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<1293/c>	sequence such as that indicated in Figure 3.1. First are theoretical approaches which depend upon some empirical knowledge to apply theoretical concepts such as the continuity equation. Secondly are direct empirical measurements, thirdly are experimental investigations; and fourthly there are historical techniques. Direct empirical measurements are provided by national monitoring agencies including measurements of meteorological elements and of river discharge. In many cases such measurements may not be available with spatial and temporal sampling frequencies that meet the demands of research programmes. Hence additional measurements have often had to be made and not only should these be related to an a priori hypothesis but also they may be derived from small experimental areas. Although measurements in small watersheds were undertaken in the late nineteenth century, it was after the mid twentieth century that the movement developed very rapidly and absorbed the attention of some physical geographers. The Vigil Network scheme was initiated in the mid 1960s and involved the careful measurement of processes at individual sites and in selected study basins. Observations were intended to be made of stream channel changes, mass movement, vegetation changes, precipitation, reservoir sedimentation, and dendrochronology, and the intention to maintain measurements over a decade or more has been realized at some sites (e.g. Leopold and Emmett, 1965). A range of objectives for watershed experiments was identified by Ward (1971) and these extend from specific black box approaches to comprehensive studies in which there is an attempt to monitor many of the processes operating within a small area. The Hubbard Brook experimental basin (15.6 ha) in New Hampshire was monitored in great detail including the effects after complete clearing of the woody vegetation and treatment with herbicides for three years. Some small instrumented areas have been selected as representative of particular conditions whereas others were experimental, in which change due to logging or other forms of land use change could be monitored either by change in one basin or by comparison of several areas in which changes were taking place to differing degrees. A substantial number of small instrumented areas have been instituted in different parts of the world and physical geographers contributed to the initiation and running of a considerable number of these. The aims and objectives of all experiments were not always formulated as clearly as possible and there was sometimes a tendency for instrumentation to be set up in the hope that a specific problem would arise once measurements were obtained. In this and other cases a number of problems often arose reflecting lack of control and replicability of measurements, insufficient representativeness, unreliable accuracy of data, and problems of finding suitable methods of analysis of the data collected. Thus Ackermann (1966) writing about the United States suggested that ` small experimental watersheds have cost this country
	**uncounted millions of dollars**
Key: **Footprint** **ConEn1** **Footprint** **ConEn2** **Footprint** **ConEn3**	and unfortunately have yielded a small return on the investment of time and money.' However a considerable number of advances were made in the framework of small

	instrumented areas and there is no immediately obvious alternative to the approach when large numbers of empirical values are required. Newson (1979) has argued that process studies in geomorphology seek to quantify three systems; the mechanical sediment system, the chemical system, and the hydrological system, and it is notable that progress towards the quantification of these systems has been achieved by greater cooperation of physical geographers with scientists in other disciplines and in response to requirements of engineers and planners for resource information. Figure 5.1: Event sequence (above) and conjectural variance spectrum (below) after Church (1980). In the event sequence is shown the long-term mean, the linear trend, the well-defined cycle, and the intermittent signal so that a typical sample period as shown will produce statistics which are biased with respect to the whole sequence. The conjectural variance spectra for glacial transport is standardized on the annual cycle. Experimental investigations embrace a range of approaches which include field plot experiments, through laboratory hardware models which attempt to use scaled-down versions of the real world, to analogue models which employ a different medium for investigation. A Kaolin glacier was an example of the last-named (Lewis and Miller, 1955) but much more extensively used have been measurements using rainfall simulators especially in relation to erosion experiments, flumes, wave tanks and wind tunnels. In all cases the potential available has probably not been fully explored in geomorphology (Mosley and Zimpfer, 1978) but of all the limitations the difficulty of overcoming the scale problem and of relating the observations to geophysical event sequences (e.g. Fig. 5.1) have been most evident. Historical techniques in physical geography offer some of the most imaginative available and have been reviewed by the cooperation of a geomorphologist and a historical geographer (Hooke and Kain, 1982). They contend that: … evidence from the past has considerable potential for providing longer term perspectives for studies of current physical processes, for understanding the nature and causes of change and, above all, for understanding the magnitude of the impact of human activities on the physical environment. They review graphical, written and oral sources, statistical sources and series, and non-documentary sources and clearly demonstrate the amount of scope which remains for the use of such sources. The methods available are constantly increasing in number and their utility is greater as the complexity of contemporary processes is revealed. One somewhat unconventional data source is the newspaper for reconstructing past event-frequency and character and a series of studies by M.G. Pearson (e.g. Pearson, 1978)