Monitoring of Soil and Nutrient Losses in the Sichuan Purple Hilly Area in China

Erik Van Den Elsen[1]***, Chen Yibing***[2]***, Jannes Stolte***[1]***, Shi Xuezheng***[3] and ***Coen Ritsema***[1]

[1]Wageningen-UR, ALTERRA, Green World Research, Dept. Soil and Land Use,
P.O. Box 47, 6700 AA Wageningen, Netherlands
Fax: +31 317 419000
E-mail: H.G.M. van den Elsen@alterra.wag-ur.nl
Sichuan Academy of Agricultural Sciences, 20 Jingjusi road, Chengdu, Sichuan, 610066 P.R China
Institute of Soil Sciences, Chinese Academy of Sciences, P.O. box 821, 71 East Beijing road Nanjing, Jiangsu, 210008 P.R. China

Abstract: The Hilly Purple area of the Sichuan Basin is one of the most important agricultural areas in Western China. This area has been degraded by constant soil erosion, which has reached 3,035 t/km^2 (Luo Xiachuan, 1992). Soil erosion has direct negative effects on the productivity of the land by loss of nutrients, water and soil. This loss of productivity affects the farmer's income. Also, it increases the pollution and siltation of the Yangtze river, causing several problems downstream. The EROCHINUT project has started in 1998 with the overall objective to develop a new methodology to improve land and water management on farm and watershed level in the current socio-economic situation by integrated use of participatory and soil erosion and nutrient modelling techniques. An integrated farm and watershed management approach will be used for this purpose. Within the 7km^2 large watershed, a catchment is selected for the soil erosion modelling work. Within this catchment, three sub-catchments were selected, having their own characteristic mixture of crop fields and hillslopes. In the outlet of these three sub-catchments flumes were built in order to measure the outflow during rain events causing runoff. These flumes were equipped with automatic samplers and ultrasonic level sensors that measured the water level and took water samples. These samples were analysed and sediment and nutrient concentration were determined. The results from these analyses were used in the physically based LISEM model (De Roo *et al*., 1992) to quantify the losses of soil and water.

Keywords: soil erosion, monitoring, farmers participation, nutrient losses

1 Introduction

The Hilly Purple area of the Sichuan Basin is one of the most important agricultural areas in Western China. This area has been degraded by constant soil erosion, which has reached 3,035 t/km^2 (Luo Xiachuan, 1992). Soil erosion has direct negative effects on the productivity of the land by loss of nutrients, water and soil. This loss of productivity affects the farmer's income. Also, it increases the pollution and siltation of the Yangtze river, causing several problems downstream.

The EROCHINUT project has started in 1998 with the overall objective to develop a new methodology to improve land and water management on farm and watershed level in the current socio-economic situation by integrated use of participatory and soil erosion and nutrient modelling techniques. An integrated farm and watershed management approach will be used for this purpose. The research watershed for the socio-economical study encompasses about 7 km^2. Within this watershed, a catchment is selected for the soil erosion modelling work. This catchment is about 9 ha in size. The physically based model LISEM (De Roo *et al*., 1992) is used to quantify the losses of soil and water. The model was extended with a nutrient module to quantify the losses of nutrients. In order to calibrate the LISEM model, quantification of water discharge was needed as well as quantities for sediment and nutrient losses.

Fig. 1 Location of the project area within the Sichuan Province

Fig. 2 Impression of the project area

2 Catchment selection

Within the main catchment, three sub-catchments of respectively 9.0 ha, 2.3 ha and 2.0 ha were selected. These sub-catchments represented flat cropland, hillslope and a combination of cropland and hillslope. This selection of sub-catchments was done because the area of the complete catchment was too large and its agricultural structure too complex to model properly. The outlets of the sub-catchments were equipped with flumes in order to be able to measure discharge quantities.

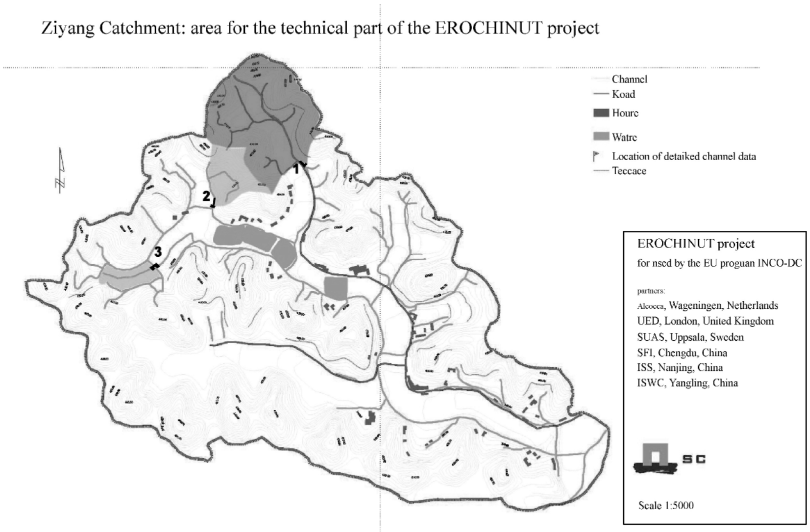

Fig. 3 Location of the three sub-catchments

3 Installed equipment

Since the three selected sub catchments had different area sizes, the maximum flow capacity of the flumes was adapted accordingly. Automatic samplers were installed at each of the flumes in order to take water and sediment samples, which could later be analysed. Ultrasonic level sensors, connected to the samplers, enabled the measurement of water levels in the flumes. Every two minutes the data logger inside the sampler did a water level measurement. In this way, a water level rise due to runoff coming from the slopes could be detected. The samplers converted the level measurements to flows so that flow dependent discharge samples could be taken. This "flow-paced" sample taking was different for each flume. From the samples that were taken, the sediment load, P, N and K concentrations were determined. These measurements, together with precipitation data, formed the complete data set that was used as input for the LISEM model calibration and scenario runs.

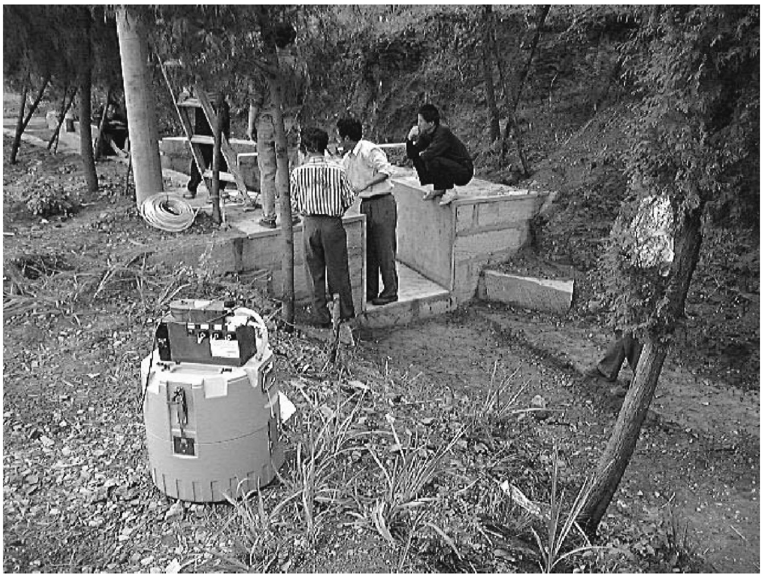

Fig. 4 Installation of a sampler at a flume

4 Measurement results

In 1999, rain intensities of up to 90 mm・h^{-1} , within a total of 9 runoff events, were recorded. Table 1 gives an overview of the events and the recorded flows and samples over the 1999-measuring season.

Table 1 Overview of the events recorded in 1999

	Flume 1	Flume 2	Flume 3	Flume 1	Flume 2	Flume 3
Event	Max flow [l/s]			number of samples taken		
09/08/99	302	68	38	24	6	6
10/08/99	128	36	12	23	4	11
16/08/99	158	36	-	22	3	-
21/08/99	-	-	-	-	-	-
28/08/99	249	69	-	22	24	-
02/09/99	-	-	-	-	-	-
07/09/99	-	-	-	-	-	-
11/09/99	108	36	39	4	1	4
14/09/99	208	59	41	24	24	2

Corresponding flows recorded at the three flumes located at the three catchments were 302.3 l・s^{-1}, 68.5 l・s^{-1} and 36 l・s^{-1} respectively for cropland / hillslope (9.0 ha), hillslope (2.3 ha) and cropland (2.0 ha). Highest concentrations of sediment in the discharge water were generally measured directly after the beginning of the rainstorm, and measured 17.1 g・l^{-1}, 9.11 g・l^{-1} and 7.27 g・l^{-1} for the three sub-catchments respectively.

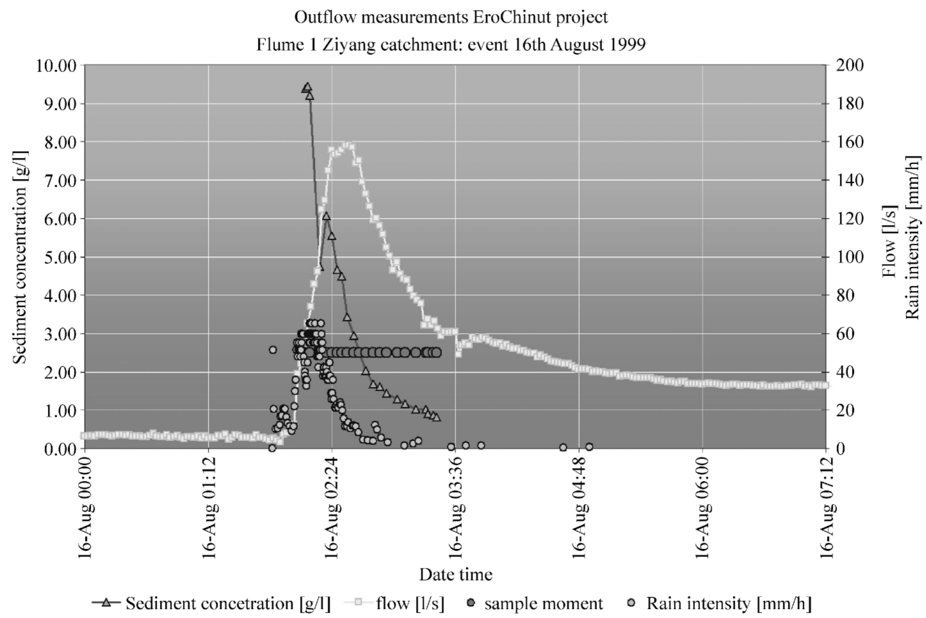

Fig. 5 Example of a hydrograph measured at flume 1

The concentration of nutrients in the discharged water / sediment mixture could sometimes be related to the sediment concentration itself. In other cases, there was no significant relation between the two. Further analysis of the data is still taking place.

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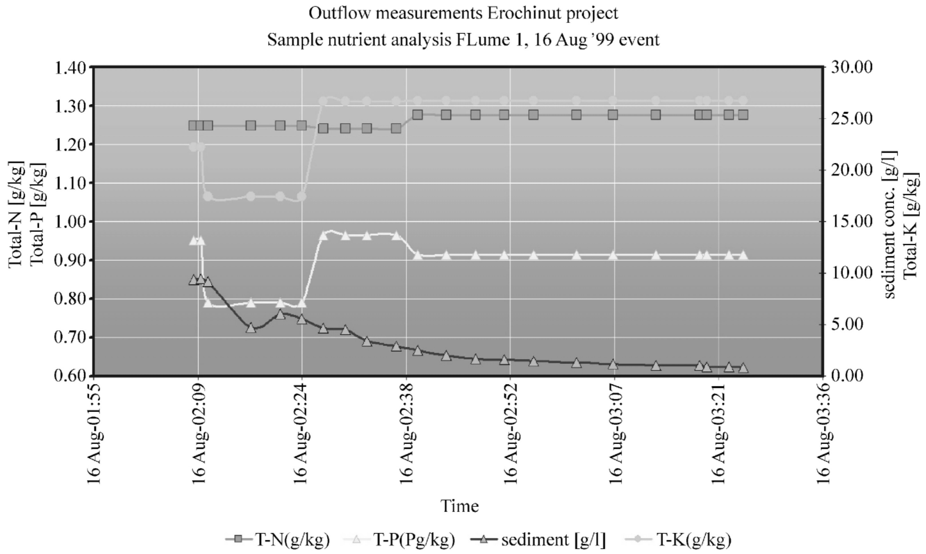

Fig.6 Nutrient analysis of the samples taken in flume 1 at the 10 August 1999 event

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