Building and Refining Scenarios
Module 4b– Selecting Drivers and Logics

I. Preparing for the process
II. Building and refining scenarios
III. Using scenarios to evaluate, prioritize, and implement management actions

Phases in Scenario Planning

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### Assateague Island National Seashore

The ID team identified the most important and most uncertain climate drivers that will affect conditions in the Park over the next 40 years.

#### Moving Target
- Epidemic change (wave-driven washover)
- Higher productivity in the marshes
- Increased sediment from runoff
- Island size decreases; estuarine and marine area increases
- Dune erosion
- Simplified habitats
- Impacts on infrastructure

#### Shifting Sands
- Dynamic; similar to today
- Expansion of complexity and stability of estuarine communities
- Lengthening of growing season
- Some lowering of the water table with impacts on flora and fauna
- Migration of species northwards
- Greater risk of vector-borne diseases

#### Parched
- Less precipitation; more drought events
- Lowering of water table; less available fresh water to the ecosystem
- High precip events may bring nutrient spike, blooms, and negative impacts to fisheries
- Increased risk of fire

#### Intense storms, Increased frequency
- Fragmentation; formation of multiple inlets
- Greater potential for breaching
- System unable to keep up with pace of change – from island to sandbar
- Habitats simplify, become uniform; less diverse
- Huge potential impacts to full range of communities (aquatic, terrestrial, salt marshes)

#### Drowning in Place
- Loss of land mass from sea level rise; island exists “further back”
- Individual storm events have big impact on resetting the landscape
- Recovery of system between extreme events is more likely
- Salt water inundation and intrusion into freshwater aquifer
- Shift in types of plants (tolerance for saline environs, higher temperature etc.)

### Climate Variable General Change Expected Confidence Level

<table>
<thead>
<tr>
<th>Climate Variable</th>
<th>General Change Expected</th>
<th>Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Increase, but not uniform</td>
<td>Virtually certain</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Probable decrease in total annual precipitation</td>
<td>Low</td>
</tr>
<tr>
<td>Sea Level</td>
<td>Increase</td>
<td>Moderate</td>
</tr>
<tr>
<td>Drought</td>
<td>A modest increase in drought frequency in the warm season</td>
<td>Moderate</td>
</tr>
<tr>
<td>Snow cover</td>
<td>Increase in snow-free days; decreased snow accumulations</td>
<td>High</td>
</tr>
<tr>
<td>Length of growing season</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Extreme Events: Temperature</td>
<td>Warm Events Increase / Cold Events Decrease</td>
<td>Moderate to high</td>
</tr>
<tr>
<td>Extreme Events: Precipitation</td>
<td>Possible decrease of frequency of heavy rain, but countered by rise in intensity.</td>
<td>Low to moderate</td>
</tr>
<tr>
<td>Extreme Events: Cold Season Storms</td>
<td>Increased intensity.</td>
<td>Low to moderate</td>
</tr>
<tr>
<td>Extreme Events: Warm Season Storms</td>
<td>Increased intensity; possible decrease in frequency</td>
<td>Low</td>
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</table>

Note: 1. The study also included additional information such as “Range of Change Expected & Reference Period”, “Size of Expected Change Compared to Recent Changes” and “Synoptic Signs”. The complete table can be found in the appendix to this document.
### Building Scenarios: Steps

1. Refine scope and focus question
2. Identify key external drivers
3. Assess and prioritize critical drivers
4. Explore and select scenario logics
5. Develop outlines of time evolution
6. Develop scenario narratives
7. Evaluate scenarios

### Scope/Focus and Key Drivers

- Identify a focal issue: the intersection of knowable & unknowable and controllable & uncontrollable
- Identify uncertainties with large impact on focal issue: 2-3 critical drivers or themes
- Consider views of key actors within your system

**Question**: What is a Driver?
Drivers: Key Uncertain Forces Outside Your Control

- changes in seasonal hydrology: rain/snow, seasonality shift, frequency and intensity of extreme events
- timing and type of precipitation
- seasonal water balance
- shifted seasonality
- rate of change: 4°C at 2100 vs. 2060
- fire frequency and severity
- extreme temperature events (>90, <70, <32)
Non-climate Uncertainties – Budgets…

From NYT, 2 Feb 2010

White House Budget Balance: Forecasted and Actual

PEST-STEEP-PESTLE Brainstorming

**Objective:** to identify all the variables that could have important impacts for your management challenge

<table>
<thead>
<tr>
<th>PEST-STEEP-PESTLE</th>
<th>Emerging Trends</th>
<th>Johansen, 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political</td>
<td>- Diasporas and emerging economies</td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td>- human migrations</td>
<td></td>
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<tr>
<td>Sociological</td>
<td>- distant connections</td>
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<tr>
<td>Technological</td>
<td>- Commons and collaboration</td>
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<tr>
<td>Legal</td>
<td>- volunteerism</td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>- coordination</td>
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**Activity 3**

- PESTLE Brainstorming: at least 5 drivers for each!
**Building Scenarios: Steps**

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**3. Assess and prioritize critical drivers**
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**PEST-STEPPPESTLE Brainstorming**

**Objective:** to identify all the variables that could have important impacts for your management challenge

**PEST-STEPPPESTLE**

- Political
- Economic
- Sociological
- Technological
- Legal
- Environmental

**Easy Method to Rank the Results:**
- Use sticky dots and vote
- Report out and re-vote
- Six dots per person
- Apply in any combination (1 on 6, 6 on 1)

**Activity**

- PESTLE Brainstorming: at least 5 drivers for each!
Southwest Regional Climate

- Drier Spring Season
- Intense and prolonged winter drought in Upper River Basin
- Cold Snaps
- Multi-Season Drought
- Tornadoes
- Monsoon Onset
- Windier
- Flooding – Atmospheric Rivers

Cienegas Montane Systems

- Resource funding
- Species conversions
- Catastrophic fire regime
- Soil loss
- Societal tolerance for fire
- Increased T
- Groundwater hydrology, springs
- Fire severity/impacts
- Invasive plants
- Increased wind
- Ignitions human
- Ignitions natural
Crown of the Continent Region

High

Temperature increases

Shifts in temperature extremes

Winter precipitation increase

Fire frequency and severity

Changes in seasonal hydrology/Seasonal water balance

Summer precipitation increase/decrease

Rate of temperature change

Crossing environmental temperature thresholds

Timing and type of precipitation

Shifts in other extremes: Precip, Wind

Low

UNCERTAINTY

Low

Uncertainty

High

IMPACT

IMPACT

Cienegas Upland Systems

High

Decadal climate events: drought & warming

Decreased winter precip.

Energy development

Targeted eradication techniques

Decadal flooding

Significant decline in funding

Collapse of social order

Fire frequency

Invasive species

Low

UNCERTAINTY

Low

Uncertainty

High

IMPACT

IMPACT
**Alternative Impact vs. Uncertainty Table**

```
Indirect IMPACT

Higher
UNCERTAINTY

“Potential Jokers”  “Key Uncertainties”

“Context Shapers”  “Significant Trends”

Lower
UNCERTAINTY

Direct
IMPACT
```

modified from Ratcliffe 2002

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**Prioritizing Critical Drivers**

**Objective:** to prioritize drivers for use in building scenarios

**Outcomes**
- Identify 2-7 drivers to consider in generating scenarios
- Identify drivers that should appear in all scenarios

**Activity 5**
- Impact vs. Uncertainty Plot
## Building Scenarios: Steps

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## Scenario Logics

1. Refine scope and focus question  
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3. Assess and prioritize critical drivers  
4. **Explore and select scenario logics**  
   - Quadrant Method  
   - Nested Quadrants  
   - Chained Quadrants  
   - Themes  
   - Decision Tree  
   - Matrix  
   - NPS “Flash Cards”  

**Goal:** Strategically select 3-5 diverse and challenging scenarios for building out into more detail
Southwest Regional Climate Scenarios

FOR ALL CLIMATE QUADRANTS: Temperatures increasing; Temperature extremes increasing; Environmental thresholds exceeded; Earlier spring runoff; Growing season & Fire season extended; Phenological mismatches

Cienegas Montane Systems

Preservation
- Water conservation
- Low overall water use
- Protected natural areas
- Less funding?
- Survivalist stewards remain

Loved to Death
- Low per capita water use
- High visitation/urban impact
- Protected natural areas
- More funding?

No One’s Watching
- Shortage of watch dogs
- Boom and bust extraction?

Developers Rule
- Inc water use
- Inc insecurity
- Inc invasive species
- Maximal extraction
- Only accidental habitat left
- “Last Child in the Woods”
Salt River Basin, AZ Water Supply Research

AZ & NM Water Management Research
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Climate Scenarios

- PDO moderation in early decades
  - warmer, more humid & dynamic system
  - increased storminess
  - droughts intra-annual
  - overall increase in productivity
  - fires more isolated in time, space
- Dynamic, volatile climate
  - hydrologic flashiness: rain-on-snow; storms year-round
  - water stresses locally moderate
  - significant chances of intense intra-annual drought
  - rapid ecological responses
  - emergence of novel ecosystems

- Drier climate in non-winter months
  - recurring summer/fall moisture stress: streams, meadows, wetlands
  - fire regime changes: higher severity, extent, frequency
  - with every disturbance, shift to drier ecosystems
  - eventual regional change favoring shrubs and grasslands

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Race to Refuge

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Volatile Surprise
Nested Scenario Development

- Cross the critical uncertainties together to form a high-level matrix. This creates 4 different pictures for the future social and political landscape around climate change.

**Nature of Leadership**

- **Broad Understanding, Heightened Urgency**

**Big Problems, Big Solutions**

- Coordinated action around the world as climate change (and its effects on weather, resources and people) becomes seen as an increasingly urgent and widespread challenge. Political leaders initiate bold decisions and policies to mitigate the worst, and adapt to the inevitabilities of climate change effects.

**Wheel-Spinning**

- Despite growing scientific evidence that has convinced leaders across the world, climate change remains a remote concern for the majority of everyday people. Consumers and businesses rail against carbon caps and prices, claiming them to be "just another tax" imposed by the elite.

**Is Anyone Out There?**

- To the frustration of many, climate change becomes a variable concern that is often ignored by political and business leaders. Scientific consensus breaks down, other societal challenges loom large, meaning that climate change is seldom on the front pages, or in the forefront of political and business leaders’ minds.

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**Nested Scenarios for Planning**

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**Senior commitment**

- **Alignment**
- **Long-term perspectives**

**Widespread indifference**

- **Competing concerns**

---

**Non-Winter Precipitation**

- **Rate of Change of Temp. Increase**
- **Surprise Refuge Colorado**

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**Lack of senior commitment**

- **Varied approaches and alignment**
- **Short-term concerns**

---

**Cross the critical uncertainties together to form a high-level matrix. This creates 4 different pictures for the future social and political landscape around climate change.**

NPS, 2010
SOCIETAL CONCERN

NATURE OF LEADERSHIP

Broad understanding
Heightened urgency

Big problems, Big solutions...

Wheel-Spinning...

Is Anyone Out There?

Non-Winter Precipitation
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Climate Complacency

Nested Scenarios for Planning

Cienega Watershed Scenario Planning

Sporemageddon

Snowpocol

Haboolob Trap

Florida

No Analog

SUMMER COOL

WINDY

WEST

WINTER BARREN

SUMMER HOT

EAST

MORPHING

DROUGHT

EASY

MORPHED

DISCUSS

FLAMBOYANCE

No Analog

Tucson Good Ol' Days

Discrepancy of Cordillera Trench

Hi & Lo

Thorro's

The Hope: Natural

Winter

Lizard

No Analog

Gila Bend Disco Inferno

three months of Lima
Scenario Logics

1. Refine scope and focus question
2. Identify key external drivers
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   - Quadrant Method
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Goal: Strategically select 3-5 diverse and challenging scenarios for building out into more detail

Chained Scenarios: Tucson Water 2000-2050, 2008 Update, and Beyond

Tucson Water: 225,000 connections, 775,000 people, 350 square miles

and 2008 Update
Chained Scenarios: Short-term Uncertainty over Customer Values re: CO R Water

- Industry Standard
  - Public Accepts EPA/ADEQ Water Quality
  - Some Direct Treatment of Colorado River Water at the Hayden-Udall Plant
- Surface Enhancement
- Enhanced Recharge
- No Direct Treatment - All Colorado River Water is Recharged

Chained Scenarios: Long-term Uncertainty over Customer Values re: Wastewater Effluent

- Potable-Plus Treatment
- Recharge Optional
- No Potable Use
- End-Use Treatment
- Recharge Required
- Potable Use
Combining Short- and Long-term Scenarios

Revisiting the Scenarios in 2008

New critical uncertainty: Water demand

Some uncertainties gone: Decision H2O in 2006/7. Customers OK with basic water standards
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### Theme-based Scenario Development

**Water Utilities Climate Alliance (WUCA):** 10 large metro providers to 43M
- review and test decision approaches (Scenario planning, Robust Decision Making, Portfolio Analysis)

**Denver Water’s Planning Futures**
- **Traditional Future** - The future is extrapolated from past trends, few other unanticipated major changes occur. (“Business as Usual”)
- **Water Quality Rules** - The public demands the highest practical quality of drinking water.
- **Hot Water** - A warmer climate accompanied by more frequent and more severe droughts.
- **Economic Woes** - An ongoing energy crisis accompanied by a prolonged, deep economic downturn.
- **Green Revolution** - Environmental values become dominant social norms.

Waage, 2010.
**Decision Tree Scenario Development**

**Perceived Advantage:** can start with "official future", "least change", or "business as usual" futures

Good for “Yes/No” uncertainties. Examples:
- new mining development
- species goes extinct
- transformative fire
- others??
- wilderness designation
- invasive becomes naturalized
- Indian water rights settlement

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**IPCC SRES Scenarios: Drivers of Global Climate**

**Caution!** With lots of drivers: More difficult to confirm plausibility and internal logical consistency of scenarios

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<td>Scenario Group</td>
<td></td>
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<td>Population growth</td>
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<td>low</td>
<td>low</td>
<td>high</td>
<td>low</td>
<td>medium</td>
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<tr>
<td>GDP growth</td>
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<td>very high</td>
<td>very high</td>
<td>medium</td>
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<tr>
<td>Energy use</td>
<td>very high</td>
<td>very high</td>
<td>very high</td>
<td>high</td>
<td>high</td>
<td>low</td>
<td>medium</td>
</tr>
<tr>
<td>Land use changes</td>
<td>low-medium</td>
<td>low-medium</td>
<td>low</td>
<td>low</td>
<td>medium</td>
<td>high</td>
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<tr>
<td>Resource availability</td>
<td>high</td>
<td>high</td>
<td>medium</td>
<td>medium</td>
<td>low</td>
<td>low</td>
<td>medium</td>
</tr>
<tr>
<td>Pace and direction of technological change</td>
<td>rapid</td>
<td>rapid</td>
<td>rapid</td>
<td>rapid</td>
<td>slow</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>Change favoring</td>
<td>coal</td>
<td>oil &amp; gas</td>
<td>balanced</td>
<td>non-fossil</td>
<td>regional</td>
<td>efficiency &amp; de-materialization</td>
<td>as usual</td>
</tr>
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</table>

From: IPCC 4th Assessment

**Flash Cards:** Put one variable on each flashcard, with two opposites choices of conditions, on each side. Then flip and choose!

---

**Selecting Scenario Logics**

**Objective:** create and test different driver combinations to develop strategic scenario ‘skeletons’

**Process**

- Work with combinations of different drivers, rapidly assess the plausibility of scenarios, the divergence of the challenges (and opportunities) posed
- Identify specific scenarios to build out

**Activity 6**

- Explore and select scenario logics