

OPERATIONS RESEARCH (OR) METHODS FOR WILDFIRE DECISION MAKING UNDER RISK & UNCERTAINTY

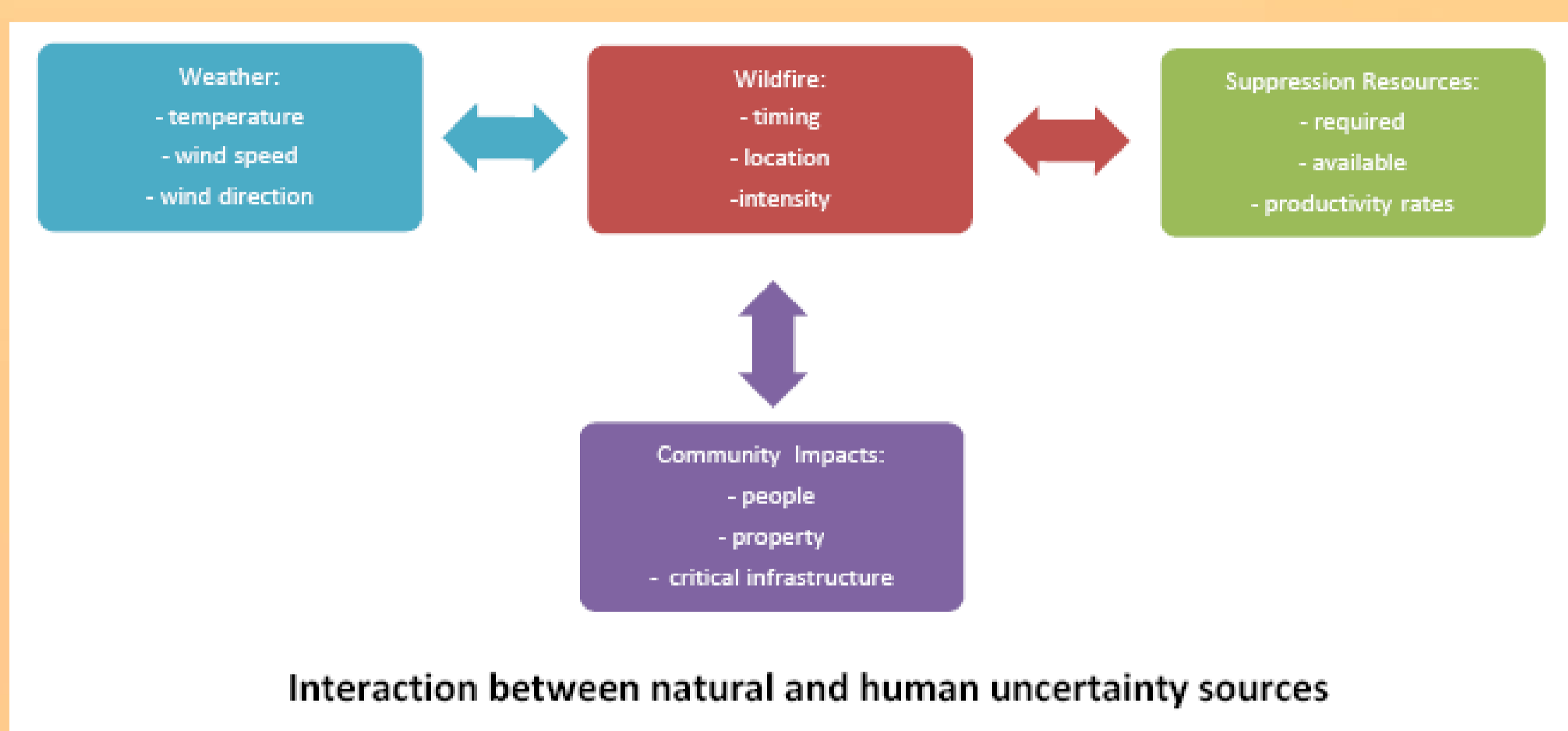
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1. Uncertainty in Wildfire Management

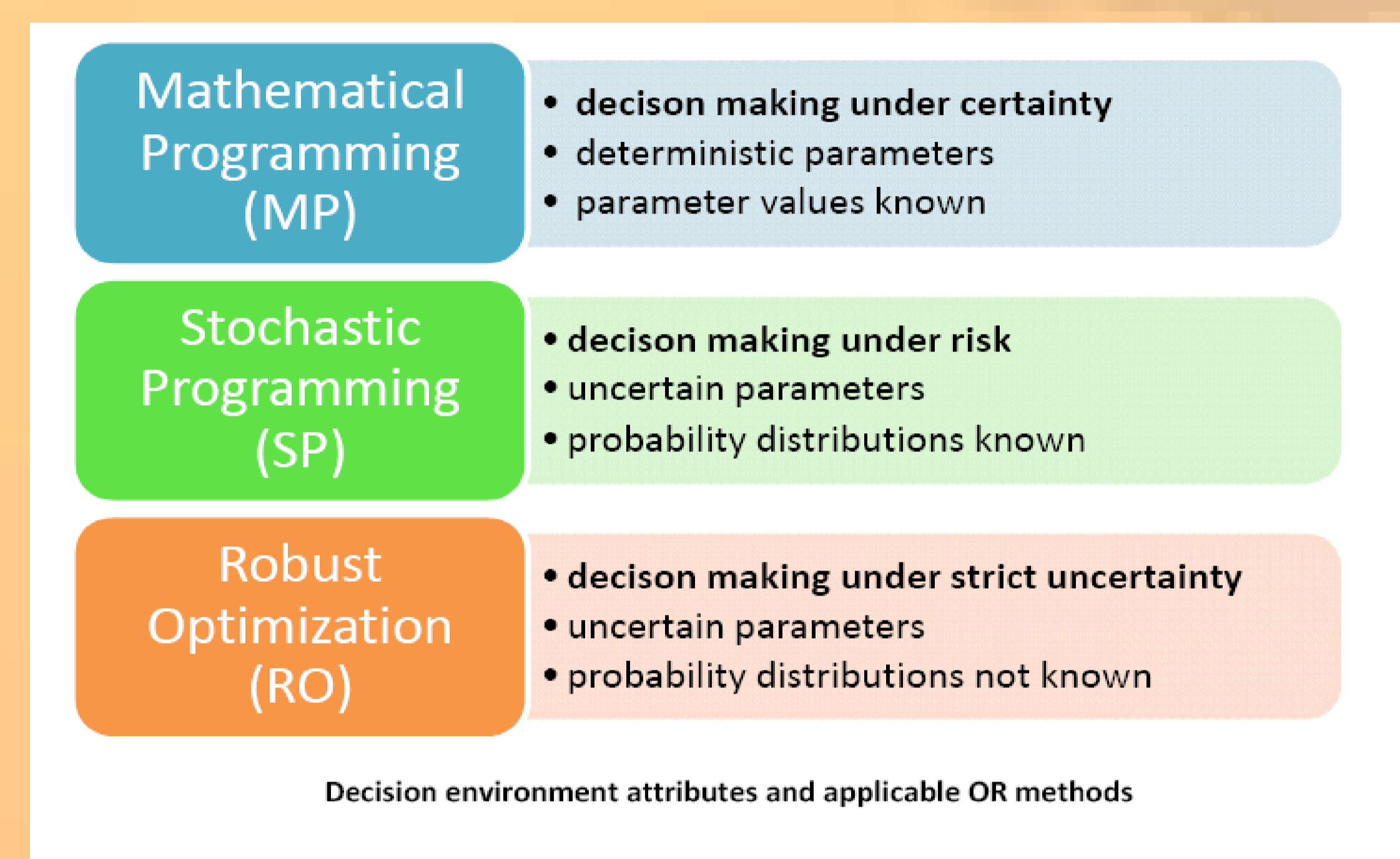
Wildfire managers make difficult decisions in conditions of uncertainty. Efforts have been made to reduce uncertainty through advances in science and technology. However considerable residual uncertainty exists due to the complex nature of wildfire management.

Uncertainty sources include natural and human systems and their interaction.



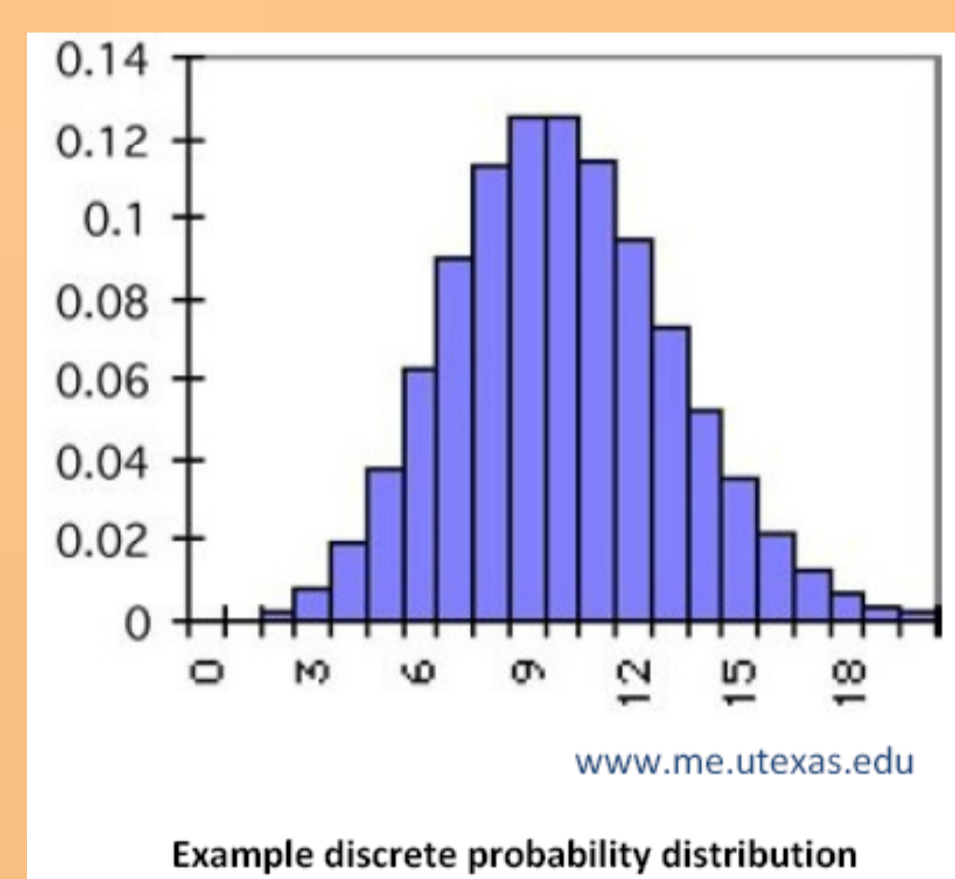
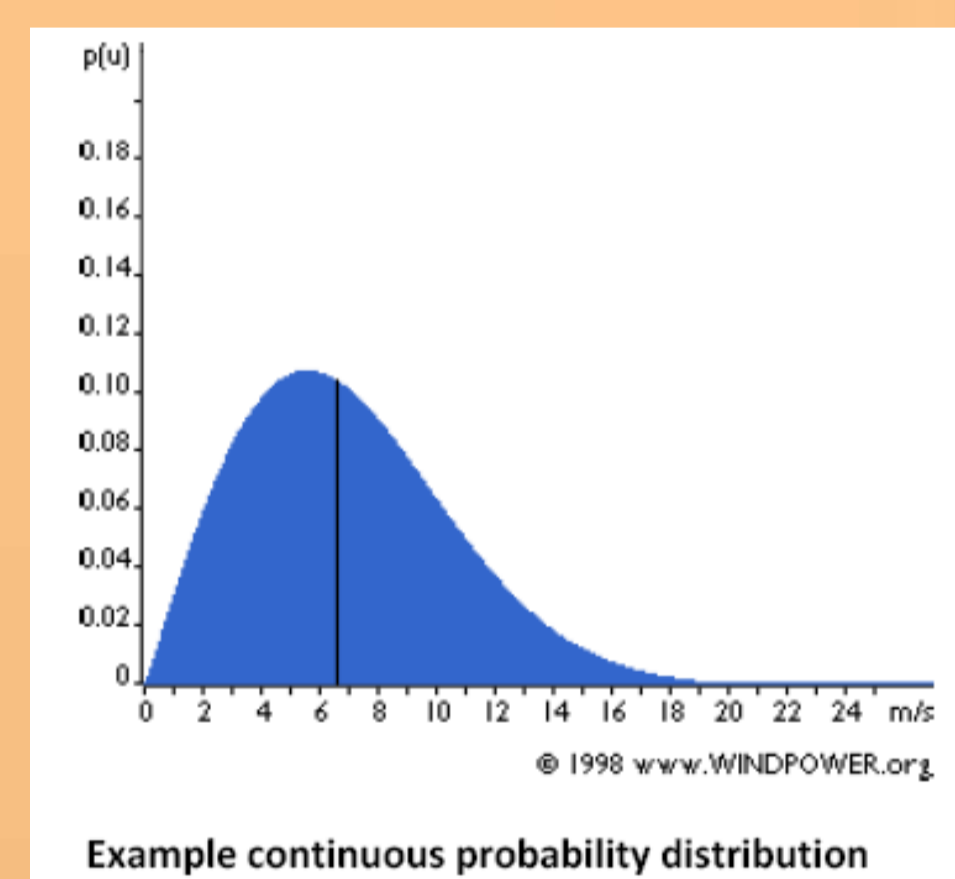
2. Operations Research (OR) Methods

OR is the use of an analytical approach to aid decision making in complex real-world systems. OR methods have been used in the development of wildfire decision support systems. Decision making environments can be divided into three categories: certainty, risk and strict uncertainty. OR methods are available for each of these decision categories.



3. Stochastic Programming (SP)

SP models are applicable for decision making under risk. SP models require estimates of random parameter distributions. These distributions can be either continuous or discrete.



There are a range of approaches to formulating SP models, some of these are detailed in the table below.

Mean Outcome	Mean-Variance	Probabilistic
<ul style="list-style-type: none"> minimizes expected cost 	<ul style="list-style-type: none"> minimizes weighted sum of expected cost and variance incorporates decision maker risk aversion 	<ul style="list-style-type: none"> probability of constraint violation below a specified threshold

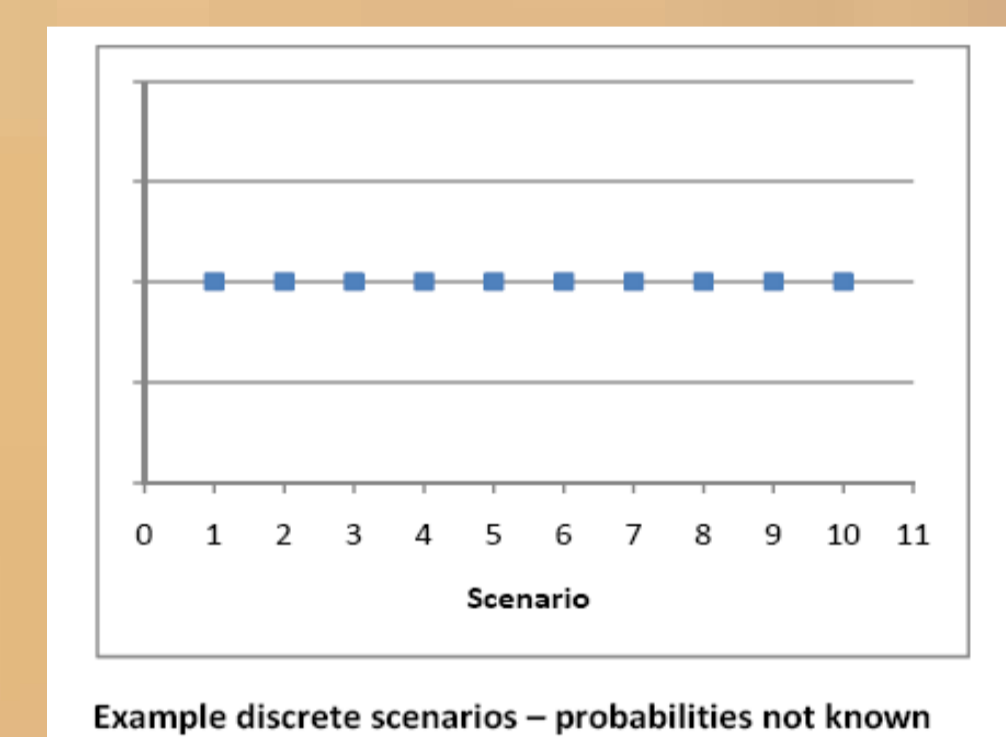
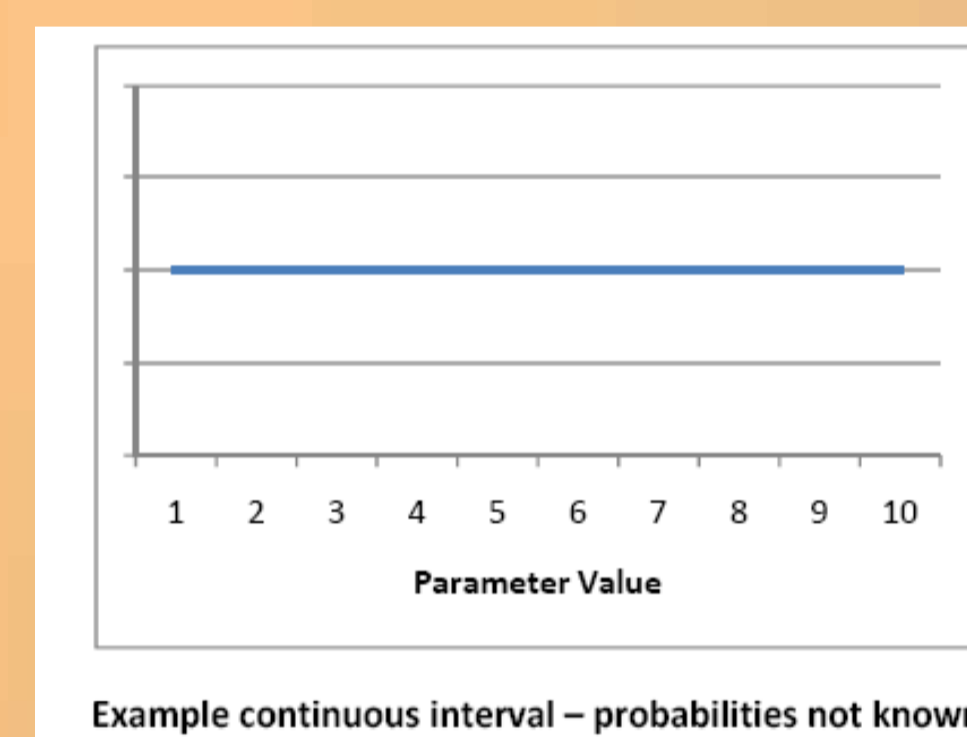
Stochastic programming approaches and objectives

Examples from the literature of SP applications include:

- emergency facility location and vehicle assignment
- disaster-relief logistics
- fuel management planning
- supply change management

4. Robust Optimization (RO)

RO models are applicable for decision making under strict uncertainty. RO models do not require probability information about uncertain parameters. An uncertain parameter may be described by a continuous intervals or by discrete scenarios.



There are a range of approaches to formulating RO models, some of these are detailed in the table below.

Minimax	Model and solution robustness	Restricted scenario space
<ul style="list-style-type: none"> minimizes maximum cost across all possible scenarios conservative approach that can lead to costly solutions focuses on catastrophic scenarios appropriate when critical for system to function well in worst-case scenario 	<ul style="list-style-type: none"> model robustness: almost feasible for all scenarios solution robustness: almost optimal for all scenarios weighted objective function balancing feasibility and optimality incorporates decision-maker preferences 	<ul style="list-style-type: none"> restricted “reliability set” of scenarios specified by decision-maker minimizes maximum cost across reliability set excludes catastrophic scenarios that are unlikely to occur

Robust optimization approaches and objectives

Examples from the literature of RO applications include:

- emergency facility location
- supply change management