THE McCLEAN HYDROMETRIC DATA COLLECTION

A. WERRITTY

Department of Geography, University of St Andrews

Captain W.N. McClean was one of the pioneers in the development of a systematic programme of river flow measurements in Great Britain. He commenced his work on the River Garry in the Great Glen of Scotland by installing a water level gauge at Invergarry in January 1913 and by introducing the then relatively unknown technique of current metering to rate the cross-section. He maintained a continuous record of flow on the Garry until the end of 1915 when it became impossible to sustain the work on account of the First World War.

The results of this pioneering gauging of river flow were published as a paper entitled 'Rainfall and Flow-off, River Garry, Inverness-shire'[1]. In this paper the field installations, instruments and methods of data reduction are all described in considerable detail. These were to become McClean's standard methods of operation for the next twenty years. At the initial site on the Garry a water-level gauge was installed very close to the Lodge of Invergarry House (Plate 1). Current metering was generally undertaken at a 76 feet* wide cross-section within a 200 yard long relatively uniform pool in depths up to 16 feet and velocities up to 8 feet per second. The velocity readings were obtained by using an Amsler propeller-type current meter manually operated from a bosun's chair suspended from a cableway (Plate 2). A stage-discharge relation was established in a tabular form between the lowest - 192 cubic feet per second (cusecs) - and highest - 4868 cusecs - measured flows in December 1912 and January, February and June 1913. The results of the three-year record were reported graphically (Fig. 18) as mean daily flows (expressed as inches of runoff - to permit direct comparisons with catchment rainfall). In addition to the gauging station McClean also installed 8 daily raingauges (supplementing the 5 gauges operated by the British Rainfall Organisation) which enabled him to produce detailed measurements of the catchment water balance for selected short periods - incorporating one, or several, hydrological events - and for each of the water years between 1913 and 1915.

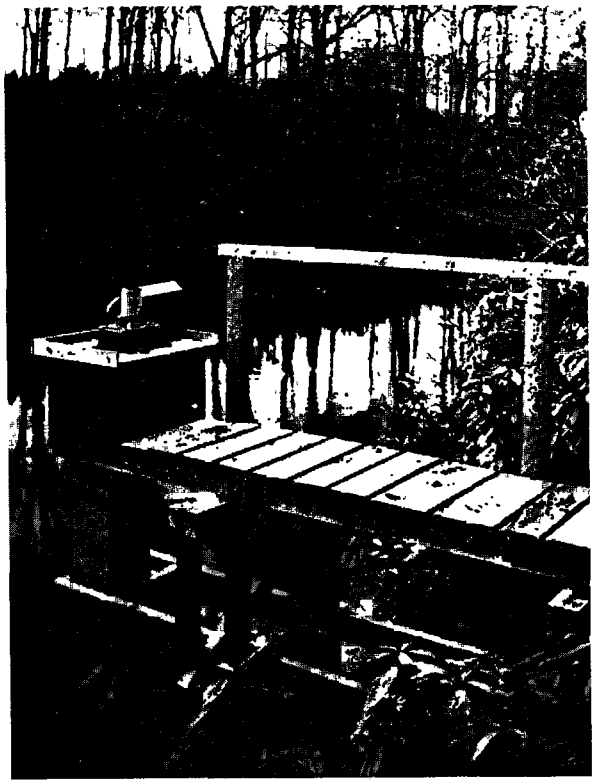

Plate 1. Water level recorder installed at Invergarry Lodge, Invergarry - 1913.

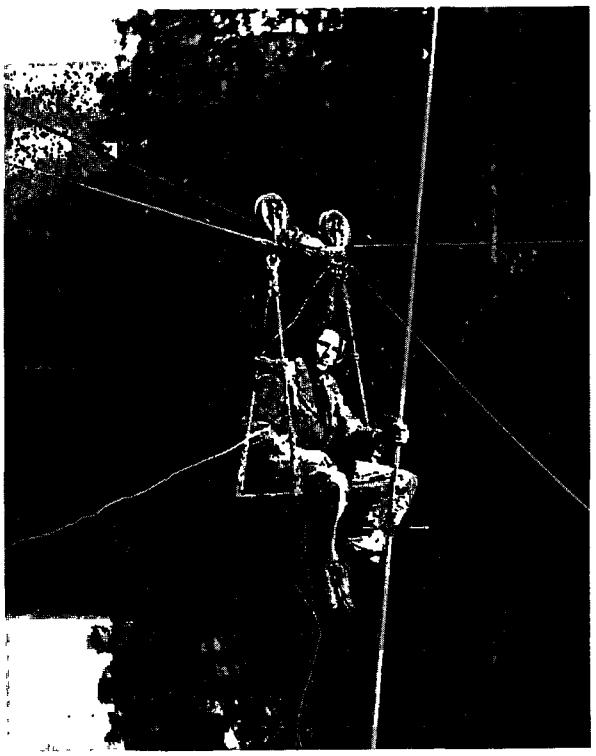

Plate 2. Current metering from a bosun's chair on the River Garry - 1913.

* Because of the historical nature of this article imperial units have been adopted throughout.

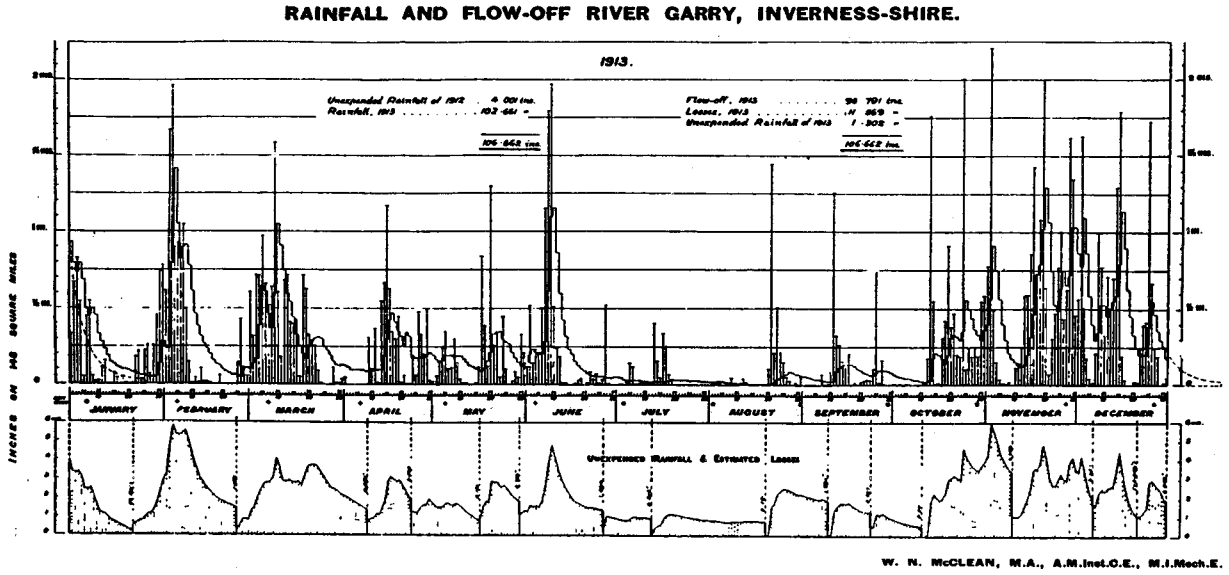

Figure 18. Rainfall and 'Flow-off' for the River Garry.

In 1929 McClean returned to the Great Glen with an ambitious programme to gauge all the major rivers within the River Ness basin. This constituted the first major project for 'River Flow Records' a private organisation established by McClean to provide a standardised framework for measuring and reporting river flows. By 1931 water level gauges had been installed on the Rivers Garry, Moriston, Ness and Foyers and on Lochs Ness, Oich, Garry and Quoich (Fig. 19[2]). Raingauges were also added to supplement the British Rainfall Organisation's network. By this time some of McClean's procedures had been modified since the initial work on the River Garry. Under low and medium discharge conditions the hazardous bosun's chair arrangement for flow gauging was replaced by a cableway controlling the position of twin punts from which current metering was undertaken (Plate 3). At some sites an alternative procedure involving a suspended current meter with sinker weight was employed[3]. McClean did not

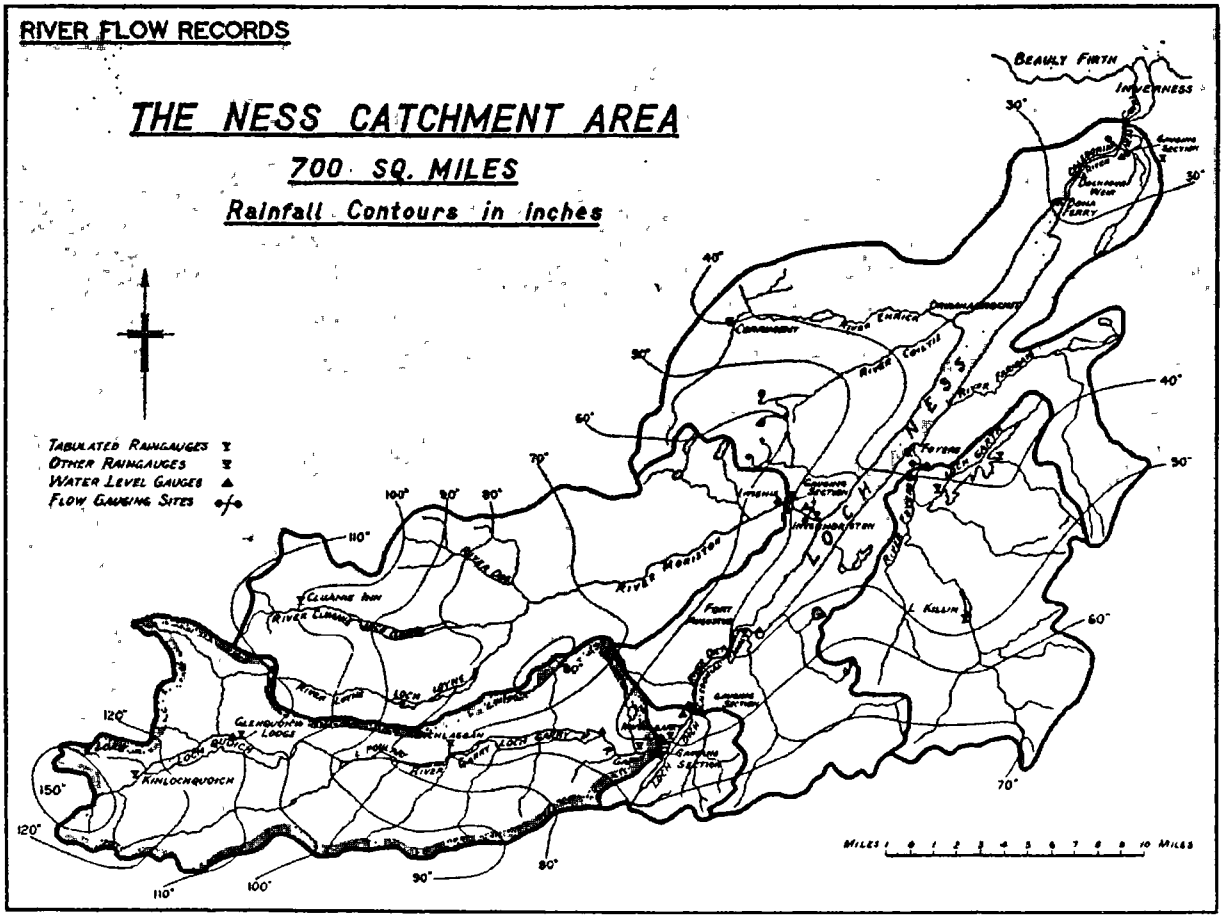

Figure 19. Capt. W. N. McClean's hydrometric network in the River Ness catchment – 1931.

Plate 3. Twin-punt current metering platform in use on the River Ness – 1930.

confine his gauging activities to Scotland and this latter method was subsequently deployed to good effect on the River Dee in North Wales, during 1937/38 and became standard practice throughout the United Kingdom[4].

In 1929, McClean initiated a programme of river flow measurement on the (Scottish) River Dee by the installation of a water level gauge at Cairnton, near Banchory. McClean had hoped to develop this into a series of four gauging stations between Balmoral and Aberdeen. In this he was to fail, and the gauging station at Cairnton – later moved just upstream to Woodend – remained the only gauge on the Dee until 1972. McClean further extended his surface water survey to include gauging stations on the River Spey at Laggan Bridge in 1935 and at Aberlour in 1938. Much of the hydrometeorological network installed by McClean in the early 1930s was to be maintained by him until the late 1940s. By then many of the original gauging stations had either been discontinued or had been taken over by other public authorities associated with the Inland Water Survey. It is noteworthy that two sites (River Dee at Woodend and River Ness at Ness-Side) have unbroken records at or near their original location continuously since 1929. The gauge on the River Spey at Aberlour also has a very long record extending from 1938 up to 1974.

The primary records compiled by 'River Flow Records' are now held by St Andrews University under the custody of the University Librarian with access supervised by Dr A. Werritty of the Geography Department. These records comprise daily rainfall postcards and weekly charts of water level at selected sites including loch levels as well as river gauging stations (Tables 7 and 8). The reduced data are in the form of stage/discharge conversions via rating tables and lists of peak flows and low flows for selected stations. From this database, summary results were published by 'River Flow Records' for each catchment in a tabular format, reporting both daily rainfall and runoff on a quarterly basis[5]. These were later converted into annual reports[6] and ultimately into a series of fifteen year records[7].

In addition to establishing and maintaining 'River Flow Records', McClean was also a strong advocate of a national water survey in which central government would influence and coordinate the measurement of river flows throughout the United Kingdom. In 1933 McClean served as the Secretary of a Committee of the British Association which concluded that a systematic survey of the water resources of Great Britain was urgently required[8]. In 1934, following a severe drought, a joint approach was made by the British Association and the Institution of Civil Engineers urging the Govern-

TABLE 7 McCLEAN: WATER LEVEL RECORDS

Catchment	Station	Nat. Grid Ref.	Dates of Record			
R. Ness	Ness Castle Farm	NH 639410	02/09/30-27/09/41	(M)		
R. Ness	Dochfour Weir	NH 613396	14/10/29-20/04/48			
Loch Ness	Fort Augustus (loch level)	NH 382091	07/09/29-12/10/31	(M)		
R. Foyers	R. Foyers (Foyers)	NH 499199	31/07/30-25/11/43	(P,M)		
Loch Oich	Pier (loch level)	NH 323015	19/06/29-10/09/31	(M)		
R. Garry	Invergarry	NH 314011	01/01/13-31/12/15	(P,M)	04/09/29-05/01/41	(P,M)
Loch Garry	loch level	NH 275025	21/10/31-10/02/37	(P,M)		
Loch Quoich	Glenquoich (loch level)	NH 025031	17/07/33-03/01/43	(M)		
R. Moriston	Invermoriston	NH 412172	23/03/30-27/12/42	(P)		
Loch Arkaig	loch level	*	11/09/33-10/08/40	(P,M)		
R. Lochy	Gairlochy	NN 176842	06/01/36-01/01/43	(M)		
R. Spey	Laggan Bridge	NN 615942	21/02/35-27/11/35	(P,M)	01/08/39-01/11/39	(P,M)
R. Spey	Aberlour	NJ 278439	21/08/38-06/12/43	(P)		
R. Dee	Cairnton	NO 632960	01/10/29-30/09/49	(R)		

(P) : data available on punched cards/magnetic tape
(M) : weekly charts on microfilm
(R) : data only available in reduced form of tabulations of water level every 3 hours
* precise location uncertain

TABLE 8 McCLEAN: DAILY RAINFALL RECORDS

Catchment	Station	Nat. Grid Ref.	Dates of Record	
R. Ness	Inverness (Culduthal Reservoir)	NH 665412	01/01/30-31/12/52	
R. Foyers	Foyers Catchment (4 gauges)	various	01/09/29-31/12/41	
R. Oich	Fort Augustus (Monastery)	NH 381091	01/02/29-20/09/47	
Loch Oich	Loch Oich (Portmacdonell)	NH 323016	23/09/29-12/08/46	
R. Garry	Invergarry (+ 12 other gauges)	NH 308011	01/01/13-31/12/15	
R. Garry	Glenquoich Lodge	NH 030030	01/09/29-07/07/45	(P)
R. Moriston	Invermoriston	NH 412172	01/09/29-31/12/45	(P)
R. Moriston	Cluanie Inn	NH 076118	01/09/29-31/12/45	
R. Moriston	Cluanie Lodge	NH 098109	31/08/30-13/01/40	
R. Enrick	Corrimony	NH 376303	25/01/31-25/12/37	
Loch Arkaig	R. Arkaig (Achnacarry)	NN 179879	27/07/30-05/07/47	
Loch Arkaig	Glen Dessary	NM 968927	03/08/30-05/01/46	(P)
R. Lochy	Gairlochy	NN 177842	02/01/38-05/10/40	
R. Shiel	Glen Shiel	*	01/03/30-28/03/52	
R. Spey	Lochaber district (7 gauges)	various	12/37- 03/47	
R. Dee	Dee catchment (10 gauges)	various	01/10/32-31/08/49	

(P) : data available on punched cards/magnetic tape
* precise location uncertain

ment to carry out a national water survey. As a result the Inland Water Survey Committee was appointed in January 1935, the date at which the national surface water archive can be said to have commenced[9] (see preceeding article). McClean's contribution to the national water survey was explicitly recognised in the Inland Water Survey's Second Annual Report[10] and by the inclusion of data from the Ness basin and the Rivers Dee and Spey in the Surface Water Year-Book for 1935–36[11] and 1936–37[12].

McClean was also very active in promoting the development of hydro-electric power in the Scottish Highlands. The development of the programme of river and rainfall gauging in the Ness basin from 1929 onwards arose directly from McClean giving evidence on behalf of the West Highland Water Power Scheme at a Parliamentary inquiry in 1929. Although this scheme was rejected, the database generated by McClean for the Rivers Garry, Moriston, Foyers and Spey was to prove of great value in the planning and development of subsequent hydro-electric schemes in these catchments.

In addition to establishing the overall relationship between rainfall and runoff in the Scottish Highlands, McClean was also concerned to identify hydrological extremes as represented by both floods and droughts. An interest in identifying the severity and frequency of periods of substantial rainfall defiency formed a major aspect of McClean's work on water resources in Scotland[13]. However, in terms of river gauging the floods were of greater significance. During the period of detailed flow measurements (1930–1945) three significant floods were

recorded in the catchments monitored by McClean. The first was a flow of 10,500 cusecs on the River Garry (15 January 1932). This was succeeded by a more severe flood in the Great Glen (20 December 1936) which produced a peak flow of 16,500 cusecs on the River Moriston. The River Dee, however, produced the most extreme runoff conditions recorded at the flow measurement stations maintained by McClean when a flow of 40,000 cusecs was recorded at Woodend on 24 January 1937 (Fig. 20). This flow, with an estimated return period of at least 200 years, remains the largest gauged flow at that site. McClean notes that a comparable flood also occurred on the Dee on 4 December 1920. This interest in hydrological extremes is also evident in McClean's membership of the 'Committee on Floods in relation to Reservoir Practice' which reported to the Institution of Civil Engineers in 1933[14]. Two of the most extreme floods recorded in Table 1 of that report were based on McClean's work in the Scottish Highlands and include his estimate of a flow of 60,000 cusecs on the Ness in January 1849.

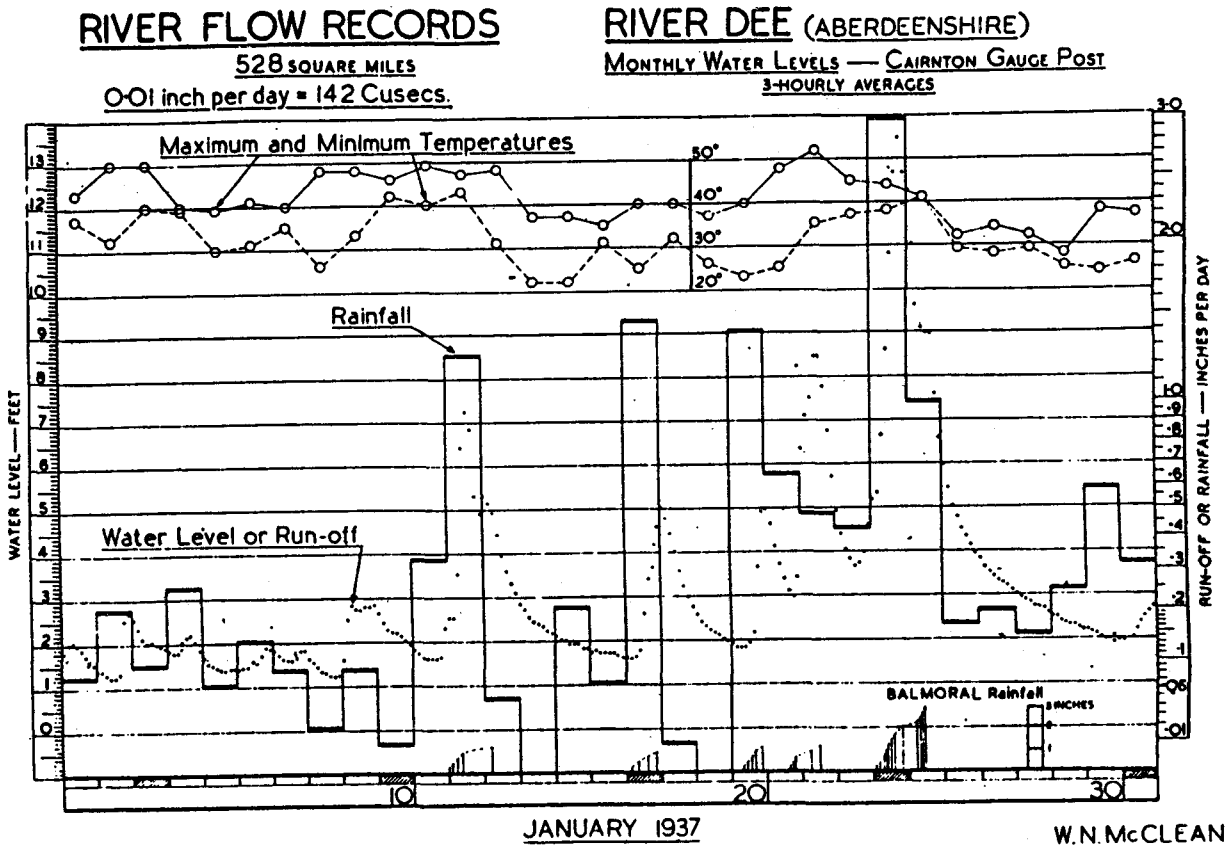

Figure 20. Hydrometric data summary for January 1937 – River Dee at Cairnton.

REFERENCES

1. McClean, W.N. 1927. Rainfall and Flow-off, River Garry, Inverness-shire. Trans. Institution of Water Engineers. 32.
2. McClean, W.N. 1933. Practical riverflow measurement and its place in Inland Water Survey, as exemplified by the Ness (Scotland) basin. Trans. Institution of Water Engineers, 39, 233–276.
3. McClean, W.N. 1934. Flow of the River Dee. Engineering, Sept. 1934.
4. McClean, W.N. 1939. Flow Gauging on the River Dee – Demonstration at Erbistock near Chester. Water and Water Engineering, July 1939.
5. McClean, W.N. 1931. Rivers Garry and Moriston (Inverness-shire). Quarterly records from July 1929 to March 1931. River Flow Records*.
6. McClean, W.N. 1937. Rivers Garry, Moriston

and Ness (Inverness-shire). Graphical records of water level, flow, and rainfall, from September 1929 to December 1935. River Flow Records*.
7. McClean, W.N. 1945. River Garry, monthly and 12-monthly summary of rain and runoff for 15 years. River Flow Records*.
8. British Association 1933. Report of Committee on Inland Water Survey. British Association Reprints (N.S. No. 31), 69 pages.
9. Ministry of Health and Scottish Office 1936. First Annual Report 1935–36. Inland Water Survey Committee.
10. Ministry of Health and Scottish Office 1937. Second Annual Report 1936–37. Inland Water Survey Committee.
11. Ministry of Health and Scottish Office 1938. Surface Water Yearbook for 1935–36 H.M.S.O.
12. Ministry of Health and Scottish Office 1939. Surface Water Yearbook for 1936–37 H.M.S.O.
13. McClean, W.N. 1925. Analysis of Scottish rainfall records. Trans. Institution of Water Engineers. 30.
14. Institution of Civil Engineers 1933. Interim Report of the Committee on Floods in Relation to Reservoir Practice. 42 pages.

* River Flow Records was published privately by McClean. Copies of these papers can be obtained from the Geography Department, University of St Andrews.