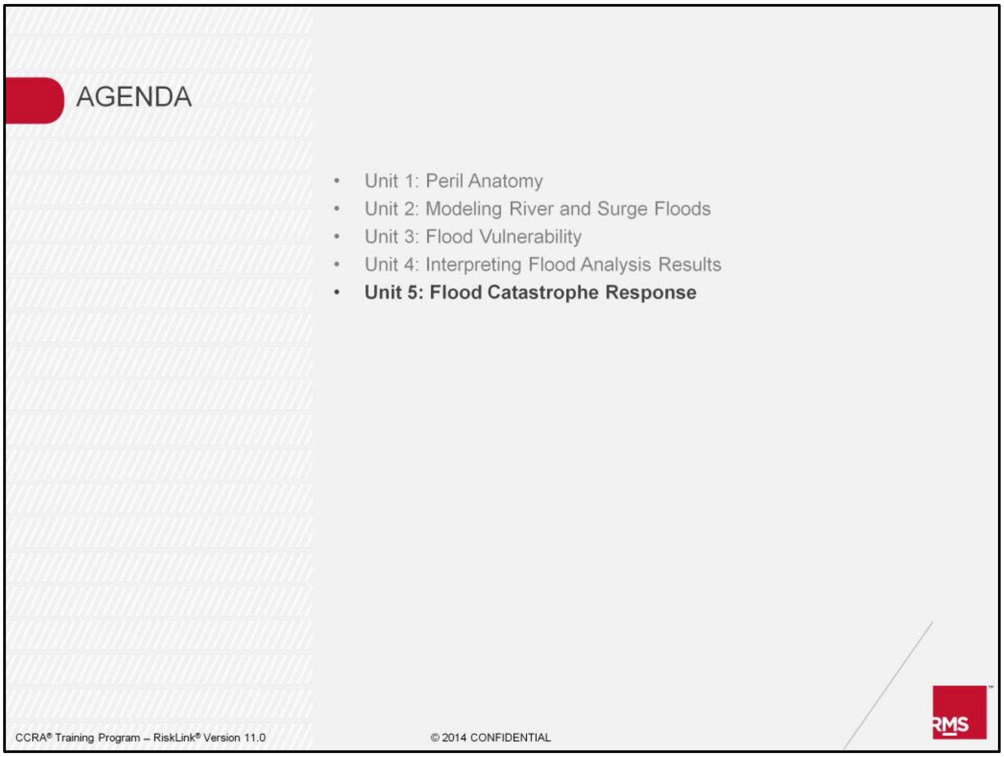
FLOOD MODELING

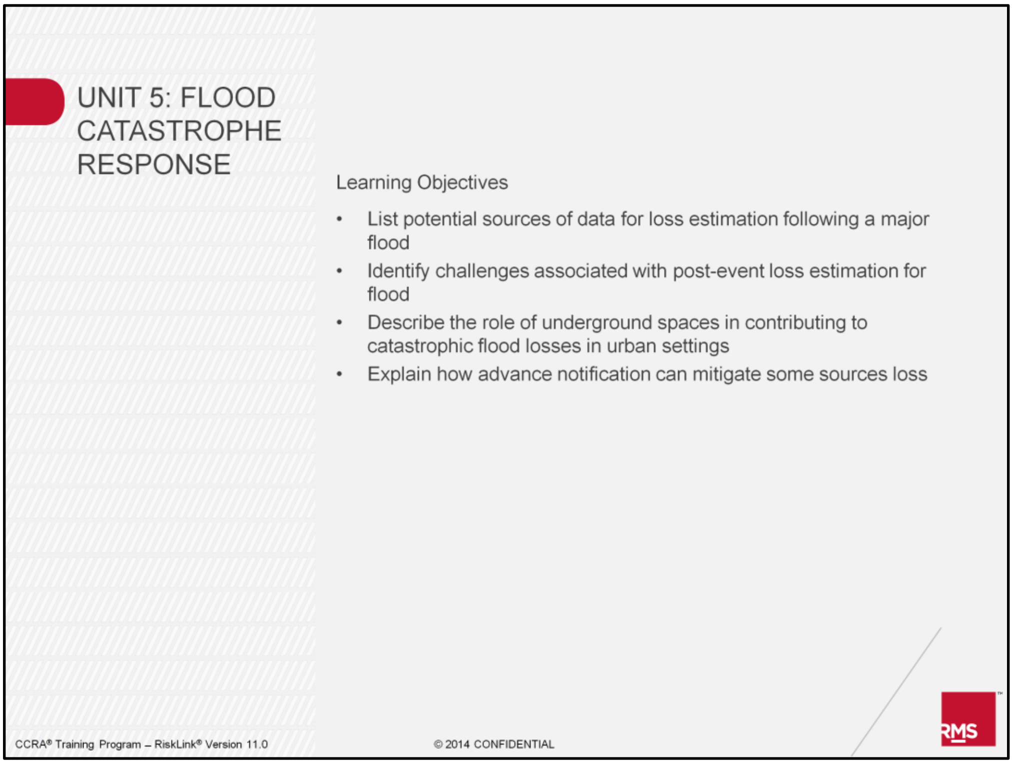
UNIT 5

RMS® CCRA® Training Program

Certified Catastrophe Risk Analyst



This unit discusses the vulnerability module of the Europe windstorm model.



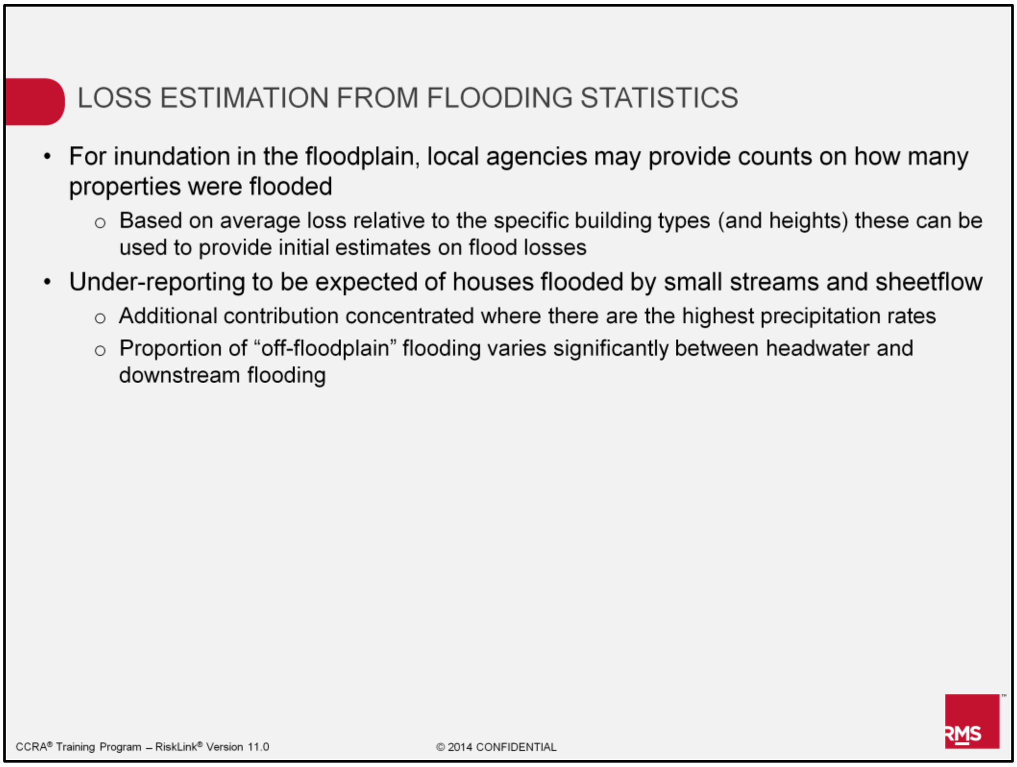
At the end of this unit you should have a good understanding of each of the five learning objectives listed on this slide.

POST-EVENT LOSS ESTIMATION

- Flood loss is highly localized
  - Within a floodplain it may be very dependent on specifics of local defense failures
- For inland flooding there is even more of a challenge to capture the off-floodplain components of flood loss
- Private flood insurance in many territories is extremely variable
- For storm surge, there is likely to be overlap with wind losses (particularly for tropical cyclone)
- Therefore, post-event insured loss estimation for floods is particularly challenging

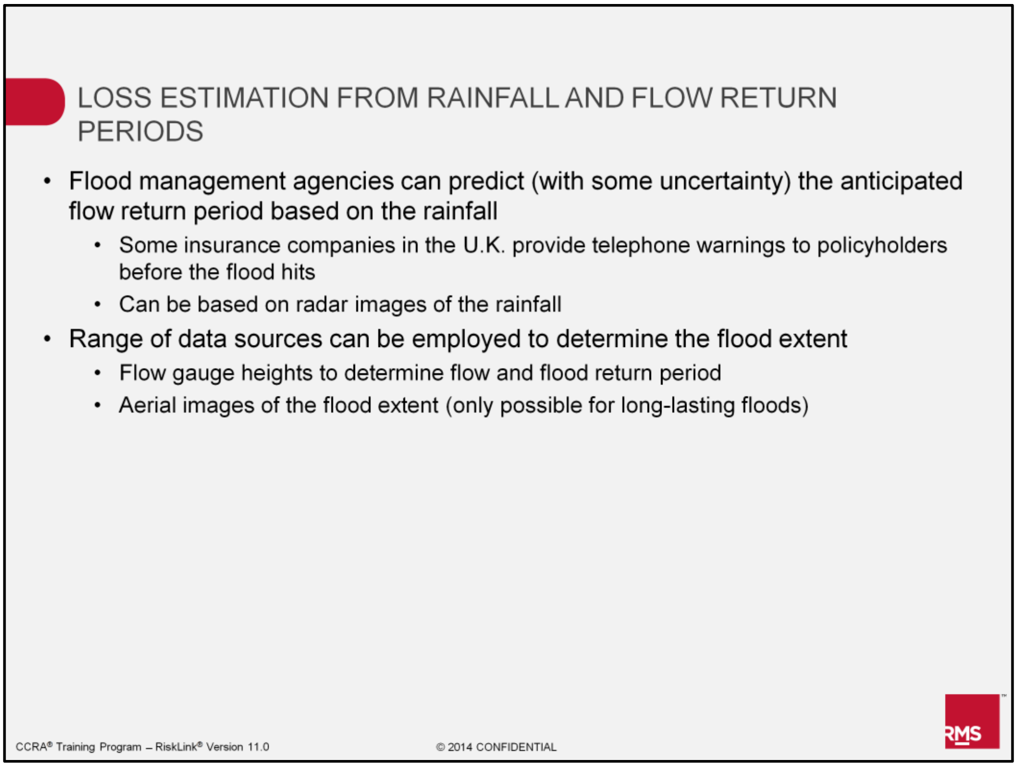
The off-floodplain components of flood loss are even more difficult to anticipate as part of flood loss estimation. While we can predict overall the risk of sheet flow, exactly where water will accumulate and the path it follows over the land to reach the rivers in a specific event can be very difficult to predict.

Another factor that can also be very important in evaluating market losses, especially in countries where flood insurance is not a universal coverage, is knowing who has flood insurance and who does not. If flood underwriters have tried to avoid insuring in the highest risk locations or if the coverage is an option as part of other coverages, anticipating who has flood insurance and who does not can be a real challenge. For storm surge, especially in tropical cyclone, the areas that are likely to be most impacted by the highest flood damage are also likely to be experiencing the highest wind speeds. There may often be ambiguity as to what damage was caused by the flood and what was caused by the wind, and this can be a major problem where there are separate insurance coverages for the two perils.



In some countries there may be agencies that provide counts on the number of properties flooded in the major river floodplains. However, these will almost always be understated because they do not provide counts for smaller streams or other sources of flooding such as sheetflow. From the number of properties flooded and the average loss that can be expected relative to specific building types and heights, it may be possible to provide some initial estimates on flood losses. There can, however, be a lot of underreporting of flooding outside the principal floodplains.

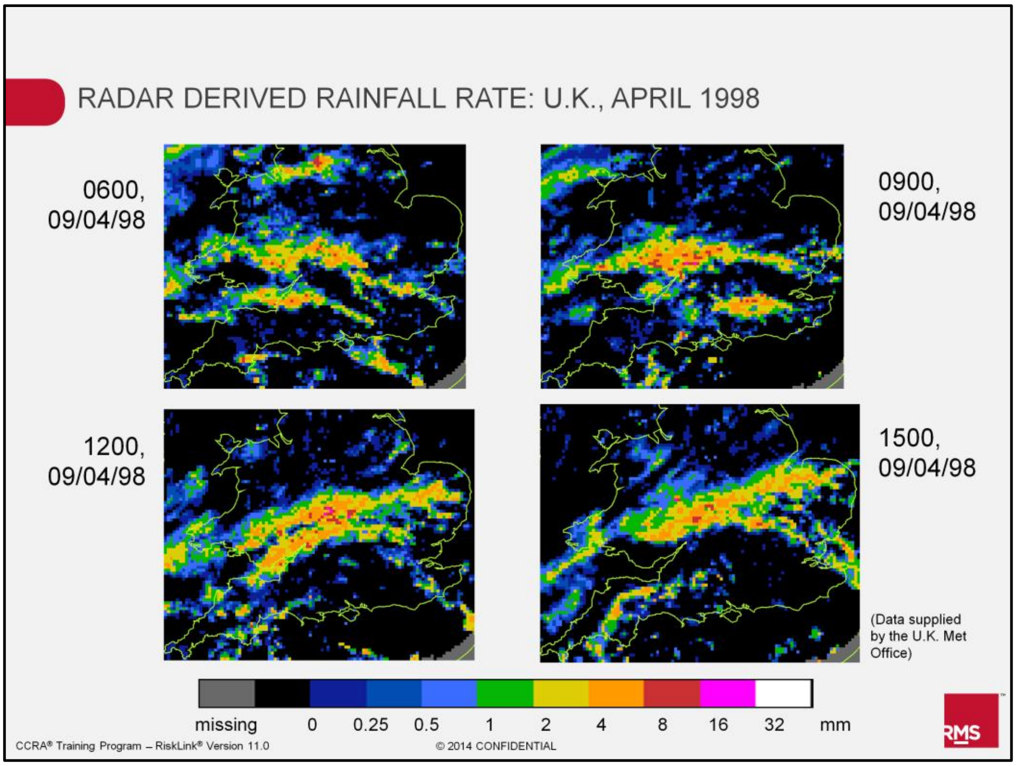
Because off-floodplain contributions are likely to be a higher proportion of the total loss from flash flood events in the summer, a greater proportion of loss is not going to be captured by the identification of properties flooded in designated floodplains.



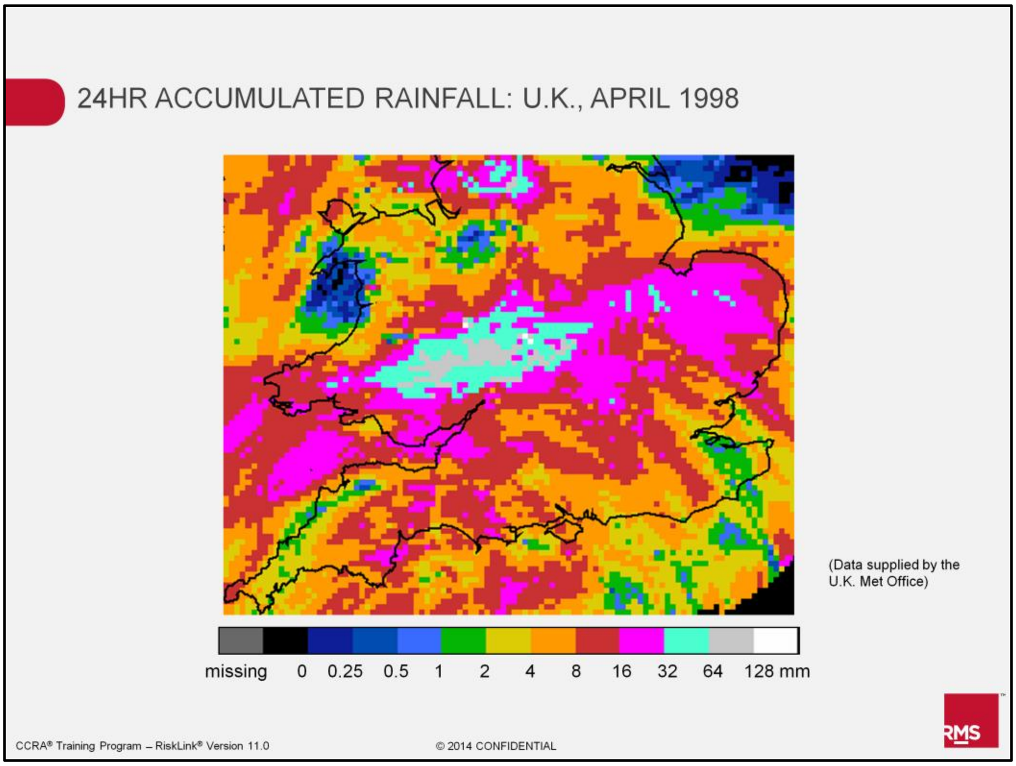
In most developed countries there are government run flood management agencies that work to predict the flows to be expected on a particular river as a function of the precipitation that has already happened or by monitoring the flows upstream. Meteorological agencies will typically look at radar images of the rainfall associated with an event and use that information to predict the cumulative rainfalls. However, on small streams the speed with which precipitation turns into flooding can be so quick that it may not be possible to anticipate them. For larger, longer rivers it may be possible to give a day or more warning.

Some insurance companies in the U.K. have moved to provide telephone warnings to their policyholders before a flood hits in the hope that the policyholders will take action to reduce the losses from the flood.

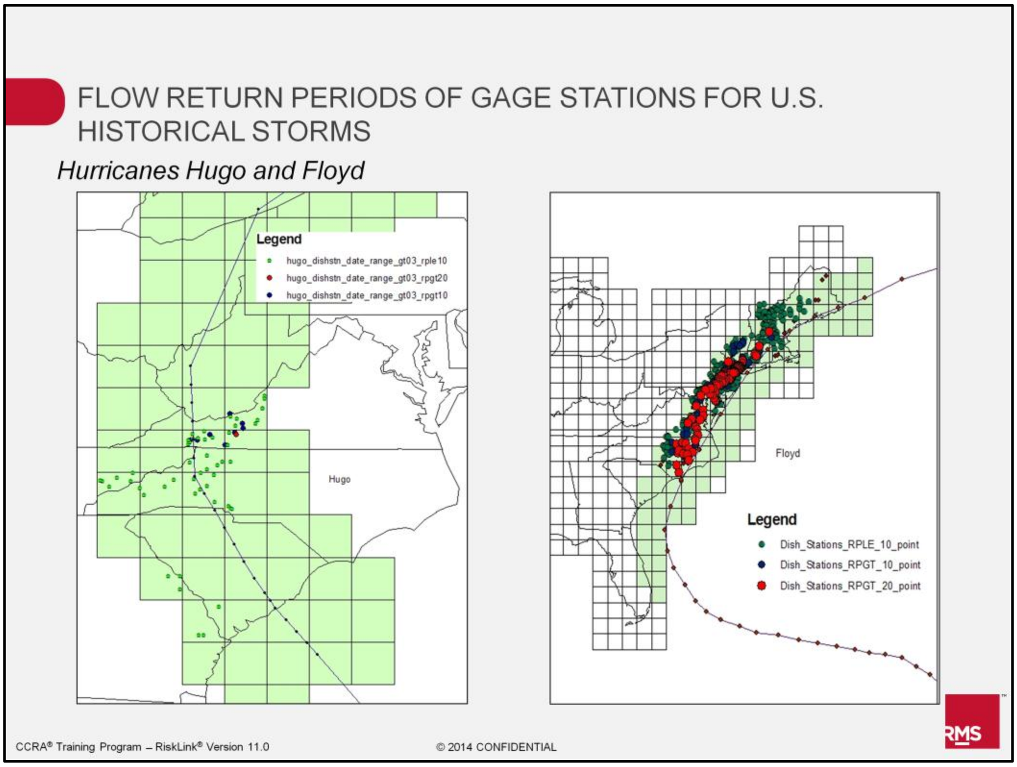
It may also be possible to find aerial images of the flood extent, although in many floods the water rises and falls over such a short period of time that conditions may not be conducive to taking aerial images. Satellite images are often obscured because heavy rain means thick cloud cover. So it is only for big floods on major river systems that images of the flood extent tend to be available.



This is an example of the power of radar data, which is now used for deriving rainfall totals. The slide shows a series of radar images for precipitation in the U.K. for the April 1998 event. They were taken at a series of time intervals and indicate the rainfall rates per hour.



It is possible to integrate these intervals and come up with the 24-hour accumulated rainfall from this event to see exactly where the highest rainfall totals are located. The rainfall totals here rise up to more than 100 millimeters over the period of flooding in 24 hours. Based on that information, it is then possible to model how this precipitation is likely to turn into flooding in the rivers in the path of this footprint.

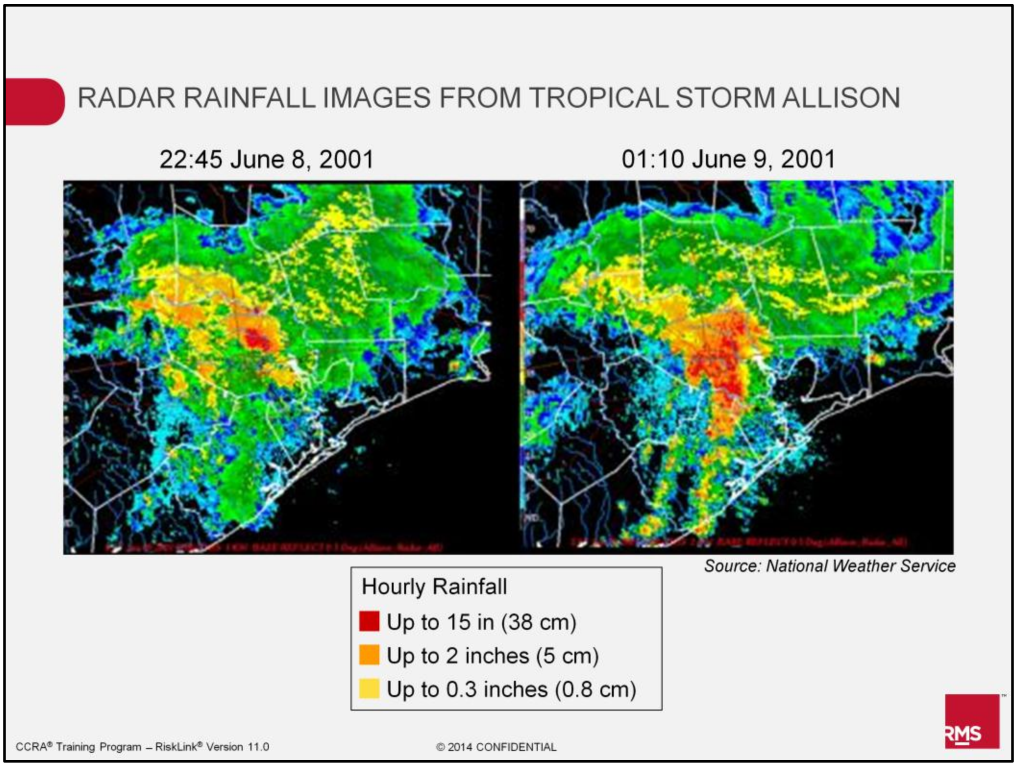


In the U.S., the data on river flow is publicly available. So it is possible to see what these flow return periods are in the aftermath of a particular storm.

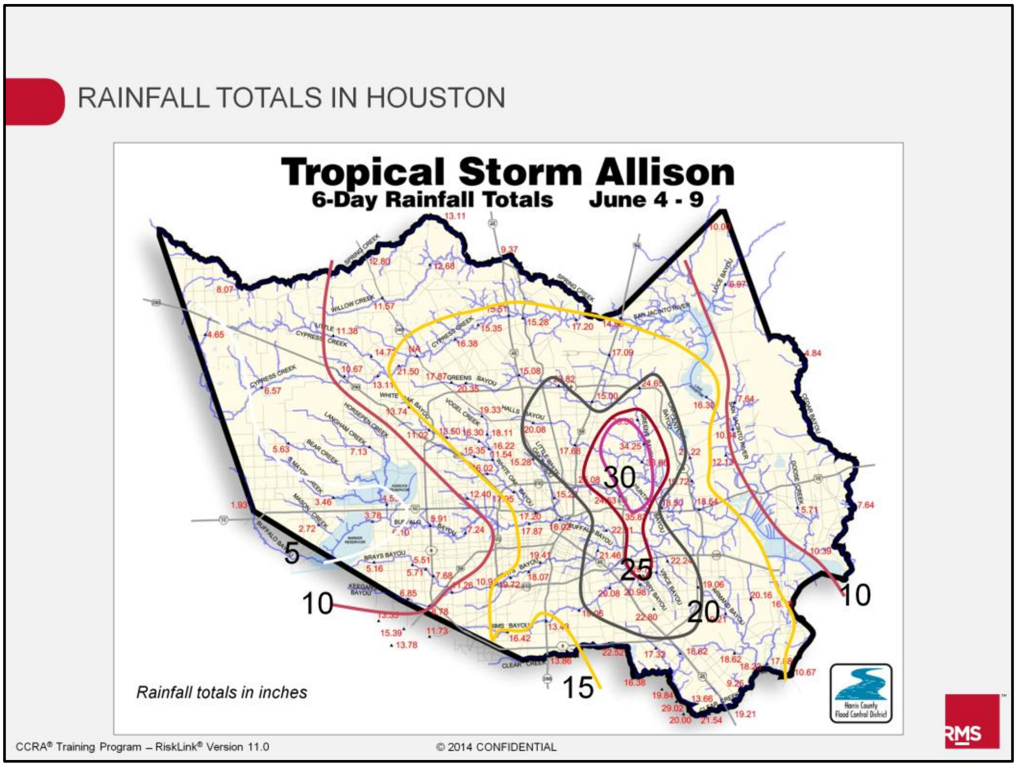
These are examples of two storms, Hurricane Hugo in 1989 and Hurricane Floyd in 1999, showing the return period of flow on the different streams in the path of these storms. Green is a low return period, under ten years. Red is greater than 20-year return period. You can see that in Hugo there were not significant numbers of streams and rivers that experienced high flows.

This contrasts with Floyd, where on the left-hand side of the track there were very significant rainfall totals. The red dots represent the streams that experienced flows greater than a 20-year return period. There were very high levels of flood damage and significant insurance losses due to Hurricane Floyd as a result.

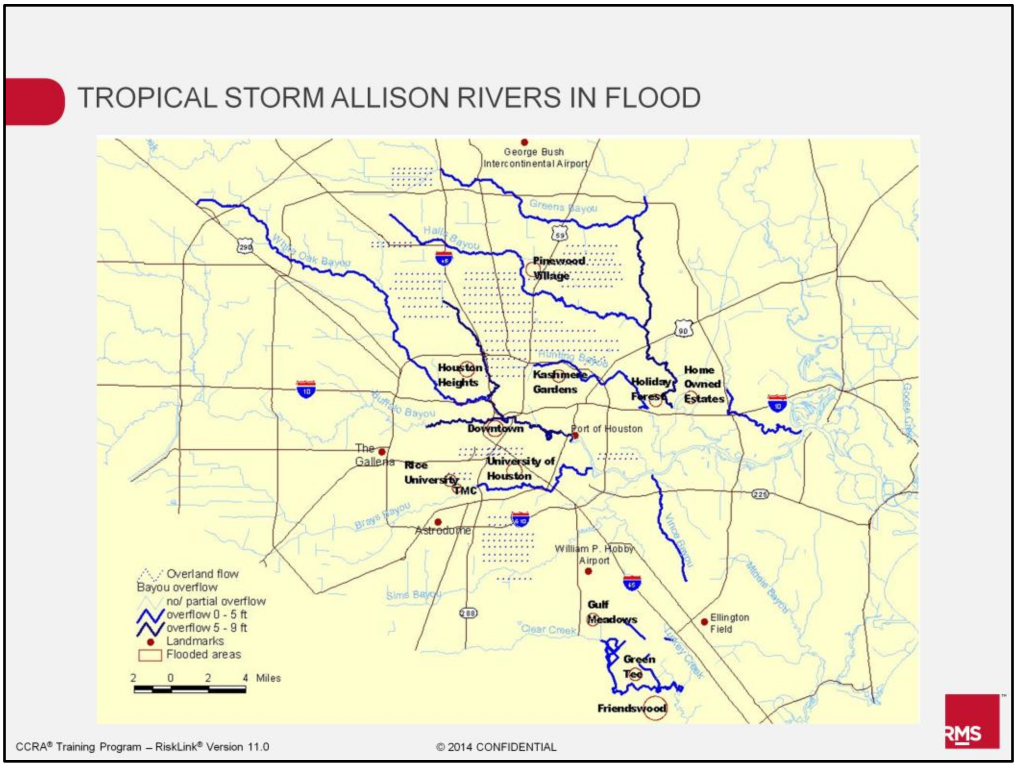
Tropical Storm Allison was a tropical storm not a hurricane, but it stalled over the coast of Texas in June 2001. Although it was a weak storm, because it stalled right over the coast it was continually re-supplied with moisture from the Gulf of Mexico and dropped large amounts of rain over the Houston area over an extended period of time. You can see the loop of the storm in this image; it started off in the gulf and headed off further along the coast to the east.



This slide shows radar images of rainfall from Tropical Storm Allison. They highlight different time periods of the level of hourly rainfall. In some areas, rainfall totals ranged between 2 and 15 inches an hour.

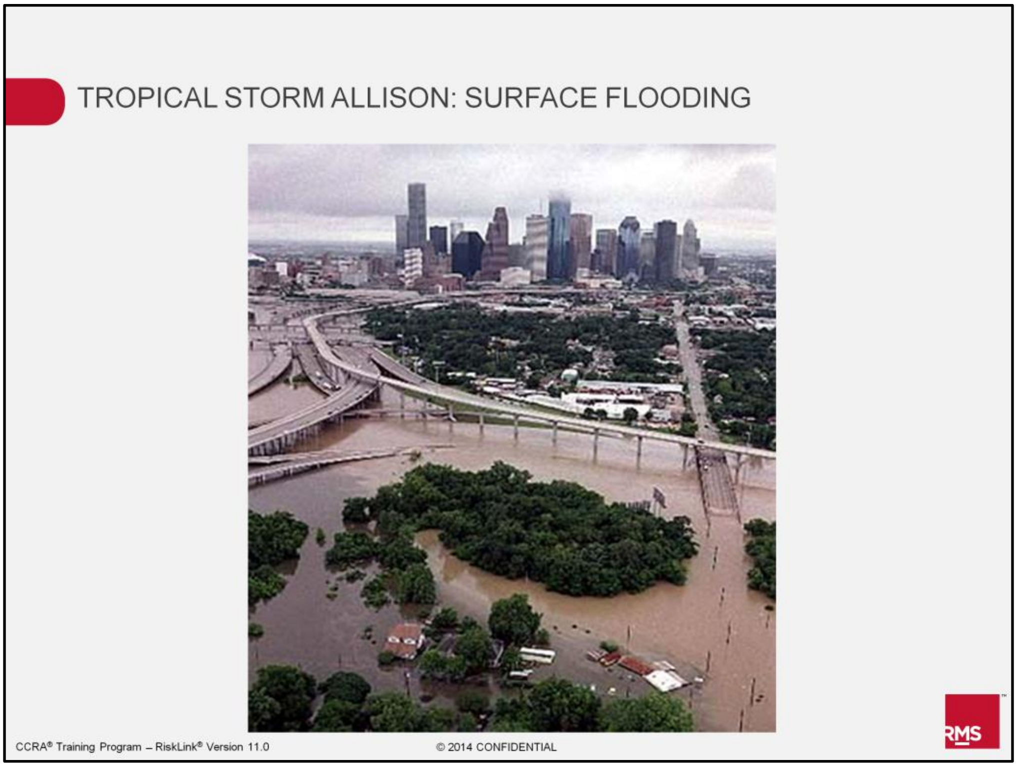


These were the rainfall totals overall across Houston. The highest amount of rainfall was 30 inches in a six-day period, from June 4 to June 9, while Tropical Storm Allison hung over the city.

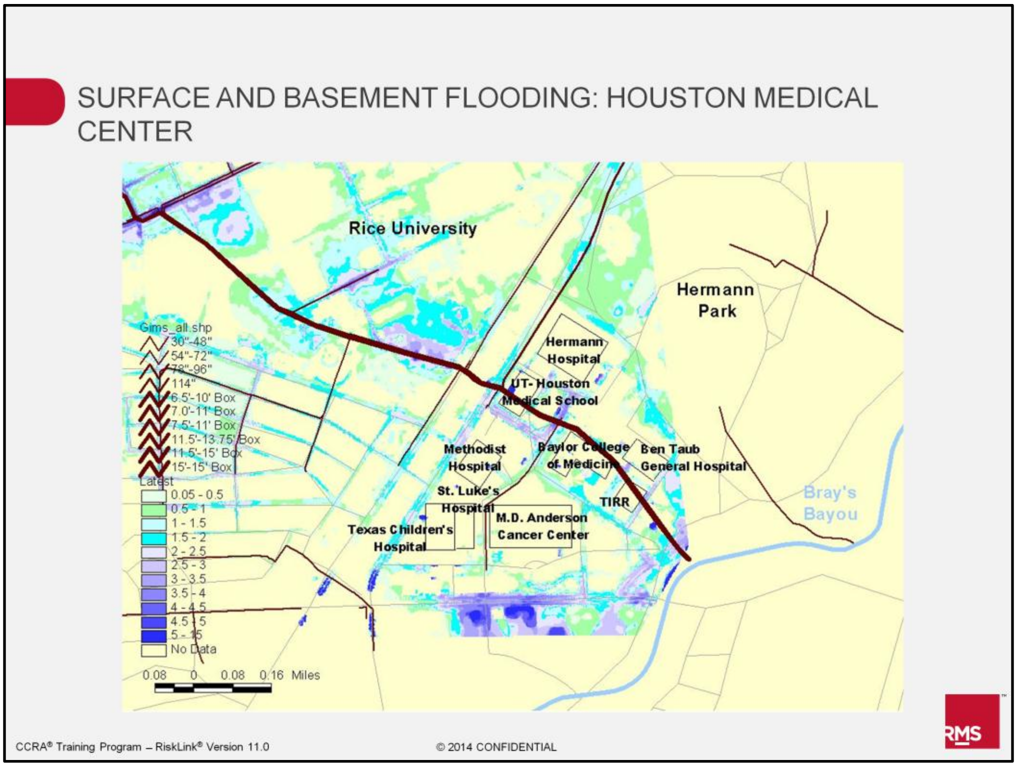


This map shows the rivers that flooded during Tropical Storm Allison. From the rainfall totals it is not difficult to predict which rivers would flood. As many of these rivers are fairly short with small catchment areas, they are going to respond very rapidly to the rainfall.

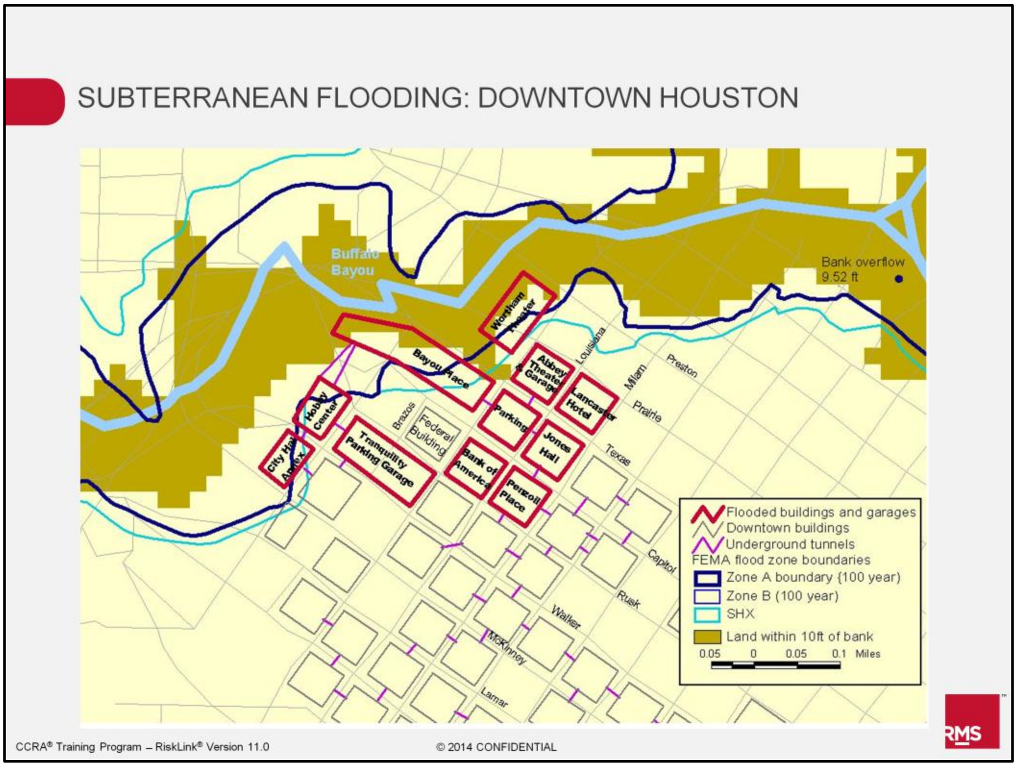
The areas that were subjected to sheetflow are marked by the dotted lines. The volume of rain exceeded the capacity of Houston's drains, which caused the water to flow through the streets and properties.



This is a photo of the city in the aftermath of Tropical Storm Allison. Large parts of the low-lying areas were flooded.



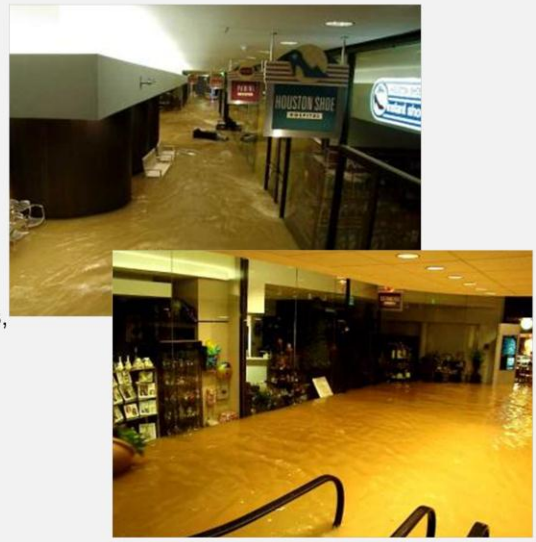
There were two areas of high flood loss in Allison. One was in the Houston Medical Center area, which we mentioned earlier in this course. Water entered an underground garage and then got into the basements of a number of the principal hospitals through these underground connections. There was also water in the streets. This map shows the flood depths of water in the streets. Many of the streets had about one-and-a-half to two feet of flood water. In the lowest lying areas, the flood water extended to more than four or five feet. The water in the streets was also then flowing into neighboring buildings.



In the downtown Houston area, an underground network of tunnels had been constructed for access purposes partly in an area designated a floodplain. During the event, flood water from the nearby rivers entered these tunnel systems transporting the flood waters to areas outside of the designated floodplain. These flood waters flowed into the subway network and into stores and the basements of a number of high-rise buildings. The Federal Building, however, was protected because there was no underground tunnel connecting it to its neighbors, all of which had their basements flooded.

TROPICAL STORM ALLISON, HOUSTON 2001

- Indoor pedestrian tunnel system connects 81 buildings, and houses many shops and restaurants
- Sixteen square blocks of downtown were flooded underground
- Water forces destroyed unreinforced concrete block walls, metal doors, and partition walls



Flooded pedestrian tunnel and underground shops
(photo credit: www.diannashipman.com)

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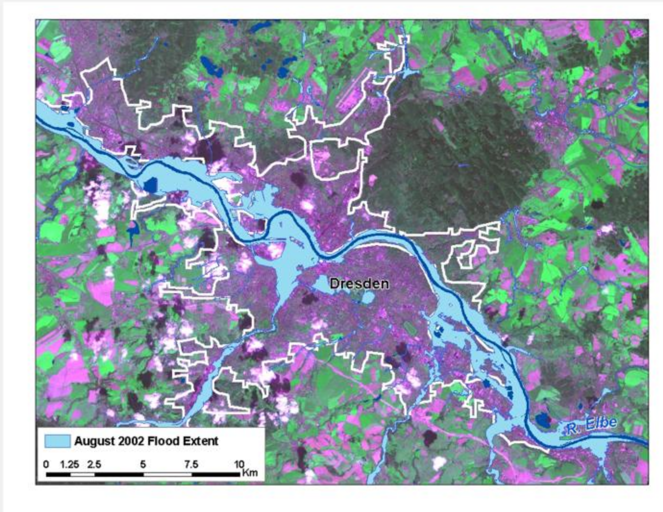
These are photos from inside the pedestrian tunnel system after Tropical Storm Allison. A total of 81 buildings were connected by this pedestrian tunnel system. It was fortunate that some doors held, preventing the whole system from becoming flooded. Ultimately, 16 blocks of the downtown area were flooded underground. The water flowing through the system caused considerable damage, particularly to a lot of equipment located in basements of the buildings and to the shopping mall located within the tunnels

DATA: FLOOD FOOTPRINTS ELBE 2002

- Largest central European flooding event in recent times
- Used for calibration of model components



This image shows the Elbe and tributaries flood extent of the 2002 flood in Dresden. The Elbe was flowing at a return period of about 200 years at the peak flow during this event. We have used these reconstructed flood footprints to calibrate vulnerability functions and the off-floodplain components.

PREVENTATIVE ACTION AND CLAIM SIZE

- Households that moved portables:
  - 74% Content claim <£5,000
  - 9% Content claim >£10,000
- Households that moved nothing:
  - 50% Content claim <£5,000
  - 23% Content claim >£10,000
- Significant at 95% level (X2)

Wansford (River Nene)

Northampton (River Nene)

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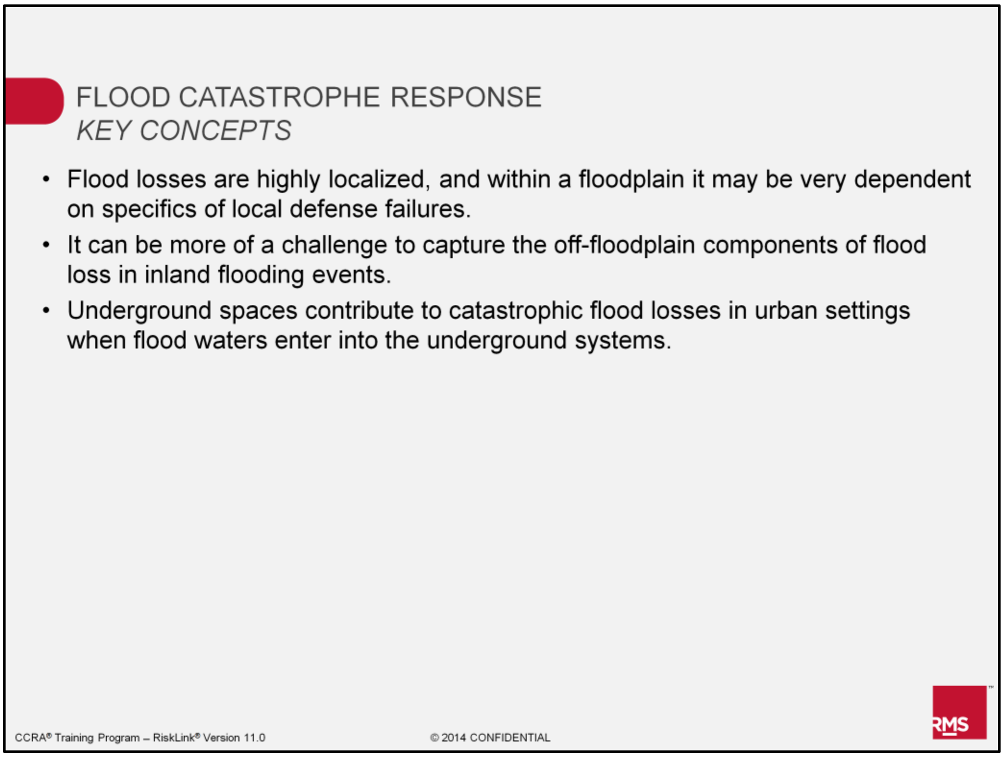
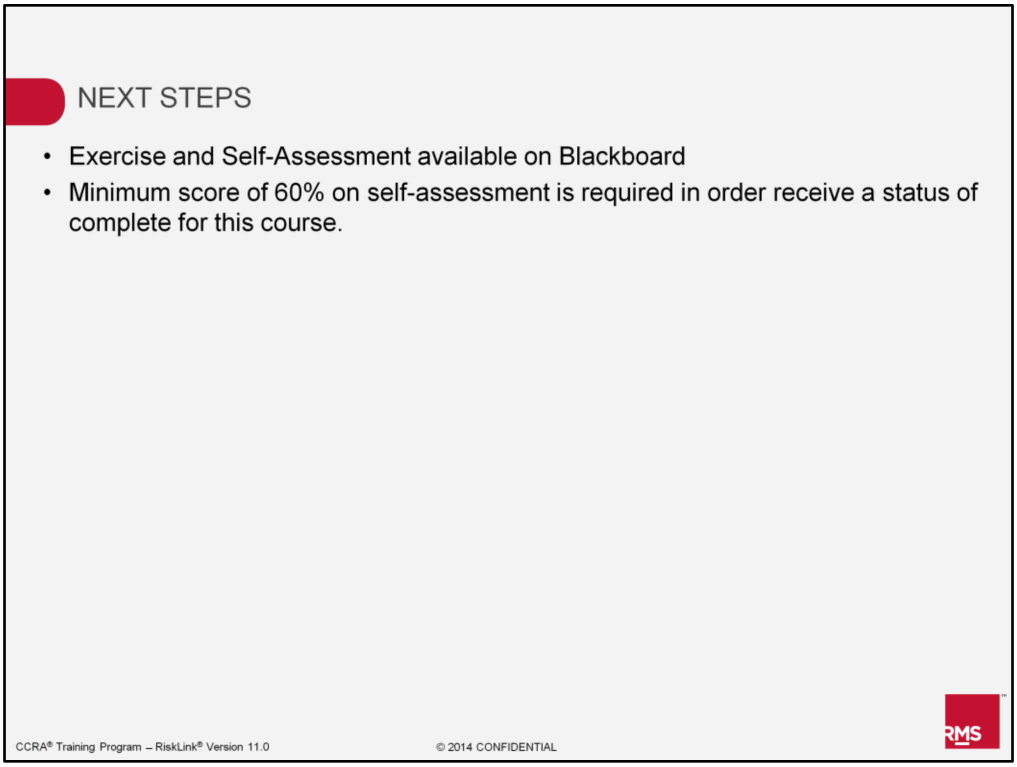
In a 1998 study in the U.K., we looked at the degree to which the extent of flood losses was mitigated when people were given advance warning of the flood. This study showed there was a demonstrable impact in reducing losses where a warning was given.

Where households had a warning and had moved portables, we found that 74 percent of the contents claims were less than £5,000, and only nine percent of the contents claims were greater than £10,000. For households that either did not receive a warning or did not take any action as a result of the warning, only 50 percent of the contents claims were less than £5,000 and 23 percent were greater than £10,000.

This highlights that warnings do make a difference and can make a significant reduction in the overall claim size for contents losses. This is something we hope can be put into effect more widely by insurers in the future.



This slide summarizes the key concepts from Unit 5. Review the summary to make sure all key concepts are clear to you before continuing on.



In order to fully complete the course work for this peril, complete the exercise and self-assessment available on the Blackboard. You must score a minimum of 60% on the self-assessment in order to receive credit for completing this course.

Completion of three peril model courses is mandatory in order to be eligible to sit for the CCRA® exam.