IS-02

Introduction of GeoWEPP for Evaluating Sediment Yield in Mountain Areas in Japan: The Agatsuma Watershed

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1. Introduction

Spatiotemporal erosion prediction in mountain regions is necessary for assessing sediment discharge. Erosion can lead to sedimentation, resulting in riverbed aggradation and decreased check dams volumes. Because extreme rainfall often leads to landslides and debris flows on steep slopes, sediment discharge monitoring in mountain watersheds is essential for detecting sediment-related disasters. The evaluation and prediction of the erosion rate would also be useful in terms of separating disaster events from baseline sediment discharge.

Studies have applied erosion models, such as the Universal Soil Loss Equation (USLE), to estimate the erosion rate in mountainous forests (e.g., Kitahara *et al*., 2000). However, the USLE is an empirical model that requires intensive calibration with *in-situ* data, and the targeted slope/plot scale is inadequate for watershed-scale application.

Process-based models such as GeoWEPP allow us to assess the sediment discharge in mountain watersheds lacking detailed datasets. GeoWEPP is a geospatial interface of the Water Erosion Prediction Project model used to predict erosion/sediment yield on a hill-slope or watershed scale (Flanagan *et al*., 2013).

This study applied the GeoWEPP model to the Agatsuma River watershed and compared the results with observation data, to validate the model.

2. Material and Method

The Agatsuma River watershed is in Gunma Prefecture and comprises more than 100 sub-watersheds. This study ran GeoWEPP for 15 sub-watersheds with varying forest ratios to estimate sediment yields.

The input data for GeoWEPP in this study were a digital elevation model (DEM) from the Geospatial Information Authority of Japan , a land-cover map with 10-m resolution obtained from the Japan Aerospace Exploration Agency based on ALOS AVNIR 2 satellite images, and a soil map from Agrimesh.

The rainfall and temperature data were for 21 years from the Kusatsu and Tashiro rainfall stations and were used to generate .PAR and .Cli files for the simulation. Other inputs were a soil file and a management file that were linked with the digital map and database file.

For comparison with the GeoWEPP outputs, the discharge and sediment yields at the study site were estimated from previous observations (Namba *et al*., 2007). Because the observations were limited spatiotemporally, we used a Tank Model and sediment rating curves (SRCs) to calculate the sediment yields. The Tank Model was developed to reproduce the temporal discharge for the sub-watersheds and was calibrated using 12-year daily discharge data from the Murakami Observatory, located downstream in the Agatsuma Watershed. The SRCs were derived from 3-years' suspended sediment concentration and discharge measurement data. As the number of observations was limited to 2–18 times per sub-watershed/year, the suspended sediment data from 96 sub-watersheds were classified into five classes according to the forest ratio. Then, SRCs were derived from each class.

3. Result and Discussion

The GeoWEPP Watershed Method simulation creates a map and report files. The map in Fig. 1 shows the sediment yield for the hill-slope for each sub-watershed and was classified into several classes. The results were dominated by class 1, which has a sediment yield of 0–68 g/day/m^2.

The comparison of the GeoWEPP results and the observations for the 15 sub-watersheds showed variation in both the discharge and sediment yield. All of the discharge from GeoWEPP was less than the observed (Tank Model) results, while the sediment yields were lower for 4 of the 15 sub-watersheds and higher for the other 11 sub-watersheds compared with the observations.

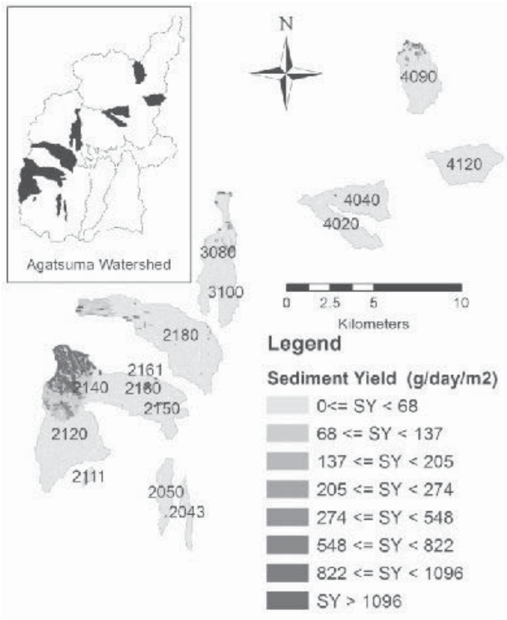

Fig. **1** GeoWEPP results for 15 sub-watersheds. (The numbers are the watershed ID.)

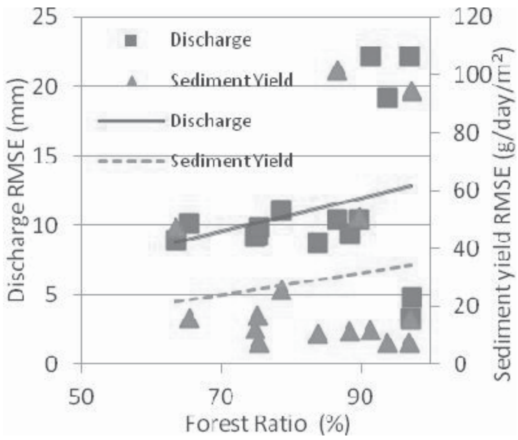

Fig. **2** Root mean square error (RMSE) and forest ratio.

The sediment yield was underestimated in the sub-watersheds where the forest ratio was less than 90% and the watershed was smaller than 500 ha. For the other 11 sub-watersheds, the forest ratio ranged from 63–97% and the watershed size from 40–1449 ha.

Figure 2 shows the root mean square errors (RMSEs) of the discharge and sediment yield of the forest ratio for each sub-watershed. For both the discharge and sediment yield, the RMSE increased slightly with the forest ratio.

GeoWEPP errors can occur with inaccurate input parameters and systematic model errors. In addition, the DEM resolution affects the size of the critical source area and minimum channel length, which is related to the density of the channel network, resulting in significant changes in the discharge and sediment yields. Azis *et al*. (2012) noted that higher resolution of the DEM improves the reliability of erosion rate estimates. With low-resolution DEM, the channels appear longer, suggesting that there is more water erosion; this results in an overestimation of the sediment yield.

In this study, the properties of each soil type and land management factor were generalized, although they are not uniform in the field. Moreover, the accuracy of the land cover map (an average 50–78% confidence level for the forest) also reduces the accuracy of the results. Based on sensitivity analysis, soil texture and land cover greatly affect the discharge and sediment yield. In addition, the combination of the Tank Model and SRCs used to estimate the sediment yield may have caused errors in the observations.

Because the WEPP model eliminates hydrological processes beneath the root zone (Savabi and William, 1995), it could naturally be a source of discharge underestimates, especially for a forested watershed. In a forested watershed, surface flow is seldom observed due to the high infiltration rate, while subsurface flow contributes to discharge at the outlet point.

4. Reference

Aziz, S. Abd., B. L. Steward, A. Kaleita, and M. Karkee, 2012, *Transactions of the ASABE* 55, 3: 785–98.

Flanagan, D.C., J.R. Frankenberger, T.A. Cochrane, C.S. Renschler, W.J. Elliot, 2013, *Transactions of the ASABE*. 56(2): 591-601.

Kitahara, H., Y. Okura, T. Sammori, A. Kawanami, 2000, *Journal of Forest Research* 5,: 231–36.

Namba, Y., N. Hotta, M. Suzuki, Y. Shuin, 2007, *Journal of Erosion Control Engineering* 59, 6: 14–24.

Savabi, M. R. and J. R. Williams, 1995, NSERL Report No. 10. West Lafayette, Ind.: USDA-ARS National Soil Erosion Research Laboratory.