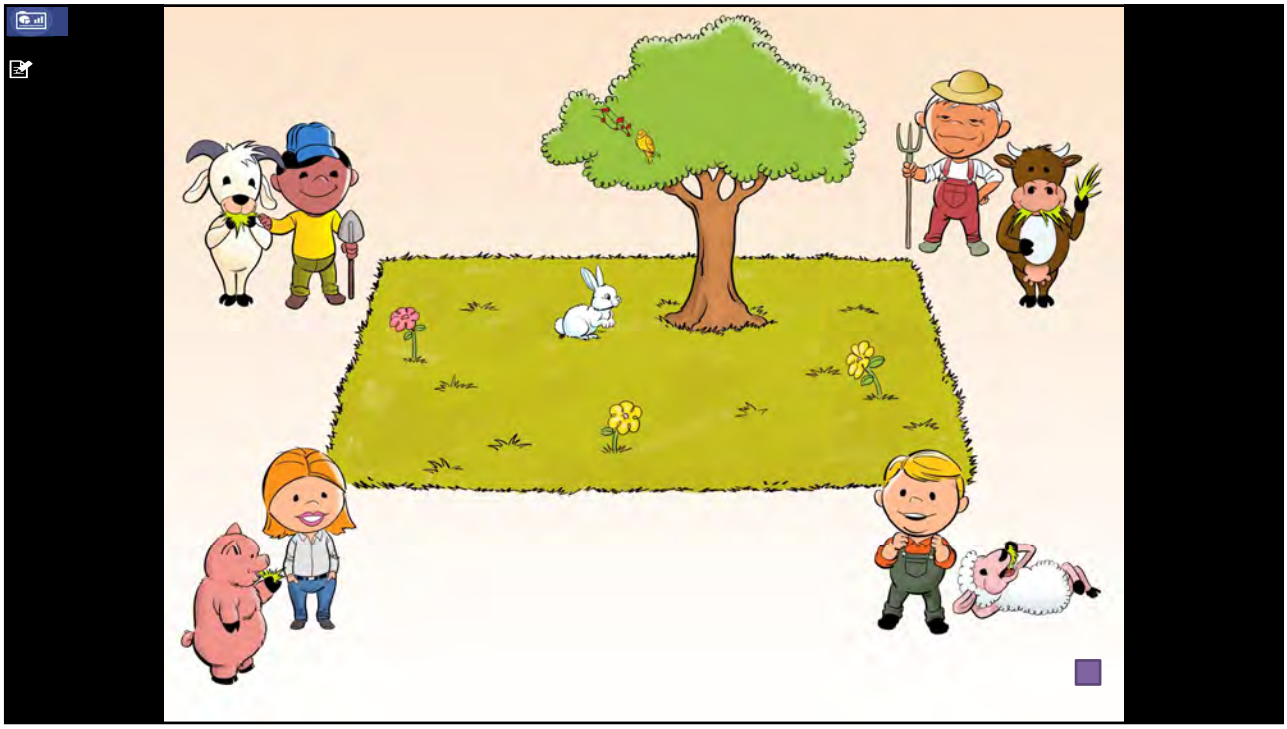
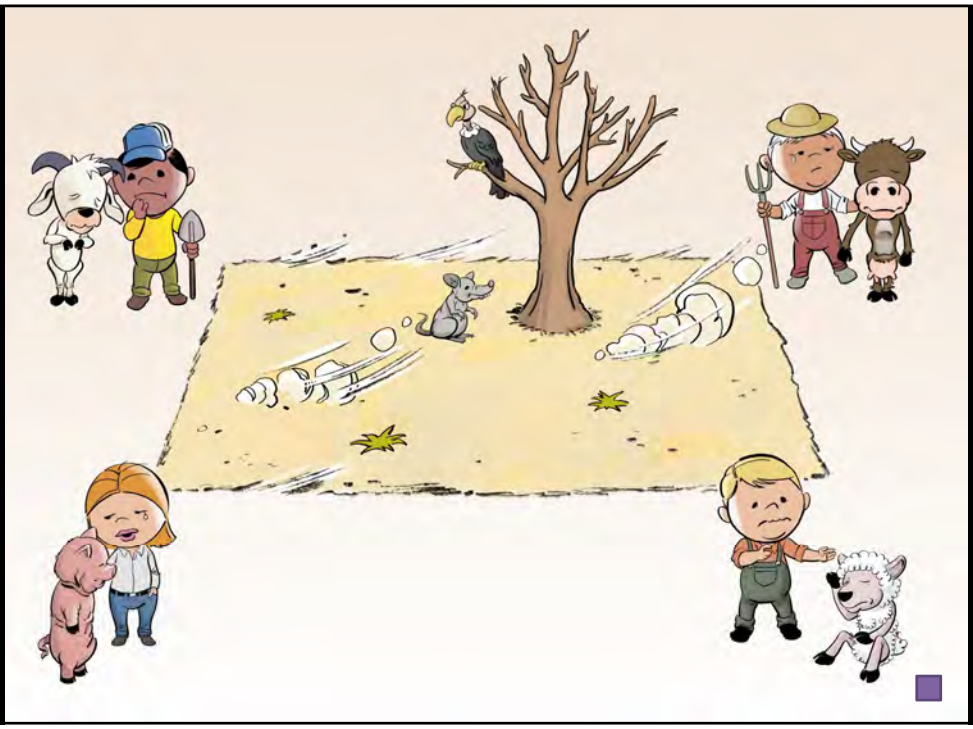
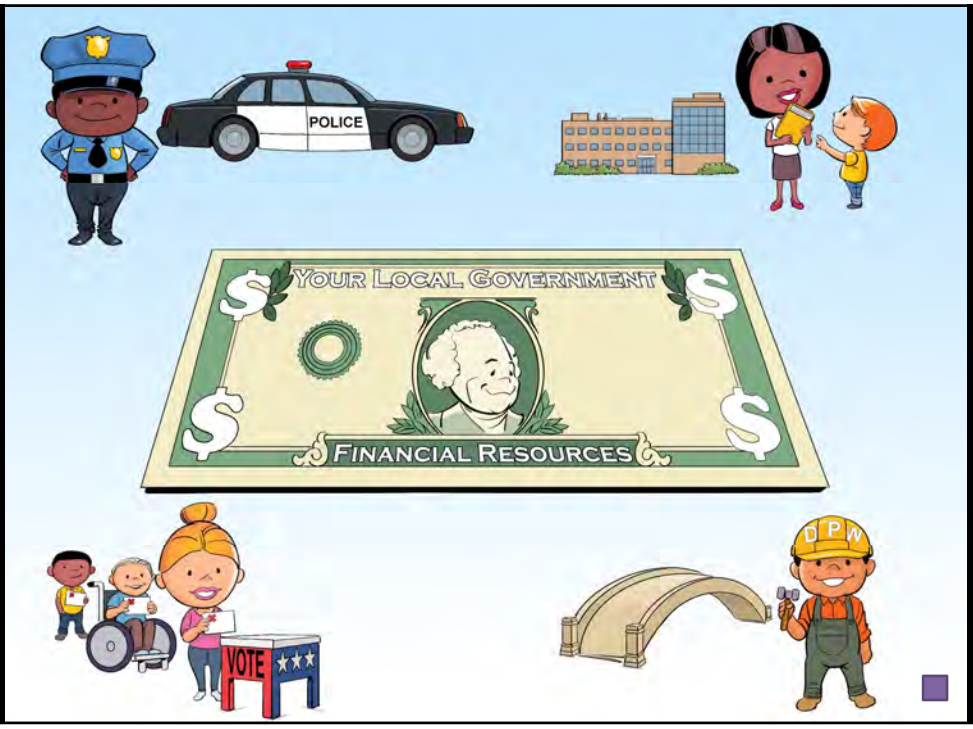
# Reserves
## *How Much is Enough?*

Finding the Right Amount for your Community

California Municipal League, December 2018



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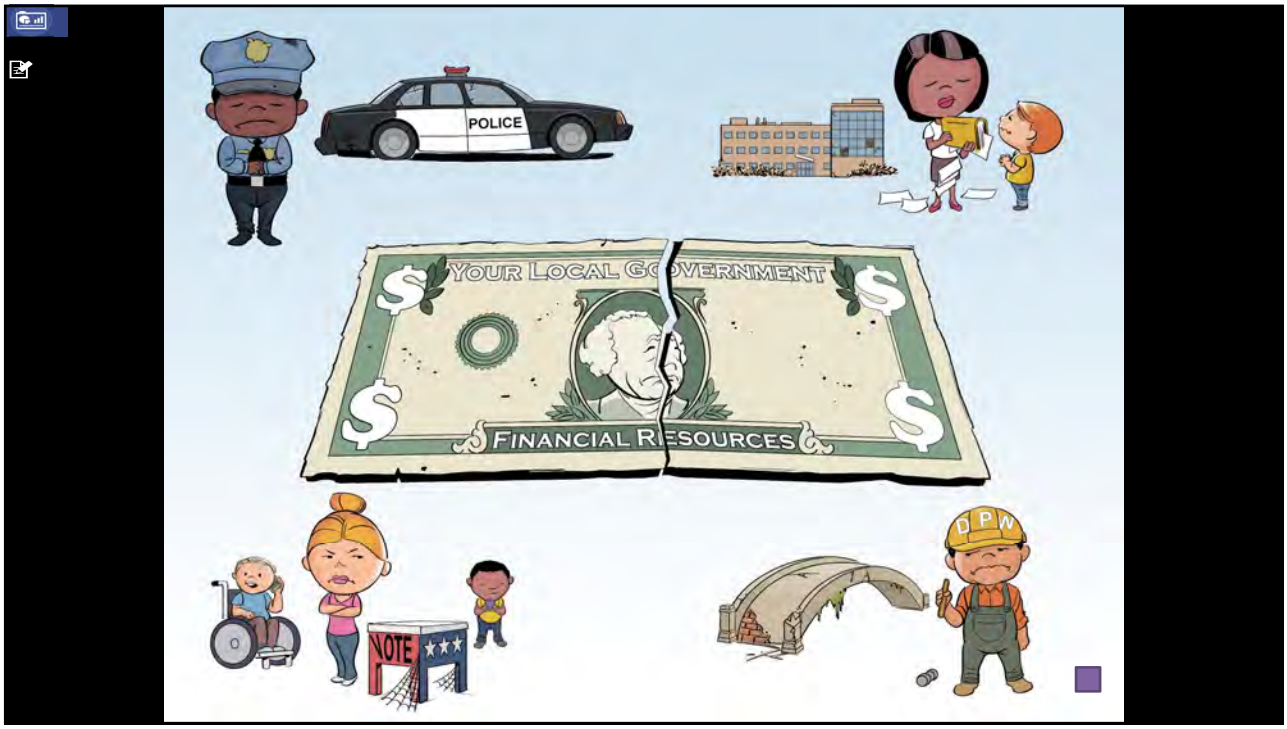
YOUR LOCAL GOVERNMENT
FINANCIAL RESOURCES
VOTE
DPW


POLICE
YOUR LOCAL GOVERNMENT
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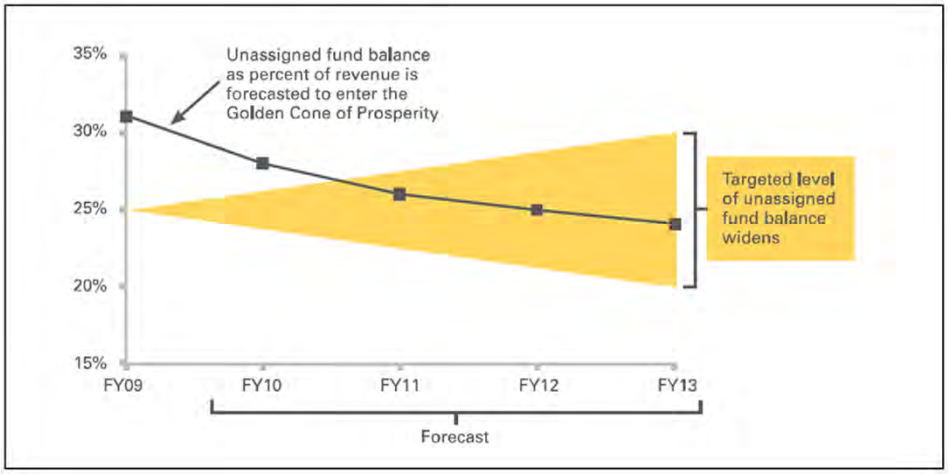
# The Golden Cone of Prosperity




# A Reserve is a Hedge Against Risk

***But how much is enough?***

# A Complete Definition of Risk*

**The probability and magnitude of a loss, disaster, or other undesirable event**

*Definitions on this and previous slide from Doug Hubbard in *The Failure of Risk Management*

# Why We Need Probabilities

"Without numbers, there are no odds and no probabilities; without odds and probabilities, the only way to deal with risk is to appeal to the gods and the fates. Without numbers, risk is wholly a matter of gut."

-Peter Bernstein, *Against the Gods: The Remarkable Story of Risk*

# Why Not Go With the Gut?

What will the next color be?

vs.

# Cognitive Biases

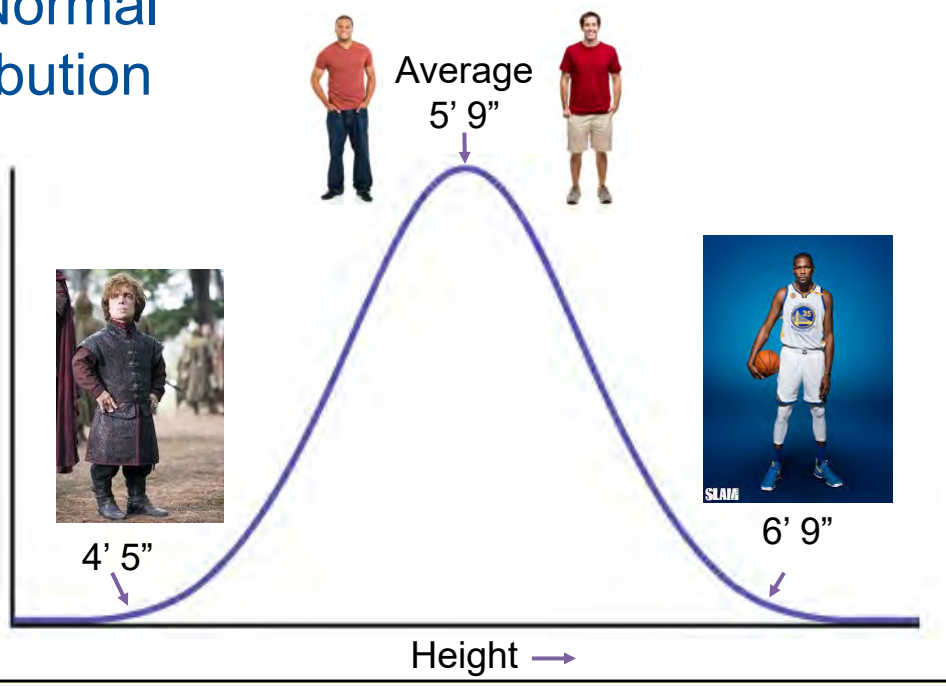
- **Overconfidence bias.** We are overconfident in our predictions and underestimate uncertainty. Research shows we usually underestimate uncertainty by around 50%.
- **Availability bias.** Details that are more easily recalled are overweighed when assessing risk.
  - Example: Flood insurance
- **Confirmation bias.** Random patterns will be taken as evidence if they match an expectation.

# Beware the "Flaw of Averages"*

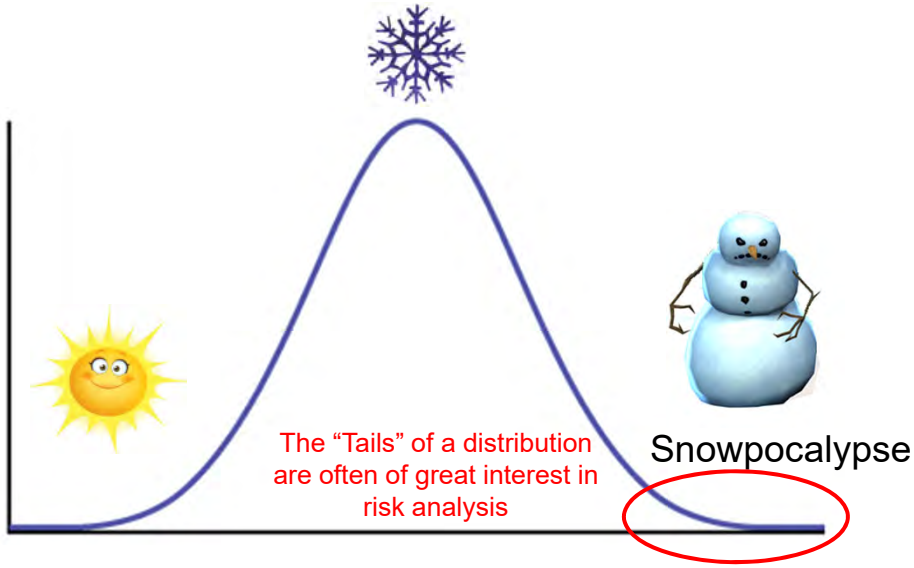
- Averages condense down a range of possibilities into a "convenient" single number
- This obscures the variation you are subject to
- Variation is a source of uncertainty
- Understanding uncertainty is key to understanding risk

*See Sam Savage, *The Flaw of Averages*, 2009

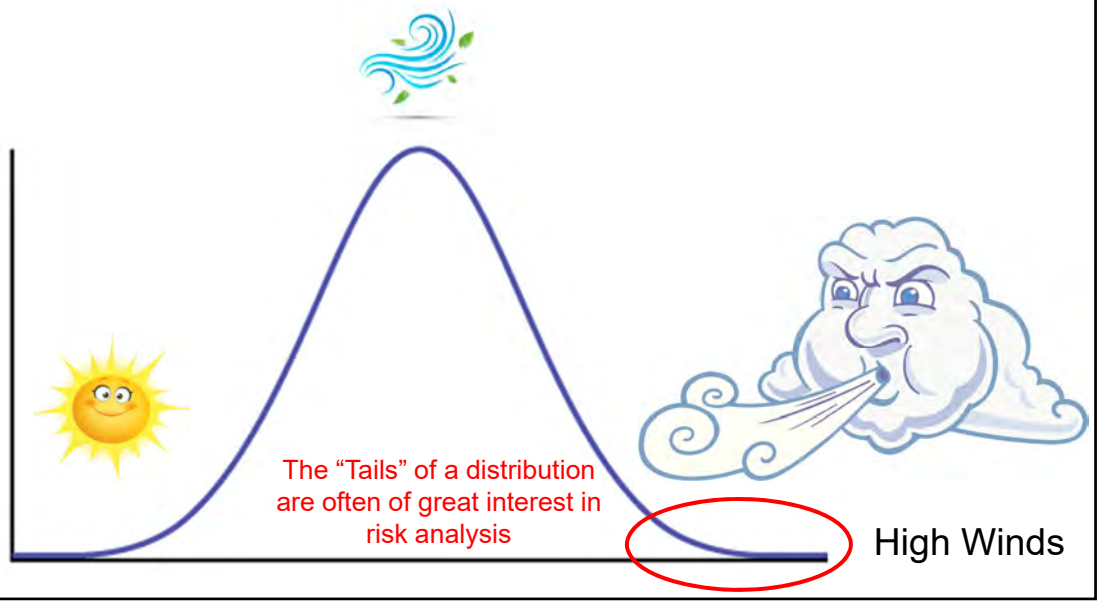
# The Normal Distribution



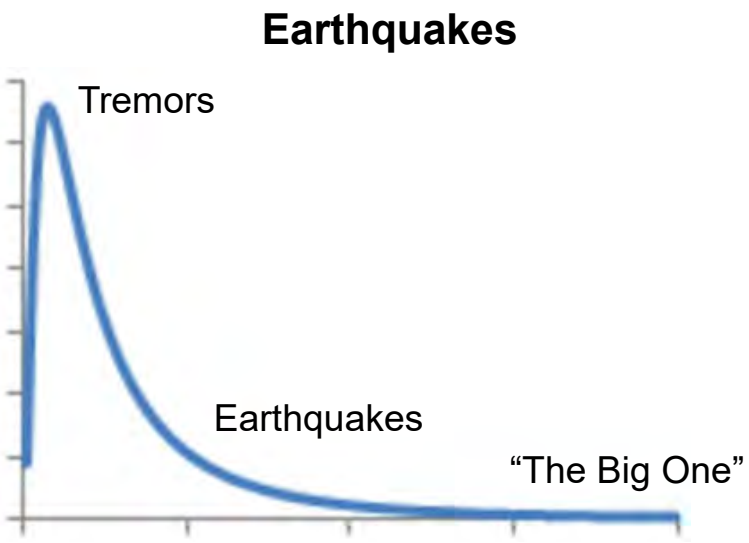
# Normal Distribution in Cities



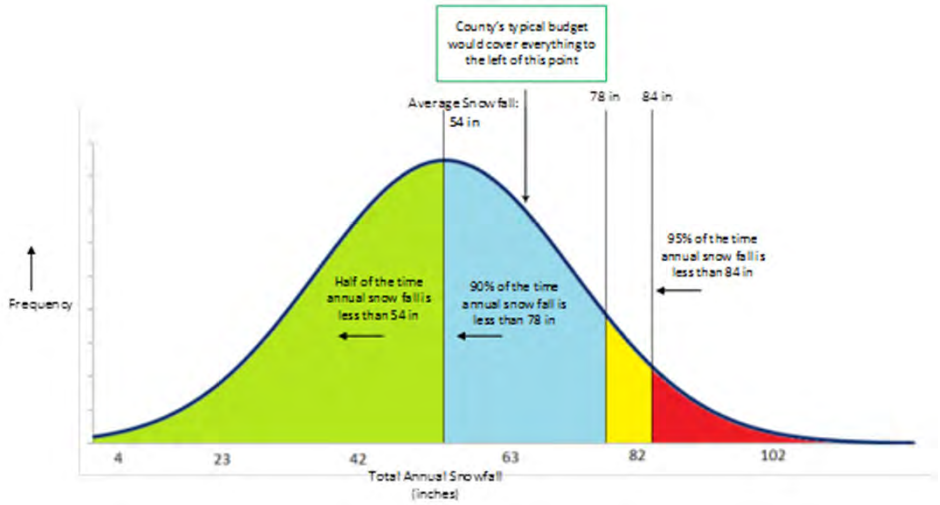

# Normal Distribution in Cities



# Asymmetrical Distribution



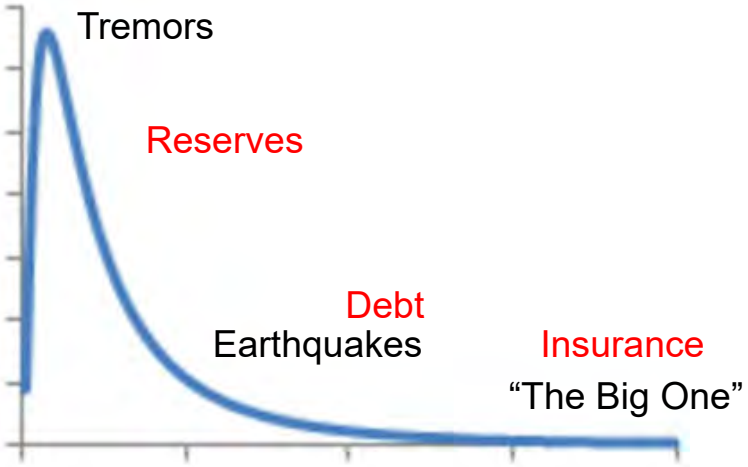

# "Subway" Uncertainty*




*Terminology from Spyros Mikridakis, et al. *Dance with Chance*

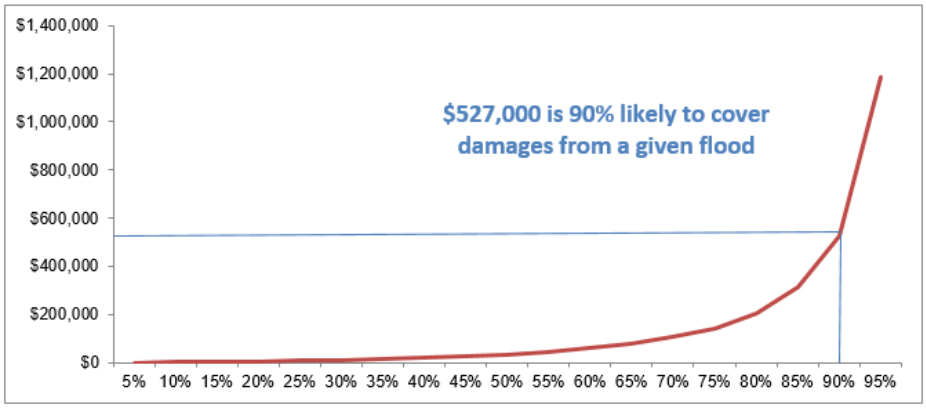
# “Meteorite” Uncertainty

**Earthquakes**




# Cumulative Probability Chart

Floods



# Risks aren't Additive

| Likelihood of covering the extreme event | Hazardous Materials | Wildfires | Total (New Distribution of Total Risk) | Total (Simple Sum of Individual Risks) |
|---|---|---|---|---|
| 90% | $3.1 million | $2.5 million | $4.7 million | $5.6 million |
| 95% | $3.5 million | $2.8 million | $5.2 million | $6.3 million |
| 99% | $4.1 million | $3.2 million | $6.1 million | $7.3 million |

# Probability of Extreme Events over Various Time Horizons

## Poisson Distribution

| | | Time Horizon | | | | |
|---|---|---|---|---|---|---|
| | | 1 year | 2 Years | 3 Years | 4 Years | 5 Years |
| Number of Extreme Events that Occur | 0 | 81.9% | 67.0% | 54.9% | 44.9% | 36.8% |
| | 1 | 16.4% | 26.8% | 32.9% | 35.9% | 36.8% |
| | 2 | 1.6% | 5.4% | 9.9% | 14.4% | 18.4% |
| | 3 | 0.1% | 0.7% | 2.0% | 3.8% | 6.1% |
| | 4 | 0.0% | 0.1% | 0.3% | 0.8% | 1.5% |
| | 5 | 0.0% | 0.0% | 0.0% | 0.1% | 0.3% |

# The Method

## Triple-A Approach to Uncertainty

- Accept
  - Uncertainty is inevitable
- Assess
  - Find potential impact, using reference cases – historical or analogues
- Augment
  - Uncertainty will usually be underestimated!

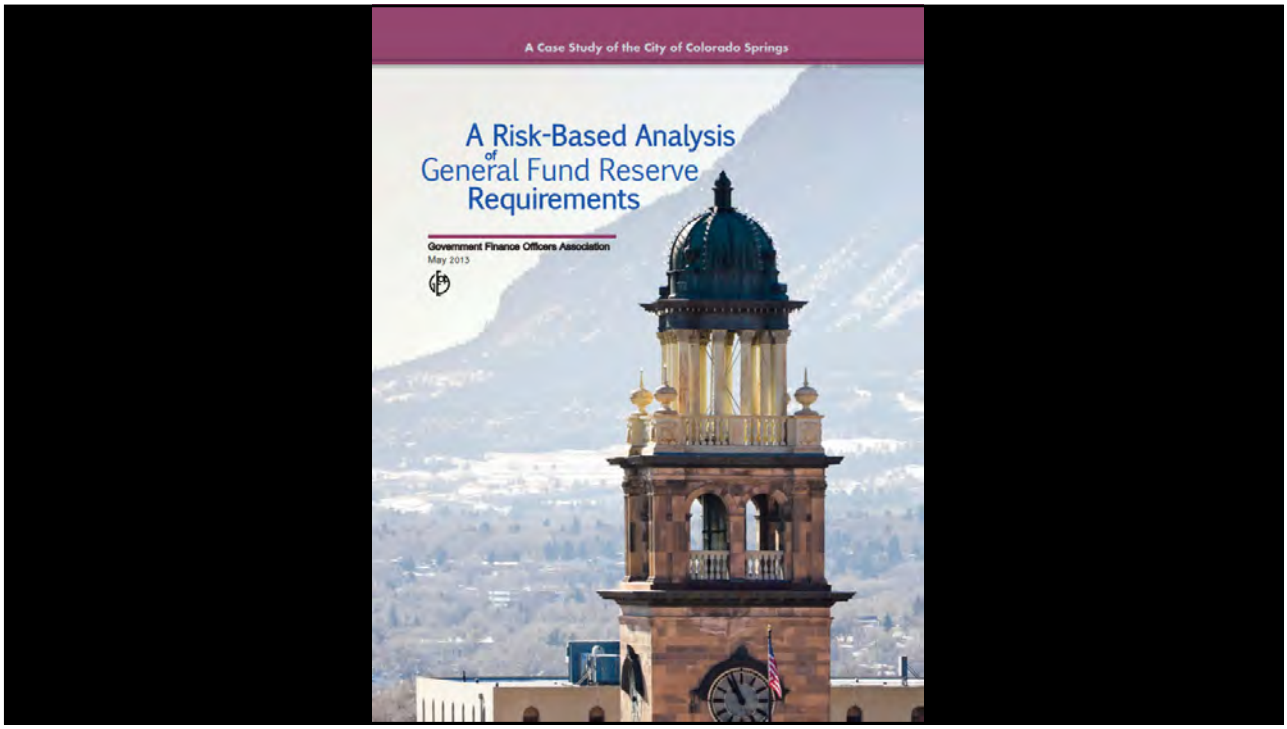
# Probability Management

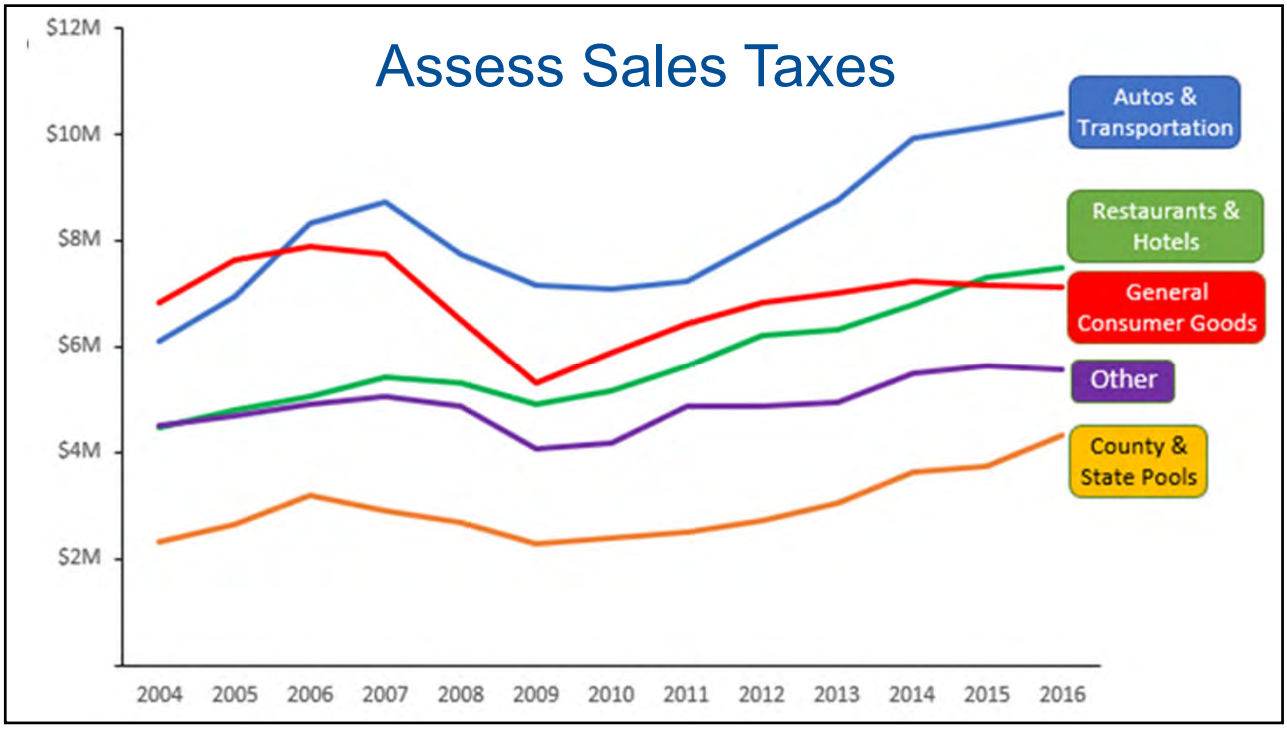
- Open-source standard for probabilistic analysis
- Works in 100% native Microsoft Excel
  - Free set of tools gives you shortcuts
- Makes “Monte Carlo” analysis more accessible than ever before

Probability Management

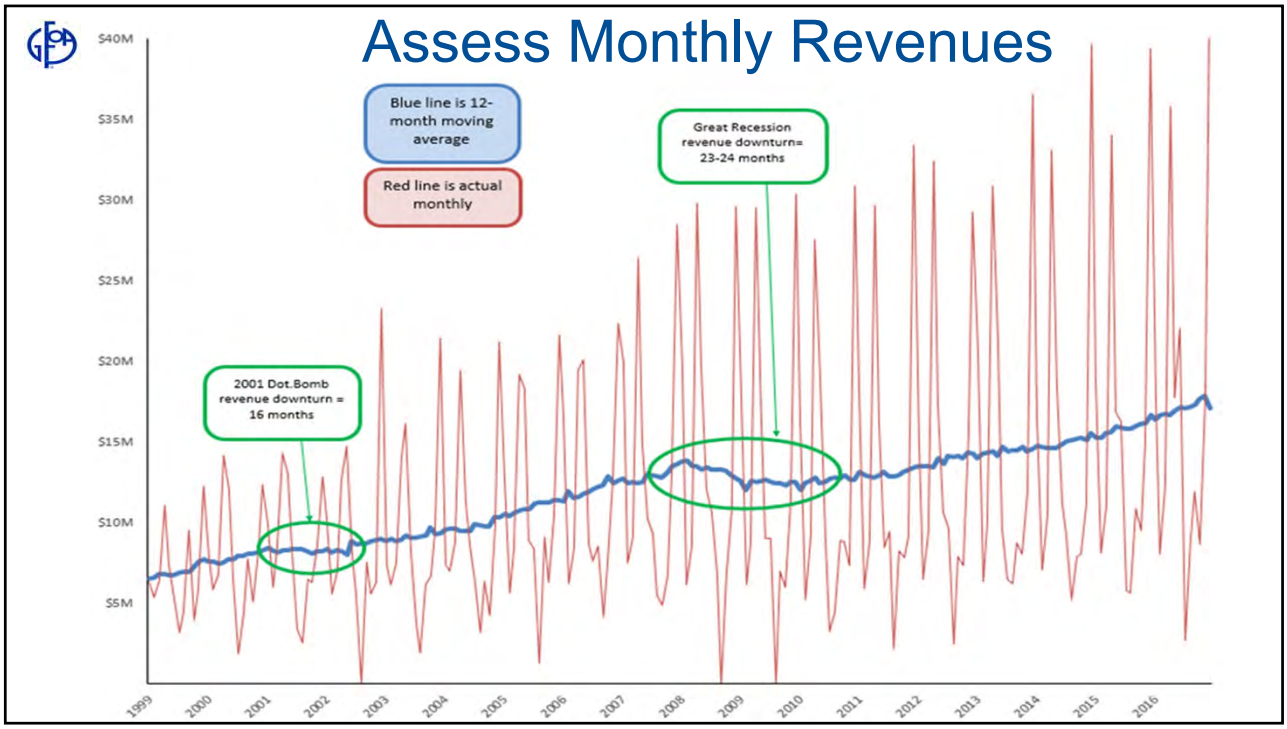
# Monte Carlo Analysis

- Computerized equivalent of developing your own custom set of dice to represent the likelihood of an undesirable event, and then rolling them thousands of times to see what happens

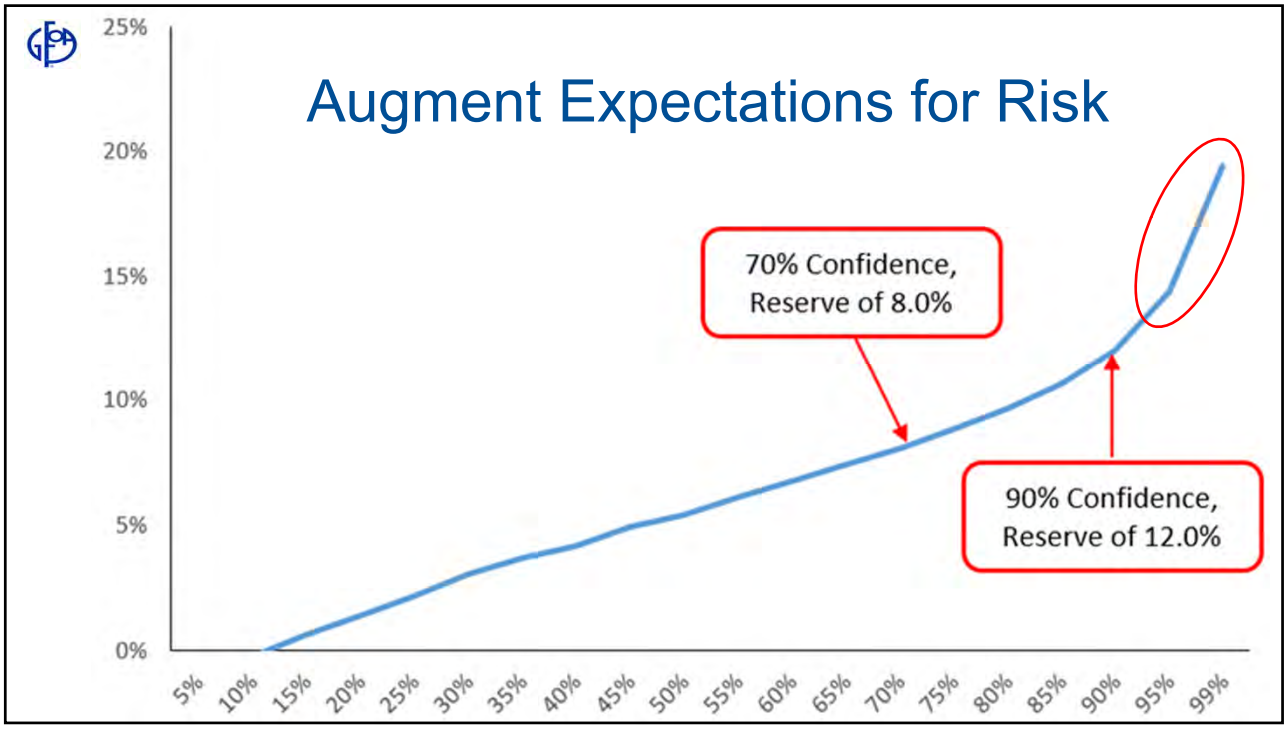

A Case Study of the City of Colorado Springs
A Risk-Based Analysis of General Fund Reserve Requirements
Government Finance Officers Association
May 2013


Assess Sales Taxes
$12M
$10M
$8M
$6M
$4M
$2M
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Autos & Transportation
Restaurants & Hotels
General Consumer Goods
Other
County & State Pools

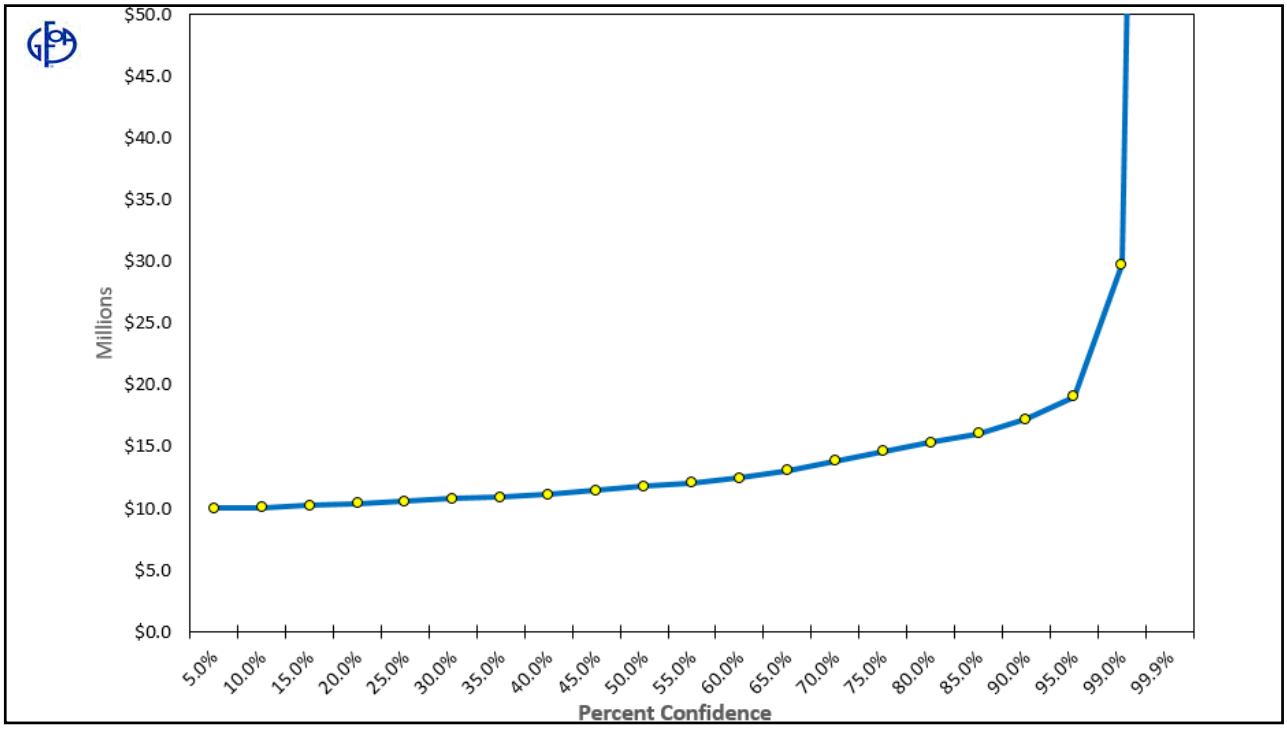
# Assess Monthly Revenues




# Augment Expectations for Risk



# The Model


$50.0
$45.0
$40.0
$35.0
$30.0
$25.0
$20.0
$15.0
$10.0
$5.0
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Millions
5.0%
10.0%
15.0%
20.0%
25.0%
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35.0%
40.0%
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55.0%
60.0%
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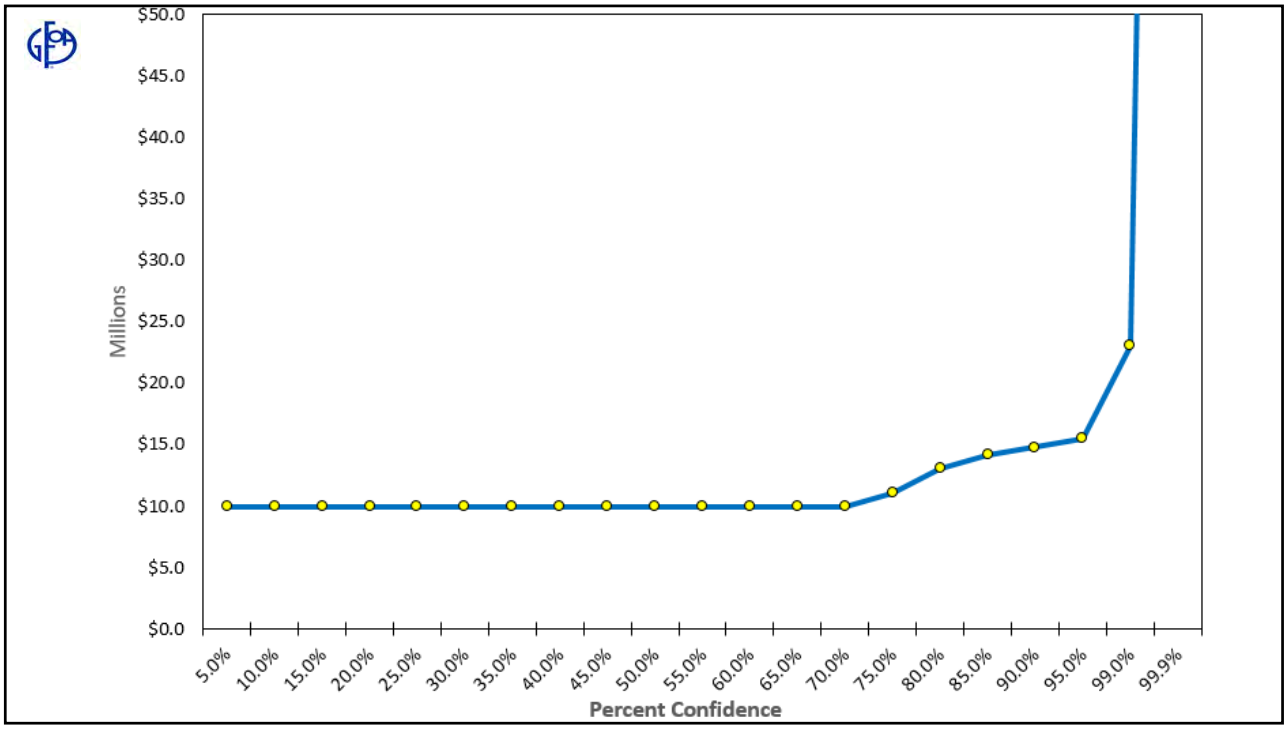
75.0%
80.0%
85.0%
90.0%
95.0%
99.0%
99.9%
Percent Confidence


$50.0
$45.0
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Millions
5.0%
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80.0%
85.0%
90.0%
95.0%
99.0%
99.9%
Percent Confidence