Drought and fire in Hawaii and the US Affiliated Pacific Islands

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Telling a Story – Resource management introduction

WHAT IS WILDFIRE:
Wildfire (wildland fire) is any unwanted, unplanned, damaging fire burning forest, shrubland or grassland vegetation.

![Wildfire Triangle Diagram](attachment://triangle.png)
Telling a Story – Resource management impacts

Forests

Rangelands
Telling a Story – Resource management impacts

Agriculture

Watersheds, Nearshore Fisheries & Coral Reefs
**Telling a Story – Resource management impacts**

**Cultural Resources**

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**Telling a Story – Resource management impacts**

**Communities at the Wildland-Urban Interface**
The national context:

Clay Trauernicht et al. (2015)

**Telling a Story – Resource management statement**

**THREAT:** Fire in Hawaii and the US API is a novel threat and essentially entirely human caused.

**GOAL:** Reduce or eliminate wildfire from the region.

**ACTIONS:**
- Fire prevention via public outreach, pre-fire suppression planning, fuels reduction and management, green-break/green-strip, ecosystem restoration, fire suppression, post-suppression rehabilitation and restoration, policy development and legislation, coordinating effectively across ownerships, mutual assistance agreements.
**Telling a Story – Resource management needs**

**IMPROVEMENTS NEEDED:**
- Pre-fire planning and risk mitigation
- Outreach, education & preparedness
- Fuels treatment options
- Tools for fire responders
- Accurate fire danger rating system
- Regionally relevant validated fire modeling
- Prescriptions and funds for post-fire response, including erosion control
- Pre-fire Restoration
- Policy changes
- Wildland fire program dedicated only to this issue

**Telling a Story – Resource management questions**

**ECOLGICAL CHANGE:**
Hawaii’s forests are classified by elevation and moisture regime. There are three classified moisture regimes: Dry (< 1,200 mm annual rainfall), Mesic (1,200-2,500 mm), and Wet (> 2,500 mm).
- What are short-term versus long-term changes going to look like?
- At what point will climate change cause an irreversible shift in these moisture regimes?
- How will this shift in moisture regimes alter local fire dynamics?
Changes in vegetation

Native forest vegetation

Non-native, fire prone grasses
**Telling a Story – Resource management questions**

OUR QUESTIONS:
• How will fire danger change into the future?
• Which areas of Hawaii and the USAPI will experience a climate driven increase in fire danger?
• How will fire weather parameters change?
• How will intensity of severe events change?
• How will length of multi-year dry periods change?
• How will baseline multi-decadal climate change?

**Telling a Story – Resource management responses**

RESPONSES TO DROUGHT:
• Short-term allocation of resources to address severe, episodic but short-lived drought events (e.g., El nino), with emphasis on public outreach and prevention.
• Longer-term resource commitments to longer-lived, multi-year, but less severe dry periods (e.g., climate variability), with emphasis on shorter-term increases in fire suppression capacity.
• Long-term changes in baseline climate conditions (e.g., climate-driven biome change), with emphasis on long-term investments in fire suppression, containment, fuels reduction, and restoration.
RESPONSES TO DROUGHT:
Where will restoration of forest ecosystems be possible and where will it be a lost cause?
Retrospective look at Wildfire in Hawaii

Annual area burned in Hawai‘i State 1904-2012

Statewide Ignitions 1989-2012

Accessible online: gis.ctahr.hawaii.edu
### Daily High Temperature Patterns

<table>
<thead>
<tr>
<th>Temperature</th>
<th>1950s Frequency</th>
<th>2000s Frequency</th>
<th>% Change in Frequency</th>
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<tbody>
<tr>
<td>20</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>21</td>
<td>1</td>
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<td>28</td>
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<td>640</td>
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<td>29</td>
<td>888</td>
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<tr>
<td>30</td>
<td>445</td>
<td>358</td>
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Number of days with High Temperatures at or above 31°C:
1950s: 69 days or 2.3 months
2000s: 1104 days or 3 years

### Daily Minimum RH Patterns

<table>
<thead>
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<th>Minimum RH</th>
<th>1950s Frequency</th>
<th>2000s Frequency</th>
<th>% Change in Frequency</th>
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<td>-16%</td>
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<td>1133</td>
<td>711</td>
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<tr>
<td>&lt;=100</td>
<td>0</td>
<td>0</td>
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Fire Weather Changes

Andrew Pierce et al. (In Prep)

90th Percentile Fuel Moisture and Fire Weather

<table>
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<th>Fuel Type</th>
<th>1950s</th>
<th>2000s</th>
<th>%Change</th>
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<tr>
<td>&lt;0.6 cm diameter fuels</td>
<td>8.1</td>
<td>7.6</td>
<td>-6%</td>
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<td>0.6 - 2.5 cm diameter fuels</td>
<td>9.4</td>
<td>8.6</td>
<td>-9%</td>
</tr>
<tr>
<td>2.5-7.6 cm diameter fuels</td>
<td>14.4</td>
<td>12.5</td>
<td>-13%</td>
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<tr>
<td>Live Herbaceous fuels</td>
<td>86.3</td>
<td>80.6</td>
<td>-7%</td>
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<tr>
<td>Live Woody fuels</td>
<td>116.8</td>
<td>99.7</td>
<td>-15%</td>
</tr>
<tr>
<td>Wind Speed (km/h)</td>
<td>41.8</td>
<td>42.2</td>
<td>1%</td>
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Drier fuels under similar wind conditions

Hawaii Drought Projections

2007 Waialua Fire
**Telling a Story – Resource management scale**

**SPATIAL SCALES FOR MANAGEMENT:**
Primarily leeward and mesic shoulder areas of larger Hawaiian islands, and entire Island areas for smaller Hawaiian Islands like Lanai.

Under drier and warmer conditions, especially during severe El Nino conditions, entire islands of Hawaii and USAPI, with a focus on savanna areas of USAPI in nearly all years.
TEMPORAL SCALES FOR MANAGEMENT:
Planning for fire management (Statewide Fire Management Planning, ICS, FMPs) usually occurs in 3 to 5 year blocks, usually focused on identifying and or supporting: equipment purchasing; staffing and infrastructure needs; and training needs. Ideally, there are two meetings a year (pre-fire and post-fire season) to address fire-related management activities including: fire / ignition prevention; fire mitigation (for example managed fuel breaks, fuel reduction treatments, restoration to break grass fire cycle); pre-suppression implementation; training and planning; post-fire review including assessing past fires within a scenario framework.

Ellsworth et al (2010) found:
• A positive linear relationship existed between volumetric soil moisture (%) and live, standing dead, and litter fuel moisture ($P<0.01$).
• Cumulative rainfall was also positively and linearly correlated with live fuel moisture ($P<0.01$).
• Correlation of fuel moisture with readily measured variables such as soil moisture and weather variables provides an opportunity to improve fire modeling in Hawaii.
**Telling a Story – Resource management data**

**VARIABLES OF INTEREST:**
Relative Humidity, avg and max air temperature, rainfall amount & distribution, wind speed & direction, soil moisture.
Ideally, fuel moisture, current and future thresholds of 80th, 90th, and 97th percentile fire weather conditions and information on changes to energy release and burning indexes.
Trends data that show how these measures change under future fire weather conditions.
Spatial information on which landscapes/islands will be most susceptible to future changes in fire weather.

**Telling a Story – Data for resource management**

**HOW IS CLIMATE INFORMATION INCORPORATED INTO MANAGEMENT?**
More focused on fire weather and fire danger rating systems, which to date have been of marginal value. Improved characterization of forest type – biome type, especially how vegetation type might change in the future.

**IN TERMS OF BASELINE CONDITIONS, HOW IS “NORMAL” DEFINED?**
Mean annual rainfall, mean monthly temperatures, maximum daytime temperatures, mean and max winds speeds, average fuel moisture and greening events, fuel loads.

**HOW DOES MANAGEMENT DIFFER UNDER AVERAGE & EXTREME CONDITIONS?**
Average temperature, RH, wind and rainfall conditions versus dry, hot, windy ESPECIALLY following a prolonged wet period (high fuels).

**HOW WILL CLIMATE CHANGE ALTER THE GAME FOR HOW YOU MANAGE?**
Increase periodicity of rainfall events; more droughts; increased temperatures, especially maximum air temps; altered wind patterns; reduced soil and fuel moisture; higher plant mortality rates.
**Telling a Story – Other resource management needs**

OTHER CONCERNS OR QUESTIONS:
- How will future climate affect the spread of fire-prone invasive species?
- How will restoration for fire affected landscapes be impacted by future climates (more difficult to restore to closed canopy dry and mesic forest, for example)?
- How do we affect policy changes that prevent fire prone invasions, improve HFD access to private lands, increase money for fire related management, and enhance coordination across ownerships?

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**Telling a Story – Other resource management needs**

OTHER CONCERNS OR QUESTIONS:
We are about to enter into a huge El Nino event.
- How are we addressing this event at a multi-agency level?
- Can we come together across agencies and entities to plan for this event?
LESSONS LEARNED:
Things get more complicated in the US Affiliated Pacific
Grassland and savannah systems in US API are anthropogenic via human caused fires, are tightly linked with fire, are slow to recover and cause erosion and biodiversity loss.
Palau Fire History Results (2012-2013)

- 1.7% of total non-mangrove area of Babeldaob burned
- 11.7% of non-forest vegetation area burned
- > 180 fires
- ~ 0.4% forest area burned
- Top reasons for burning – arson (36 %), farming (26%), hunters (15%), government (13%), brush piles (6%), unknown. (4%)

_Telling a Story – Resource management lessons_

**LESSONS LEARNED:**
Fire is multi-faceted!
LESSONS LEARNED:
Integrating accurate climate information into wildfire planning and management will likely have major benefits for the future of the region’s biodiversity, human health and safety, hydrological resources, cultural resources, in-stream biota, and nearshore reef and fisheries condition.
Mahalo

Photo by Ashley Shaw