Wildfire Management in the United States

“The most important characteristic of an organism is that capacity for self-renewal known as health. There are two organisms whose processes of self-renewal have been subjected to human inference and control. One of these is man himself. The other is land”.

--- Aldo Leopold (1949)

Forests as a Resource

- For wood products ---construction
- Flood and erosion control
- Rangeland
- Wildlife habitat

Multiple-Use Management

- Needs Include:
  -- Timbering
  -- Grazing
  -- Agriculture
  -- Soil conservation
  -- Oil & gas leasing
  -- Mining
  -- Wildlife protection & watershed management – hunting & fishing

Forest Ownership

- **Forestland** is defined by U.S. Forest Service as land which is at least 10% covered by forest trees of any size.
- U.S. has over 737 million acres, covering ~1/3 of the total U.S. land area.

  -- 54% owned by private individuals, 37% by public agencies, 9% by private industries.

Forest Fires

- Antecedent climate
- Weather at the time of fire
- Vegetation structure and composition
- Abundance and distribution of live & dead fuels
- Fire regime characteristics

-- climate

-- vegetation classification

-- biophysical variables (elevation, slope, aspect)

--geographical location

From the air, the smoke of a forest fire looks like a fine plume, as in this photo of a forest fire in Virginia...

On the ground, it's a different story…

The aftermath of the fires at Yellowstone

Wildfires

Historical Perspective

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- Natural role of fire is to maintain a healthy ecosystem, to reduce the impact of disease and insects, and to maintain open meadows.
- **20th Century fire detection, prevention, and suppression efforts were successful in reducing wildfires.**

Wildfires
Historical Perspective

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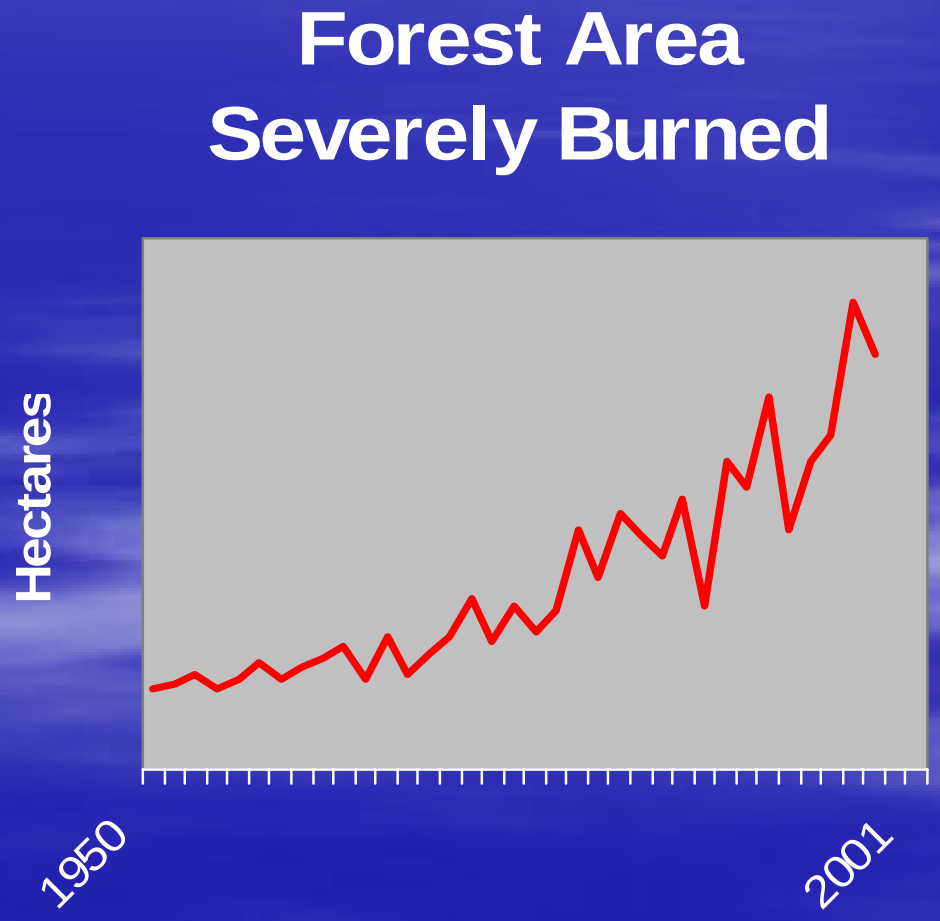
Historical Perspective

- However, the older forest growth, greater supply of fuels, and rapid urban population settlements increased areas of high fire risks.
- As a result, wildfire size, intensity, severity, and area burned have increased since the 1970s.
- **Similarly, wildfire suppression costs and hazards to life and property have increased substantially.**

Issue: Wildfires are a serious and growing problem in the US.

In 2000:

- 3,000,000 hectares of wild lands burned
- US$ 2 billion was spent to fight forest fires
- $ billions in losses of property and resources
- Human lives lost



Wildfires and Insurance

- In 1990's, several large wildfires in California led to insurance payments of $3 billion. The Insurance Services Office (ISO) attributed the large wildfires to active fire suppression, larger population base, and increased frequency of lightning and drought (associated with warmer temperatures).
- The ISO then focused industry attention on wildfire risk management.

U.S. Climate and Wildfires

Research indicates that lightning, responsible for 1,000 – 3,000 fires in the southern U.S. each year (and more common in the SW U.S.), will increase 40 – 50% due to changing climate conditions.

Heilman et al. 1998

The Nature of Wildfires
-Caused by Lightning-

Climatology and Wildfires

Extreme wildfire years are caused at least in part by antecedent drought and summer blocking pattern by a middle tropospheric ridge.

(From Gedalof et al. (2004)

Climatology and Wildfires

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- Although there are subtle differences in the structure of the atmospheric anomalies that characterize extreme wildfire years, anomalous “blocking” ridges of high pressure typically divert precipitation away from the region in the weeks preceding wildfire occurrence.
- **When the blocking pattern is strong, persistent high winds and lightning strikes cause severe wildfire outbreaks in fuel-rich areas.**

PDO and U.S. Climate

Warm PDO: 1925 – 46;
1977~ 98

- **Winter & spring:**
  warm **&** ***dry*** **in Pacific NW;** ***cool*** **&** ***wet*** **in South.**
- ***Dry*** **in Great Lakes region.**

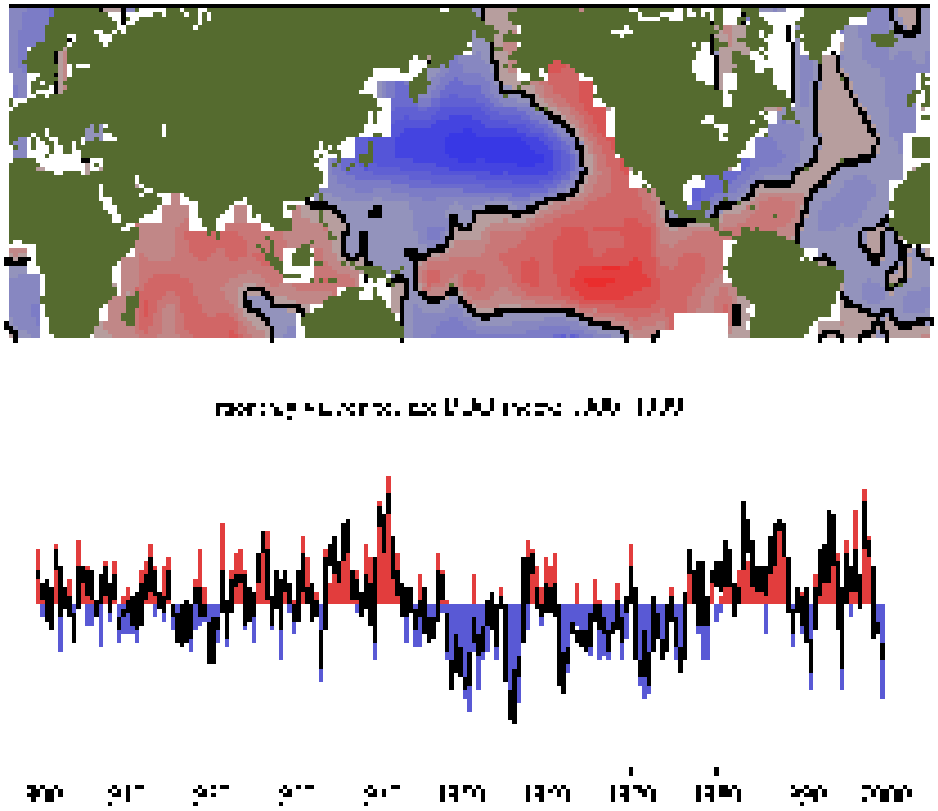
Cool PDO: 1900 – 24;
1947– 76

- **Winter & spring:**
  cool **&** ***wet*** **in NW;** ***warm*** **&** ***dry*** **in South.**
- ***Wet*** **in Great Lakes region.**

David Peterson, USDA Forest Service

The Pacific Decadal Oscillation

- an **El Niño-like** pattern of climate variability
- **20 to 30 year periods** of persistence in North American and Pacific Basin climate
- **PDO fingerprints** found in records of **temperature**, **precipitation**, **snow pack**, **streamflow**, and **marine ecosystems**



Mantua et al. 1997: *A Pacific Interdecadal Climate Oscillation with Impacts on Salmon Production*, **Bulletin of the American Meteorological Society, Vol 78, p 1069-1079.**

Years with fire area > 80,000 hectares

PDO	Warm-phase	Cool-phase
Idaho:	**14**	**7**
Oregon:	**14**	**5**
Washington:	**10**	**2**
Total	**38 (73%)**	**14 (27%)**

National Forest data, 1916-2002

U.S. Climate and Wildfires

In the eastern U.S., middle tropospheric ridge patterns either over the central or eastern states produce hot, dry weather in the southeastern states that is prevalent during severe wildfire seasons.

Heilman et al. 1998

Keetch-Byram Drought Index

- **Drought Index** for fire potential assessment
- Net effect of evapotranspiration & precipitation
- **Cumulative moisture deficiency** on forest floor & upper soil layers
- **Index** ranging from **0** (no moisture deficiency) to **800** (maximum drought)
- Inputs: latitude, annual precipitation, max. temperature, daily rainfall

Keetch-Byram Drought Index Table

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- **KBDI = 600-800: Extreme Fire Danger. Severe drought, increased wildfires. Intense, deep-burning fires with ignition of dead limbs from sparks.**

National Fire Danger Rating System

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- Fire danger expresses an assessment of both constant & variable factors affecting inception, spread, intensity & difficulty of control of fires and the impact the fires cause.
- **Constant factors do not change rapidly with time but vary with location (slope, fuel, value: high-low)**

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- Variable factors change rapidly with time and can influence extensive areas. These are primarily weather variables affecting fire behavior.
- If there is no chance of ignition, there is no fire danger. If fuels are absent, there is no fire danger etc.
- **There are a number of fire danger rating systems.**

National Fire Danger Rating System

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National Fire Danger Rating System

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- **Indices of fire spread are combined with KBDI to provide an index of the total severity of the fire, termed the Burning Index.**

Fire Danger Assessment Technology
Remote Sensing

- Remote sensing is a developing technology for wildfire monitoring and fire danger assessment. AVHRR (Advanced Very High Resolution Radiometer) and MODIS (Moderate Resolution Imaging Spectroradiometer) instruments provide global high-resolution products like NDVI (Normalized Difference Vegetation Index) and surface temperatures which are related to fuel moisture status.

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- MODIS instrument senses the earth's entire surface in 36 spectral bands, spanning visible to infrared spectrum.
- Fuel moisture content is an important index for fire potential.
- **U.S. National Fire Plan defines remote sensing mapping, vegetation features, and fire fuels parameters as technology goals.**

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GIS Applications

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- GIS is a tool to integrate risk conditions, fuel conditions, forest value, NDVI, land quality, weather patterns, topography, and other fire-related risk factors.
- **GIS can compute & generate fire danger maps based on knowledge base of traditional and remote sensing fire-risk model.**

An Agency Strategy for Fire Management

- **The Forest Service's ability to provide adequate support to large fires is diminishing.**
- **The Forest Service fire and fuels program is not well integrated with the land management program of the agency.**
- **Many cooperators and partners think the Forest Service is ineffective and inefficient in fire management.**

A Report from the National Management Review Team

January 12, 2000

National Fire Plan

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- The plan recognizes that, unless hazardous fuels are reduced, the number of severe wildfires will continue to increase.
- **Commitment & cooperation of federal agencies, states, local communities & private sector.**

National Fire Plan

- **LANDFIRE Project: Joint, interdisciplinary project between U.S. Forest Service, U.S. Geological Survey, Bureau of Land Management, National Park Service, Bureau of Indian Affairs, & U.S. Fish and Wildlife Service.**

National Fire Plan

- LANDFIRE Project: Joint, interdisciplinary project between U.S. Forest Service, U.S. Geological Survey, Bureau of Land Management, National Park Service, Bureau of Indian Affairs, & U.S. Fish and Wildlife Service.
- **Resources in fire ecology, GIS technology, remote sensing and image processing to map fuels and fire regimes at broad scales, compounded by complex spatial and temporal dynamics of wildland fire.**

National Fire Plan

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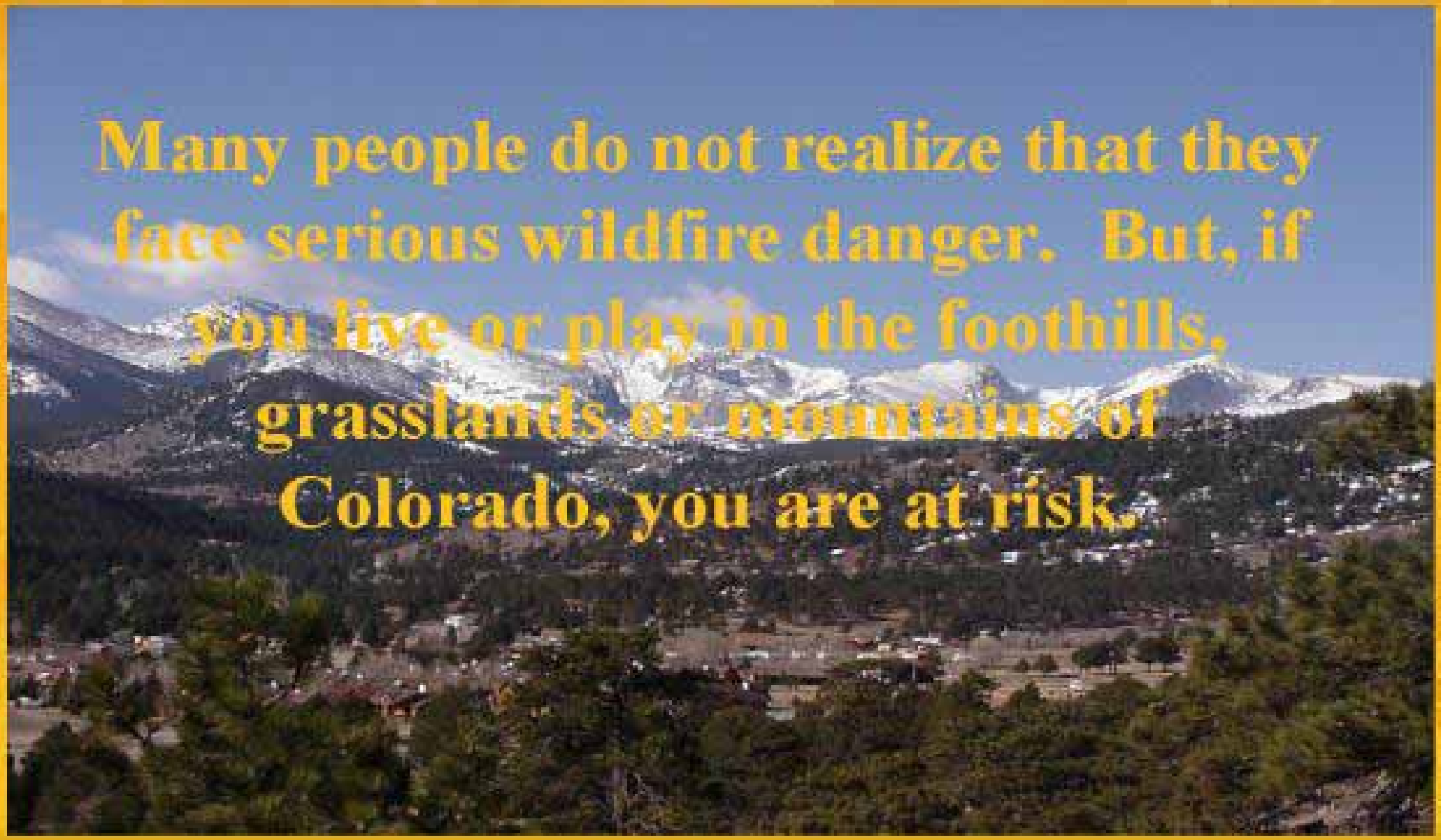
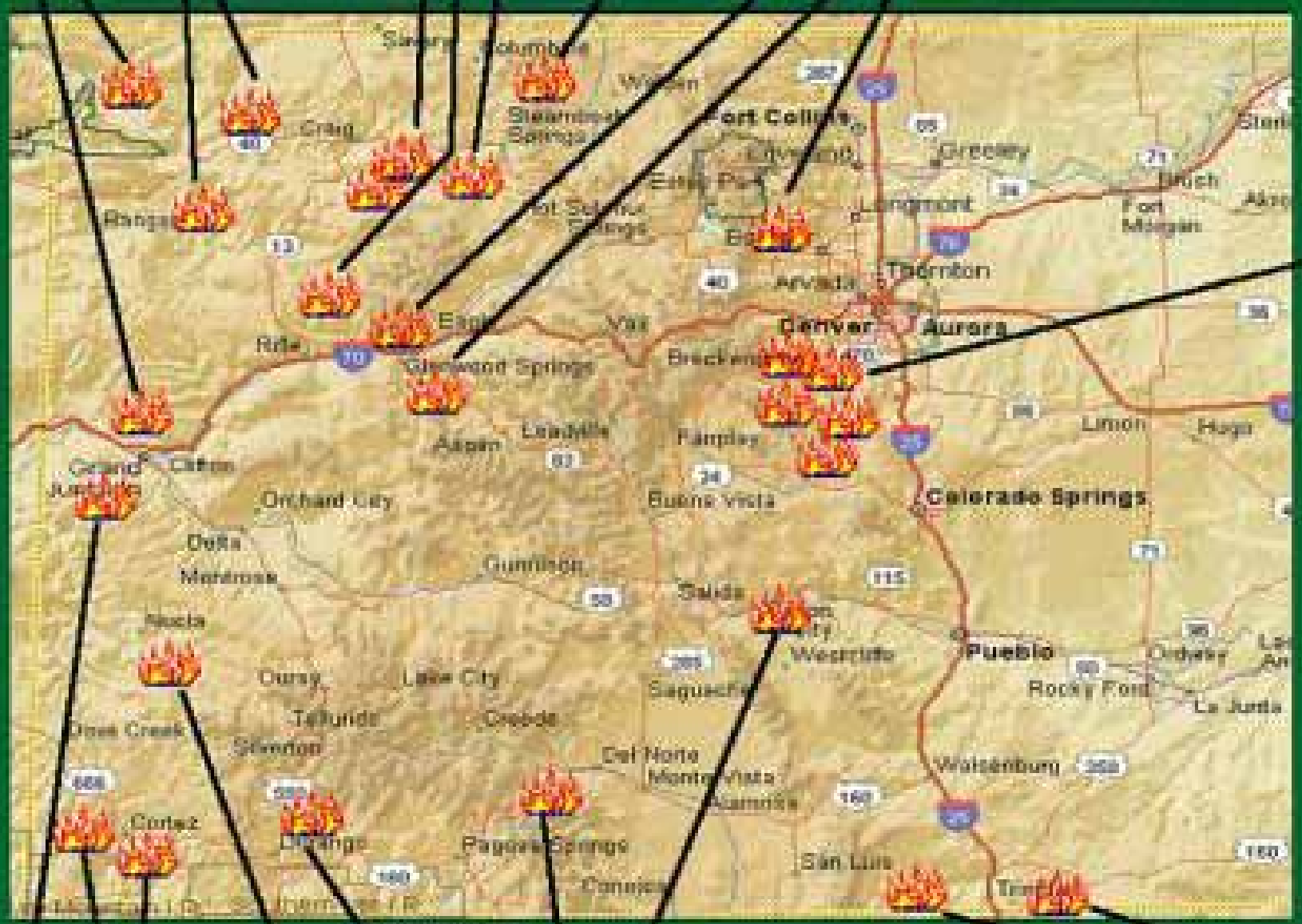
- LANDFIRE maps also characterize fuel conditions based on fire behavior, fire effects and fire danger research.
- **LANDFIRE is regarded as a complimentary tool to local efforts and a safety net for wild land fire managers.**

Why Do Wild Land Fire Managers Need A Safety Net?

WHO IS AT RISK?

You Are At Risk





2002 Colorado Wildfires

Before

After

What Contributed to These Conditions

- Lack of Forest Management
- General Misunderstanding of Fire Ecology
- Increase Population Density
- Successful Fire Suppression

Community-Based Wildfire Management: Lessons Learned from Community Forestry

Cecilia Danks
Watershed Research and Training Center,
Hayfork, California, USA
and
University of Vermont
Burlington, Vermont, USA

Community Forestry

Community forestry provides lessons for how to manage wildfire in a way that has social, economic and ecological benefits – for forest communities and the nation as a whole.

The U.S. has learned from community forestry efforts abroad – through visits, exchanges and individuals.

Features U.S. forest communities share with those in other countries

- Physically isolated
- High poverty & underemployment
- Dependent on forest for livelihood
- Limited capital
- Small businesses
- Resourceful people with knowledge of local forests

Community Forestry means that local communities…

share in:

Decision-making

Benefits

contribute to:

Labor

Expertise

To achieve

Social Well-being and Environmental Health

Community-based Wildfire Management

- Decision-making – Local “Fire Safe Councils” that advise on fire planning.
  -- Informal citizen groups
- Benefits
  -- Sustainable rural livelihoods
  -- Decreased threat of catastrophic fire affecting homes & community
  -- Healthier forest: reintroduce fire as a natural process

Community-based Wildfire Management

- Labor -- Community-based businesses
  -- Value-added industries
  -- Direct agency employment
  -- Prescribed small-scale burns
- Expertise -- Fire history, weather patterns
  -- Access points, water sources
  -- Local knowledge

Fire Management

- **Prescribed Burning: the natural cycle of low-intensity fires burning through open forest grasslands to diminish fire risk, thin the forest, and reduce fuel load.**

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- **Ecological Restoration: regaining the natural characteristics of ecosystems damaged by overuse, pollution, or neglect; specific to each forest condition.**

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- Prescribed Burning: the natural cycle of low-intensity fires burning through open forest grasslands to diminish fire risk, thin the forest, and reduce fuel load.
- Ecological Restoration: regaining the natural characteristics of ecosystems damaged by overuse, pollution, or neglect; specific to each forest condition.
- **Mechanical Thinning: maintain structural diversity, while providing space and opening among groups.**

Contrasting Approaches to Fire Management

	Current	Community-based
Underlying Assumptions	--Fire as a catastrophe --Communities as victims	--Fire as part of ecosystem --Communities as partners
Resources	--Allocated as emergency --$$$$ to suppression --$ to prevention	--Allocated on an-going basis --$ to suppression --$$$$ to fuels management

Contrasting Approaches to Fire Management

Current

- Centralized capacity to respond
- Outside experts
- Mobile, specialized crews

Community-based

- Decentralized capacity to manage
- Local knowledge
- Place-based, multipurpose crews

Two Components of Managing Wildfires

Suppressing Fire

- Large Scale Activity
- Irregular in any one place
- Short duration
- High levels of skill, technology, and capital

Managing Fire

- Small scale actions across landscape
- Consistent, annual work
- Long-term activity
- Intermediate skills, technology, and capital

Policies to Enable Community-based Wildfire Management

- **Invest in both approaches to manage fire – fire-fighting and fuels management**
  - **Field project implementation**
  - **Skills training and industry development**

Policies to Enable Community-based Wildfire Management

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- **Involve communities and their local skills and knowledge**

ANADIA Pilot Project
Conclusions

- **Increased climate variability and fire suppression measures which promoted forest growth and fire fuels aided severe wildfires in recent decades.**

ANADIA Pilot Project Conclusions

- Increased climate variability and fire suppression measures which promoted forest growth and fire fuels aided severe wildfires in recent decades.
- **Fire management strategies need to address ecosystem management at the local level, including inter-disciplinary climate, wildfire and ecosystem expertise, technology and knowledge.**

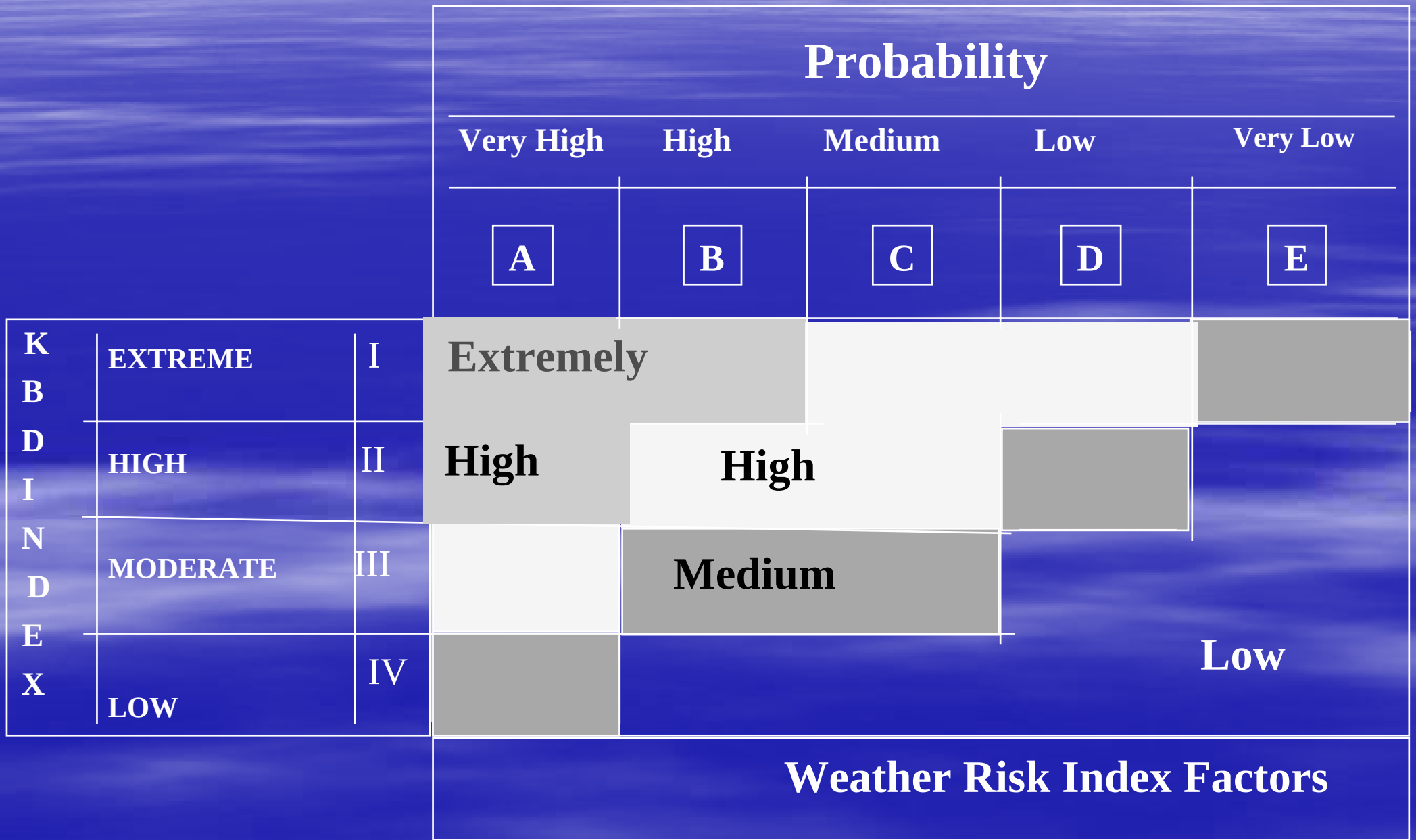
ANADIA Case Study

- **Thus, an objective is to classify the relationship between weather and climate, and wildfire history at regional levels for different forest zones in the U.S.**

ANADIA Case Study

- Thus, an objective is to classify the relationship between weather and climate, and wildfire history at regional levels for different forest zones in the U.S.
- **The integration of antecedent fire weather data, current seasonal data, and forecast products that have sufficient skill to provide guidance, into indices could be developed and tested at the regional level to guide fuel management and resource allocation decisions. The indices would be part of a risk management strategy.**

THE RISK ASSESSMENT MATRIX
KEY TOOL FOR RISK ASSESSMENT



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