exhibit large variations. For instance, a women's dress shop can vary from a fashion house with a small number of highly priced items to an outlet with many hundreds of dresses. The damage to the latter, per m^2, would be much higher. The allocation of value class during the field survey goes some way to overcome this problem. The ANU field booking sheets also use the Australian standard industrial classification (ASIC, 1983) code for all buildings in the commercial sector. This classification is based on an internationally agreed 4-digit land-use classification. The equivalent South African code is given in the standard industrial classification (SIC) of all economic activities, see DOS (1993).

In addition to such detailed studies, reconnaissance questionnaires for the commercial sector based on information of the total value of stock and equipment provide a useful check. The total value can be apportioned by height using information on the vertical distribution of retail stock. Data for this are given in Penning-Rowsell and Chatterton (1977). Similar surveys in Australia confirm these values and the information can be extrapolated for use for other countries.

The FHRC and ANU research into stage-damage curves for the commercial sector are the only recently published studies available. It is again stressed that special attention should be paid to this sector as damages frequently far outweigh those to residential property.

Problems in constructing stage-damage curves

The recommended procedure for the construction of stage-damage curves is that they should be based on synthetic studies. However, the construction of either synthetic or actual damages stage-damage curves poses a number of problems. These can be classified as:

- what to include
- what values should be allocated to items
- how many building types should be used
- scatter and error
- interpolation and extrapolation.

What to include?

The basic components are damage to building and contents. There is, however, a decision to be made on whether to include vehicles and boats, damage to gardens and whether clean-up costs should be incorporated into the curves.

Vehicles (including caravans) and boats are nearly always excluded. This is because they can readily be moved at times of flood and are often separately insured for flood damage. However, losses to vehicles and boats stored at residential or commercial premises can be substantial, especially for extreme flash floods. The normal procedure is not to incorporate such losses into building stage-damage curves.

Gardens present a different problem. Normally garden equipment, e.g. lawnmowers and tools, and fences are included. Often such items are located below the floor level of the dwelling and the residential stage-damage curves used by the FHRC and ANU allow for such damage by extending the stage-damage curves to below floor level (Fig. 1). However, the loss of the plants or lawns is difficult to assess and, for keen gardeners, becomes an intangible loss. These are excluded from flood loss.

The most difficult category to assess is the cost of clean-up. It is usual practice to incorporate these into the overall stage-damage curves for residential property. There is considerable variation both in the estimates of the time required and in how the time
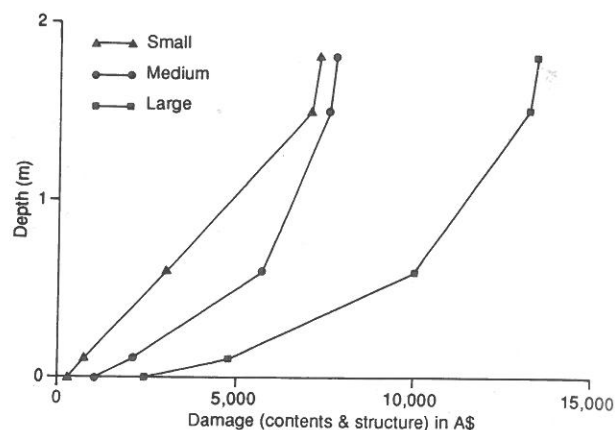

Figure 2
Actual direct damage residential stage-damage curves (contents and structure) for differing residential classes, Sydney 1986 (from Smith et al., 1990)

should be costed. Penning-Rowsell and Chatterton (1977) suggest 15 to 20 h per house; Higgins and Robinson (1981) 50 to 60 h for the 1974 Forbes event and the 1974 flood for Lismore averaged 5 person-days per dwelling (Smith et al., 1979). SMEC (1975) for the Brisbane floods of 1974 suggests 62 person-days for flooding 0.30 m over the floor rising to 91 person-days at 1.80 m. Even more problematic is how to convert time to monetary values. The overall approach is to use average hourly wage rates. For the commercial sector it is common practice for the majority of staff to be employed in clean-up operations after a flood. In such cases clean-up costs are excluded; this is to avoid double counting when indirect losses are incorporated.

What values should be allocated to items?

This is of major significance to overall total direct damage. The normal methodology, followed by both the FHRC and ANU, is to use the concept of average remaining value. This is defined as the average pre-flood value of the item. Care must be taken to allow for the residual value of items after they have been flooded; in some cases the damage can be taken as the repair charge to restore to pre-flood condition. Traditionally average remaining value was used by insurance companies. In those cases where insurance policies replace damaged items with new goods, the assessment of flood losses should remain with the average remaining value concept. For convenience, flood damage surveys often assume that the average remaining value is 50% of a comparable new item. For the commercial sector stock is relatively easy to value and losses to equipment should be costed as average remaining value as described above.

How many building types?

This is of particular importance for the residential sector. There is no clear-cut answer; the number depends on time available and the variations in the area under study. The synthetic method used by the FHRC is the most comprehensive and presents residential stage-damage curves that cover all types of dwelling in the UK.