# Chapter 5

# Peak discharge estimation

For the design of soil conservation structures it is necessary to estimate the peak discharge that will occur for a specified average recurrence interval. Such a discharge is often referred to as a 'design flood'. It should not be confused with the estimate of a flood height resulting from a specific rainfall event over a catchment. Such an estimate is referred to as a 'deterministic' design.

As can be seen from Chapter 3, *Runoff processes*, the peak rate of runoff produced by a catchment is dependent on many variables. If peak runoff rates from a catchment were measured over a long period of time, it would be possible to get a reasonable indication of the magnitude of the peak rates that could be expected for different ARI's from that catchment. However, runoff records are non-existent for the small agricultural catchments that are the subject of most soil conservation designs. For this reason it is necessary to use a method that provides an estimate of the peak rate of flow taking selected catchment characteristics into account.

Methods of estimating runoff vary in complexity depending on the hydrologic processes they attempt to simulate. The simulation of all runoff generation processes and relationships requires a high degree of expertise as well as sophisticated software and large amounts of data. Ideally, the method used should be developed using data from the catchment for which the design is required or from similar catchments. If this is not possible, the next best approach is to use methods developed elsewhere but having parameter values derived using local data.

Runoff estimation methods based on local hydrologic data are listed below. For more detailed information about the use of these methods refer to *Australian Rainfall and Runoff – A guide to flood estimation* (Pilgrim 1998).

- **Flood frequency analysis:** the flood peak discharge record of a catchment is analysed to provide a direct estimate of the desired design flood for that catchment.

- **Regional flood frequency models:** these models use relationships developed between runoff data and characteristics of catchments in the region. This approach was used to develop a version of the Rational Method for use in small catchments in the Darling Downs (the model is described in Chapter 7).

- **Runoff routing techniques:** runoff is followed from its point of origin to the design point using models which represent the runoff processes using storage routing concepts with a series of conceptual storages. The output represents the direct runoff hydrograph at the design point (a hydrograph being a graph showing discharge plotted against time). Examples of such techniques include the following:
    - Use of a single storage at the outlet, for example, synthetic unit hydrographs as described by Cordery and Webb (1974).
    - Use of a network of storages, for example, models such as RORB (Laurenson and Mein 1988) and WBNM (Boyd 1978).
    - Use of the continuity and Manning equations as in the ANSWERS model of Beasley *et al*. (1980).
    - Application of the differential equations of unsteady flow such as in the kinematic wave based model, KINCON (Connolly and Barton 1990) (not available for commercial use).

- **Water balance models:** these predict the hydrologic behaviour of a catchment by continuously simulating water movement through the hydrologic cycle.

The use of large amounts of resources in collecting data for calibration and/or use of sophisticated models is not warranted for the small catchments that are the basis of most soil conservation designs. Table 5.1 shows the results of a survey carried out by the Department of Primary Industries in 1988, which indicates the proportion of waterway designs carried out in catchments of different sizes in Queensland cropping areas. Scarborough *et al.* (1992) indicates that some 70% to 80% of catchment designs for the Coastal Burnett district are less than 50 ha.

Table 5.1 Proportion of waterway designs carried out in catchments of different sizes in Queensland

| Catchment size | 0–20 ha | 20–50 ha | 50–200 ha | 200–500 ha | 500–1000 ha | >1000 ha |
|---|---|---|---|---|---|---|
| Percentage of designs | 33% | 30% | 25% | 9% | 2% | 1% |

In Queensland, the Rational Method of runoff estimation is normally used for the small catchments involved in most soil conservation designs. More sophisticated methods may be necessary for the design of soil conservation works in catchments exceeding 1000 ha. In the following chapters, two versions of the Rational Method are described—the **Empirical version** and the **Darling Downs Flood Frequency (DDFF) version.**

The Empirical version is considered to be an arbitrary method because it is based on estimated parameters rather than measured hydrologic data. However it is the preferred option for the design of small catchments dominated by paddocks with contour banks. The Darling Downs Flood Frequency version of the Rational Method is considered to have limitations when applied to a contour banked catchment. These limitations are described in Chapter 7. ■