



Main abiotic injurious factors in TS



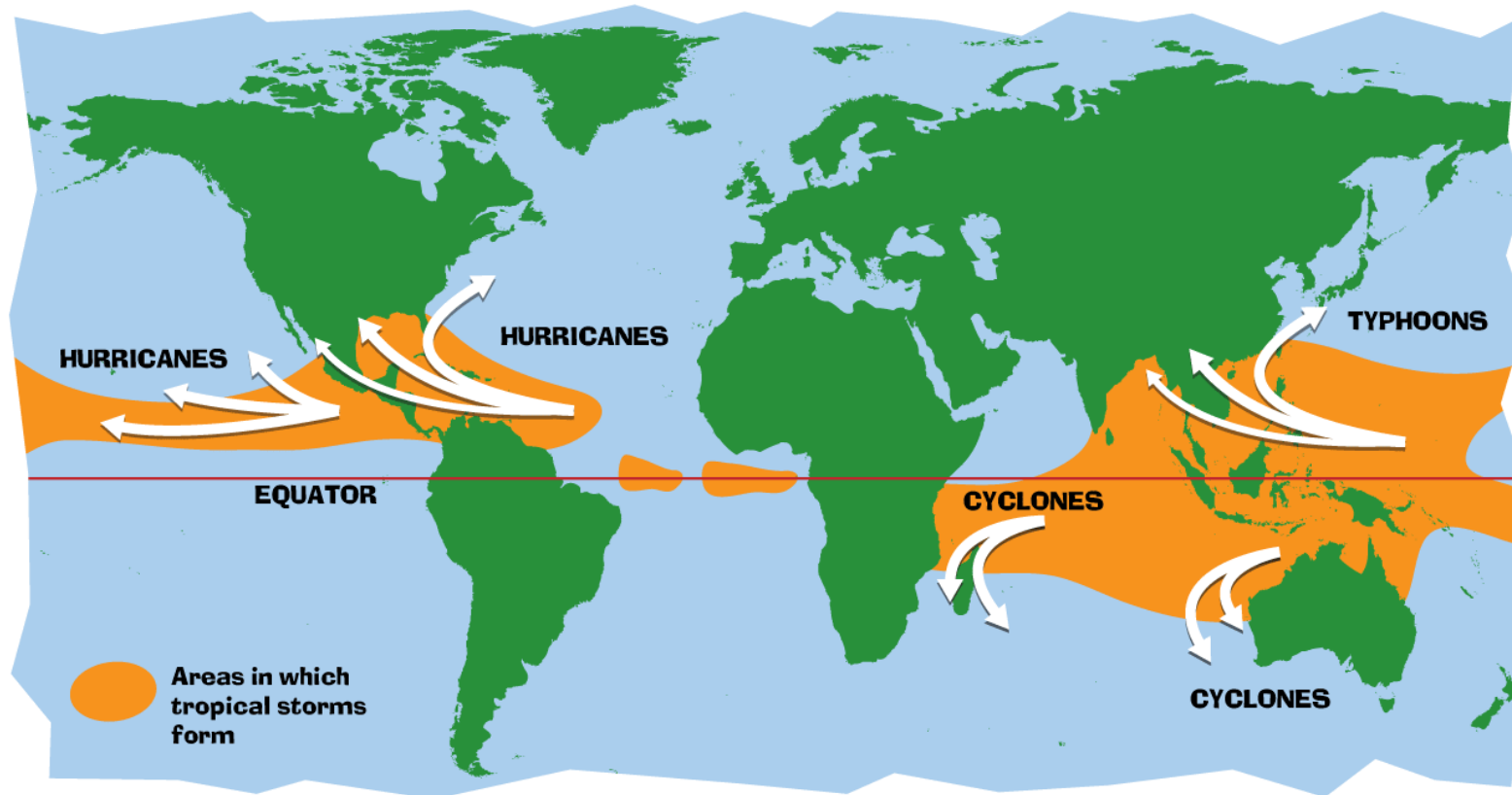
Main groups of factors in TS

- Meteorological: cyclones, wind storms, tornadoes
- Climatological: drought
- Hydrological: floods
- Geophysical: tsunamis, earthquakes, volcanic eruptions
- Anthropogenic: fire, air pollution etc.

Timing of disturbances

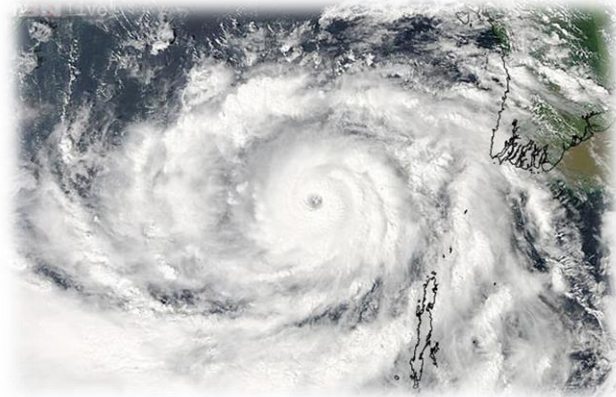
- largely controlled by climate
- tropical cyclones typically occur from April to December in the Northern Hemisphere and from November to April in the Southern Hemisphere
- tornadoes in spring and autumn
- floods during seasons of precipitation
- fires during periods of low fuel moisture and high temperatures

Wind



Cyclones (synonyms hurricanes and typhoons)

- a system of winds rotating inwards to an area of low barometric pressure
- occurring within 30 degrees north or south of the equator are called tropical cyclones
- surface winds can reach speeds of 200km/h or more



Type of damage

- three primary features of cyclones that cause damage: rainfall, storm surges and winds
- cause extensive forest damage by uprooting, wounding, bending, and breaking trees
- standing water, which often accompanies hurricanes, can cause additional stress and mortality
- it is important to have a plan for managing damaged timber



Prevention

- Large-scale areas!!!
- Damage heavily depends on the tree height!
- Broadleaf trees better adapted than coniferous.
- Coniferous - endangered by bark beetles outbreaks.

Management plan after cyclones

- ◉ the area should be sketch mapped or aerial photographed
- ◉ ground check of the damage to determine the need for salvage
- ◉ the main goals in management of storm-damaged trees is to reduce growth loss, product degrade, and mortality



The main types of damage

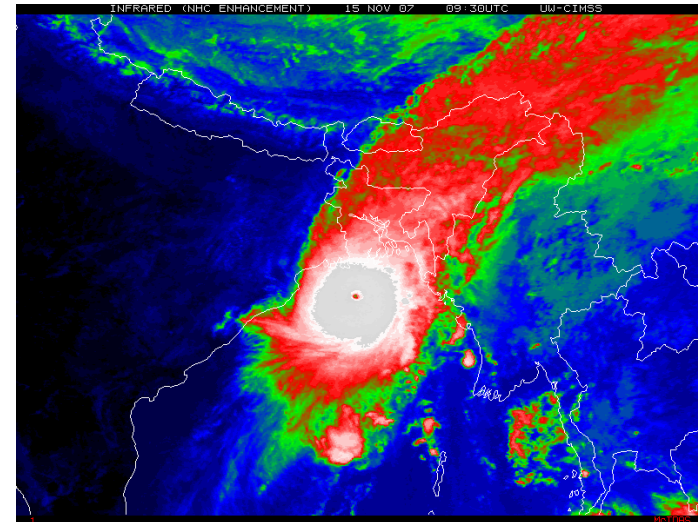
- Breakage Root Damage Twisted trunks



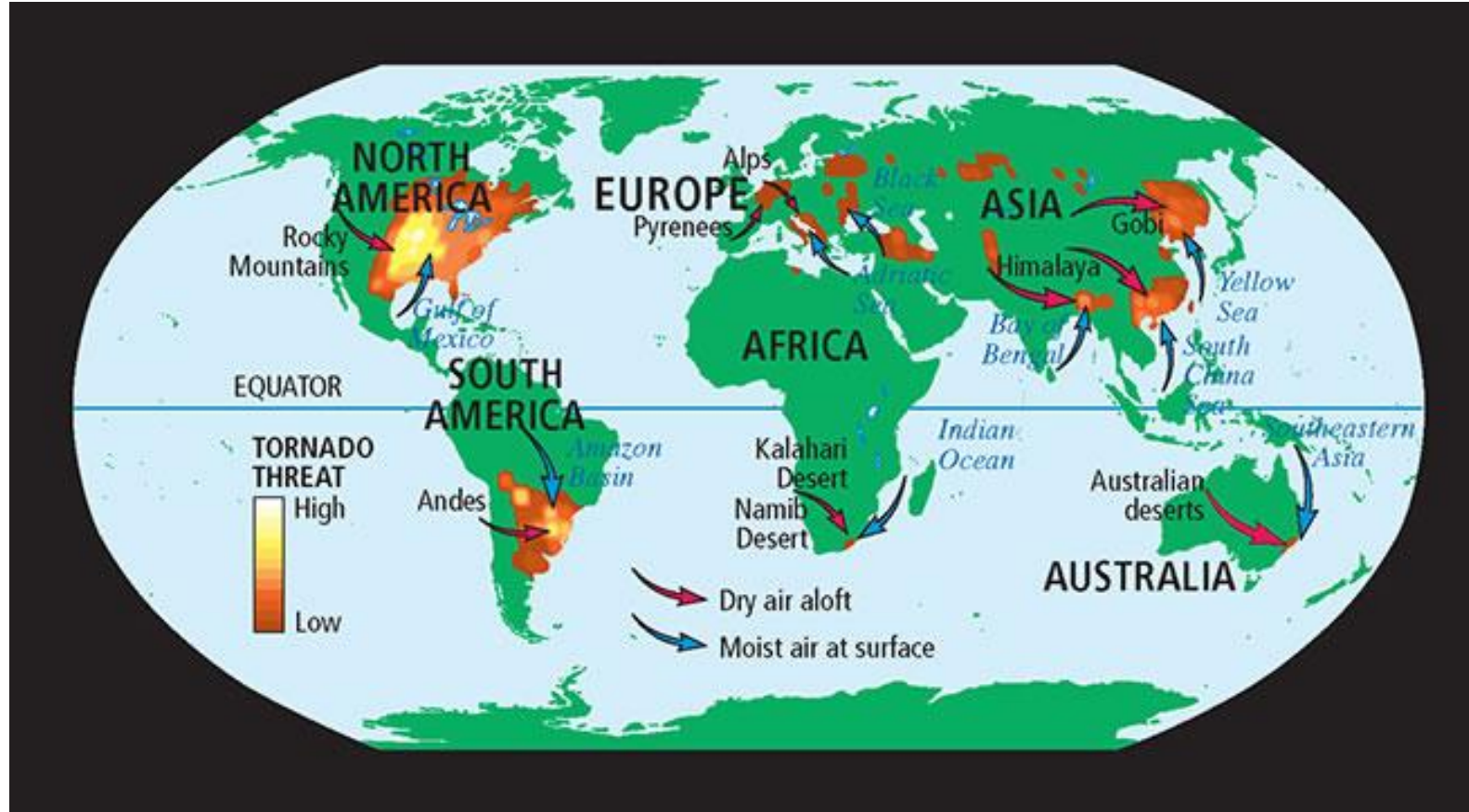
- Recommendation: during a later harvest trees should be removed, since the problem will not disappear with time and considerable losses may be incurred

Tropical cyclone: Sidr 2007

- hit Bangladesh affecting approximately 8.7 mil. people, damaged nearly 4.1 mil. trees
- approximately 20,000–25,000 hectares of the Sundarban mangrove forests, a UNESCO World Heritage Site, incurred severe damages and a further 60,000 hectares were partially damaged by cyclone

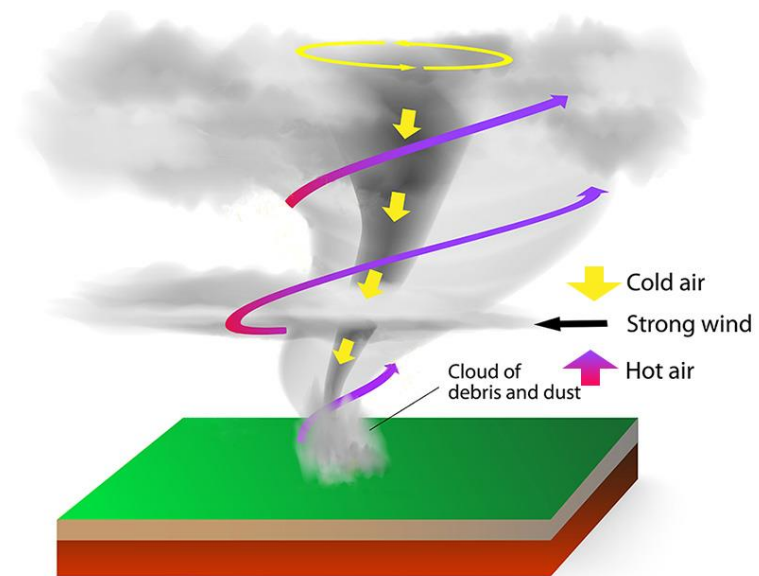


Tornadoes



Definitions

- short lived, relatively small, complex, violent and unpredictable storms
 - a violently rotating column of air extending between, and in contact with, a cloud and the surface of the earth
 - most common in spring in late afternoon
-
- greatly surpass tropical cyclone winds in intensity, reaching an estimated maximum exceeding 400 km/h
 - they develop under three meteorological conditions: long lived supercell thunderstorms; ordinary thunderstorms and in cyclones after they make landfall



Type of damage

- an intermediate disturbance, influence both the structure and composition of forest stands.
- usually affects a much smaller area for a much shorter time frame than a hurricane
- unpredictable, vary significantly in intensity and duration, and do not occur at regular intervals
- from branch break and single tree gaps to extensive areas of complete blowdown
- above a certain intensity can blow down almost all of the trees in a given area, regardless of species, age, or size and impact the species richness, percentage cover, and seedling density of a forest stand



Damages

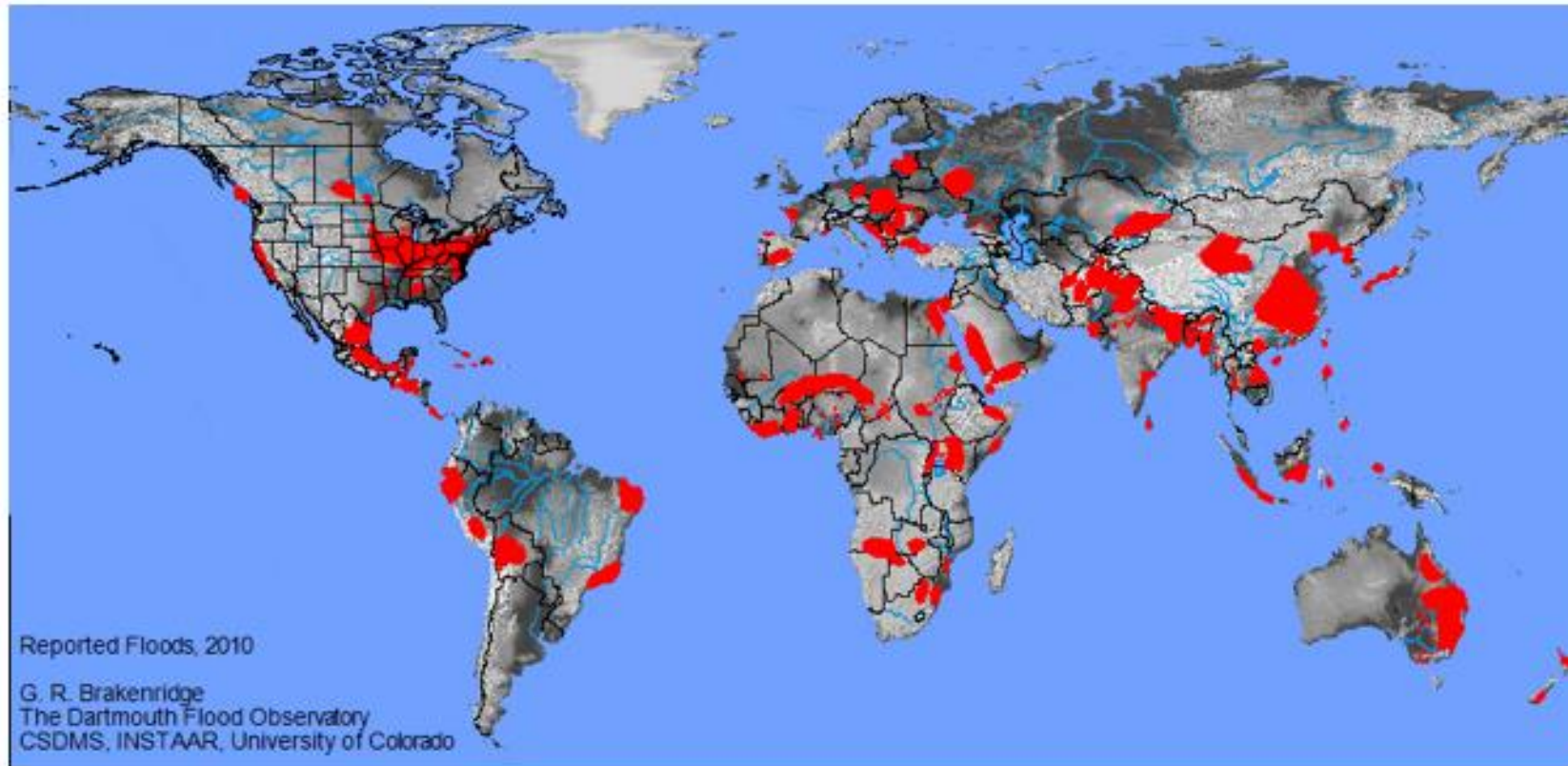


- ◉ damaged trees should be removed, since the problem will not disappear with time and considerable losses may be incurred during a later harvest (attack by bark beetles)



Heavy rains and Floods

Reported Floods, 2010



Definitions

- an overflow of an expanse of water that submerges land, a deluge
- may result from the volume of water within a body of water, such as a river or lake, which overflows, with the result that some of the water escapes its normal boundaries
- can also occur in rivers, when the strength of the river is so high it flows out of the river channel, particularly at bends or meanders and cause damage to forests along such rivers



Damages

- floods cause anaerobic conditions, a lack of oxygen, resulting in poor root growth or root death
- floods during the growing season are generally more damaging to trees than floods that occur before trees leaf out in the spring
- trees are damaged more by floods that last for longer periods of time and damage is generally greater on trees with standing water around them than trees in saturated soil
- damage is usually greater on trees where the foliage is submerged and tends to increase as more foliage is covered with water
- cold water is usually less damaging than warm water and moving water less damaging than stagnant water because of higher oxygen content
- young trees are especially susceptible to physical injury from fast water currents and floating debris

Management

- Vigorous trees tend to be damaged less by temporary flooding than stressed trees.
- **Large** trees tend to survive better than small, submerged trees.
- Young trees and very old trees tend to suffer more damage from flooding than other trees
- **Select flood tolerant (cottonwoods, willows, and cedar etc.) species for planting on flood-prone sites.**



Flood tolerance of selected trees

Tolerant

Silver maple
Sweetgum
Persimmon
Green ash
Honeylocust
Overcup oak
Eastern cottonwood
Water hickory
Black willow
Tupelo gum
Bald cypress

Moderately tolerant

Red mulberry
Swamp chestnut oak
Hackberry
Winged elm
Hawthorn
Osage orange
Boxelder
Loblolly pine
River birch
American elm
Sycamore
American holly

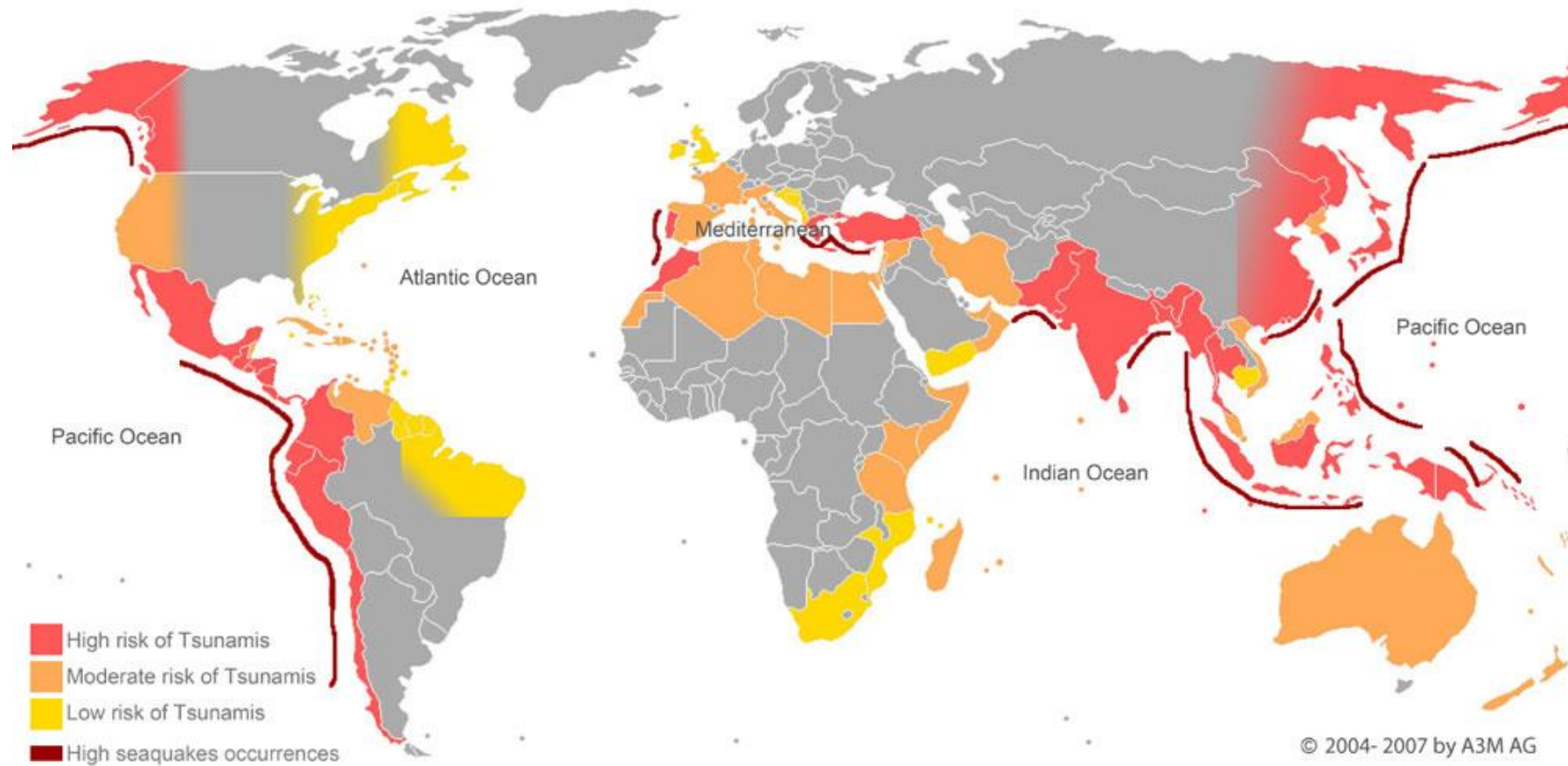
Intolerant

American ash
Chinkapin oak
Mockernut hickory
Shagbark hickory
Black locust
Sassafras
Flowering dogwood
Sourwood
Southern red oak
American basswood
Blackjack oak
Black cherry

Shortleaf pine
Virginia pine
Eastern red cedar
Eastern redbud
Black walnut
Swamp hickory
American beech
Tulip poplar
Yellow buckeye
Sugar maple
Post oak



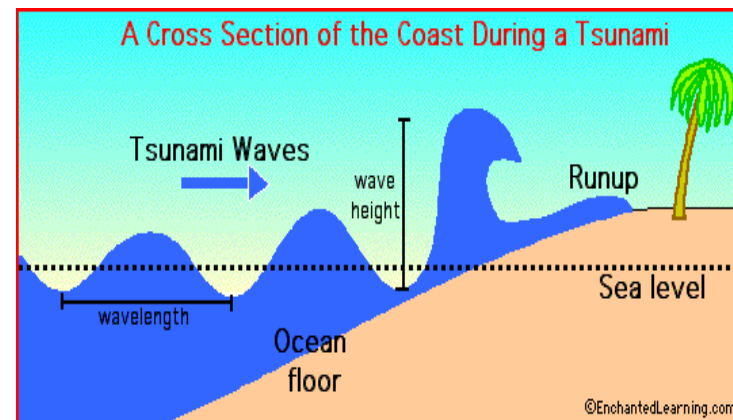
Tsunamis



- 60 % occur in the Pacific Ocean

Definitions

- tsunami is a series of enormous traveling ocean waves of extremely long length generated primarily by earthquakes occurring below or near the ocean floor
- also be generated by underwater landslides and volcanic eruptions, or meteorites
- In the deep ocean, the tsunami waves travel at over 800 km/h, with a short wave height (few cm)
- coastal waters – the waves slow down and the water can pile up into a dozen of m wall heigh (large about 30 m)



Damages

- affect large, densely inhabited coastal areas with high needs for wood products
- mangroves, coastal forests, home gardens, agroforestry systems and trees in the coastal landscape
- changes in topography, soil salinity and freshwater inflow from upstream may also adversely affect forests in the longer term
- the post-tsunami demand for wood and non-wood forest products is also anticipated to cause severe pressure on tree resource



Management strategies

A systematic and comprehensive assessment is required that addresses:

- estimation of size areas and severity of damage to forest and trees by the tsunami;
- the economic impact of the tsunami in terms of destruction of primary forest products (e.g. fuelwood and building materials) and secondary forest products (e.g. wooden boats, piers, houses and other buildings and infrastructure);
- changes in topography, soil salinity and freshwater in-flow from upstream which may adversely affect the mangroves and other coastal forests in the longer term;
- risk assessment of forest pest outbreaks and implementation of preventative and phytosanitary measurement



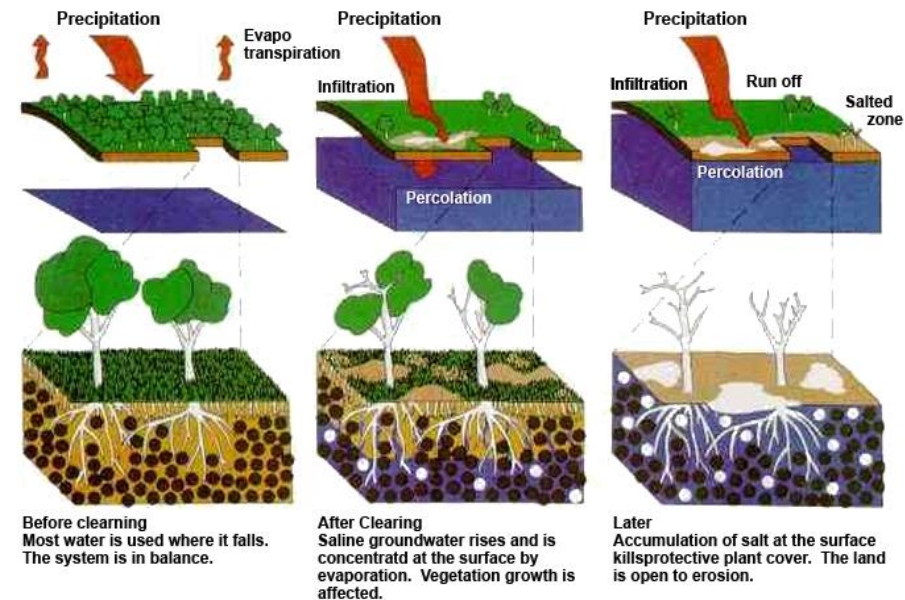
Soil salinity

- where forests and trees have been adversely affected by the increase in soil salinity, salt resistant tree species exist and can be planted to assist in rehabilitation of inundated lands.

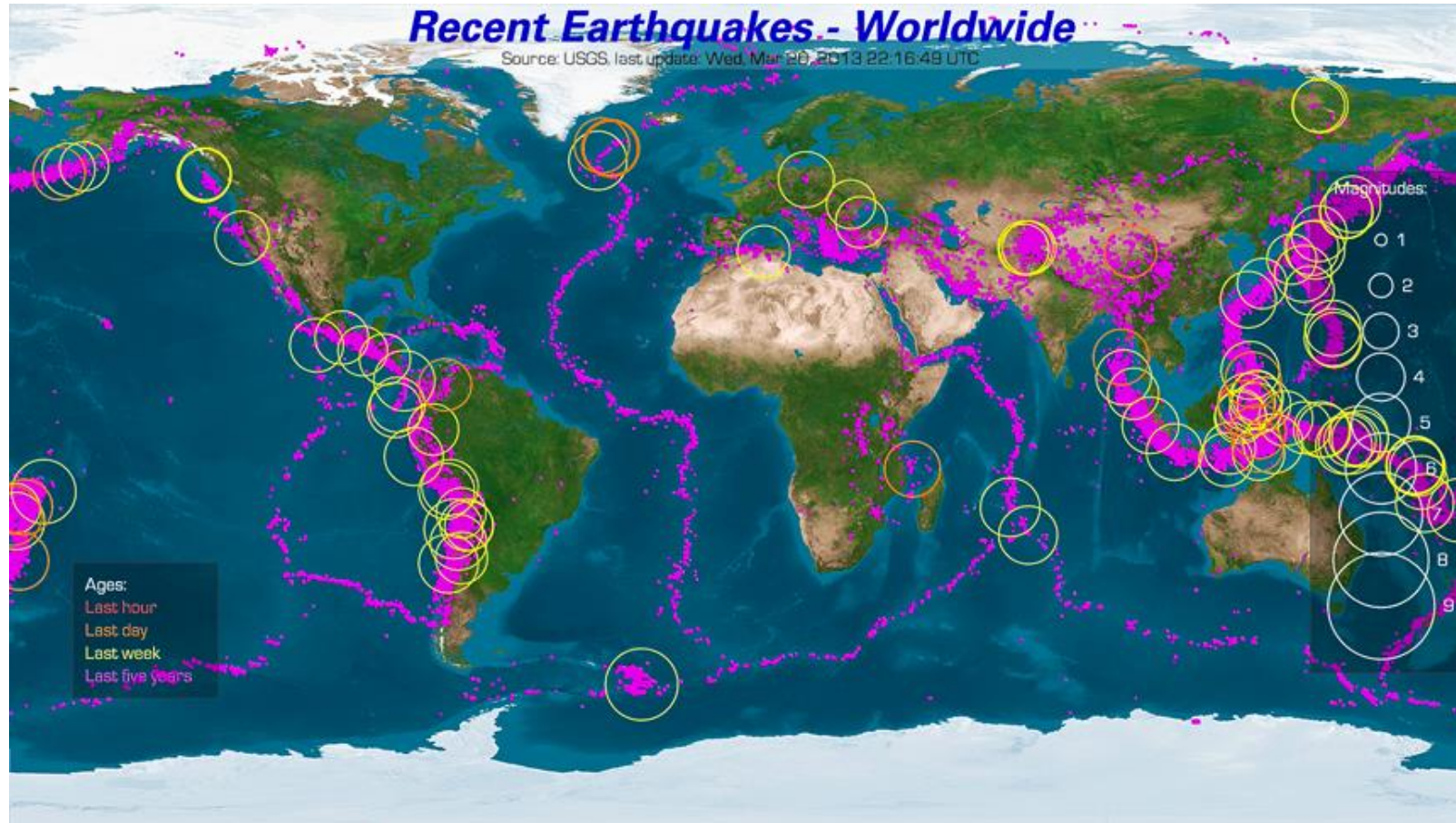
Needed activity:

- A systematic and comprehensive assessment is required that addresses:
- areas and severity of damage on agricultural and forested land inundated by salt water;
- strategies to be developed to rehabilitate soils affected by increased levels of salinity.

Surface changes and Soil Salinity



Earthquakes



Definitions

Earthquake (tremor or temblor)

- the result of a sudden release of energy in the Earth's crust that creates seismic waves
- the moment magnitude of an earthquake is conventionally reported, or the related and mostly obsolete Richter magnitude
- magnitude 3 or lower earthquakes being mostly imperceptible
- magnitude 7 causing serious damage over large areas

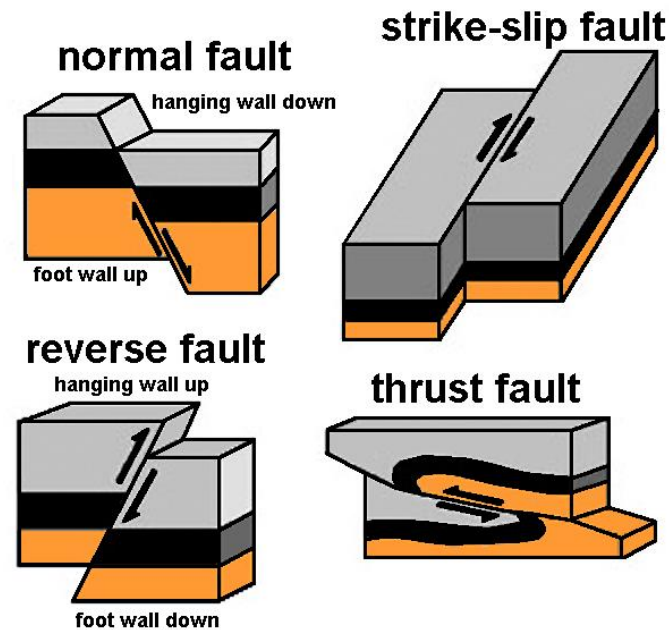


ForHeal Types of earthquakes and faults

- Tectonic
- Away from plate boundaries

Faults:

- normal,
- reverse (thrust)
- strike-slip



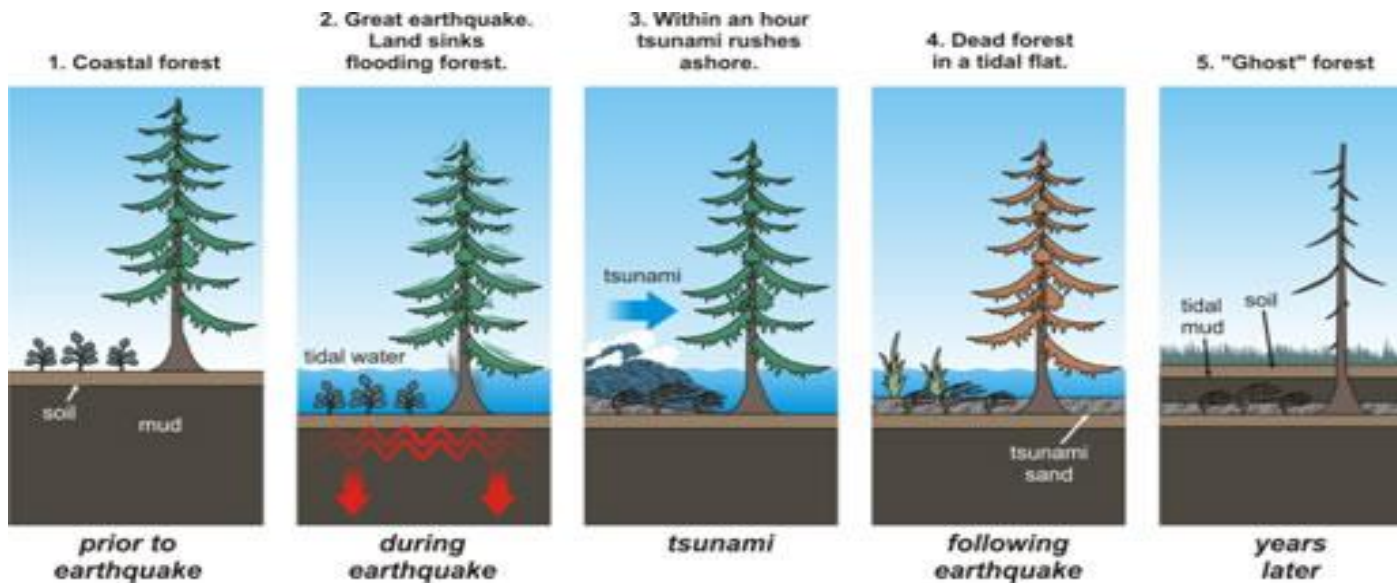
Type of damage

Direct – caused directly by movement of land:

- Immediate - uprooting or breakage of trees
- Delayed - damage of root systems

Indirect – connected to changes in water regime

- Drought
- Overwatering
- Soil salinity

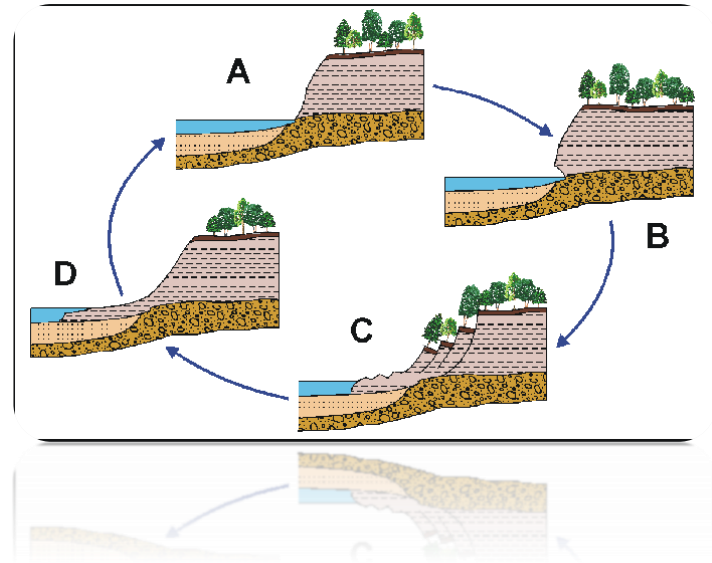


Management

- afforestation after disaster: changes in water regime and soil moisture
→ **different tree species**



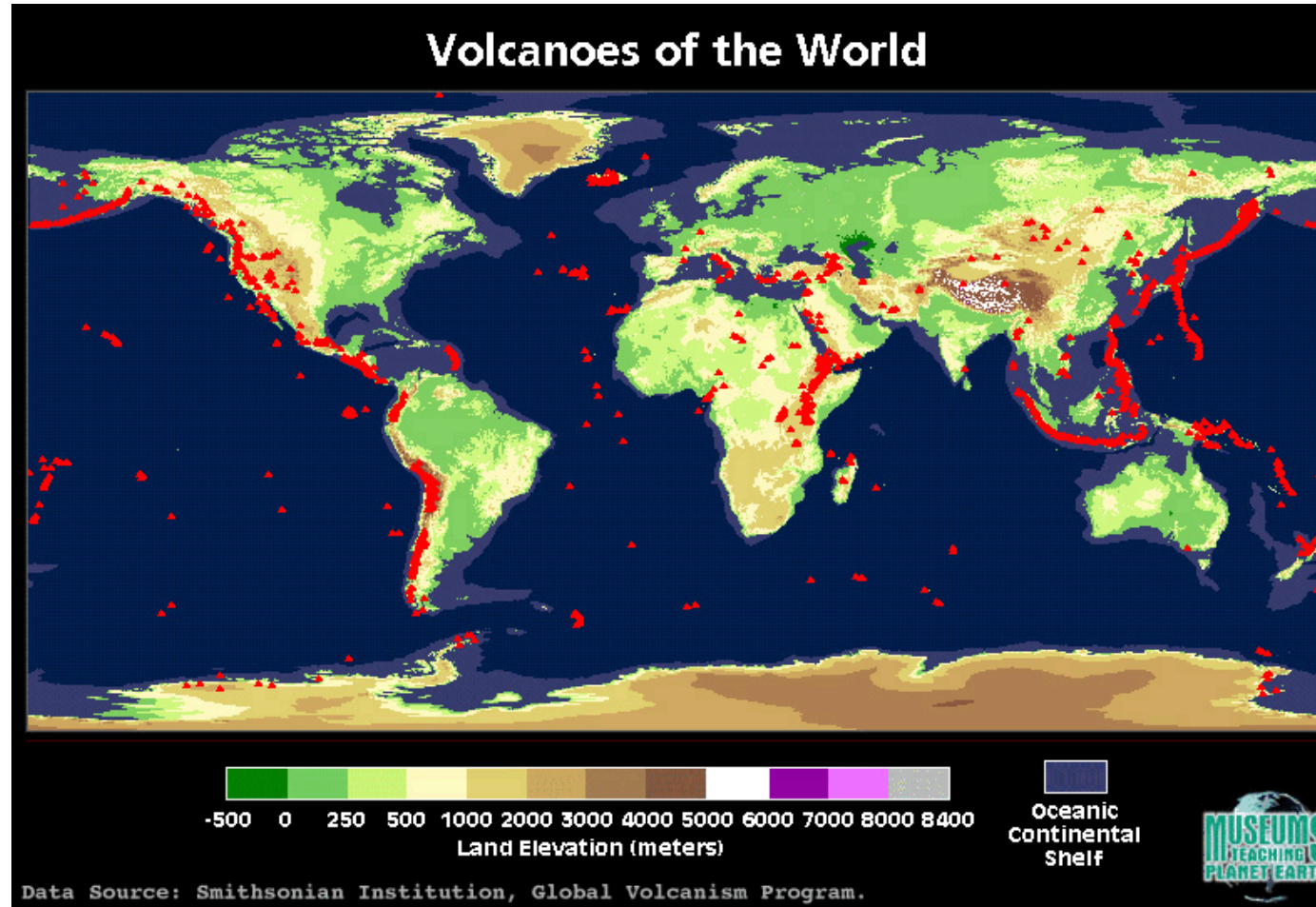
Landslides and mudslides



Landslides and mudslides

- occur when heavy rain, overflowing crater lake sends large amounts of earth, rock, sand or mud flowing swiftly downhill and mountain slopes
- earthquakes, volcanic eruptions, heavy rain storms, and cyclones can trigger landslides
- forest harvesting, particularly clear cutting, and road building - increased surface erosion
- shallow landslides - little impact on trees
- deep landslides, can denude hundreds or even thousands of square km of land
- shallow landslides can be prevented by tree cover where as deep landslides cannot be prevented, even with high forest cover

Volcanic activity



Definitions

- cca 1,500 potentially active volcanoes worldwide, plus hundreds more on the ocean floor
- many of these are located along the Pacific Rim ="Ring of Fire"
- volcanic eruptions have the least potential of leaving residual materials behind
- the intense force of the blast, and the large amount of earth that is either moved or covered with various kinds of debris, makes it a disturbance that is more severe than the hottest fire or the most intense windstorm



Impact on forests by ...

- gases (sulphurdioxide, carbondioxide, hydrogenfluoride)
- lahars –volcanic flows composed of hot or cold water and rock fragments
- landslides
- lava flows
- pyroclastic flows – fast moving currents of hot rock and gas that travel downhill a long slope
- depressions
- tephra–fragments of volcanic rock and lava that become airborne through explosions or the rise of hot gases
- volcanic ash



Damages

- young forests are most at risk from ash fall; stands of trees less than two years old are likely to be destroyed by ash deposits thicker than 100 mm
- mature trees are unlikely to succumb from ash fall deposition alone, but the accumulated weight of ash can break large branches (>500mm)
- defoliation also occur



Management of forests close to volcanoes

- volcanos are usually far from human settlements – thus no management is done
- prediction of eruptions is impossible – and if the forests are planted – only short rotation system may be recommended
- on the other hand, rich volcanic soils allow extremely high production of wood – mainly for energetic purposes (heating, cooking) etc.

Drought

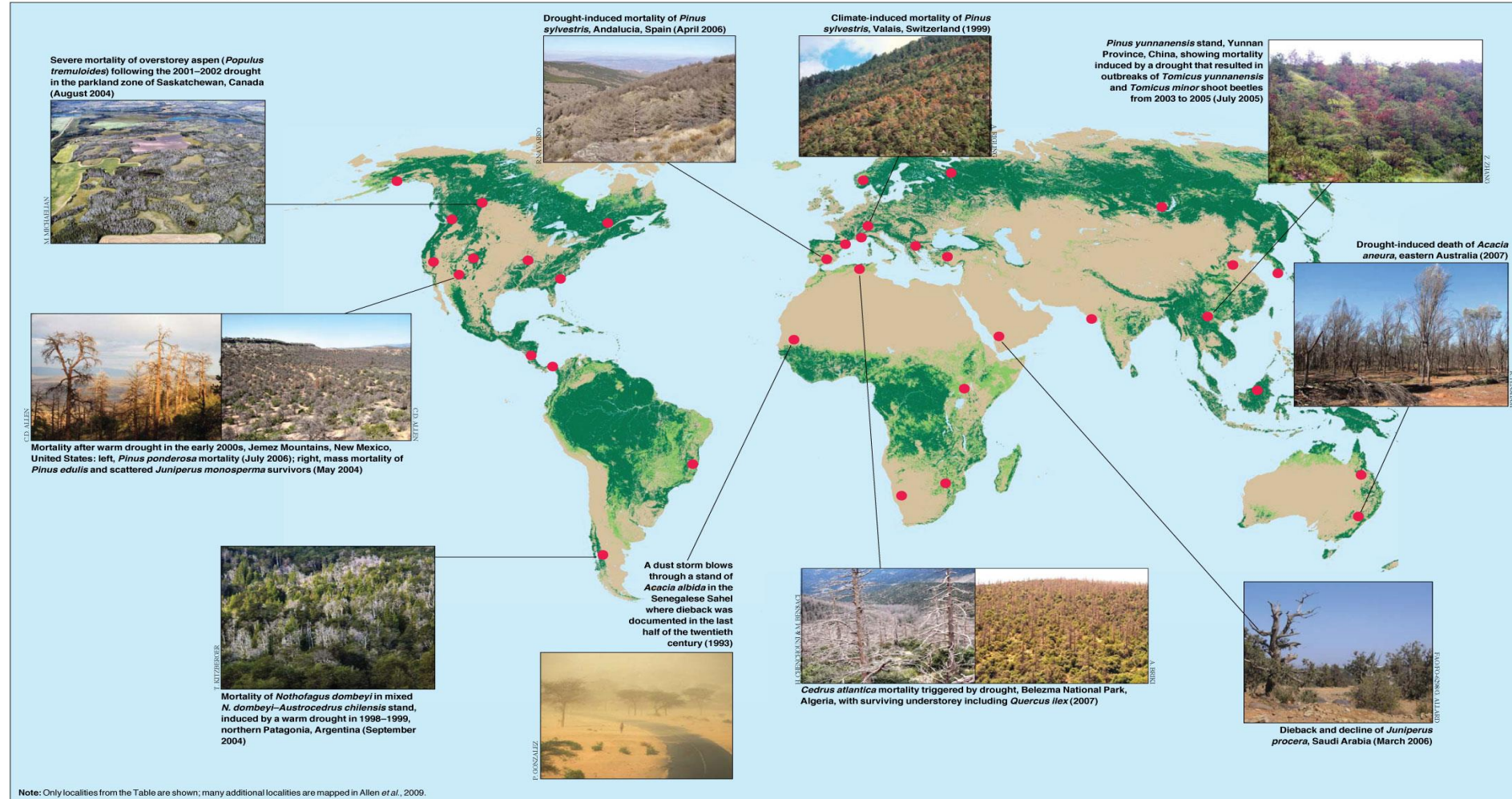


Definitions

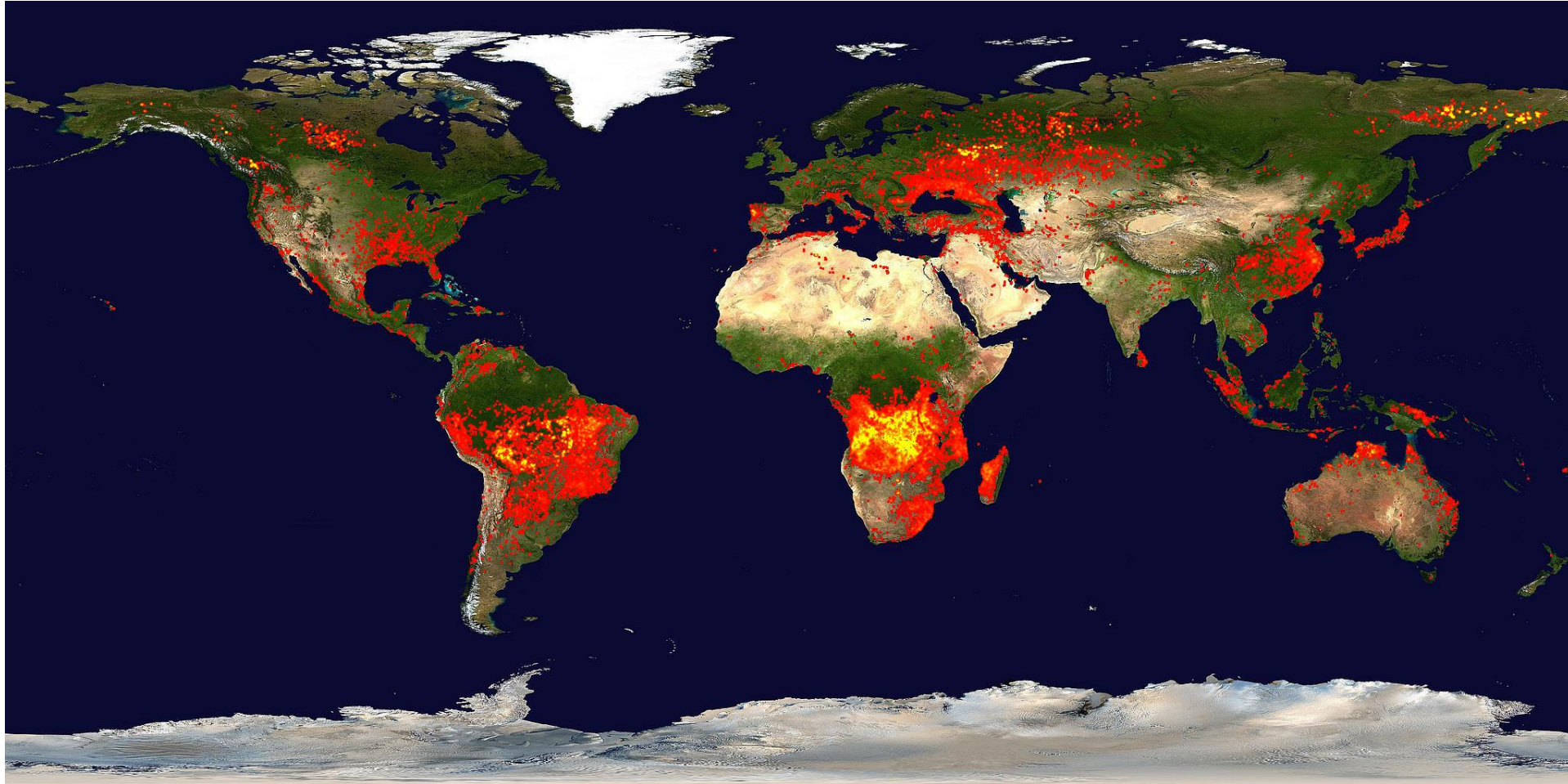
- caused by a deficiency of precipitation over time and as such can develop slowly
- sometimes over years increases in the frequency, duration, and/or severity of drought and heat stress associated with climate change could fundamentally alter the composition, structure and biogeography of forests in many regions
- of particular concern are increases in tree mortality associated with climate induced physiological stress and interactions with other disturbances such as pest outbreaks and fire



Localities with increased forest mortality related to climatic stress from drought and high temperatures

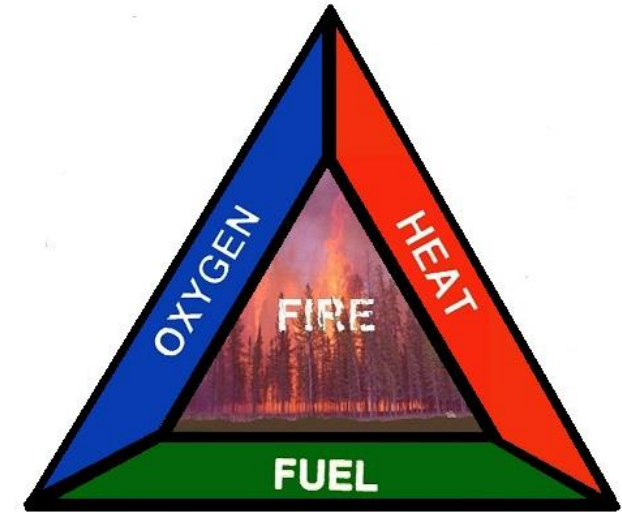


Fires



Definitions

- a wildfire is any uncontrolled, non-structure fire that occurs in the wilderness, wildland, or bush
- wildfires are common in various parts of the world, occurring in cycles
- they are often considered beneficial to the wilderness, as many plant species are dependent on the effects of fire for growth and reproduction
- however, large wildfires often have detrimental atmospheric consequences
- nine out of ten wildfires are reportedly caused by some human interaction



„Fire triangle“

Fires

- globally, an average of 400 to 500 mil. ha burn each year from forest fires
- bilateral and multilateral cooperation in forest fire management has increased over the past few years.
- however, cooperation on forest fire management has focused on fire suppression rather than prevention



Types of forest fires



In a forest where fires rarely happen, fuel builds up: There's **surface fuel** (grass, logs, woody debris, brush); **ladder fuel** (shrubs, small trees, snags); and **tree crowns**.

- 1 Surface fires spread quickly through brush and woody debris.
- 2 Ladder fuels allow the fire to move up toward the forest canopy.
- 3 Tree crown fires are so intense, they're difficult to control.

Ground Fires

- ❑ Burn the organic materials beneath the surface litter of the forest floor
 - ❑ Fuels like peat, coal, tree roots
 - ❑ Common in wet, boggy areas
 - ❑ Smoldering fire, usually no flames
 - ❑ Very high heat → kills root systems



Surface Fires

- Burn surface litter and small vegetation
 - Forest canopy is not generally burned
 - Most fires begin as surface fires
 - Easiest to control



Crown Fires

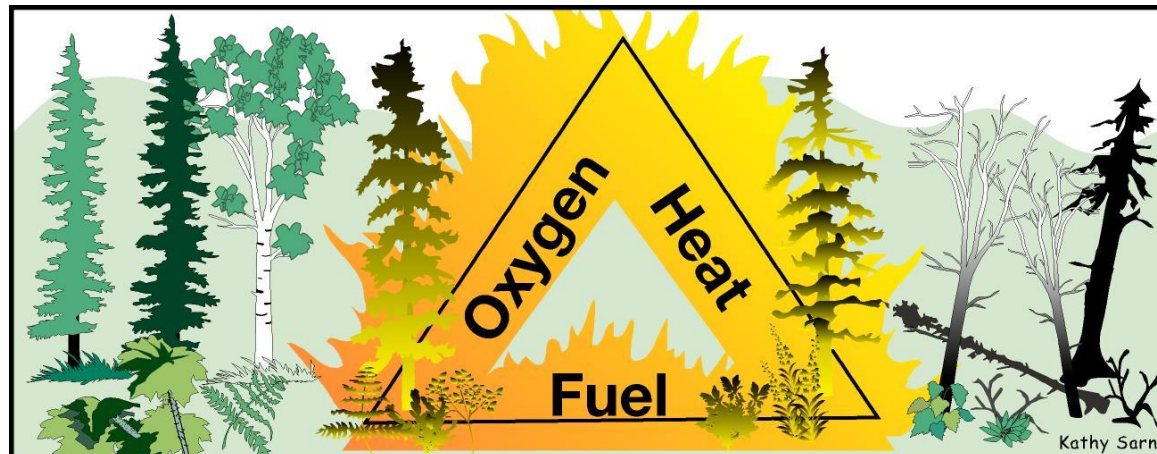
- Burn from top to top of trees or shrubs
 - Most dangerous type of fire
 - Can easily spread due to wind
 - Many conifers are highly flammable

<https://www.youtube.com/watch?v=KvBRWTumoZI>



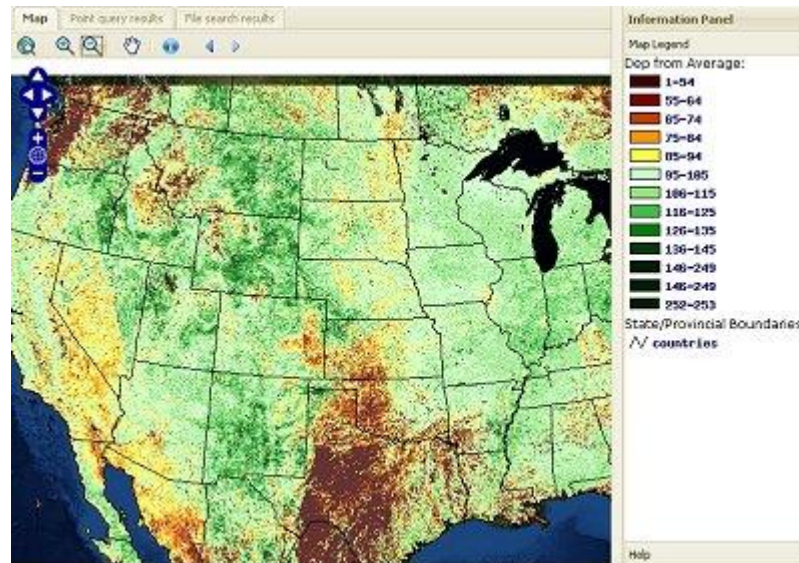
Fuel Types

- ❑ Influence fire behavior
- ❑ Two types
 - ❑ Ground fuels → peat, duff, tree roots, leaves, dead grass, weeds, low shrubs
 - ❑ Aerial fuels → burnable material in canopies above 6 ft from the ground



Prevention

- Not continuous afforestation
- Not afforestation in the vicinity of human settlement
- Preventive fires of understored vegetation
- Preference of broadleaf species
- Educational programs
- Restoring the water in the landscape
- Preventive monitoring and use of GIS for risk estimation



- ❑ Lookout towers
 - ❑ An **alidade** → determine the azimuth of a detected fire from two lookout towers
 - ❑ **Triangulation** → 2 azimuths taken from two towers pinpoints fire location
- ❑ Telephone reports from motorists
- ❑ Fire-watch planes
- ❑ Remote sensing equipment
- ❑ **Satellite imaging systems – MODIS, Landsat and other**



Suppression

- isolation of fires – separation of forest to smaller blocks
- professional firemen organizations
- aerial anti-fire service (including the construction of water reservoirs)



Afforestation after disaster

- no afforestation in risky areas!!!
- preference of tree species with low production of flammable products
- spatial separation of forests blocks via anti-fire lines (which must be cleaned – by preventive fires, grazing by animals)



Other antropogenic factors

- **Oil spills:** impacts on coastal forests and mangroves, covering or blocking specialized tissues needed for respiration
- **Air pollution**
- **Radioactive contamination**



