# Title: Concepts of Flood Risk

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Prepared by: Dr. Mohammed Abdulkadir and Dr. Micha Werner

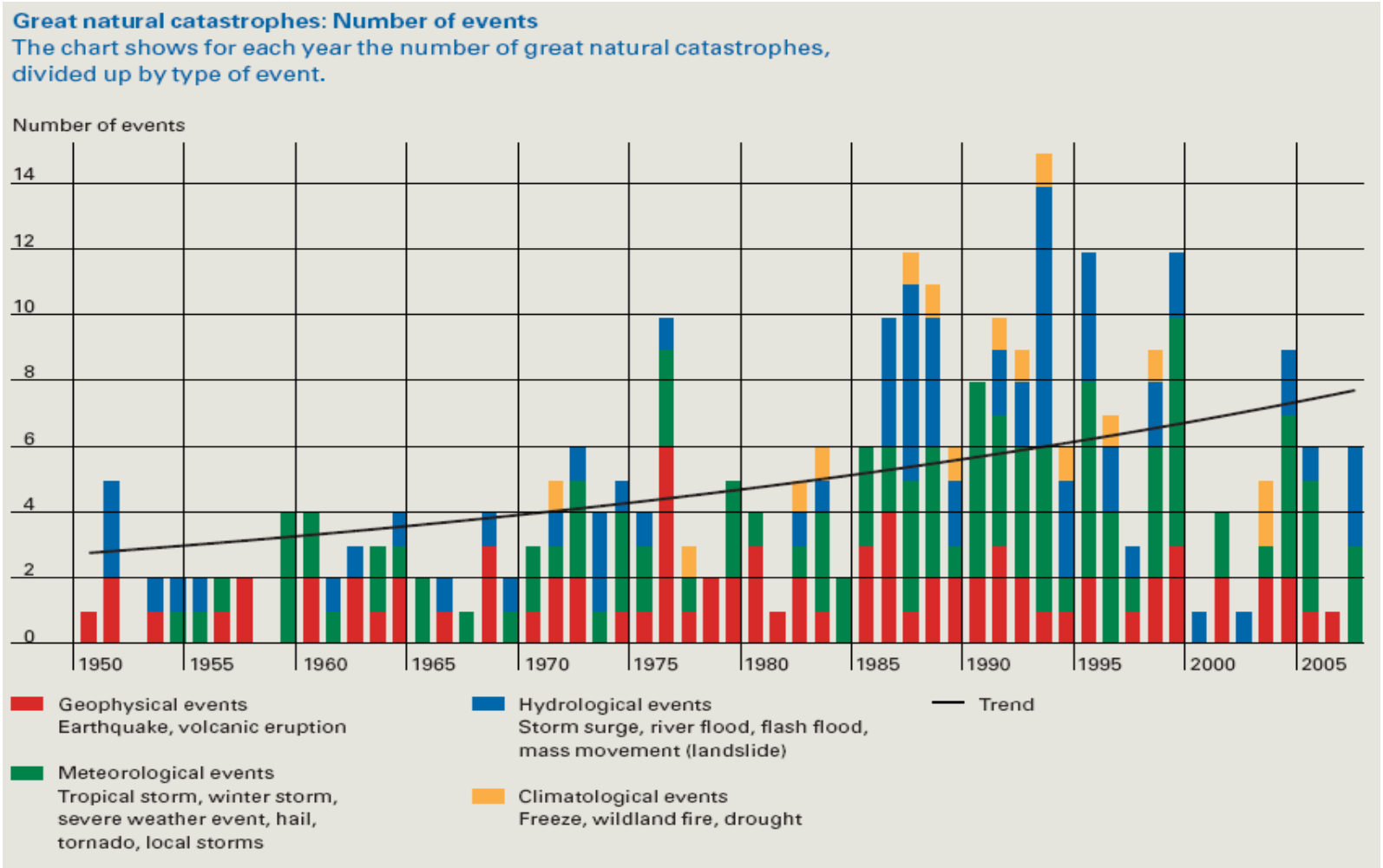
# Outline of presentation

- Hazards
- Flood Event
- Flood losses
- Classification of floods
- Flood management
- Concepts of flood risk
- Hazard & Vulnerability
- Sources, Pathways, Receptors, Consequences, Human factors

# Hazards

- "natural hazard" refers to all atmospheric, hydrologic, geologic (especially seismic and volcanic), and wildfire phenomena that, because of their location, severity, and frequency, have the potential to affect humans, their structures, or their activities adversely.
  - ATMOSPHERIC (Hailstorms, Hurricanes, Lightning, Tornadoes)
  - SEISMIC (Fault ruptures, Ground shaking, Tsunamis, Seiches)
  - OTHER GEOLOGIC/HYDROLOGIC (Debris avalanches, Expansive soils, Landslides, Rock falls, Submarine slides, Subsidence)
  - HYDROLOGIC (Coastal flooding, Desertification, Salinization, Drought, erosion and sedimentation, River flooding)
  - VOLCANIC (Gases, Lava flows, Mudflows, etc…)
  - WILDFIRE (Brush, Forest, Grass, Savannah)

# Trends in number of natural catastrophes



# Flooding hazard

- Flooding is a result of heavy or continuous rainfall exceeding the absorptive capacity of soil and the flow capacity of rivers, streams, and coastal areas
- Two types of flooding

  i. land-borne floods, or river flooding, caused by excessive run-off brought on by heavy rains, and

  ii. Sea-borne floods, or coastal flooding, caused by storm surges, often exacerbated by storm run-off from the upper watershed.

  E.g. Tsunami


Cordaio


Cordaio


Cordaio

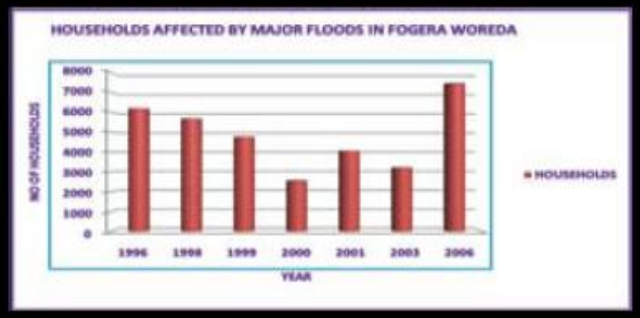
# Flooding …Ethiopia

- Inundatation of lands risk in some of the basin
  - Awash: 200,000-250,000 ha during high flows
  - Baro-Akobo Plain an area of about 300,000-350,000 ha is prone to annual flooding
  - Wabi-Shebelle Basin some 100,000 ha may be inundated
- The level of the waters of two main lakes (Awassa and Besseka) has been gradually increasing
- Flooding in 2006 and 2007 in Lake Tana which affects many house holds and farm lands
- Flood damages to settlements along their banks example the case of *Dire Dawa,* initiated by torresntial rain during the rainy season

# Gambela

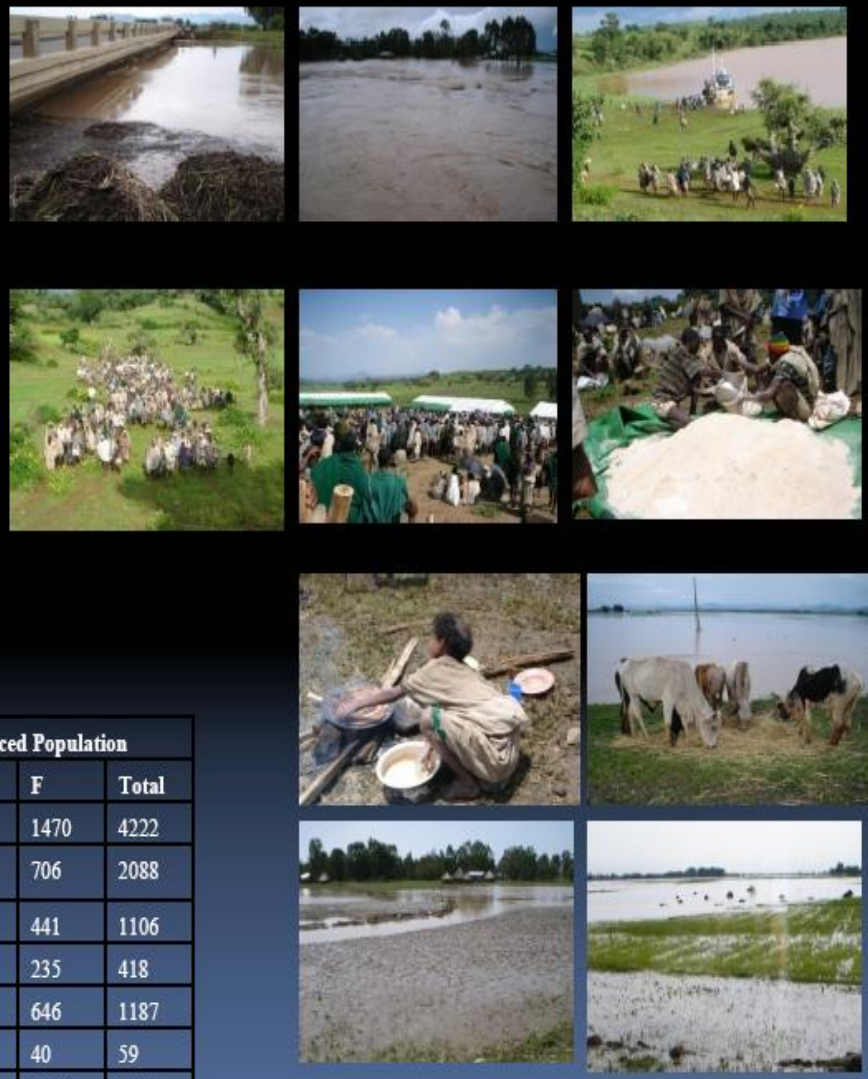
*SAMSON WAKUMA ABAYA, Msc Thesis*

- There have been many destructive floods in Fogera Woreda, including very severe floods of 1996, 1998, 1999, 2000, 2001, 2003 and 2006



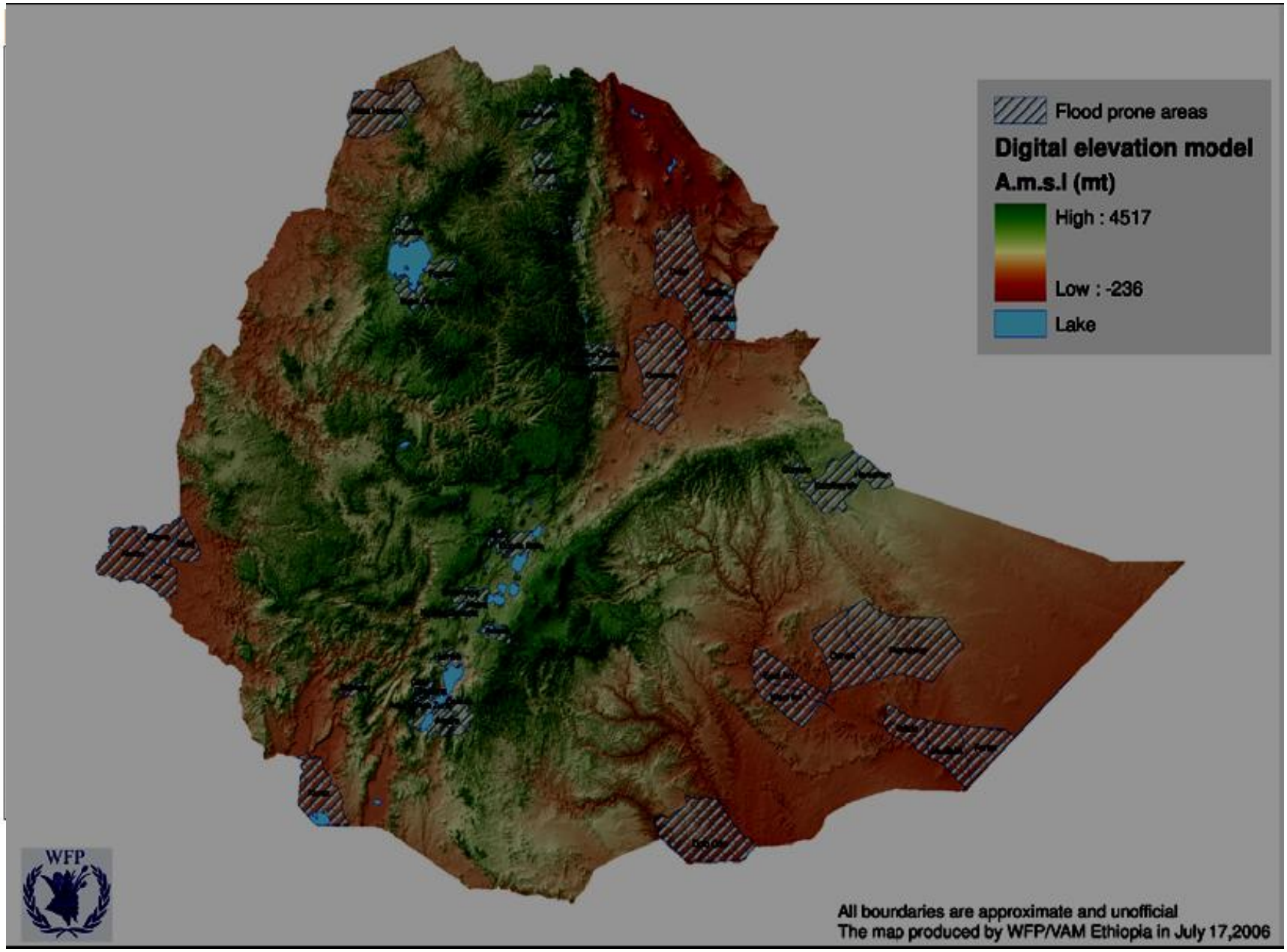

- *(Shiferaw and Wondafrash, 2006)*

| S.N | PA Name | Total Population | | | Affected Population | | | Displaced Population | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | M | F | Total | M | F | Total | M | F | Total |
| 1 | Nabega | 5393 | 5120 | 10513 | 5393 | 5120 | 10513 | 2752 | 1470 | 4222 |
| 2 | Kidiste Hana | 3122 | 3438 | 7060 | 3122 | 3438 | 7060 | 1382 | 706 | 2088 |
| 3 | Wagtera | 4721 | 4721 | 4482 | 4521 | 4021 | 3819 | 665 | 441 | 1106 |
| 4 | Shina | 4813 | 4569 | 9382 | 1532 | 1454 | 2986 | 183 | 235 | 418 |
| 5 | Shaga | 3629 | 3445 | 7074 | 2054 | 1948 | 4002 | 541 | 646 | 1187 |
| 6 | Abua Thua | 2834 | 2690 | 5524 | 1765 | 1525 | 3290 | 19 | 40 | 59 |
| **Total** | | **24512** | **24512** | **48756** | **18387** | **17305** | **35692** | **5542** | **3538** | **9080** |



***Dagnachew and Wubet***

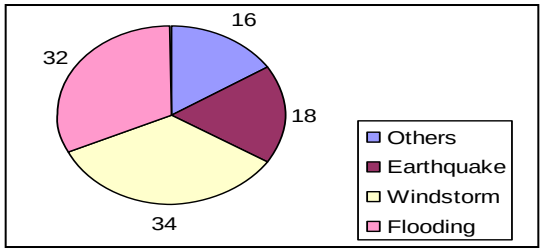
The following map is showing the flood affected areas of Ethiopia in the year 2006.



# What is a Flood Event?

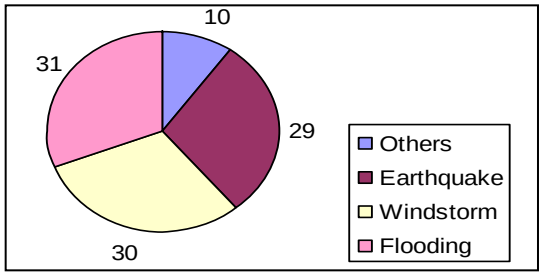
- Hydrological event (in the general sense) characterized by high discharges and /or water levels
- Can lead to inundation of land adjacent to streams, rivers, lakes, wetlands and other water bodies
- Caused by and/or exacerbated by intense or long-lasting rainfall, snowmelt, dam break, earthquake, landslides, ice jams, high tides, storm surges, operational failure

# Losses due to flooding



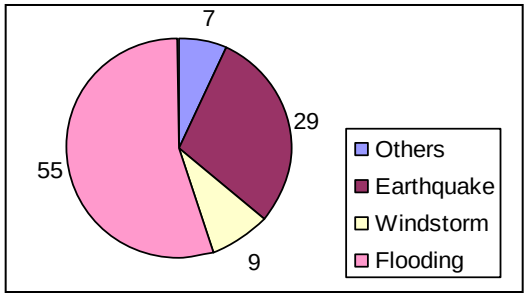

- 1986 - 1995: One third of the total (natural hazards) loss events, caused by floods

*Number of natural worldwide catastrophes in % (1986 – 1995)*




- 1986 - 1995: One third of the total economic loss resulting from natural catastrophes caused by floods (total of US$ 630 billion)
- Largest losses in cities and/or farmland

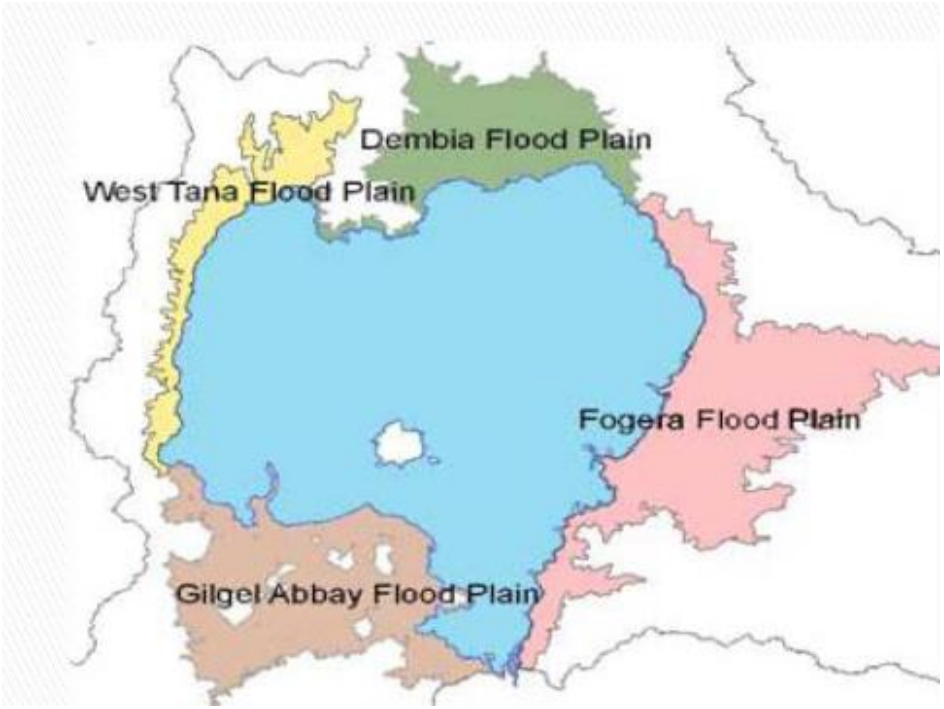
*Economic losses resulting from natural catastrophes in % (1986 – 1995)*




- 1986 - 1995: 55 % of total fatalities caused by storm surges, river floods and flash floods (approx. 220,000)
- Majority in Asia
- Approx. 97 % of fatalities in developing countries

*Fatalities caused by natural catastrophes in % (1986 – 1995)*

# Flood Damages




**2006**

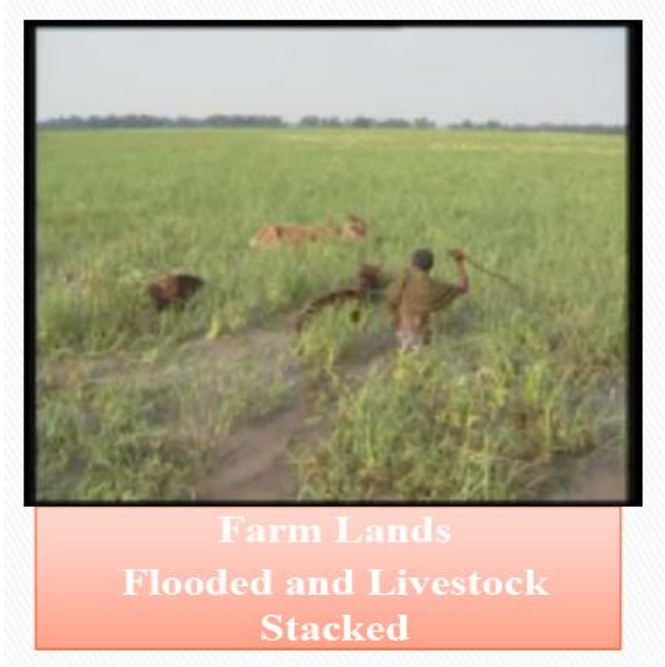
- 98,000 people affected in the Amhara Region
- 38,000 people displaced
- Farm lands either washed away or water logged
- Cattle heads swept away
- Communicable diseases –AWD and Malaria

*Source: Lake Tana sub basin flood mitigation project in four Weredas*

# Flood Damages

**2007**

- **30,212 households and 122, 889 people affected**
- **24,388 ha of farm lands**
- **153,500 livestock owned by30,212 house holds were affected**

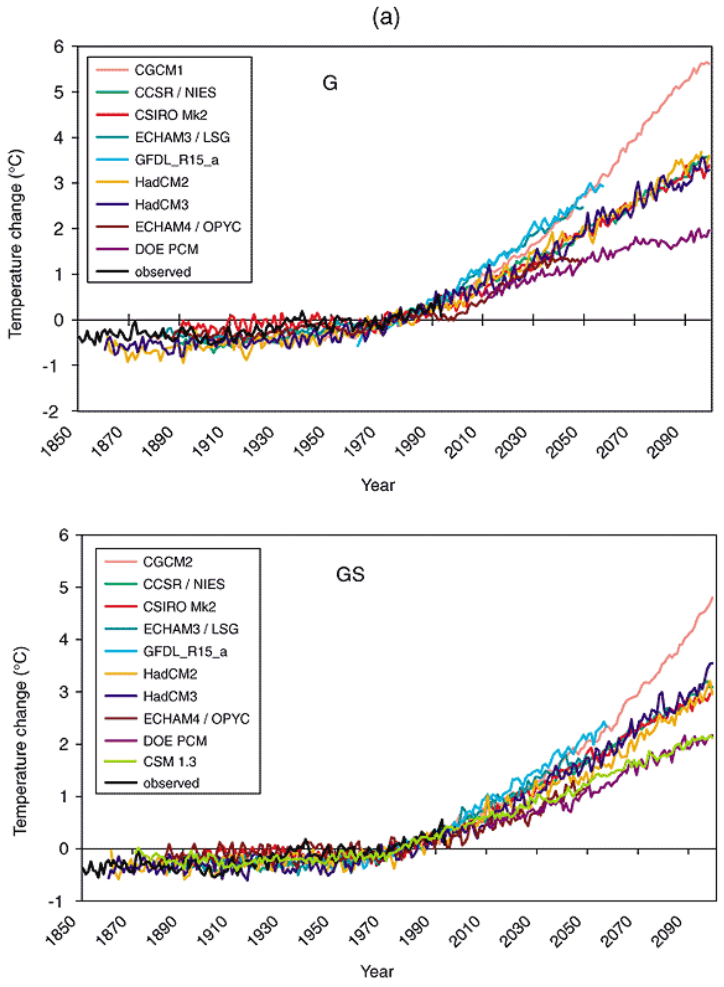

*Source: Lake Tana sub basin flood mitigation project in four Weredas*

# Possible reasons for increasing flood losses

- Increasing population & pressure on floodplains
- Increasing value of property in flood prone areas
- Increasing vulnerability (age) of strucures
- Changes in environmental conditions
- Changing climate

# Increasing flood hazard due to climate change

- The time evolution of the globally averaged temperature change relative to the years (1961 to 1990)



# Classification of Floods

- Fluvial floods: Lowlands & plains floods
- Snowmelt floods
- Flash floods
- Pluvial floods & Flooding from inadequate urban drainage
- Flooding arising from raised groundwater levels
- Coastal or estuarial flooding due to tidal surges or a dyke collapse due to wave overtopping
- Floods generated by the failure of a flood defence infrastructure

# Flash Floods

- Rapid onset floods – unpredictable
- Typically local scale / smaller basins
- Convective storms, mountainous regions
- Arid zone – Wadis
- May be extremely destructive

# Fluvial Floods – Slow onset floods

- Fluvial floods often at the basin-wide scale
- Flood may develop over number of days
- Impact of flooding widespread

*Awash flooding 2010*
*(Images http://www.behance.net/rickbajornas)*

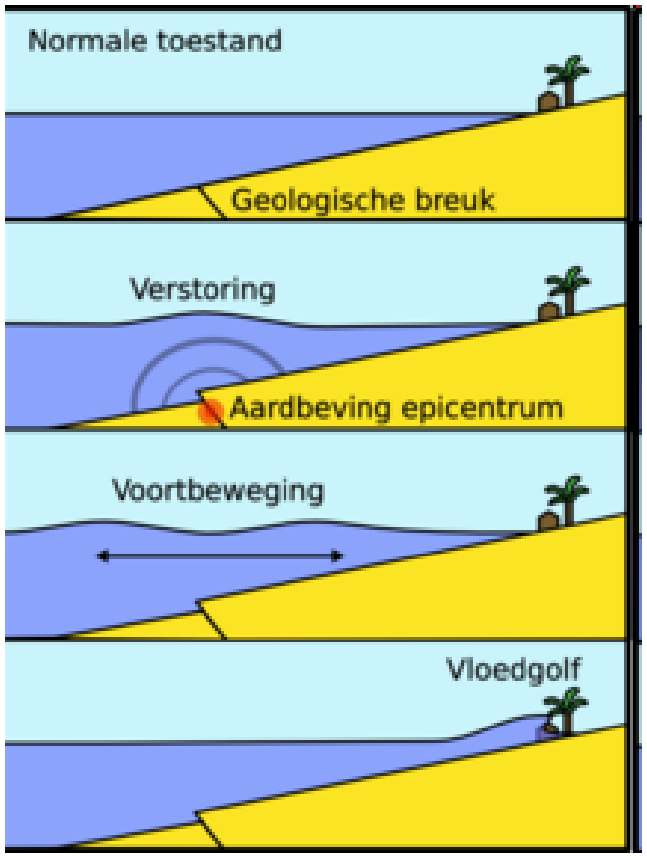
# Pluvial Flooding

- Local floods – urban
- Intense precipitation
  - impervious areas
  - impeded drainage
- Large disruption, financial damage, typically low casualties
- Health risks may be large

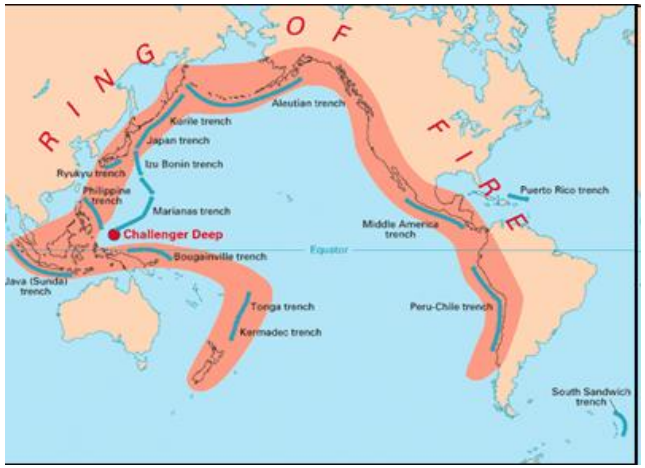
*Flooding in Bombay, India, 2005*
*Over 1000 Casualties*

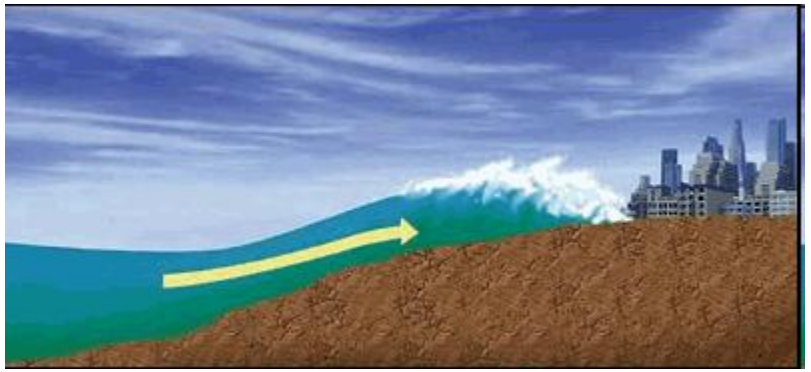
# Tsunami

- Caused by displacement of large body of water
  - Earthquakes (block shift)
  - Landslide
  - Glacial falls
- Shock wave with very long wavelength
  - Extremely fast propagation in deep water
  - Amplitude increases as bathymetry gets shallower



# Tsunami



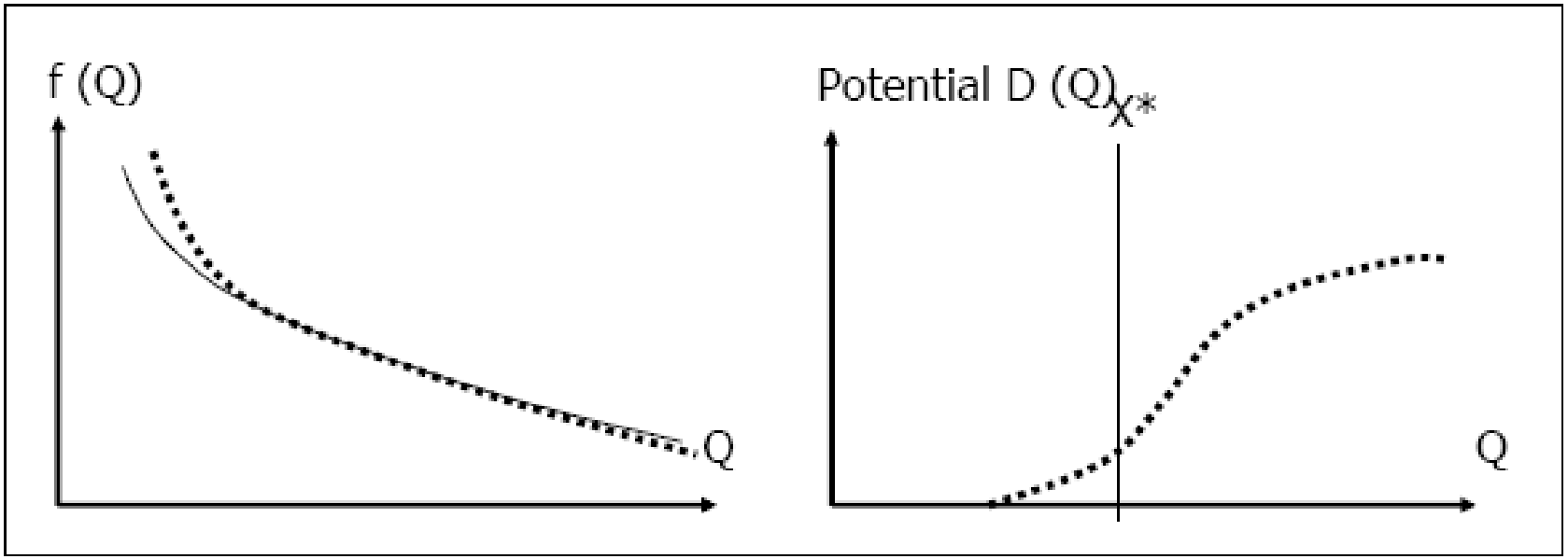
A coastline with a certain slope can
decrease the force of the waves, thus reducing tsunami risks.

The steepness of the slope plays the waves upwards,
amplifying his power.

# Flooding due to structural failure: Teton Dam

# Concepts of flood risk

- Flood event with flood peak Q
- Bigger floods occur rarely but the potential damage is quite high



# Definitions of the risk

- "the combination of the **probabilities of a flood event** and **of the potential adverse consequences** for human health, the environment, cultural heritage and economic activity associated with a flood event" (EC, 2007)
- flood risk as the expected losses from given events, in a given area, over a specified time (WMO,2009)

# Definitions of the risk

$$Flood\ \ Risk = \text{hazard} \times \text{vulnerabil ity}$$

$$Flood\ \ Risk = \text{probabilit y} \times \text{damage}$$


Mathematically

$$Flood\ \ Risk = \int_0^1 p(E)D(E)dp$$

Where $p(E)$ : Expected damage due to event *E*

$D(E)$ : Probability of event *E* occurring

# What is Vulnerability?

# What is Vulnerability?

Vulnerability = attribute or characteristics of Being resistant to a hazard

Vulnerability = Ability or capability to anticipate, cope with, resist, recover from the impacts of a natural hazard

Vulnerability= Degree or extent of potential damage or loss

Vulnerability = Conditions or situation with increase the susceptibility of a system

Vulnerability = Threat

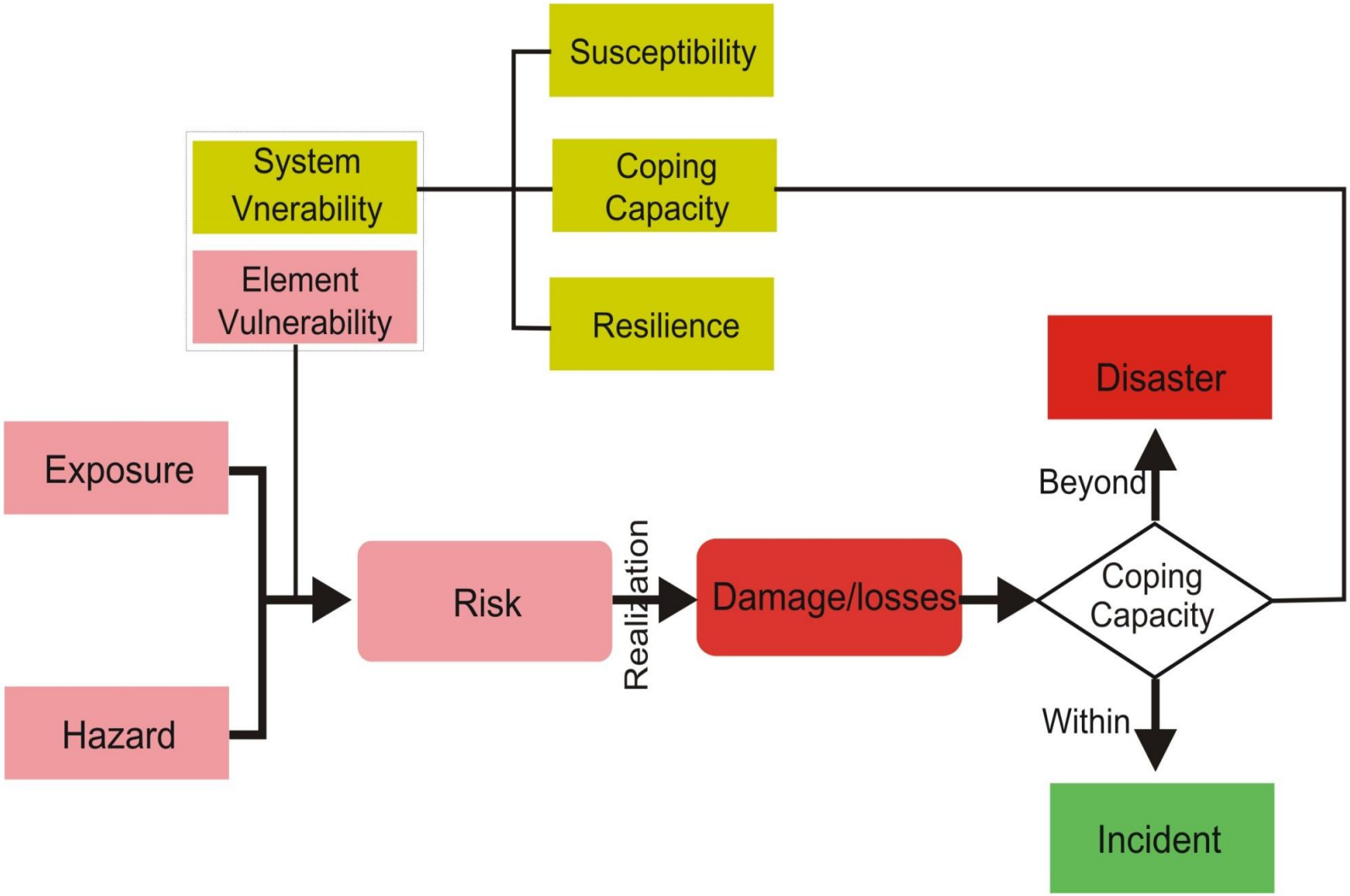
Vulnerability = exposure

*Dr. Carlos Villacis*
*GRIP Coordinator*

# Issues with the use of Vulnerability

- "The term '***Vulnerability***' is now used in such a loose and widespread manner that it is in danger of becoming as useless as the term '***Sustainability***', and so some precision is needed to rescue it." (T. Cannon, 2006)
- Definition: It is the susceptibility of damage for a given level of hazard severity

- Types: there are 2 types,
  - System vulnerability (city, sector, economy)
  - Element vulnerability (building, person, infrastructure)

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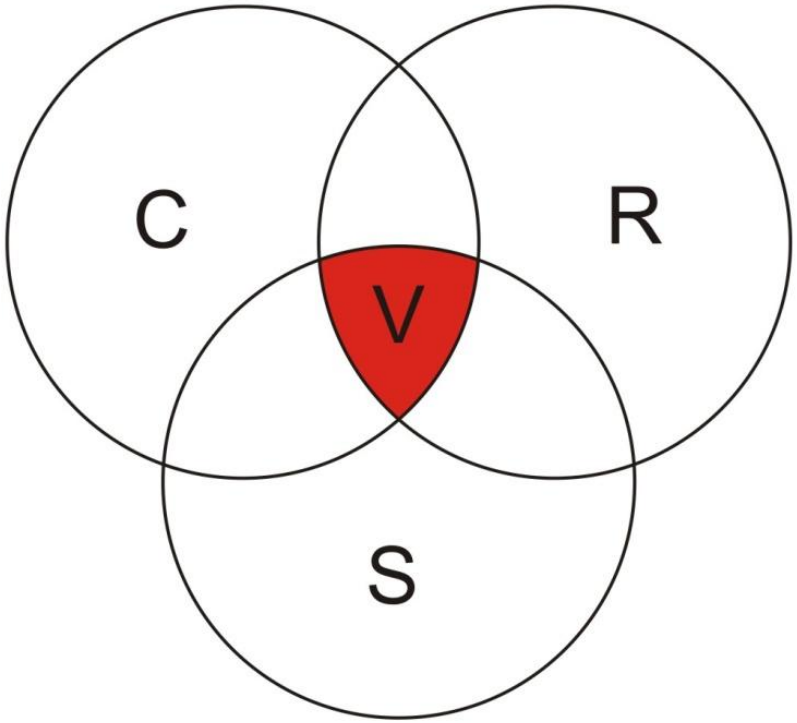
# Measurement of System Vulnerability



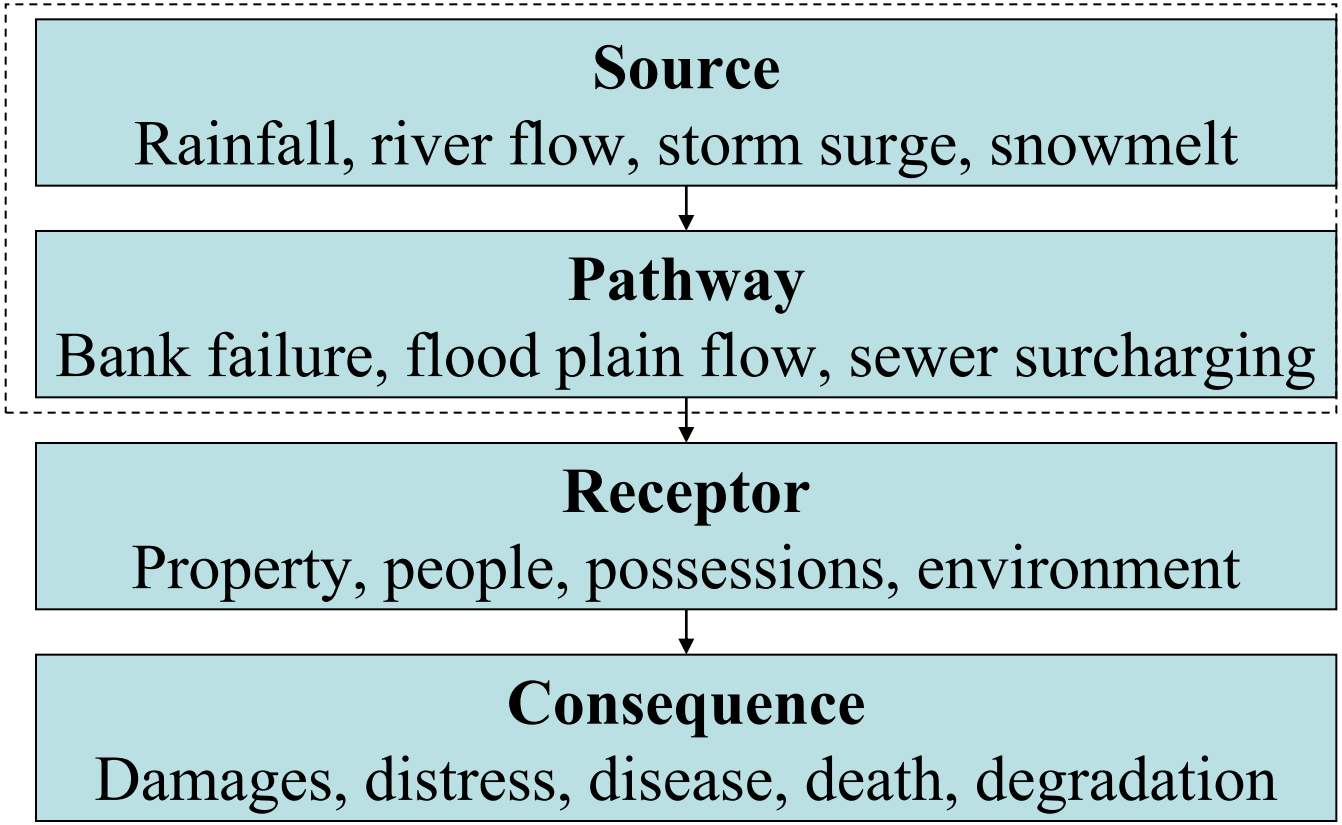

$$V = f(S, C, R)$$

S - Susceptibility
C - Coping Capacity
R - Resilience
V - Vulnerability

# Flood risk mitigation options

- Consequences of exposure to flood hazard are commonly explained through Source-Pathway-Receptor-Consequence (SPRC)
  - The nature and probability of the hazard (i.e., the source);
  - The degree of exposure of the receptor (the pathway);
  - The susceptibility of the receptor to the hazard; and
  - The value of receptor, or the element at risk. (the consequence)

# Flood risk mitigation options



# Flood hazards – causes/pathways


*Flash floods*
*- very high intensity rainfall*
*- fast responding catchments*

*Large scale fluvial flooding*
*- excessive rainfall, snowmelt*

*Dike Breach*
*- Failure or overtopping of dikes*

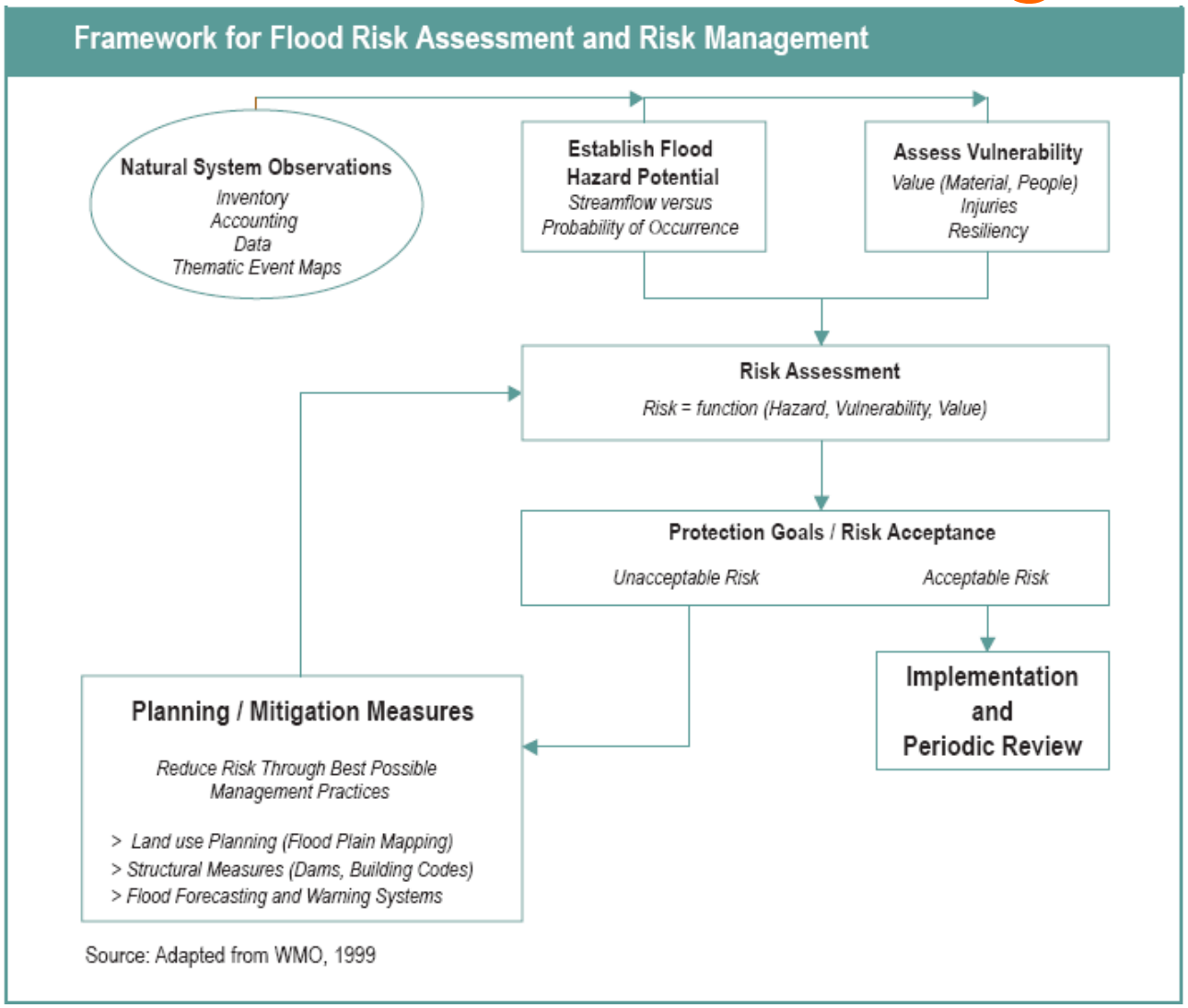
*Pluvial flooding*
*- excessive (local) rainfall*
*- Impeded drainage*

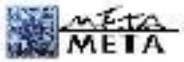
*Coastal floods*
*- high tides & surge, wave action*

# Management of Flooding

- The cause of the risk of flooding (excess rainfall, coastal surge) is beyond control
- The pathway of a flood (topography and nature of land surface and streams) can be managed to some extent
- The impacted recipients (people and property) can be managed most

# Framework for Flood Management













STRENGTHENING ETHIOPIAN UNIVERSITIES IN INTEGRATED RIVER BASIN MANAGEMENT