CHAPTER IV

AVALANCHES AND STORM SURGES

4.1 INTRODUCTION

Earlier chapters, dealing with tropical cyclones and tornadoes, have been concerned with meteorological phenomena which may cause disaster entirely, or at least principally, as a result of the meteorological conditions themselves. In tropical cyclones the winds and the rain, separately or in combination, may produce the conditions which result in disaster. In tornadoes the instruments of destruction are the rotary winds and the strong suction forces in the funnel cloud. Of course, it may be argued that there must be other contributing factors. A tropical cyclone does more damage to a large town than to an area of open country simply because the town has more at risk in terms of people, property and installations, but the principal cause is the meteorological phenomenon.

However, as explained in Chapter I, there are other potentially dangerous natural phenomena which are caused by various groups of factors of which one is the state of the atmosphere playing a direct or indirect role. Numerous examples may be listed but it will suffice to say that in any disaster associated with man's environment, meteorological conditions are very likely to be an important factor, if not in the disaster itself then in the aftermath. In aviation such meteorological phenomena as clear air turbulence and fog are regarded as potentially dangerous, but they should not cause an aircraft to crash unless a number of other adverse factors operated as well. To take another case, if an accident at a nuclear power station resulted in the release of radioactive matter to the atmosphere,

the meteorological conditions would be of major importance in determining the areas that would be contaminated and the degree of contanimation.

This chapter contains brief discussions of avalanches and storm surges which have been selected for the purposes of illustrating that category of natural phenomena which are the result of various factors, including atmospheric conditions, operating together.

Avalanches are of increasing importance in the context of disasters partly because of the growing popularity of winter sports and perhaps more significantly because population growth in developing countries with high mountain ranges, for example the Himalayas and the Andes, are placing more and more people at risk.

Storm surges are of special importance because they are not confined to tropical regions at times of tropical cyclones or typhoons or hurricanes. In any areas of the world where particular conditions of sea, coastline and ocean floor exist, an intense depression, though not possessing the violence of a tropical cyclone, may help to produce a storm surge and possibly a disaster. Whether it occurs in the tropics or elsewhere, a storm surge is a single phenomenon and the discussion in this chapter should be regarded as amplifying the rather brief treatment of this subject in Chapters I and II.

4.2 AVALANCHES

Avalanches occur in all mountainous areas of the world where slopes are sufficiently steep and where a large proportion of the precipitation is in the form of snow. Systematic observations of avalanches began in Alpine regions about the year 1870, and in the present century avalanche research institutes have been established in North America, Japan, the USSR and in a few other countries.

Protective measures against avalanche disasters are of two main classes — short-term and long-term. Short-term measures include the issue of avalanche warnings and triggering-off avalanches by artificial means. Such measures depend on local experience accumulated over many years since there is at present no widely accepted theory of avalanches. The subject is a very complex one and there is much still to be learned about the interaction of weather, terrain and snow cover and the mechanism which decides when and where an avalanche will occur.

Long-term protective measures are designed to prevent the formation of avalanches and include afforestation and structures of various kinds. However, even in this long term category there are fundamental problems concerned with the systematic demarcation of danger areas from the more vulnerable places.[12/]

12/ See Volume VI : Engineering Aspects, Disaster Prevention and Mitigation, (in preparation).

4.2.1 Classification of avalanches

Avalanches are divided into three main categories according to their dimensions :

i) Slides (sluffs). Smaller slides with length and breadth less than 50 metres.

ii) Mountain-side avalanches. Of medium size, do not fall to the bottom of the valley.

iii) Valley avalanches. Large avalanches reaching the valley bottom and, in extreme cases, causing a disaster.

In the following discussion attention is focussed on valley avalanches which are of the greatest importance, particularly for local and regional planning and for the planning of transport routes.

4.2.2 Avalanche warnings

The basic requirement in order to operate a satisfactory warning service is a network of stations making daily observations and measurements of the weather (air temperature, wind, cloud, precipitation), snow conditions (fresh snow, total depth, snow temperature) and reporting any avalanches that have been observed. These stations should be representative of their surroundings and the network density in the Alpine regions should be one station per 300 - 500km^2. The observations made at a station should be transmitted promptly to the avalanche warning centre.

The play of forces between tensions and compactness in the snow determines the time and place at which an avalanche will occur. This question and associated factors are considered by an expert in the light of long experience, and the decision whether or not to issue an avalanche warning is largely a matter of subjective judgement. However, with the gathering of data over a period of 20 years or more, attempts are being made to derive statistical relationships which will indicate the probability of occurrence of an avalanche. It should be mentioned, however, that a complete theoretical treatment of avalanches is very far away, so that warnings must necessarily be in general terms with no precise references as to specific locations or times.

4.2.3 Triggering-off avalanches

If, during heavy snowfall, large masses of snow accumulate on the slopes above some vulnerable place it is advisable to cause these masses to fall in stages before they become too big. In this way the risk of a severe avalanche bringing disaster to a settlement or damaging communications can be averted. Safety precautions — the planning of barriers to deflect the falling snow and possibly the evacuation of any threatened townships — should be taken before any triggering-off action is taken.

Triggering-off is accomplished, under the close supervision of an avalanche expert, by blasts above or in or just below the snow cover. Mine-throwers, rockets and hand-thrown explosive charges have all been successfully tested but, as will be clear, these devices must be used by experts. Figure 9 gives an example of the technique.

Figure 9

4.2.4 The building of structures

In areas above the tree-line, permanent "shores" to shore up the snow cover are constructed in the breakaway area. These are permanent structures in the sense that they are expected to give protection for several decades.