SAY, WHAT IS A 100-YEAR FLOOD?
and
WHY DO WE HAVE SO MANY OF THEM?

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We've all been there; glued to our TV sets watching the roving reporter in their raincoat, soaked to the bone, providing their "flood watch" by that troublesome spot that's flooded so many times before. After the water breaks out of its channels, we're told it was a "100-year flood." Will it be another 100 years until it happens again?

WHAT IS A 100-YEAR FLOOD ANYWAY?

It is a probabilistic assessment that means a given event has a one-in-one hundred chance (1 percent) of occurrence <u>in any given time interval</u>, or a "return period" of once every 100 years. Such assessments are based upon statistical frequency of collected data, as presented in Table 1. The reader can see from this table that the 100 year return period storm has a 9.6% chance of occurrence in 10 years, 22% chance in 25 years, 39% chance in 50 years and an 86% chance in 100 years.

So why do we hear so much about "100-year floods"? In hydrology, there are actually three types of comparative assessments: 1) rainfall within a given time interval; 2) peak stream flow; or 3) volume of flow caused by a single storm event or sequence (which may last one to six months). Each of these attributes can be measured and counted as discrete data points, to provide statistical comparison, or frequency analysis. As a consequence, we can have a 100-year storm, a 100-year peak flow event, or a 100-year flood, all of which may or may not be independent of one another. Although the media commonly use the terms "100-year storm" and "100-year flood," storm periodicity is always married to some time interval, such as 24 hours, seven days, 30 days or a "water year" (which captures the annual period of extreme precipitation, and varies from place to place, but always encompasses 12 months).

PRECIPITATION VS RUNOFF

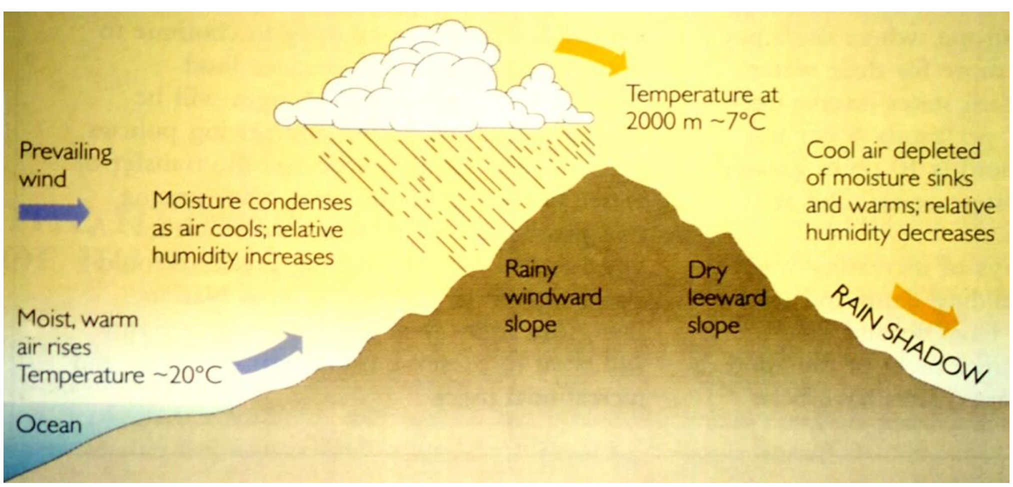
So, a 100-year recurrence frequency rainfall event <u>does not</u> necessarily precipitate a 100-year runoff, because runoff volume is built upon a host of other contributory factors; the most important being how saturated the ground already is when a storm hits. The more saturated the ground, the less moisture it can accept, so more water will be available to coalesce and accrue in channels. This temporal condition is usually referred to as the "runoff factor"(R). A runoff factor of 1.0 means 100% of the precipitation would be shed as runoff. A coefficient of 0.50 would mean about half of the precipitation could be expected to infiltrate the ground and the other half as runoff. Other factors influencing runoff include the type of ground cover and vegetation, terrain physiography, storm duration and changes in precipitation intensity.

		2	5	10	20	50	100	200	500	1000	2000	5000	10000
RETURN PERIOD YEARS		2	5	10	20	50	100	200	500	1000	2000	5000	10000
PERCENT CHANCE OF GETTING ONE OR MORE SUCH OR BIGGER FLOODS IN THESE MANY YEARS	ANY 1 YEAR	50 40 30 25	20 15	10	5	2	1	0.5	0.2	0.1	0.05	0.02	0.01
	TEN YEAR S		80	65	40	18	9.5	5	2	1	0.5	0.2	0.1
	TWENTY FIVE YEARS		99	94	71	40	22	12	5	2.5	1.2	0.5	0.25
	FIFTY YEARS			99.9	90.5	61	39	22	9.5	4.8	2.3	1.0	0.5
	ONE HUNDRED YEARS					86	64	40	18	10	5	2	1

TABLE – I

If it were to rain more or less continuously beginning in late October, by March we would begin to see extremely high levels of runoff with even modest size storms, because the soil has absorbed all the moisture it can within the given time interval. We term this condition "antecedent moisture," which describes how much moisture is already been absorbed in the ground. Short-lived, but intense bursts of rainfall usually do not cause widespread flooding, but can trigger debris flows and mudslides, which tend to clog drain inlets, causing substantial secondary flood damage.

OROGRAPHIC LIFTING CAUSES IT TO RAIN AND SNOW MORE IN HIGHER ELEVATIONS



Hydrologists have long recognized that clouds dispel greater amounts of moisture over highland areas, due to a phenomenon known as "*orographic lifting*" (shown in the above diagram). In such situations we may observe levels of precipitation two to three times as high in the higher elevations and "rain shadows" develop in areas down-wind of such highlands, which receive almost no precipitation. It often rains and snows on the windward side of the mountains while it's dry on the leeward side.

IS THE RAIN FROM ANY GIVEN STORM SEQUENCE ABOUT THE SAME EVERYWHERE?

No, local variations in rainfall intensity, from one watershed to another, are startling because of localized "storm cells." For instance, during the 8-day storm sequence ending at 4 AM on Friday January 3, 1997 in California's Sierra Nevada Mountains, 42.16 inches of precipitation was recorded at Buck's Lake (elevation 6,000 feet) in the Feather River Basin, while only 15.40 inches was measured during the same interval at Calaveras Big Trees (elevation 4,900 feet). In the Feather River drainage an additional 8 inches of water was released from snow melting because air temperatures were lower than in previous winter storms. A record peak runoff of 330,000 cubic feet per second (cfs) was recorded on the Feather River just above Oroville Reservoir. Even though the peak runoff was greater than a 100-year recurrence frequency event, the other two measures, such as flood volume (less than 1982-83) and rainfall (less than December 1955) were not records.

WHAT IS THE STORM-OF-RECORD ?

The storm-of-record is the greatest level of precipitation ever recorded, for a given time interval. The 24-hour storm-of-record in the San Francisco East Bay area occurred on October 13, 1962, when 9.4 inches fell in a single day in the Oakland Hills, with 13.73 inches recorded in 48 hours. This storm precipitated some flooding in downtown Oakland adjacent to Lake Merritt and some accumulation of slide debris in drop inlets and culverts up in the Oakland Hills. If the same storm had hit in March or April, when the ground was saturated, the resultant flooding would have been much worse.

STORM DURATION USUALLY CONTROLS DESTRUCTIVE RUNOFF

The other complicating factor is the duration of the storm. In most of the continental United States the average storm duration is about 90 minutes. On January 3-5, 1982 a subtropical storm hit the San Francisco Bay area, but its forward motion was stalled by a high pressure area sitting over the Sacramento Valley. The result was a 30 to 35-hour duration event that dumped upwards of 27 inches of rain on coastal highlands. Although the volume of moisture recorded over 24 hours didn't break the October 1962 record, the 30-hour totals were records, culminating in a series of debris flows and causing 17 deaths and millions of dollars in damage in the Bay Area.

For the north coast of California the December 1964 storms caused record flows, including a flow volume of 900,000 cfs on the Eel River, just below its confluence with the Van Duzen River. The previous record had been 500,000 cfs, recorded in December 1955. The '64 flood was precipitated by four consecutive days of rainfall, with as much as 24 inches in 48 hours recorded at Laytonville, but the storms came in the midst of an already wet winter.

WHAT DOES THE FUTURE HOLD?

We will have more 100-year rains, floods, and peak flows? In 1977 one of the founding fathers of channel hydraulics, Professor Ven Te Chow of the University of Illinois, reminded the civil engineering profession that in order to accurately predict a 10-year recurrence frequency event, we would need 100 years of precipitation records, which is about what we have today. But, in order to accurately predict a 100-year recurrence event, we would need 1,000 years of records, which we do not have. Flood predictions, like those of the weather, depend an unique set of environmental variables which are almost <u>never</u> repeated, meaning the one thing upon which WE CAN count on is that the results of any given storm will always tend to be different.

So, you know of some property along the Osage River that hasn't been flooded since 1937? That might actually mean your chances of disaster are increasing each year. My advice would be don't buy it without a boat.

REFERENCE:

Ven Te Chow and Nobutada Takase, 1977, *Design Criteria for Hydrologic Extremes*: Journal of the Hydraulics Division, American Society of Civil Engineers, v. 103, N. HY4 (April), pp. 425-436.