river basin in Ghana

John Manyimadin Kusimi [a,*], Barnabas A. Amisigo [b], Bruce K. Banoeng-Yakubo [c]

[a] Dep't. of Geography & Resource Development, University of Ghana, Legon, Accra, Ghana
[b] Water Research Institute, Council for Scientific & Industrial Research, P.O. Box M.32, Accra, Ghana
[c] Department of Earth Science, University of Ghana, Legon, Accra, Ghana

ARTICLE INFO

Article history:
Received 22 August 2013
Received in revised form 4 August 2014
Accepted 7 August 2014
Available online 3 September 2014

Keywords:
Pra River
Rating curve
Sediment load
Sediment yield
Suspended sediment concentration
Suspended sediment transport

ABSTRACT

The Pra River Basin, located in south central Ghana is a forest basin that has been engulfed by certain anthropogenic activities particularly illegal small scale mining (popularly called *galamsey*) and serious concerns have been raised by stakeholders within the basin of the level of pollution due to the release of sediments into the water bodies. This study was undertaken to assess sediment yield levels within the Pra Basin through field data collection to ascertain stakeholder's perceptions and suggest remedial measures to the land degradation problem in the basin.

Suspended sediment concentration measurements were undertaken for 10 months in selected stream discharge measuring stations within the basin by coupling dip and integrated sampling approaches. Samples were analyzed using the evaporation method. Daily mean suspended sediment concentration was calculated from which monthly and annual suspended sediment yields were derived. Suspended sediment concentration (mg/l) and sediment yield (t yr^{-1}) of the Pra Basin were found to be very high resulting in a high annual specific suspended sediment yield (t km^{-2} yr^{-1}). Illegal small scale gold mining along the rivers and alluvial gold mining within the basin were found to be the probable cause for the high sediment levels of the rivers. To promote coordinated development and sustainable management of the resources of the basin, there is the need to resource agencies in charge of regulating natural resource utilization to control land use activities particularly galamsey. This will reduce fluvial sediment concentration and sustain good water quality of the rivers and promote socio-economic development in the basin.

1. Introduction

Sediment yield is the amount of sediment load passing the outlet of a catchment and is the net result of erosion and deposition processes within a basin. It can be expressed in absolute terms (t yr^{-1}) or per unit area (t km^{-2} yr^{-1}) (Jain and Das, 2010; Restrepo and Syvitski, 2006; Verstraeten and Poesen, 2001). The amount of sediment yield generated within a catchment is a function of a number of anthropogenic and physical factors including farming, mining, construction, slope, basin area and rainfall intensity.

Information on sediment yield of a river basin is an important requirement for water resources development and management (Akrasi, 2011), because high sediment loads affect water quality, water supply, flood control, reservoir lifespan, irrigation, navigation, fishing, tourism, hydro-power generation, river channel morphology and stability (e.g. Alam et al., 2007; Hazarika and Honda, 2001; Peng et al., 2008; Schwartz and Greenbaum, 2009; Shirley and Lane, 1978). Also, watershed sediment transport can lead to a number of environmental problems, including decreases in ecological diversity and in esthetic properties of rivers and streams (Davis and Fox, 2009). Consequently, sediment transport problems have attracted increasing attention from the public, scientists/researchers, governments and organizations, local and national policy makers (Jain et al., 2010). This has led to an increasing demand for watershed or regional-scale soil erosion models or a quantitative assessment on the extent and magnitude of soil erosion problems so that sound management strategies can be developed for affected zones (Fistikoglu and Harmancioglu, 2002; Jain et al., 2010). Against this background, there is the need for reliable information on physical processes within a watershed such as rates of soil loss and for an improved understanding of sediment transport and storage in catchments to provide a basis for formulating and implementing improved erosion and sediment control strategies (Blake et al., 2002). Unfortunately, this information is lacking on most rivers in Ghana including the Pra. This is because rivers situated deep inside tropical rain forests are often poorly gauged, and data on sediment load are rare (Restrepo and Kjerfve, 2000). Also, data on fluvial sediment are very limited because it is very expensive to collect such data (Akrasi, 2005; Amisigo and Akrasi, 1998).

According to Water Resources Commission of Ghana, NGOs (e.g. Friends of Rivers and Water Bodies), District and Municipal Assemblies,

* Corresponding author. Tel.: +233 302500394.
E-mail addresses: jmkusimi@ug.edu.gh (J.M. Kusimi), barnyy2002@yahoo.co.UK (B.A. Amisigo), bbruce@ug.edu.gh (B.K. Banoeng-Yakubo).

http://dx.doi.org/10.1016/j.catena.2014.08.001
0341-8162/

chiefs, Assemblymen, residents and other stakeholders within the Pra Basin, the river catchment has come under threat from various activities such as logging, farming, urbanization and illegal small scale mining popularly called *galamsey* (e.g. Mensah, 2012). Illegal small scale gold mining along the banks and alluvial mining within the river bed have been the most destructive activities on water quality and sources of sediment injection into the rivers. These illegal small scale mining activities are so rampant and they are found along all the major rivers of the Pra Basin and virtually in every community from the source to the mouth at Sekyere Heman (Fig. 2). Their activities result in the discharge of large volumes of sediments and chemicals such as mercury into the rivers, thus polluting the water.

According to the managers of Ghana Water Company Limited (GWCL) in the Pra Basin particularly at Kibi, Twifo Praso, Dunkwa-on-Ofin, and Sekyere Heman (Figs. 1 & 2), the level of sediment and chemical pollution of the water by these galamsey activities is increasing their cost of operation as more chemicals have to be used in treating the water before it is supplied to consumers and this is militating against potable water supply. The high sediment levels are also causing the rapid deterioration of filters in treatment plants. For instance, GWCL shut down its treatment plant at Kibi (Fig. 1), a town at the source of the Birim River, a tributary of the Pra because the river has become too polluted to be treated for domestic use as a result of illegal small scale mining (Bentil, 2011). Similarly, illegal miners have besieged the raw water intake point at Sekyere Heman (Fig. 2) threatening the water quality of a 41 million Euro Water Treatment Plant due to the injection of bank materials into the river (Asiedu-Addo, 2008).

Owing to the deterioration in water quality resulting from these illegal mining activities, most residents within the basin have to depend on boreholes and sachet or bottled water as the alternative source of water supply for domestic uses. In smaller communities where they do not have boreholes and have no access to treated water, they have no option but to still depend on this polluted water which has dire consequences on their health. The water which is enriched in quartz and clay minerals

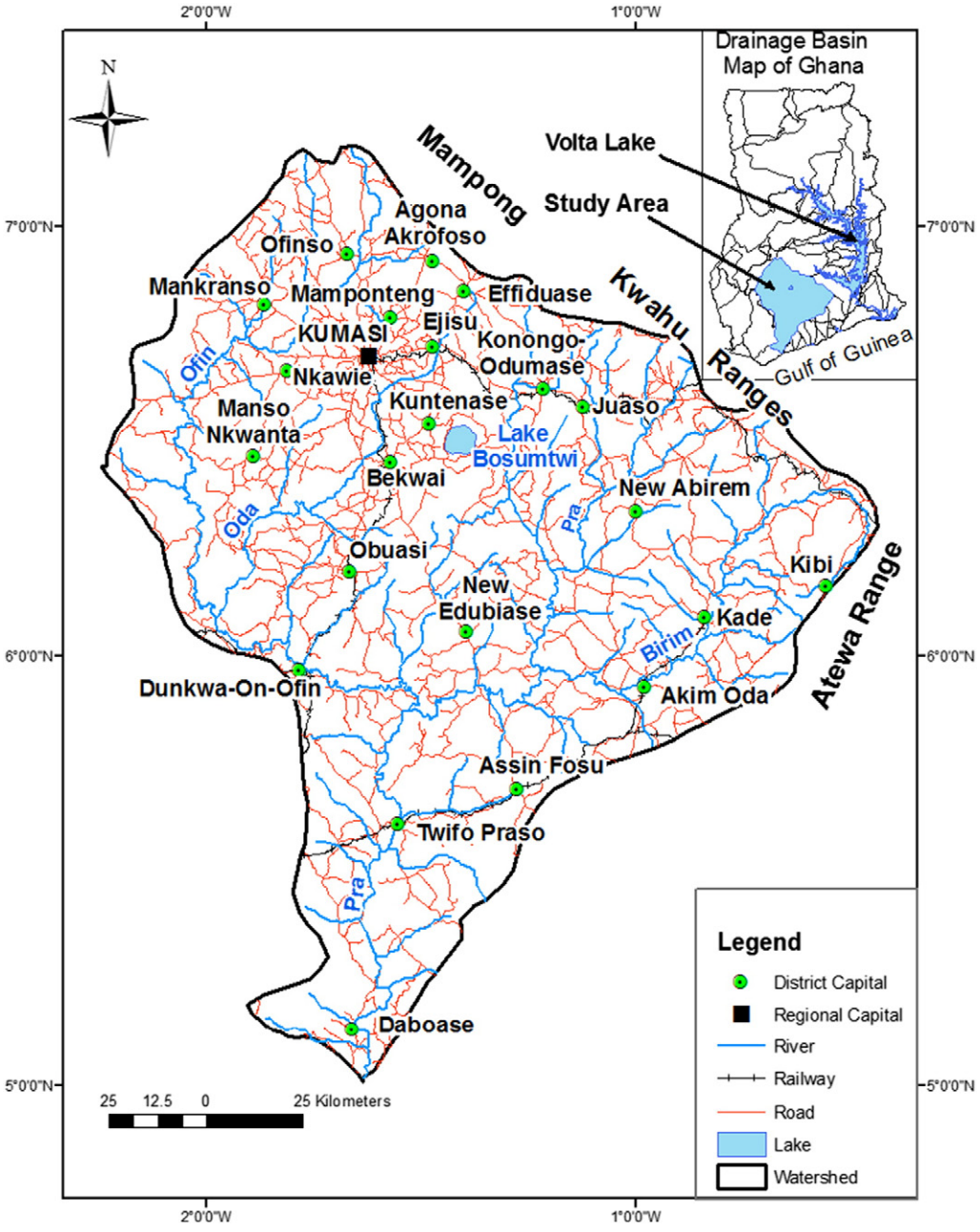

Fig. 1. Map of the Pra River Basin.