

Value of Information - Impact Assessment of a Burned Area Emergency Response (BAER) team Emergency Stabilization Plan

The Consortium for the Valuation of Applications Benefits
Linked with Earth Science (VALUABLES)

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What do we mean by Value of Information (VOI)

The situation:

- Need to take an action that will lead to a decision. You could perform a relevant, free, rapid observation and decide.
- Would you choose to act first then observe, or observe first then act? That's a no-brainer – observe first.
- How much you prefer observing before acting is known as the value of information of the observation. Simple.

Features worth noting:

- Information can only have value if it's useful for some decision. Even if it isn't used that doesn't mean the information wouldn't have been useful.
- If you know with certainty what the outcomes of your contemplated actions would be, there is no point in observing – the VOI under perfect knowledge is zero. You don't need a VOI study to decide whether to wash the dishes.
- If the observation has nothing to do with your decision, then the value of the observation is zero. You don't observe the license plates of passing cars to decide whether to buy a house.

What do we mean by VOI (2)

Features of analysis:

- The more uncertain are the possible outcomes of your actions, the greater can be the value of a relevant observation. You should do more research before deciding to invest in a start-up than to invest in Government Bonds.
- The more the possible outcomes differ in terms of desirability, the greater can be the value of a relevant observation. You should do more research contemplating a life-death operation than contemplating a visit to the dentist's office
- VOI depends on what is at stake in a decision and how uncertain decision-makers are.
- VOI is defined as the gains that result from making better decisions that are based on additional information in the presence of uncertainty.
- Components of VOI: decision theory, probability theory, utility theory and economics

These are the basic features of valuing information; they're good for helping us ask the right questions.

However, answering those questions takes work.

Observations are seldom actually free; there may be several possible observations among which we must choose, based on their cost and their value. Finding answers requires quantification (R. Cooke 2017³).

What is Earth Observation (EO), geoinformation and forest wildfire information?

- EO is remotely sensed data about the earth's systems.
- The International Organization for Standardization Technical Committee for geographic information / geomatics (ISO/TC211) states geoinformation is data associated with a geographic location on earth.
- Burned Area Reflectance Classification (BARC) maps are geoinformation derived from EO of soils, water quality, etc., to help classify burn severity and determine values at risk.

The combination is:

- Data infrastructure for decision-making
- Informative when a particular combination of scientific data and indicators are organized into an information structure for a specific decision.
- An intermediate economic good

EO is an Economic Commodity

Background and Definition

- An Intermediate economic good provides a link between economic sectors in an economy and can have many uses simultaneously.
 - Requires translation to information for systematic use in decisions.
 - Derives value by delivering unique, economically consequential, and strategically relevant information to decision makers.
- Estimating changes to the economy are modeled as the outcome for a specific introduction of EO compared to a baseline / counterfactual.

Private good (not open data) with a market price or public good (open data) with a societal benefit

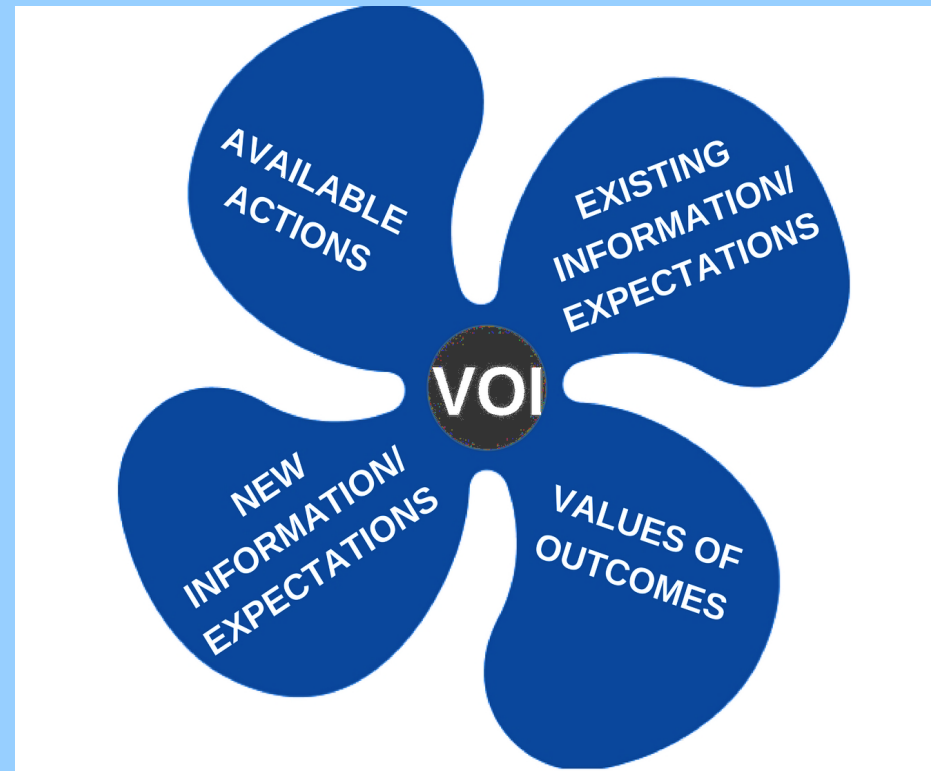
Both types exist:

- Private good: EO collected by contractual and / or license agreement and is available in the marketplace and is specific information
- Public good (one individual's use of the data does not degrade the value to another): EO collected by the public sector is general information - midlevel resolution imagery are pertinent to a variety of societal and market decisions

Four components of every VOI study

identify a decision context, available actions

identify possible observations, their costs, and their effect on uncertainty



quantify prior uncertainty of possible states of the world

quantify the utility (\$) of outcomes of actions

Consortium for the Valuation of Applications Benefits Linked with Earth Science (VALUABLES)

- VALUABLES (www.rff.org/valuable) is exploring how to assign an economic value to specific applications of remotely-sensed information.
- Specifically, VALUABLES is:
 1. Conducting impact assessments that quantify the economic value of satellite data applications in areas including air quality monitoring, climate observation, and water resource management.
 2. Building capacity within the Earth science community so scientists can better understand the terms, concepts, and methods related to impact assessments.
- Quantifying the socioeconomic benefits of open data (government provided EO) requires us to compare outcomes of decisions made **when data are open** to the outcomes of those decision made **when data are not open**.

Impact Assessment of Earth Observation (EO) in a Burned Area Emergency Response (BAER) team Emergency Stabilization Plan

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Drivers: U.S. Department of the Interior, Departmental Manual, Part 620, Chapter 3 Wildland Fire Management; USFS Manual 2500 Watershed and Air Management Chapter 2523 Emergency Stabilization-Burned Area Emergency Response, FSM Interim Directive No.: 2500-2013-1, and Interagency Burned Area Emergency Response Guidebook (2006).

Context: The Elk Complex Fire Emergency Stabilization Plan addressed the effects resulting from the wildfire on lands managed by the USFS. Response actions were considered by the BAER team had the objective of emergency stabilization on Federal lands under the jurisdiction of the BLM Boise District-Four Rivers Field Office and USFS Boise National Forest-Mountain Home Ranger District.

Decision maker's preference is to minimize post-fire risk with cost effective mitigation and restoration decisions.

Challenge: Estimate the cost effectiveness of burn area severity information for wildfire management.

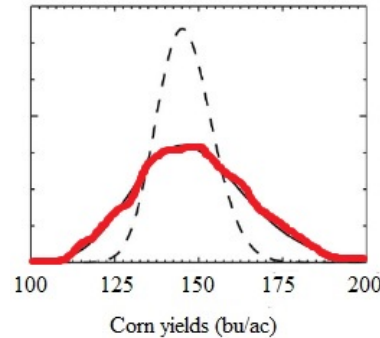
Partners: National DOI Interagency BAER Team, USDA-Agric. Research Service, USDA-USFS



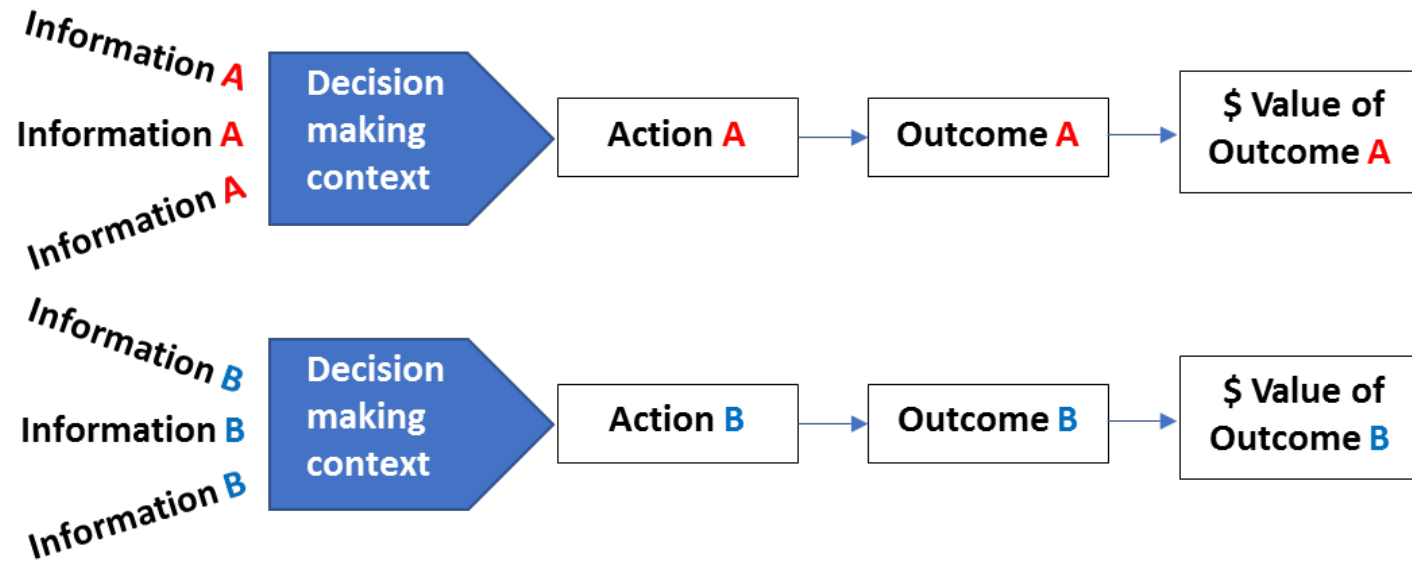
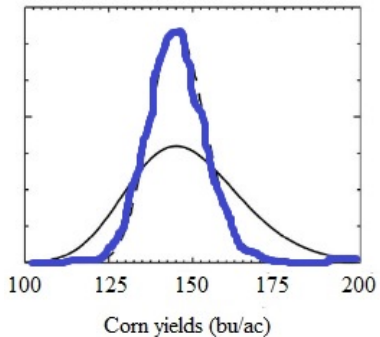
General Approach to Quantifying VOI

- The Value of Information (VOI): The gains that result from making better decisions that are based on additional information in the presence of uncertainty.

Baseline /
Counterfactual
Information
Structure

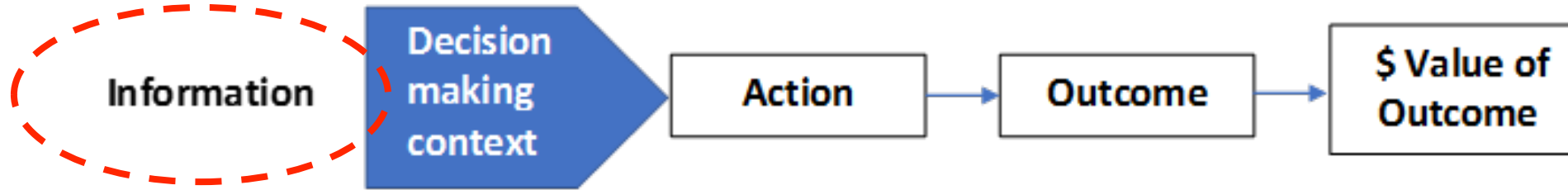


EO Information
Structure



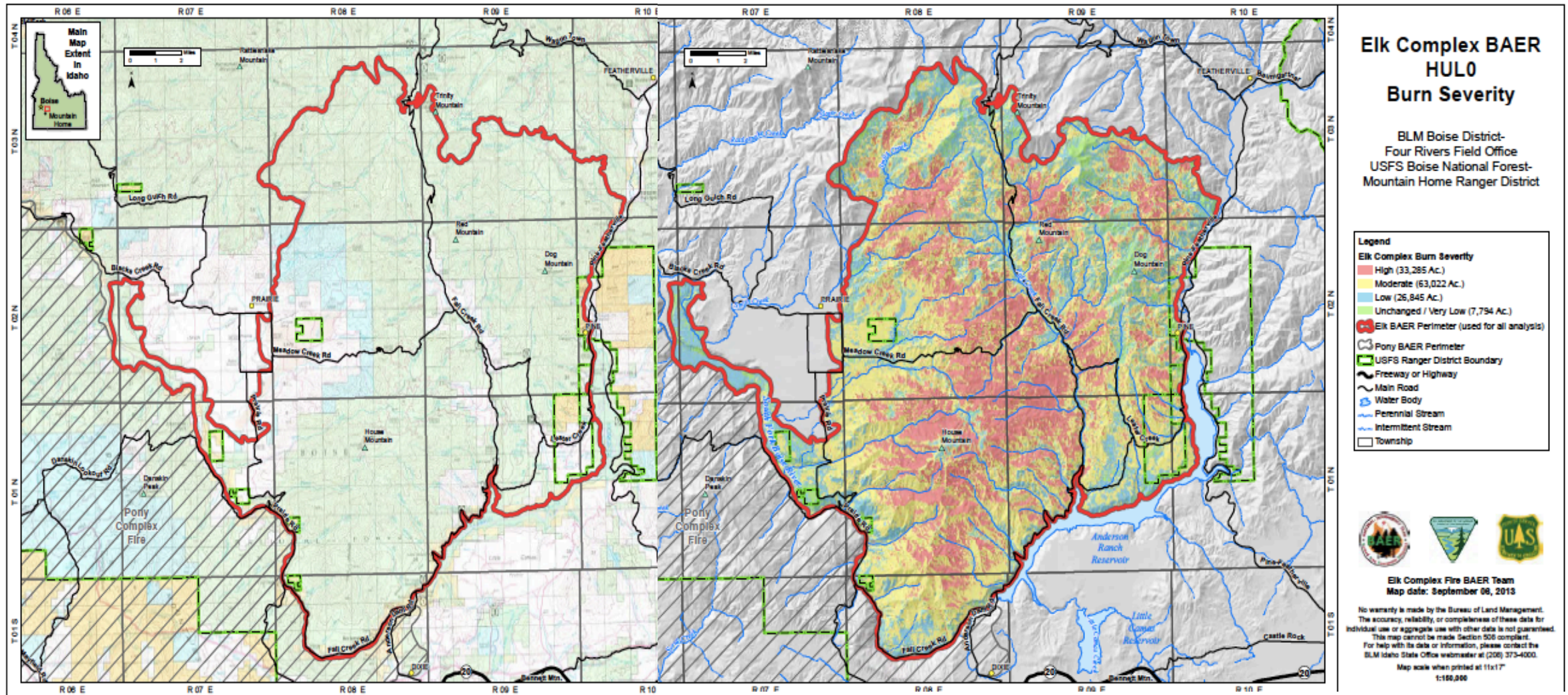
- $VOI = \$ \text{ Value of Outcome B} - \$ \text{ Value of Outcome A}$
- VOI is the **difference in informativeness** between B and A

Step 1: Characterize the “baseline” and “improved” forecasts

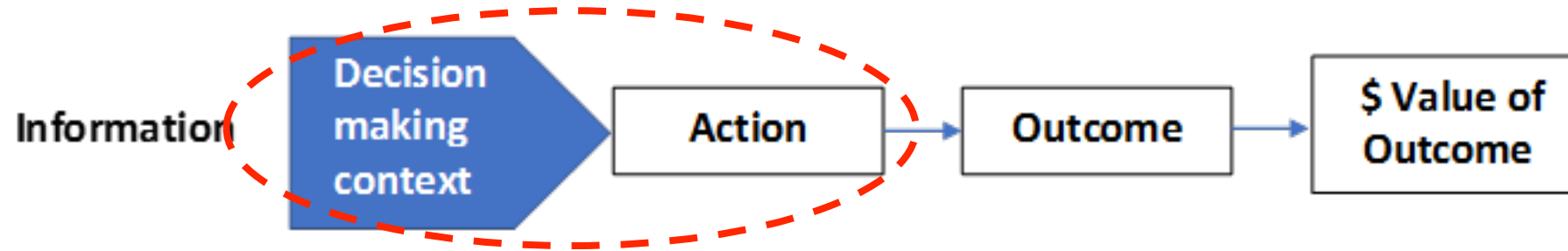


- EO from USFS-RSAC (Remote Sensing Applications Center) and USGS-EROS (Earth Resources Observation and Science) provide imagery and derived products to rapidly map soil burn severity.
 - Characterize “baseline” (pre-fire) and post-fire (observation) of the burned area as a BARC classification that represents landscape change due to fire. Utilizes Landsat.
 - Characterize the 2013 Elk Complex fire in the Boise National Forest of Idaho:
 - “baseline” and observation costs with BARC map
 - “baseline” and observation costs without EO
 - Consult with the Elk Complex Fire BAER team leader and RSAC scientists to identify values at risk priorities, probability estimates, actions taken, and cost estimates of a BARC based response and a counterfactual – helicopter and associated changes to implement the BAER response process.
 - Acquire and organize BAER decisions and costs in a spatial dataset.

Pre-fire and Burn severity maps of the 2013 Elk Complex fire in the Boise National Forest, Idaho

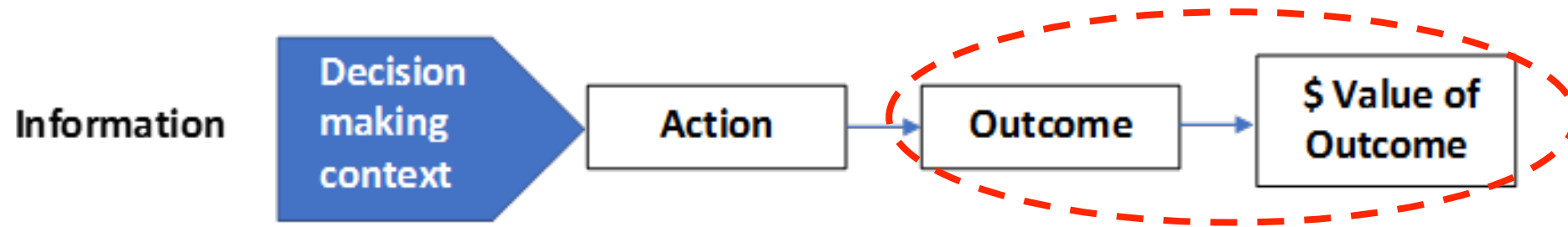


Step 2: Characterize the decision context and available actions



- The Elk Complex Fire Emergency Stabilization Plan objective:
 - Identify imminent post-wildfire threats to human life and safety, property and critical natural or cultural resources and take immediate actions to manage unacceptable risks.
 - Determine risk by assessing the probability for post-fire damage and the magnitude of consequences if damage occurred.
- EO contributes frequent, objective and timely input into the BARC and burn severity classification.
- Assessment team uses soil burn severity maps to:
 - Validate soil burn severity during field reconnaissance.
 - Classify areas into Low soil burn severity (26,845 acres), Moderate soil burn severity (63,022 acres) and High soil burn severity (33,285 acres).
 - Evaluate the magnitude of risk posed for each value and determine the appropriate response.

Step 3: Characterizing outcomes and socioeconomic benefits



Quantify the societal benefits of EO:

- If EO are available, the BAER team uses a Burn severity map based on a BARC map.
- If EO and the BARC are not available, the decision maker has to substitute helicopters for a BARC map as a counterfactual response.
 - Use of helicopters requires a reallocation of resources to make the post-fire decisions.
- Decisions are made with and without the BARC map to identify the degree to which the BARC maps are more cost effective.
- Estimate the cost of the Elk Complex Fire BAER response with the BARC map. Estimate the cost of the Elk Complex Fire BAER response without the BARC map (counterfactual). The value of the EO is the expected cost effectiveness of the BARC map.



NOAA/
NASA

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