JOURNAL OF HYDROLOGY (N.Z.) Vol. 13, No. 2, 1974

STREAM CHANNEL MEASUREMENTS IN NEW ZEALAND
(NOTE)

R. J. Eyles*

Much of the voluminous published data in fluvial morphometry are of little use, either because the data have been extracted from inadequate maps (see Haggett and Chorley, 1969, pp. 23–25; Eyles, 1973) or because they are based on varying and often unstated definitions of what constitutes a stream channel.

The New Zealand Ministry of Works collects a wide range of information from its representative and experimental basins throughout the country, and the *Hydrology Annual* is the main source of published hydrological data in New Zealand. The ordering system of Strahler (1957) is used, and in delineating stream networks it is standard practice to "extend first-order segments to the catchment boundary or to the internal divide as appropriate" (Pittams, 1966, p. 2). Use of these extended channel lengths – termed 'mesh lengths' by Horton (1945) – does not wholly avoid the problem of locating active channel heads, because decisions still need to be made concerning valley-side depressions (possible first-order channels) which join clearly established channels. Horton pointed out that there may be a 50-percent difference between channel length and mesh length for low-order streams, a figure which is far exceeded in some of the very small New Zealand experimental basins.

This is illustrated in Table 1, which contains data from the Makara Experimental Basin complex situated on Quartz Hill 8 km west of Wellington City. Quartz Hill is an uplifted remnant of an old erosion surface (Fig. 1) termed the K surface by Cotton (1957). Catchments 1 to 8 on the hill summit have "an easy rolling topography, with well grassed valley floors with no defined channels"

* Department of Geography, Victoria University of Wellington, Wellington.

(Toebes *et al.*, 1968, p. 96). Catchments 10 to 13 are much more steeply sloping, being located on the western flank of the hill where the K surface is being vigorously dissected by modern streams.

Drainage density is defined by the Ministry of Works as "the total length of channel divided by the catchment area" (Pittams, 1966, p. 2). This is the standard definition, but the term 'channel' is used to signify 'mesh length'. The mean drainage density of 25.0 km/km^2 for catchments 1 to 8 in Table 1 (A) is, on the basis of a *t* test, significantly higher (at the 0.025 probability level) than the 15.6 km/km^2 for catchments 10 to 13. The natural conclusion to draw from this would be that fluvial erosion increases in importance as an erosion cycle progresses from youth (represented by the flanks of Quartz Hill) to late maturity (represented by the basins on the summit). But it is not possible to associate drainage density as calculated by the Ministry of Works with fluvial action because the dominant processes experienced over the mesh lines in catchments 1 to 8 are sheet wash or soil creep, and not concentrated linear flow.

FIG. 1 — The erosion surface remnant on Quartz Hill at about 300 m above sea level as viewed from the north. Morphometric data from the very subdued summit relief clearly are not representative of the general landscape.
Photo. by D. W. McKenzie

TABLE 1 — Statistics for the Makara Experimental Basin complex: (A) published in *Hydrology Annual No. 15/16* (Ministry of Works 1967/68); (B) calculated on the basis of 'active' channels.

Basin No.	*A* Order	*A* Drainage density (km/km²)	*B* Order	*B* Drainage density (km/km²)
Hilltop:				
1	1	19.7	–	0
2	2	20.1	–	0
3	1	17.8	–	0
4	2	22.9	–	0
5	2	33.5	–	0
6	2	24.9	–	0
7	3	35.5	–	0
8	2	23.8	–	0
	Mean:	25.0	*Mean:*	0
Hillside:				
10	2	20.1	2	8.2
11	3	10.1	2	7.5
12	2	13.3	2	8.0
13	2	9.0	2	3.9
	Mean:	15.6	*Mean:*	6.9

Gauging stations for these catchments were, in fact, deliberately sited above the heads of active channels, the basic purpose of the experimental basin programme being to monitor changes in overland flow under various farm management practices (M. E. Yates, pers. comm.).

A more realistic picture is given in Table 1 (B), with drainage density values calculated from the lengths of 'active' channels which, in this particular area, are easily identified in the field or on aerial photographs. The only non-zero values for drainage density are in catchments 10 to 13 located on the steep hillside.

The obvious danger in this situation is illustrated in a paper by Leamy (1972) in which catchment 2 of Makara Experimental Basin is quoted as having a drainage density of 20.1 km/km². This value is derived, as we have seen, from mesh lengths – but is directly compared by Leamy with drainage densities of basins in the United States calculated from 'active' channel lengths. The figure of zero from Table 1 (B) would need to be used, and it is clear that a larger unit area than the 1.26 hectares of catchment 2 chosen from a less specialized site would be required for a truly valid comparison.

It must be concluded that morphometric data published by the Ministry of Works are misleading because of the gross error of confusing mesh length with stream channel length.

REFERENCES

Cotton, C. A. 1957: Tectonic features in a coastal setting at Wellington. *Transactions of the Royal Society of New Zealand 84*: 761–790.

Eyles, R. J. 1973: Drainage density representation on Wellington maps. *Journal of Hydrology (N.Z.) 12* (1): 19–31.

Haggett, P.; Chorley, R. J. 1969: *Network Analysis in Geography*. Arnold, London. 348 p.

Horton, R. E. 1945: Erosional development of streams and their drainage basins: a hydrophysical approach. *Geological Society of America Bulletin 56*: 275–300.

Leamy, M. L. 1972: Fine textured dissection in semi-arid Central Otago. *N.Z. Journal of Geology and Geophysics 15*: 395–405.

Ministry of Works 1965: *Hydrology Annual No. 13, 1965*. Soil Conservation and Rivers Control Council, Wellington.

Ministry of Works 1967/1968: *Hydrology Annual No. 15/16, 1967/1968*. National Water and Soil Conservation Organization, Wellington.

Pittams, R. J. 1966: Geomorphological characteristics. Handbook of Hydrological Procedures, Provisional Procedure No. 40. 8 p. (unpublished) Soil Conservation and Rivers Control Council, Wellington.

Strahler, A. N. 1957: Quantitative analysis of watershed geomorphology. *Transactions of the American Geophysical Union 38*: 913–920.

Toebes, C.; Scarf, F.; Yates, M. E. 1968: Effects of cultural changes on Makara experimental basin. *Bulletin of the International Association of Scientific Hydrology 13* (3): 95–122.