

## RIVER DISCHARGES: NEW ZEALAND'S PLACE IN THE WORLD

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Some years ago, Pardé (1960, 1966) wrote that "the high mountain ranges rising near warm seas and causing large humid air masses, make New Zealand hydrology markedly different from that of other countries with very high rainfalls". From the information then available to him, he contended that world record average annual discharges occurred in some South Island rivers with catchments of up to 100 km<sup>2</sup>, and very high average annual discharges from catchments of up to 1500 km<sup>2</sup>.

Thanks to the International Hydrological Decade, data are now being recorded in a standardized manner for a number of representative rivers of the world. Two recent UNESCO publications (UNESCO, 1969a,b) give some support to Prof. Pardé's contention, although it would seem that a catchment of 1500 km<sup>2</sup> is too low a limit for very high average annual discharges in rivers on the west coast of the South Island. Table 1 has been compiled from information given in these publications. Specific average annual discharges have been calculated for a random selection of rivers, including all the New Zealand ones listed. As specific discharge generally tends to decrease as catchment area increases, comparisons need to be made with caution; for example, the Rhone at Chancy, catchment area 10,299 km<sup>2</sup>, has a specific average annual discharge of 0.032 m<sup>3</sup>s<sup>-1</sup>km<sup>-2</sup> (cf. Clutha, 0.037 m<sup>3</sup>s<sup>-1</sup>km<sup>-2</sup>), but at Beaucaire, catchment area 95,590 km<sup>2</sup>, its specific average annual discharge is only 0.018 m<sup>3</sup>s<sup>-1</sup>km<sup>-2</sup>. New Zealand catchments are small, and it has not been possible to find many elsewhere of comparable areas and range of rainfall. The table also includes a representative sample of the better known larger catchments. Unfortunately, several countries with which interesting comparisons might have been made were evidently late in rendering their returns.

Only three of the overseas rivers in the UNESCO list have specific discharges approaching one third that of the Cleddau, all being located on islands (Iceland, Japan, Philippines). On the other hand, of the seven other New Zealand rivers listed, three

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TABLE 1 — Comparison of discharges of some New Zealand rivers with those of some overseas rivers.

| Country     | River       | Site              | Catchment area (km <sup>2</sup> ) | Av. an. discharge (m <sup>3</sup> s <sup>-1</sup> ) | Specific av. an. discharge (m <sup>3</sup> s <sup>-1</sup> km <sup>-2</sup> ) |       |
|-------------|-------------|-------------------|-----------------------------------|---|---|-------|
| New Zealand | Buller      | Te Kuha           | 6,350                             | 501   | 0.079   |       |
|             | Cleddau     | Milford           | 155                               | 23.8  | 0.153   |       |
|             | Clutha      | Clyde             | 12,020                            | 440   | 0.037   |       |
|             | Hutt        | Kaitoke           | 85                                | 8.26  | 0.098   |       |
|             | Jollie      | Mt Cook Station   | 135                               | 8.07  | 0.059   |       |
|             | Waiau       | Manapouri Outlet  | 4,620                             | 391   | 0.085   |       |
|             | Waikato     | Taupo Outlet      | 3,290                             | 129   | 0.039   |       |
|             | Waitaki     | Kurow             | 9,750                             | 235   | 0.024   |       |
|             |             |                   |                                   |   |   |       |
| Europe      |             | Bewdley           | 4,330                             | 61.5  | 0.014   |       |
|             | England     | Teddington        | 9,870                             | 76.9  | 0.0088  |       |
|             |             | Colwick           | 7,459                             | 73.8  | 0.0099  |       |
|             | France      | Beaucaire         | 95,590                            | 1,712   | 0.018   |       |
|             |             | Paris             | 44,320                            | 273   | 0.0062  |       |
|             | Hungary     | Polgar            | 62,723                            | 506   | 0.0081  |       |
|             | Iceland     | Lagarfjot         | 2,800                             | 141   | 0.050   |       |
|             | Ireland     | Killaloe          | 10,400                            | 180   | 0.017   |       |
|             | Norway      | Langnes           | 40,167                            | 695   | 0.017   |       |
|             | Romania     | Ceatal Izmail     | 807,000                           | 6,250   | 0.0077  |       |
|             | Sweden      | Bodens Waterworks | 24,488                            | 486   | 0.020   |       |
|             | Switzerland |                   | Basel                             | 35,925  | 1,030   | 0.036 |
|             |             |                   | Chancy                            | 10,299  | 334   | 0.032 |

TABLE 1 (continued)

| Country                  | River       | Site               | Catchment area (km <sup>2</sup> ) | Av. an. discharge (m <sup>3</sup> s <sup>-1</sup> ) | Specific av. an. discharge (m <sup>3</sup> s <sup>-1</sup> km <sup>-2</sup> ) |
|--------------------------|-------------|--------------------|-----------------------------------|---|---|
| <i>Africa</i>            |             |                    |                                   |   |   |
| United Arab Rep.         | Nile        | Khartoum           | 325,000                           | 1,640   | 0.0036  |
| Ghana                    | Volta       | Senchi             | 394,100                           | 1,260   | 0.0032  |
| Mali                     | Niger       | Koulikoro          | 120,000                           | 1,560   | 0.013   |
| <i>N &amp; S America</i> |             |                    |                                   |   |   |
| U.S.A.                   | Chehalis    | Porter, Wash.      | 3,351                             | 119   | 0.036   |
|                          | Colorado    | Yuma, Ariz.        | 629,100                           | 383   | 0.00061   |
|                          | Cowlitz     | Castle Rock, Wash. | 5,796                             | 259   | 0.045   |
|                          | Mississippi | Vicksburg, Miss.   | 2,964,000                         | 15,800  | 0.0053  |
|                          | Potomac     | Washington, D.C.   | 29,940                            | 296   | 0.0099  |
|                          | St Johns    | De Land, Fla.      | 8,080                             | 92.2  | 0.011   |
| Brazil                   | Paraná      | Guaira             | 806,000                           | 8,260   | 0.010   |
| <i>Asia</i>              |             |                    |                                   |   |   |
| India                    | Damodar     | Rhondia            | 19,920                            | 329   | 0.017   |
| Iraq                     | Tigris      | Mosul              | 54,900                            | 643   | 0.012   |
| Israel                   | Jordan      | Southern Station   | 1,495                             | 13.9  | 0.0093  |
| Japan                    | Chikugo     | Senashita          | 2,315                             | 116   | 0.050   |
| Philippines              | Ishikari    | Ishikari-Ohashi    | 12,697                            | 421   | 0.033   |
|                          | Tone        | Kurihashi          | 8,588                             | 271   | 0.032   |
|                          | Yodo        | Hirakata           | 7,281                             | 305   | 0.042   |
|                          | Agno        | Rosales, Pegasinen | 2,209                             | 127   | 0.058   |
|                          | Pampagna    | Arayat, Pampagna   | 6,487                             | 228   | 0.035   |

have specific discharges of more than half that of the Cleddau. Two of these, the Buller and the Waiau (Southland) have catchments of comparable size to many of the smaller overseas catchments. The low specific discharges of the three English rivers, all with catchment areas comparable to New Zealand, are interesting. Coupled with density of population, they are pointers to the United Kingdom's concern about its water supplies.

Prof. Pardé's specific average annual discharges for certain New Zealand rivers were deduced from annual rainfalls, and are in close agreement with the more accurate flow measurements now available — a remarkable achievement. He states that he would expect specific average annual discharges of  $0.24$  to  $0.25 \text{ m}^3\text{s}^{-1}\text{km}^{-2}$  from small Westland catchments of the order of  $50 \text{ km}^2$ . The highest in Europe was the Norddalsely in Norway, specific discharge  $0.16 \text{ m}^3\text{s}^{-1}\text{km}^{-2}$ . This, he says, is exceeded by certain small catchments in southern Chile where specific discharges are of the order of  $0.18$  to  $0.20 \text{ m}^3\text{s}^{-1}\text{km}^{-2}$ . None of these are listed in the UNESCO publications and, other than the Cleddau, no New Zealand flow records are available for the high rainfall area on the South Island west coast. However, on the eastern side of the Southern Alps, the Hooker (catchment area  $121.7 \text{ km}^2$ , average annual discharge  $23.22 \text{ m}^3\text{s}^{-1}$ ) has a specific average annual discharge of  $0.192 \text{ m}^3\text{s}^{-1}\text{km}^{-2}$  (N.Z. M.O.W., 1969). The average annual precipitation in the Hooker catchment is about 270 in. (6,858 mm). On the western side of the Alps the average annual precipitation in the Hokitika catchment is 368 in. (9,347 mm). The Hokitika is near the northern end of the high-rainfall belt and the Cleddau near the southern extremity. In this area of scant records there seems good justification for Prof. Pardé's contention that specific average annual discharges of  $0.24$  to  $0.25 \text{ m}^3\text{s}^{-1}\text{km}^{-2}$  occur.

#### REFERENCES

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