Floods in Camargue, January 1994.
Agence Vu. E. Franceschi

After the flood. Joyeuse River, Vaucluse.
WWP. J.-L. Vantiohen

houses and other buildings were destroyed and camp-sites in the valley bottom were devastated. The death toll reached 38 and there was considerable damage to communications, roads and power lines throughout the region, with insured losses of over US$ 300 million. The damage to communications lines meant that the local authorities (municipality and police) were unable to inform the outside world of the town's plight, thus delaying the civil defence response to the disaster for several hours.

From the above brief discussion it can be seen that the flood-producing potential of a river basin depends on its natural setting (climate, soils, geology, steepness), on the land cover (forests, crops, roads, buildings) and on the land-use (agriculture, forestry, towns and cities). Many human interventions have the effect of increasing flood potential by reducing infiltration capacity. Sensitive land-use practices can repair some of the damage. These include reforestation, particularly on land that is too steep for agriculture; terracing and contour ploughing to increase infiltration, delay runoff and reduce erosion; and the construction of small farm dams, which not only catch surface runoff but can also provide water for stock and minor irrigation schemes. Urban runoff remains a major problem. In many countries new urban developments are required to provide detention basins to catch and delay the runoff from buildings and paved areas and these can be an effective solution.

Hydrologists can simulate the response of a river basin to rainfall using computer-based hydrological models which describe the movement of the water through the soil to the river. Models conceptualize the catchment as a series of soil-water stores together with equations governing the transfer of water between the stores. Precipitation enters the topmost stores and can be evaporated, transferred to lower stores or form runoff according to the equations thus simulating the direct runoff, interflow and baseflow components of river flow. More elaborate models, describing whole river basins, will also have to include components to compute the flow of water in the river channel and thus the propagation of flood waves down the river. The use of hydrological models to forecast future flood flows will be described in chapter 5 below.

Flood frequency

In analysing the statistics of floods, hydrologists usually study the largest flood in each year, the so-called *annual flood*. From the analysis of these annual floods it is possible to estimate the probability that a certain flood would be exceeded in any year. This flood can be expressed either as water level or as discharge, the two being related by the properties of the river channel. Hydrologists prefer to use discharge in flood analyses as it is more readily transferable up and down the river and is unaffected by the construction of flood prevention works such as dykes or levees, which increase the level for any given discharge. The frequency of a flood of a given size is often described by the *recurrence interval or return period*. For example, if a flood of, say, 2,500 m3/s is said to have a return period of 100 years, then there is a 1 per cent chance that the river discharge will be 2,500 m^3/s (or higher) in any year. This definitely does not mean that the flood of a given return period occurs at regular intervals, but is merely a graphic way of describing the rarity of the flood. An important parameter of the flood frequency distribution is the *mean annual flood*, the average of the annual floods. This gives a measure of the magnitude of floods for a particular river basin and is used to scale the floods of different return periods for a catchment. It can be related empirically to the characteristics of the catchment such as area, slope, rainfall statistics, soil types, and land-use. The mean annual flood is a very common flood and has a return period of only 2 to 2.5 years. In many rivers it is approximately the flow that the river channel can carry when running bankful.

EIGHT HUNDRED YEARS OF FLOODING IN FLORENCE

04-11-1177	●●●●
??-10-1261	●●
01-10-1269	●●●●
15-12-1282	●●●●
02-04-1284	●●●●
05-12-1288	●●●●
??-??-1303	●●
??-01-1305	●●
04-11-1333	●●●●●●
05-12-1334	●●●●
06-11-1345	●●●●
??-11-1362	●●
01-11-1368	●●
21-07-1378	●●
20-10-1380	●●●●
??-05-1406	●●
??-12-1434	●●
18-10-1465	●●●●
16-01-1465	●●●●
19-01-1490	●●
10-06-1491	●●
08-01-1515	●●●●
28-08-1520	●●
15-12-1532	●●●●
??-??-1538	●●
06-11-1543	●●●●
15-11-1544	●●●●
13-08-1547	●●●●●●
08-11-1550	●●
13-09-1557	●●●●●●
31-10-1589	●●●●●●
??-01-1621	●●
09-11-1641	●●
06-11-1646	●●●●
??-01-1651	●●
04-11-1660	●●
11-05-1674	●●
11-10-1676	●●●●
19-02-1677	●●●●
18-05-1680	●●●●
20-04-1683	●●
26-01-1687	●●●●
08-12-1688	●●●●
02-06-1695	●●
??-01-1698	●●
11-10-1705	●●●●
28-02-1709	●●●●
22-10-1714	●●●●
06-09-1715	●●●
??-11-1719	●●●●
03-12-1740	●●●●●●
19-10-1745	●●
01-12-1758	●●●●●●
15-11-1761	●●
03-11-1844	●●●●●●
04-11-1966	●●●●●●

The earliest recorded flood in Florence occurred in 1177, over 800 years ago. The table lists the 56 most serious floods since that date with the dots indicating the severity of the effects of each flood. The water level reached during each flood can no longer be estimated because of changes in the structure and layout of the city. However, we do know that the social impact of flooding in the past was as great as it is today: loss of human lives, urban devastation, economic damage and loss of jobs.

Human settlements affected by floods.
FAO. L. S. Botero