Module 5. SEDIMENT BUDGETS OF SMALL WATERSHEDS
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Sediment budgets have been used to characterize the fluxes and storages of soil and sediment within and through watersheds or sub-systems within watersheds. A sediment budget was compiled for the forested condition of 10-ha Watershed 10 which was covered with old-growth and some mature forest before clearcut logging (with only a ridge road and prescribed burning in a small area near the ridge) in 1975 as part of experimental watershed studies during the International Biological Program (Table 5.1). This sediment budget study revealed that the most episodic transport process, debris flow, accounted for about half of the long-term export, although only one debris flow is estimated to occur in about 600 years under forest cover, based on the extensive debris-flow inventory data for the Andrews Forest (Swanson et al., 1982a). The pervasive and persistent process of dissolved export accounted for about 30% of annual average export.

Table 5.1. Process characteristics and transfer rates of organic and inorganic material to the channel by hillslope processes (T/yr) and export from the channel by channel processes (T/yr) for Watershed 10

			Material transfer	
Process	Frequency	Area influenced (% of watershed)	Inorganic	Organic
Hillslope processes				
Solution transfer	Continuous	99	3	0.3
Litterfall	Continuous, seasonal	100	0	0.3
Surface erosion	Continuous	99	0.5	0.3
Creep	Seasonal	99	1.1	0.04
Root throw	1/yr	0.1**	0.1	0.1
Debris avalanche	1/370 yr	1-2**	6	0.4
Slump/earthflow	Seasonal*	5-8%	0	0
TOTAL			10.7	1.4
Channel processes				
Solution transfer	Continuous	1	3.0	0.3
Suspended sediment	Continuous, storm	1	0.7	0.1
Bedload	Storm	1	4.6	0.3
Debris torrent	1/580 yr	1	4.6	0.3
TOTAL			8.9	1.0

*Inactive in past century in Watershed 10.
**Area influenced by one event.

In the first 12 years after logging (1975-1986) surface erosion increased from 80-200 kg ha^{-1} yr^{-1}, dissolve load from 332-354 kg ha^{-1} yr^{-1}, suspended load from 70-320 kg ha^{-1} yr^{-1}, and bedload from 90-305 kg ha^{-1} yr^{-1}. In general the rates of surface erosion and these export processes experienced increases for several years and then declined. On February 22, 1986, rainfall on melting snow triggered a 300 m^3 slide from a bedrock hollow at the head of the south fork. This mass moved down the channel as a debris flow, ultimately destroying the gauging station and depositing 700 m^3 of inorganic and organic debris (approximately 50:50) in the sediment basin and on the head of the alluvial fan at the mouth of the watershed. This single event accounted for about 85% of post-logging export, and the export for the period was about 7 times estimated background, based on sediment yield from multiple experimental basins and slide inventories for a more extensive area. In the flood of February 6, 1996, another debris flow (about 200 m^3) began as a streamside slide on the north fork, hit the gauging station, inflicting only minor damage, and accumulated in the sediment basin and on the adjacent road. Channel scouring by the 1996 event was less severe than the 1986 event because of smaller size and amount of large wood, and bank protection by wet snow.

Less complete sediment budgets have been compiled for other watersheds, but comparisons reveal some interesting similarities and differences (Fredriksen, 1970; Swanson and Fredriksen, 1982). Watersheds 3 and 10, for example, have been quite susceptible to debris flows, which can flush sediment from channel storage, including material that had entered channels before logging. Thus the sediment export histories of these two basins have been dominated by debris flows. Poor roads in bad locations, such as through toes of large landslide deposits, have been a major source of sediment and debris flows in Watershed 3. Watershed 1 (clearcut and burned) has not been susceptible to debris flows, possibly because of relatively wide valley floor, moderate channel gradient, and more limited number of initiation sites in its headwaters. The hot prescribed burning of the steep slopes in Watershed 1, on the other hand, appears to have contributed a large amount of surface erosion to the channel (Swanson and Fredriksen, 1982). Thus, both intrinsic watershed properties and specific aspects of management practices affect sediment routing through watersheds and its representation in sediment budgets, such as expressed in the relative significance of episodic and more continuous processes.

Sediment budgets for small watersheds do not necessarily represent larger watersheds in which they are embedded. We have not developed sediment budgets for the Lookout Creek watershed, for example, but the larger basin includes geomorphic processes and depositional features not represented in small watersheds, such as earthflow terrain and alluvial valley floor areas upstream of passive (bedrock notches) or active (landslide) constrictions.