Flood Hazard

A Resilient Future: Science and Technology for Disaster Risk Reduction

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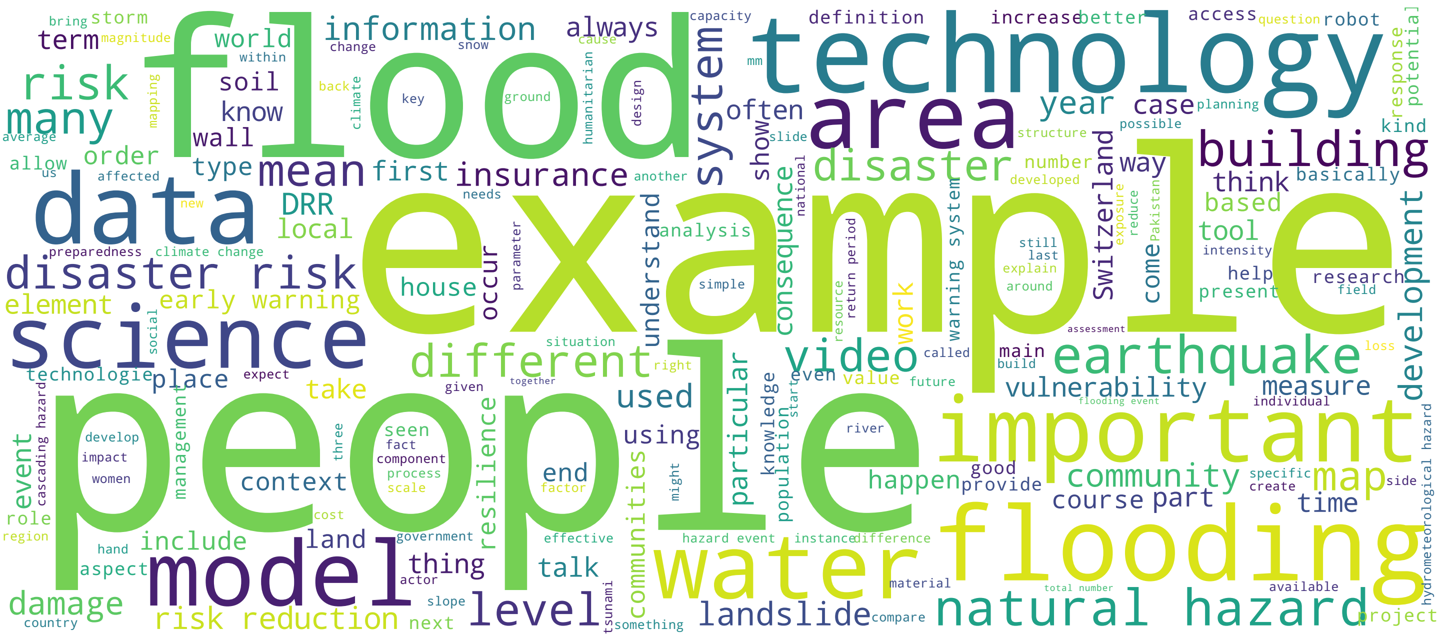

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Hello, my name is Michael Lehning. I'm a professor here at EPFL of Cryospheric Sciences, and I'm also leading the research units now on Permafrost at the WSL Davos, in fact the SLF in Davos, and this video will be on floods and other hydrometeorological natural hazards. So in this video we will give you an introduction to flooding, then give you a definition of what flooding is about. We will quickly talk about the historic context of flooding, and then go on to explain the mechanisms of flood formation. Consequences of flood will be touched upon, and then we will talk about floods in comparison to other natural hazards, give you two comparative examples of flooding, and then end up with other hydrological hazards, cascading hazard events, and sum up with the main points.

Notes

Summary

0m 04s

Introduction

Floods are the most common of all environmental hazards. On average, they claim 20,000 lives or more and affect approximately 75 million people worldwide per year

Burchardi Flood (Germany) in 1634

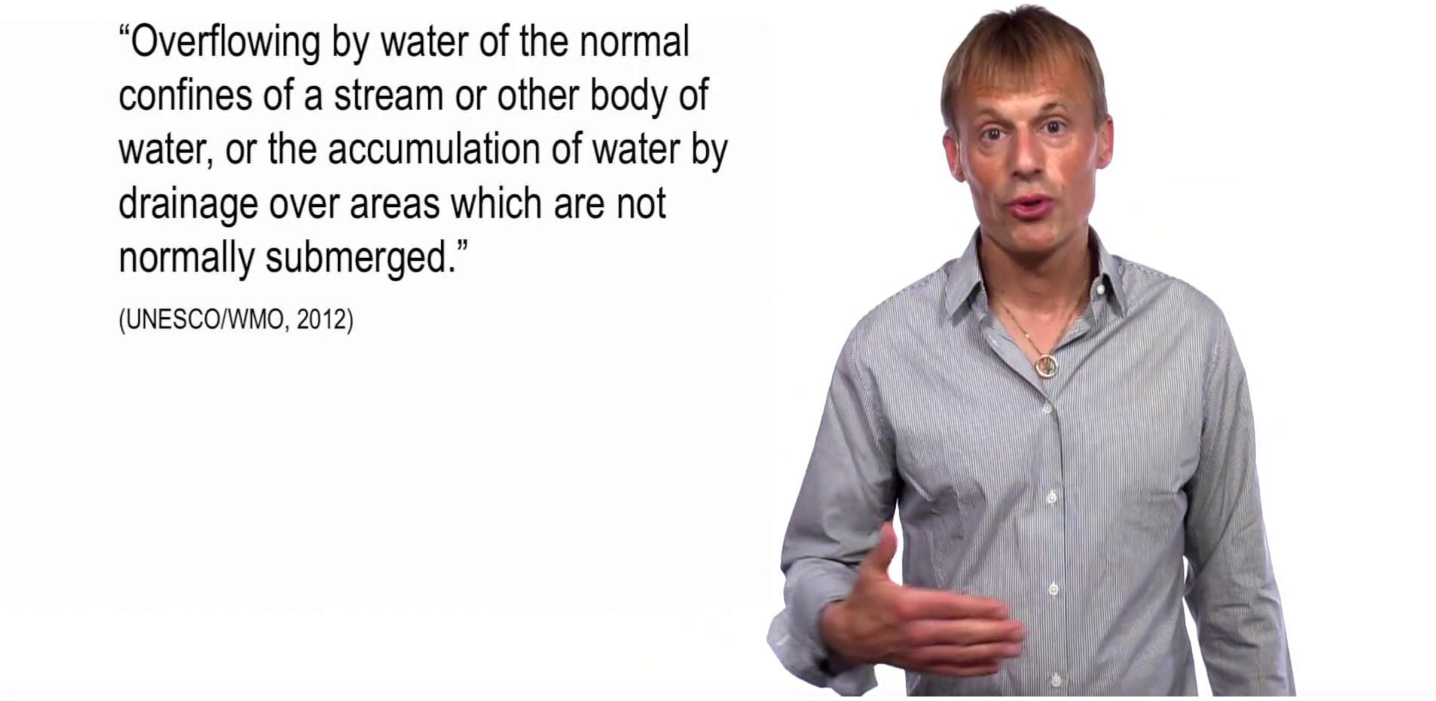
So floods are the most common of all natural hazards, and they have affected humans throughout history.

Notes

Summary

0m 59s

Flooding definition



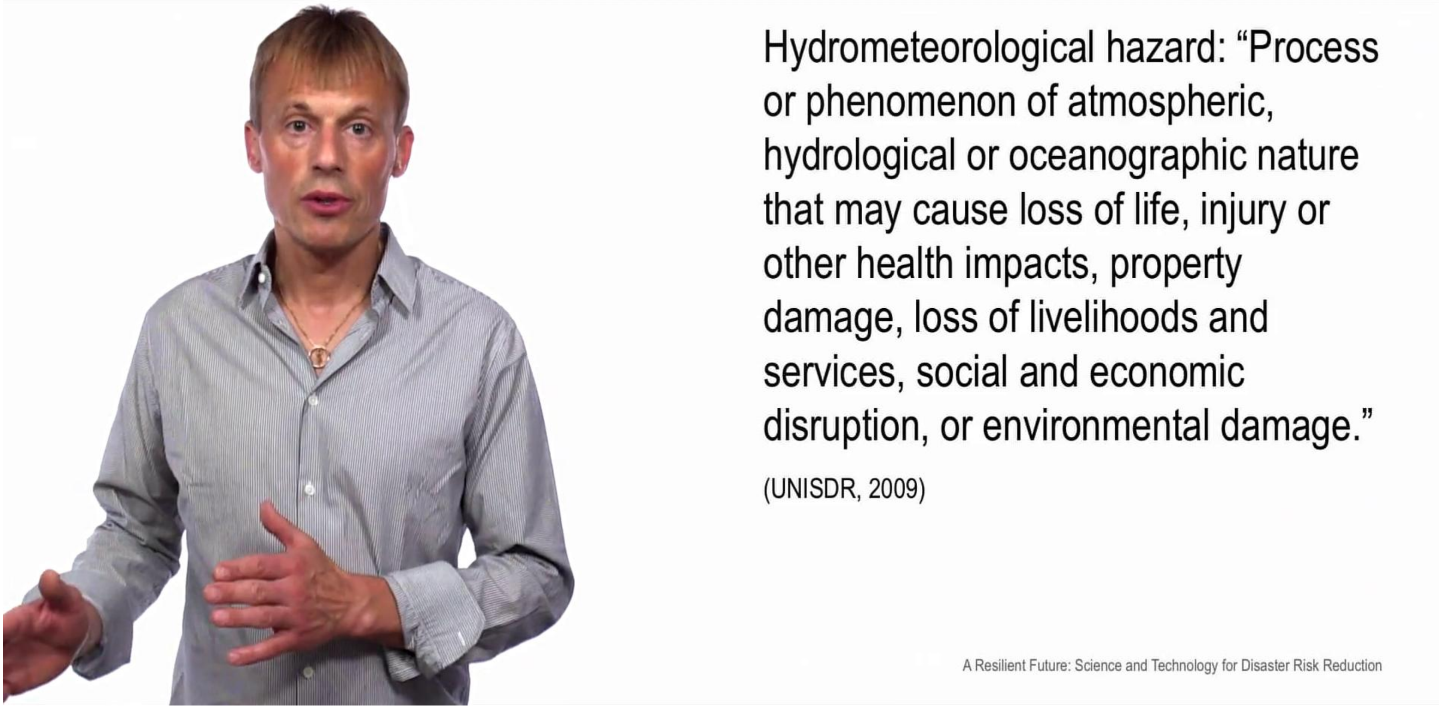
A formal definition of flood is the "overflowing by water of the normal confines of a stream or other body of water, or the accumulation of water by drainage over areas which are not normally submerged." In simple words that means you have water, and you have abundant water where you should not have water.

Notes

Summary

1m 07s

Flooding definition



The previous slide gave you the definition of flood in a narrow context, but floods are a sort of hydrometeorological hazard, and therefore I would also like to give you a more ample definition of hydrometeorological hazards. What you can see here is why the flood definition was more in terms of a physical quantity: abundant water. The hydrometeorological hazard also includes the aspect of consequences, so damage or a disruption to culture, human lives, or similar.

Notes

Summary

1m 26s

Floods and their historical dimension


(2)

Flood myths play a major role in religion and culture:

- Gilgamesh
- The Great Deluge
- Atlantis

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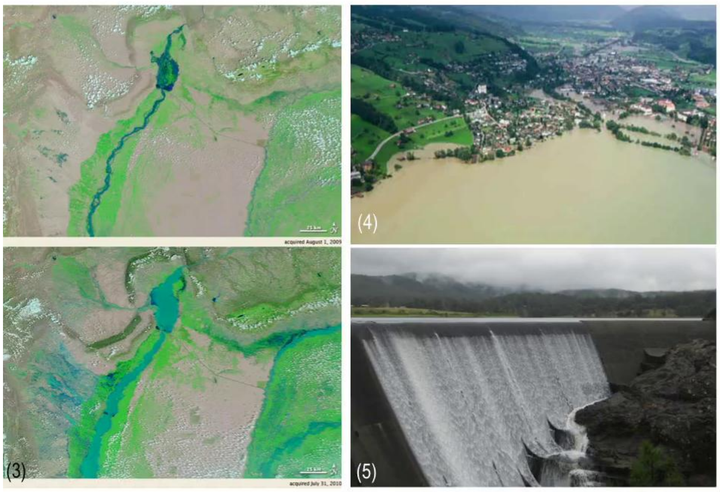
Let's take a quick look back at the historical dimension of flooding. Flood has always kept the minds of people busy, and it has always been an event that was discussed in culture.

Notes

Summary

2m 00s

Flood formation



- Rain intensity or precipitation duration exceeding absorption capacity of soils and surface waters
- Storm surges (coast)
- Blocking of rivers
- Tsunamis
- Dam overflows and failures

The most common reason for flooding is a high rain intensity, or the duration of precipitation exceeding absorption capacity of soils and surface waters. But it can also be caused by storm surges at the coast. Blocking of rivers is another mechanism that can cause flooding. So you don't necessarily have to have an abundant input of water; it is also a common cause of flooding that something blocks the drainage of water in rivers. One interesting example for a cause of flooding is a tsunami, because the origin is the earthquake that generates the wave. But when the wave hits the land, it causes large flooding. So sometimes tsunamis are seen as a hydrological event, and sometimes they are also seen as a geophysical event. Another man-made disaster related to flooding are dam overflows and dam failures.

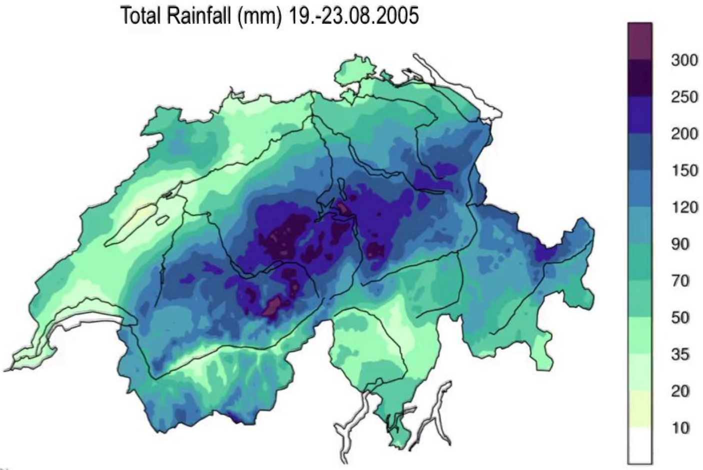
Notes

Summary

2m 12s

Flood formation: Heavy precipitation

- Very high intensity



(6)

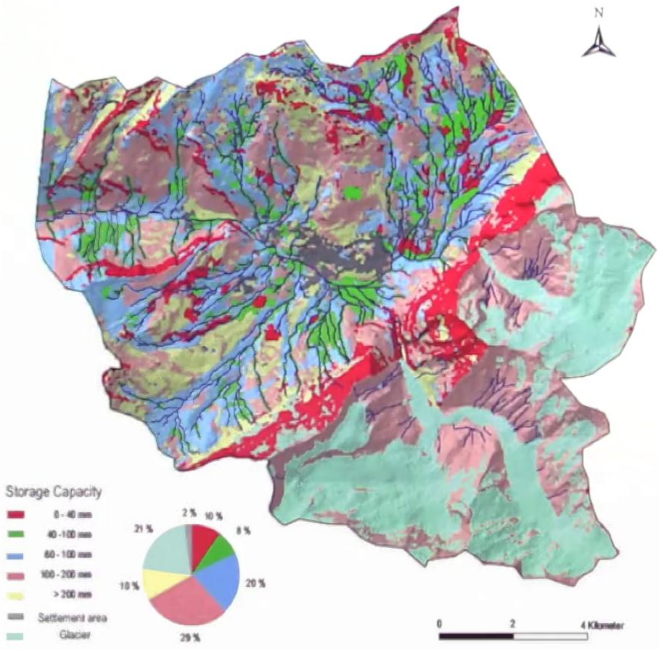
As introduced, an important mechanism of flood formation is heavy precipitation. Here we look at an example from the 2005 flood in Switzerland. You see here the rain intensity, or the total accumulated rain over four days. We get the values up to 300 mm in these areas, maximum precipitation over four days. When you compare this to typical values of yearly precipitation in Switzerland, that range between 500 and 2000 mm, you can see how extreme this event was with respect to generating a lot of water in a very short amount of time.

Notes

Summary

3m 15s

Flood formation: Disposition of catchment is important



(7)

Soils and surface waters may be able to store more or less additional water

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The disposition of the soils in the catchment is very important, something that is not often looked at. We see here an example of a small catchment in Switzerland that was analyzed in detail to show how much water the soils could store away before producing runoff. This was before the 2005 event. What we see here are areas that can only hold as much as 40 mm of rain input, while next to it, there's also soils that can hold much more water, up to 200 mm. So depending on the distribution, and the relative distribution of soils with a lot of water-holding capacity, and those with a low water-holding capacity, the same precipitation event may cause a completely different response of the catchment, and this is important to take into consideration. What also sometimes happens is that this is a function not only of the previous precipitation, but also of previous dryness. Very often it is observed that very dry soils will not be able to absorb a lot of heavy precipitation initially because they need to be wet first for the rain to infiltrate. So it can happen that very dry soils produce runoff from precipitation immediately.

Notes

Summary

4m 03s

Consequences of flooding

(8)

- Damages:
  - Direct: Drowning, infrastructure failure
  - Indirect: Diseases, sewage – drinking water, famine
- Benefits: Fertilization (Nile, Euphrates, Ganges, Yellow River), floodplain ecosystems, groundwater recharge

We distinguish between damages and actually beneficial consequences of flooding. Within the damages, we can talk about direct damages, such as drowning or infrastructure failures. Just imagine a flood hitting a house, and the house collapses. Then you can easily imagine that the collapsing house will cause fatalities. Other direct consequences include infrastructure failure on a larger scale, such as bridges which then inhibit also the teams to come in and to help people. Indirect consequences or damages are often even more important than the direct damages, in particular, because heavy flooding often damages the drinking water and sewage systems. As a consequence of that, waterborne diseases, such as cholera and typhus, may spread more easily, and as a long-term consequence, flooding may lead to famines. On the other hand, you also have significant benefits from flooding, in particular, during ancient times. The fertilization that was caused through regular flooding in the Nile, Euphrates, Ganges, or Yellow River catchments has been very important for their respective cultures to develop.

Notes

Summary

5m 30s

Consequences of flooding

- The largest historically known flood (China 1931) killed 3 million people or more
- Floods and storms regularly affect most people

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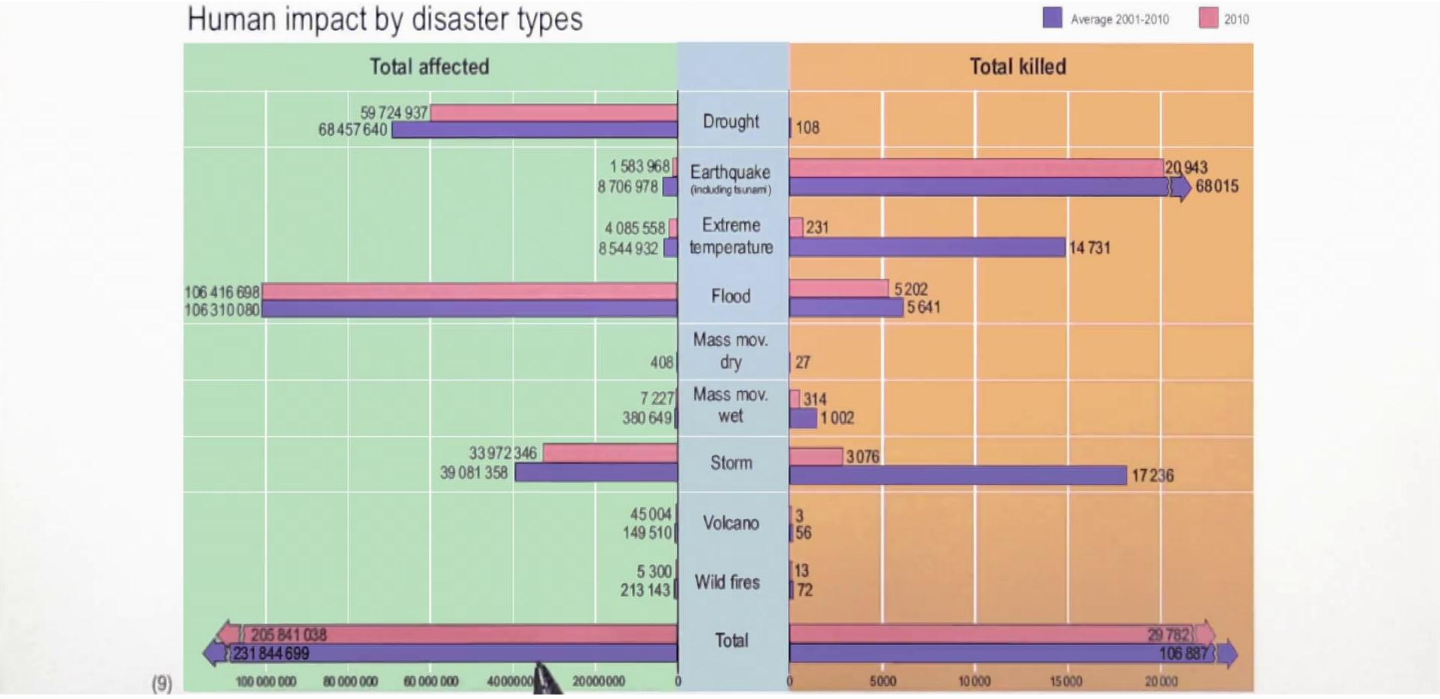
Talking about consequences of flooding, it's worth mentioning the worst flooding event in known history. That happened in China, in 1931, and killed approximately 3 million people. This shows you how devastating an individual flood can be. But it's also worth mentioning that floods occur very regularly and affect large numbers of people.

Notes

Summary

6m 49s

Floods in comparison to other natural hazards



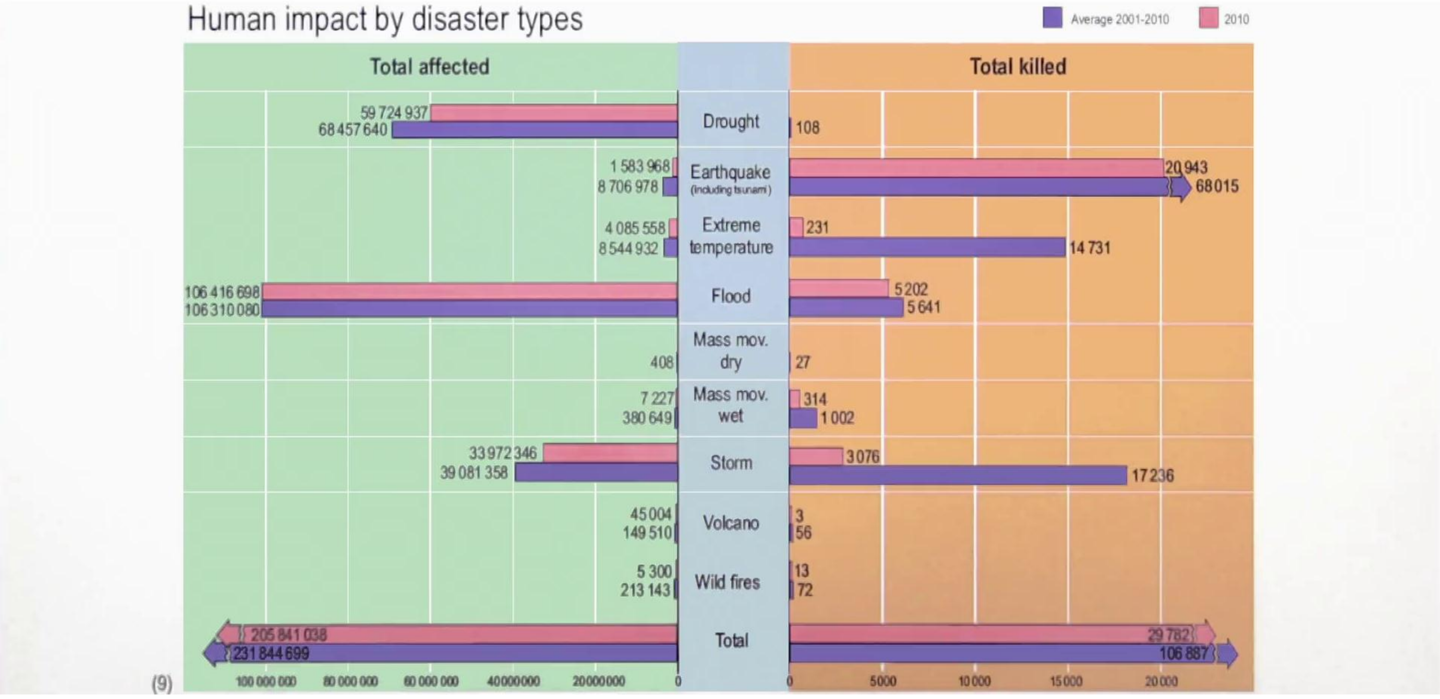
In the next few slides, we will see concrete numbers of how flooding, in comparison to other natural hazards, affects people. The numbers, they are not always consistent between each other, because there are differences in how individual organizations count consequences of flooding. Sometimes an event is attributed to flooding, or to a hydrometeorological event such as a storm, and therefore sometimes different statistics result from that. But the main message is quite clear, that a lot of people are regularly affected by flooding. So in this slide we see a statistics of flooding comparison to other natural hazards. it is important to realize that the purple color is the average between 2001 and 2010, while the pink color is an individual year 2010, which happens to be, in fact, quite close to the average, which is not always the case. What this graph shows you is that we have flood here, in the middle, that the total number of affected people is always very large for flooding, when compared to other natural hazards. The only two that generate comparable numbers are drought and storms, and, again, sometimes storms are also counted as floods and vice versa, because very often the consequence of the storm is a flood.

Notes

Summary

7m 15s

Floods in comparison to other natural hazards



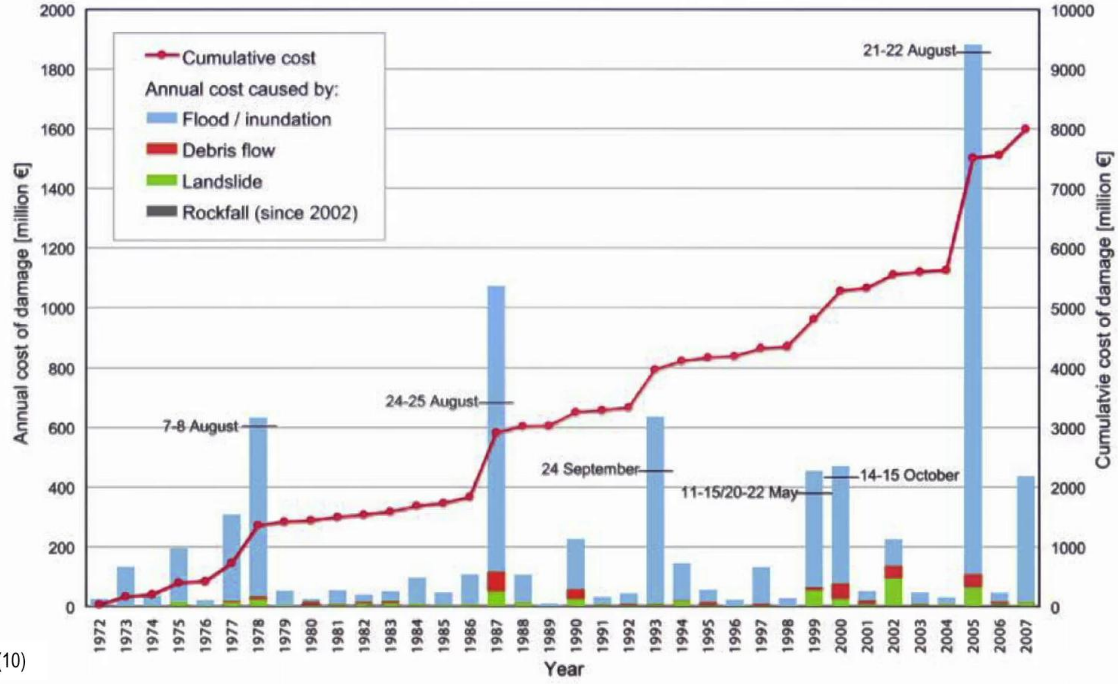
On the other hand, if we see on the right-hand side of this graph, the total number of fatalities is typically not as large for flooding events than for geophysical events such as earthquakes and tsunamis.

Notes

Summary

8m 51s

Floods in comparison to other natural hazards



(10)

For Switzerland, we have very good statistics with the years that allow you to distinguish within hydrological natural hazards between floods, debris flows, landslides, and then rock fall, apart from that. You can see in this graph that flooding is occurring quite regularly in Switzerland, and that it dominates economic loss in that country.

Notes

Summary

9m 07s

Example 1: Mountain flood as an extreme event

- 6 fatalities
- 3 billion (CHF) economic loss

(11)

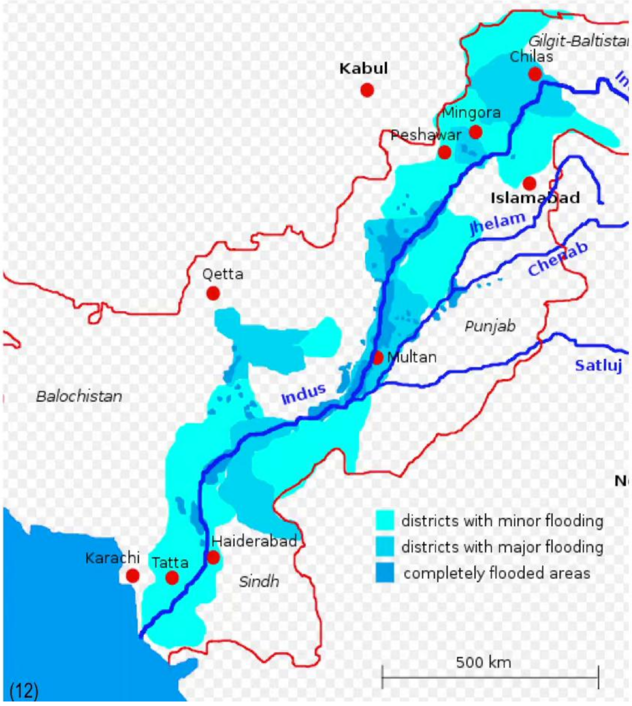
Now I would like to talk about two examples, two particular events, that occured-- one in Switzerland, and one in Pakistan, and compare those two events to each other. For the Switzerland case, we have already looked at the rain input, it was the flooding of 2005, which was a 100-year event, approximately. What does that mean? A 100-year event means that it has an approximate return period of 100 years. So that means that, on average, you expect a flood of similar magnitude to occur every 100 years. Of course you can have two or three centuries in a row where you don't have such a flood, and then you can get two or three of these floods within one decade. So this 100-year flooding in 2005 in Switzerland caused six fatalities and a total damage of three billion Swiss francs in economic loss. This is significant. But now let's look at the Pakistan example.

Notes

Summary

9m 34s

Example 2: Flood in the Indus Basin



As you can see from the map, the flood in Pakistan was larger in terms of the area that was affected by the flooding. But it wasn't that much larger, so you can see a scale of 500 km. in the bottom of the slide, and you can compare to Switzerland, which has an extension of about 200 km across the Alps. Now, if you compare these two floods, in terms of their return period, then they are comparable. Both of them had a precipitation input that you expect to occur once in about 100 years. And that translates also to runoff magnitudes that you expect to occur with a same return period, so about once in a 100 years.

Notes

Summary

10m 42s

Example 2: Flood in the Indus Basin

- 6,000 fatalities
- 50 billion (US$) economic loss

(13)

When we now look at the 2010 flooding event in the Indus Basin, in Pakistan, which extended to neighboring areas such as China, then we have a total number of fatalities of 6,000 people, and we have 50 billion US dollar damage. This is almost three orders of magnitude more.

Notes

Summary

11m 35s

Other hydrological hazards

- Avalanches
- Debris flows
- Landslides

These may increase as a consequence of climate change

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So far we have been concentrating on flooding, because on a global scale this is the most important hydrological natural hazard, but on a local scale, there are other natural hazards that are quite important. What is important to consider with all types of hydrometeorological natural hazards is that they may experience an increase in the context of climate change, and therefore they need to be looked at in quite some detail.

Notes

Summary

11m 57s

Cascading hazard event

(15)

- Cascading hazard event: One natural hazard triggers another one with potentially larger damage

  → More extreme event
- Fukushima (2011): Earthquake → Tsunami → Breakdown of nuclear infrastructure
- May be more difficult to forecast

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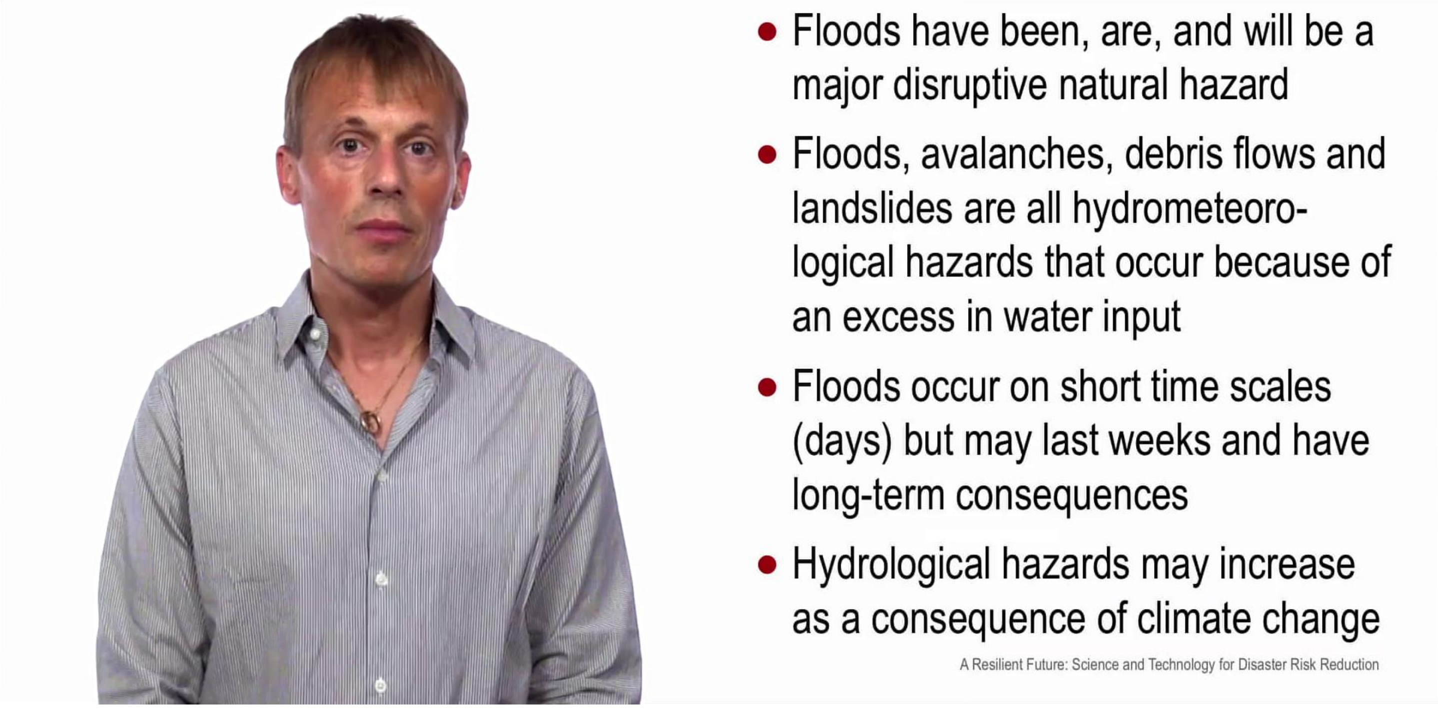
Towards the end of this video, I would like to talk about cascading hazard events. What is a cascading hazard event? It is when one natural hazard triggers another one with potentially even larger damage. So you could talk about it as if that was a more extreme event. A very famous example is Fukushima, 2011, when a subsea earthquake caused a tsunami, and that led, at the end, to the breakdown of nuclear infrastructure in Japan, with well-known catastrophic consequences. An important feature of these cascading hazard events is that they are very difficult to forecast, simply because the exact mechanistic understanding of how they are connected to each other is very often not available.

Notes

Summary

12m 26s

Flooding definition



At the end of this video I would like to summarize four important points. Point one: Floods have always been, are, and will in the future be major disruptive events, that can kill people, that can disrupt the functioning of a culture, but they can also have potential positive consequences. Floods, avalanches, and debris flows are all hydrometeorological hazards that occur because of an excess in water input. We learned about different mechanisms, how they can be formed, and said that it's not always only an excess input of water. But remember, too much water at a place where it should not be is the cause for flooding. Floods typically occur on quite short time scales, but the consequences, they can last for a long time. They can last a whole season, or even a whole year. As you all know, our climate is changing, and those changes are rapid in some areas of the world. Therefore, with the potential of hydrological natural hazards being heavily impacted by those climatic changes, we need to study them carefully.

Notes

Summary

13m 15s

References

- Hilker, N., Badoux, A., and Hegg, C.: The Swiss flood and landslide damage database 1972–2007, Nat. Hazards Earth Syst. Sci., 9, 913-925, doi:10.5194/nhess-9-913-2009, 2009.
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Notes

Summary

14m 29s

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Notes

Summary

14m 32s