According to the point description of runoff production specified by equation (15.1) it follows that runoff production from the entire basin will be given by

$$Q = \int_0^\infty \int_c^\infty (p-c) f_P(p) f_C(c)\, dp\, dc \,. \tag{15.2}$$

Some algebra leads to the result

$$Q = \bar{p} - \int_0^\infty (1 - F_P(p))(1 - F_C(p))\, dp \,, \tag{15.3}$$

where $F_p(p)$ is the distribution function of rainfall, indicating the proportion of the basin where rainfall is less than p, and $F_C(p)$ is the distribution function of capacity, indicating the proportion of the basin where the capacity of the soil to take up water is less than p. For ease of illustration, we will assume the density functions to be exponential, so that:

$$F_P(p) = 1 - \exp(-p/\bar{p}) \tag{15.4a}$$

$$F_C(p) = 1 - \exp(-p/\bar{c}) \,. \tag{15.4b}$$

Then:

$$Q = \bar{p} - \int^\infty \exp\left\{-p\left(\frac{1}{\bar{p}} + \frac{1}{\bar{c}}\right)\right\} \mathrm{d}p \tag{15.5}$$

which leads to the simple relation

$$Q = \frac{\bar{p}^2}{\bar{p}+\bar{c}} . \tag{15.6}$$

This result shows how basin runoff changes with mean rainfall for given mean soil absorption capacities under the assumption that the variation of rainfall and capacity over the basin is exponential. Figure 15.2 shows the form of this relation, and in particular how basin runoff is increased when rainfall and capacity are no longer assumed constant over the basin (when $Q = \bar{p} - \bar{c}$) but vary exponentially (when $Q = \bar{p}^2/(\bar{p}+\bar{c})$). The approach may be developed further to give a new type of rainfall-runoff model, based either on a storage capacity excess mechanism generating saturation overland flow or on an infiltration capacity excess mechanism producing Hortonian overland flow, and incorporating groundwater and channel translation com-