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G7 Transport Academic Workshop

Transportation Planning for Uncertain Times: A Practical Guide for Decision Making Under Deep Uncertainty

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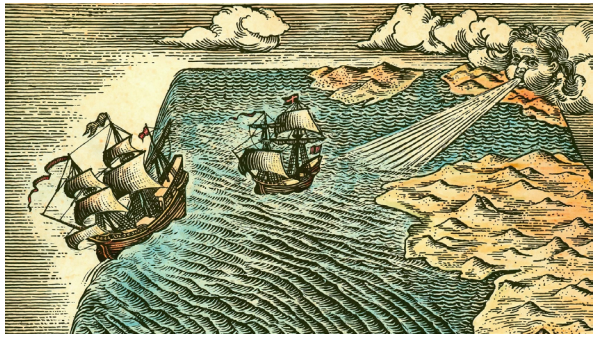
Politecnico di Milano, Bovisa Campus, Milan (Italy)

We Can Shape the Future, Even If We Can't Predict It

We know some things about the future

- It will surprise us
- We need good information to shape it



- It may seem obvious that quantitate analysis can best inform policy by making predictions about the future
- But predictions -- a core principle of the scientific method – can complicate the use of quantitative information when:
    - Uncertainties are deep
    - People disagree

Fortunately, there is a better way

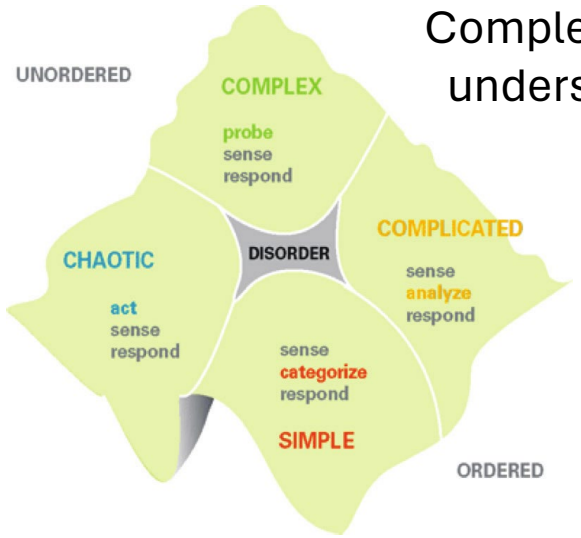
Traditional Planning Is Inadequate for a World of Complexity

Traditional planning

- Single decision maker
- Single vision of common good
- Predictable, if complicated systems

Today's World

- Polycentric governance
- Diverse views of the common good
- Complex systems



Cynefin framework

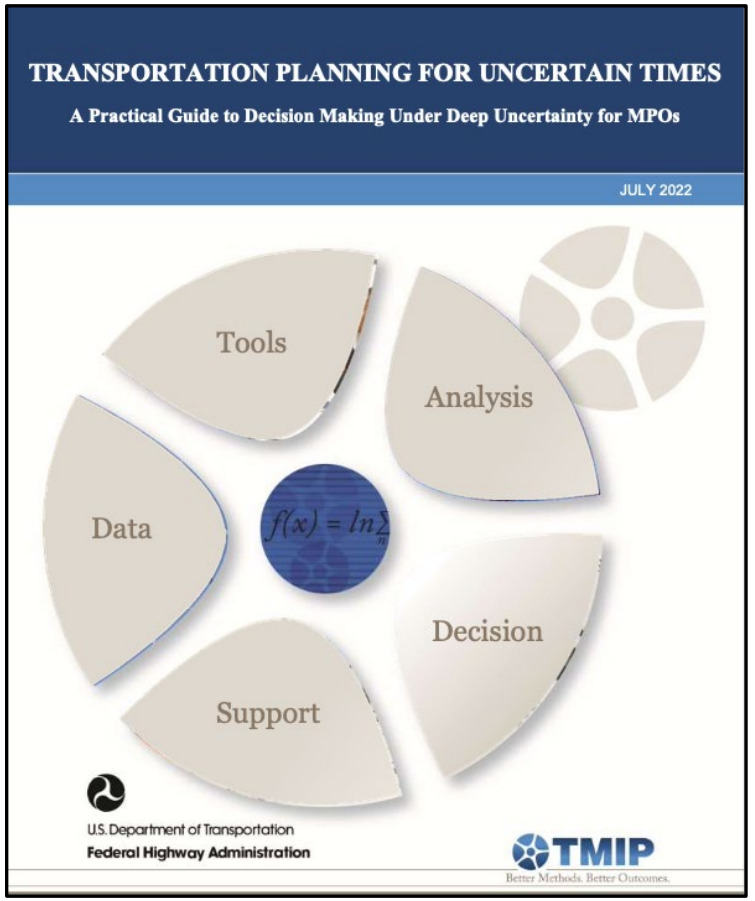
Complex systems can be understood, even if not predicted

Challenges include:

- Wicked problems
- Distrust in institutions
- Many voices
- Need for transformation

Why Do Transportation Agencies Use Predictions?

- Prediction-based approaches
  - Required by law
  - Follow established practice
- Some audiences demand predictions
- Perceived lack of alternatives



Lempert, R., S. Popper and C. C. Hernandez (2022). Transportation Planning for Uncertain Times: A Practical Guide to Decision Making Under Deep Uncertainty for MPOs. Washington, DC, Federal Highway Administration.

Outline

- Decision Making Under Deep Uncertainty (DMDU)
- Example Applications
- Observations

Traditional Planning Begins with a Consensus Understanding of the Future

"Predict then Act"

What will future conditions be? → What is the best near-term decision? → How sensitive is the decision to the conditions?

Predict

Act

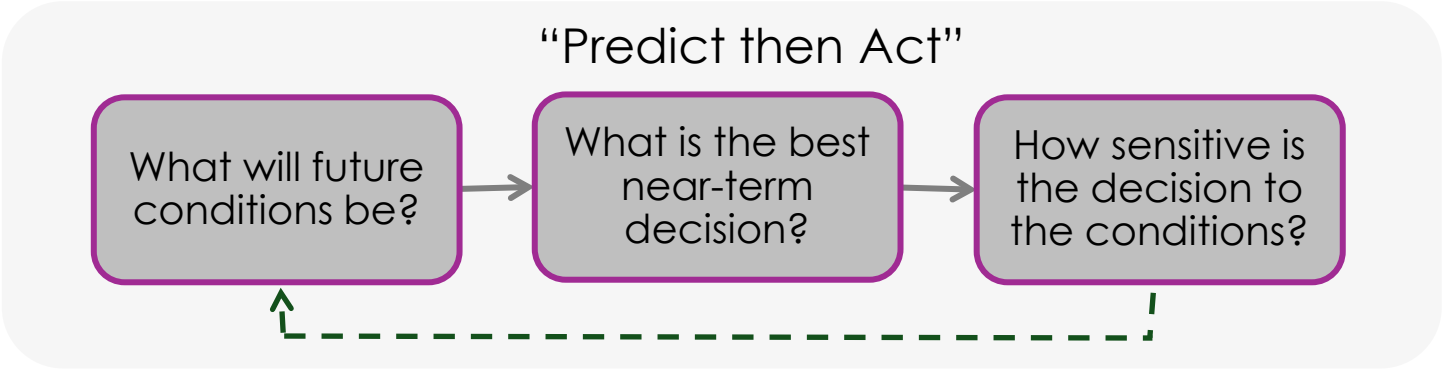
"Predict then Act" Can Break Down When Uncertainties are Deep

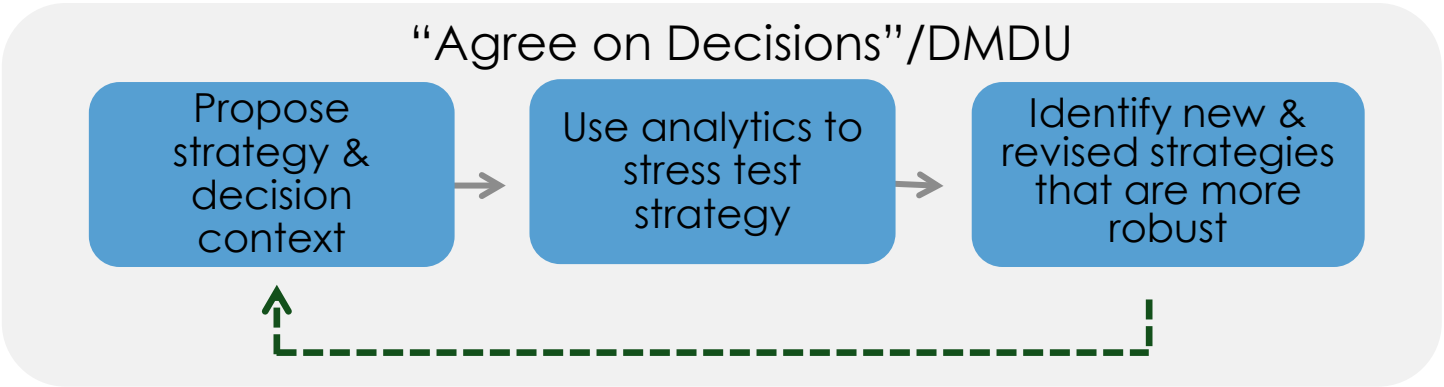
Under conditions of deep uncertainty:

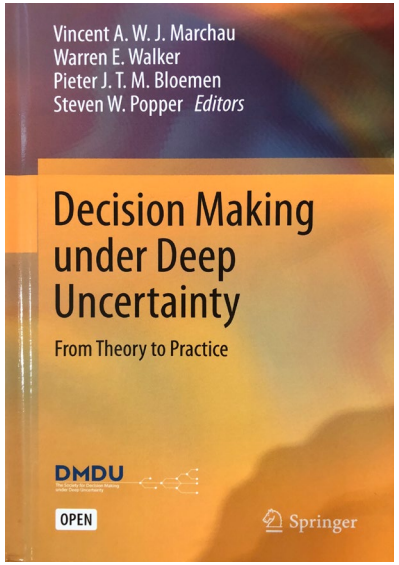
- Uncertainties are often underestimated
- Competing analyses can contribute to gridlock
- Quest for prediction distracts from main task of seeking creative solutions

Deep uncertainty occurs
when the parties to a decision
do not know or do not agree
on the likelihood of alternative futures
or how actions are related to consequences

To Inform Decisions Under Deep Uncertainty, Invert the Order of Traditional Analysis





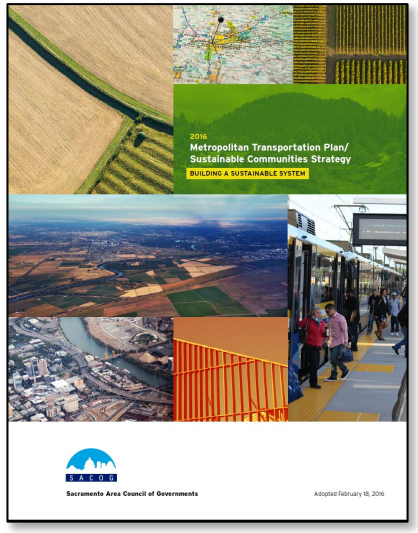


Marchau, V. A., Walker, W. E., Bloemen, P. J., & Popper, S. W. (2019). Decision making under deep uncertainty: from theory to practice Springer

How Can SACOG Meet Its Aggressive Climate Goals?

Sacramento Council of Governments (SACOG) aims to improve mobility and equity while meeting stringent greenhouse reduction requirements

SACOG's 2016
Regional Transportation Plan
Sustainable Community Strategy



- SACOG's 2016 plan aims to meet these goals by 2035 with:
  - Targeted transportation investments and
  - More compact growth
- Used to stress test this plan over many futures
  - Used simple model fit to agencies travel demand model
  - Results helped to identify key vulnerabilities and potential responses

Lempert, R., J. Syme, G. Mazur, D. Knopman, G. Ballard-Rosa, K. Lizon and I. Edochie (2020)
Meeting Climate, Mobility, and Equity Goals in Transportation Planning Under Wide-Ranging Scenarios:
A Demonstration of Robust Decision Making. Journal of the American Planning Association

There Exist Different Types of Scenarios

Scenarios are:

- Focused descriptions of fundamentally different futures.
- Neither predictions nor forecasts, but are used to provide a view of the implications of developments and actions.

Normative
How can we reach our goals?

Used to describe alternative decision options

Explorative
What might happen?

Used to help ensure decision options reach goals no matter what the future brings

Many transportation agencies use normative scenarios.
DMDU includes explorative scenarios.

Use DMDU to Answer SACOG's Question

Checklist of steps in process

- [x] Frame the decision challenge, including:
  - What are we trying to achieve?
  - What actions might we take to achieve our goals?
  - What uncertainties affect our achieving our goals?
- [ ] Stress test proposed strategies over a wide range of futures
  - Identify most important factors affecting whether we meet or miss our goals
- [ ] Identify new or revised strategies that meet our goals over a wider range of relevant futures

DMDU Begins with Decision Framing

Stakeholders' questions:

- Can SACOG meet its aggressive climate goals?

Uncertain Factors (X)	Policy Levers (L)
Relationships (R)	**Performance Metrics (M)**

DMDU Begins with Decision Framing

Stakeholders' questions:

- Can SACOG meet its aggressive climate goals?

SACOG's MTP/SCS used a single set of best estimate assumptions

Uncertain Factors (X)	Policy Levers (L)
• Gas prices • ZEV market share • Fleet fuel economy • Economic growth • Millennial behavior • VMT elasticity to cost of driving • VMT elasticity to economic growth	• Base case policy - *2016 MTP/SCS* • Response options - VMT fee - Alternative land use scenarios
Relationships (R)	**Performance Metrics (M)**
• Cohort model	• Total GHG emissions • SB375 GHG emissions • Mobility • Equity

DMDU Begins with Decision Framing

Stakeholders' questions:

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DMDU analysis explores 10,000 sets of assumptions

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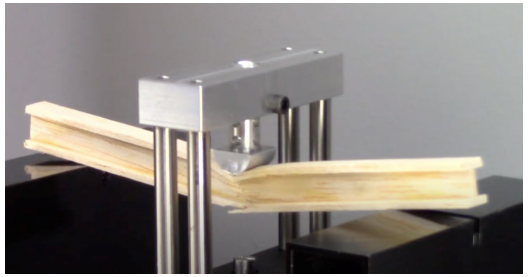
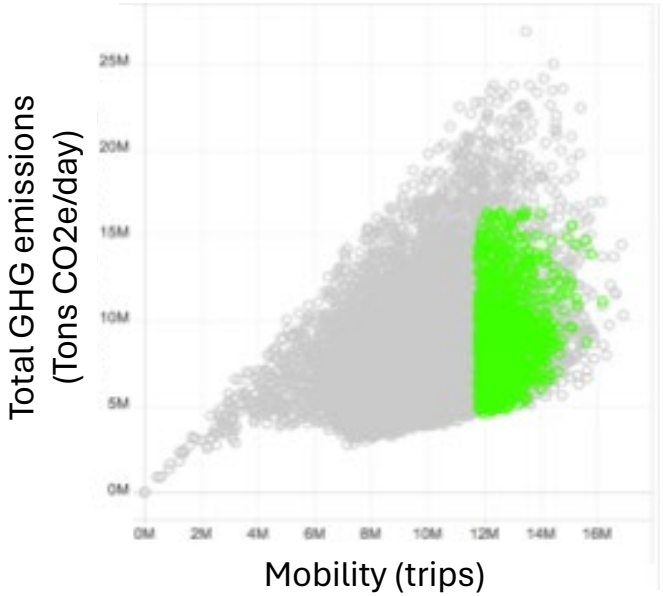
Under What Conditions Would SACOG Meet Its Mobility, Equity, and Climate Goals for 2035?

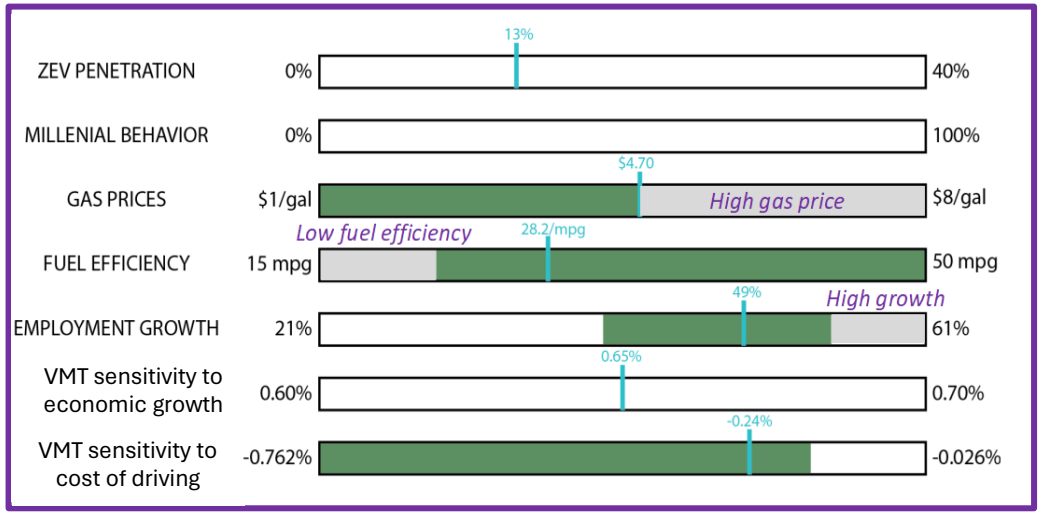


Run model over many plausible futures



Green = case meets all SACOG goals
Grey = case misses some SACOG goals

"Scenario discovery" classification algorithms show key drivers of success



- Green bars show parameter variation ranges that best differentiate futures that meet and miss goals
- Variables without green bars are not a key driver/differentiator for meeting or missing goals

On scenario discovery:

Bryant & Lempert (2010). Thinking inside the box: a participatory, computer-assisted approach to scenario discovery Technological Forecasting and Social Change

Kwakkel (2017) "The Exploratory Modeling Workbench: An open-source toolkit for exploratory modeling, scenario discovery, and (multi-objective) robust decision making." Environmental Modelling & Software

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Robust Strategies Are Often Designed to Adapt Over Time in Response to New Information

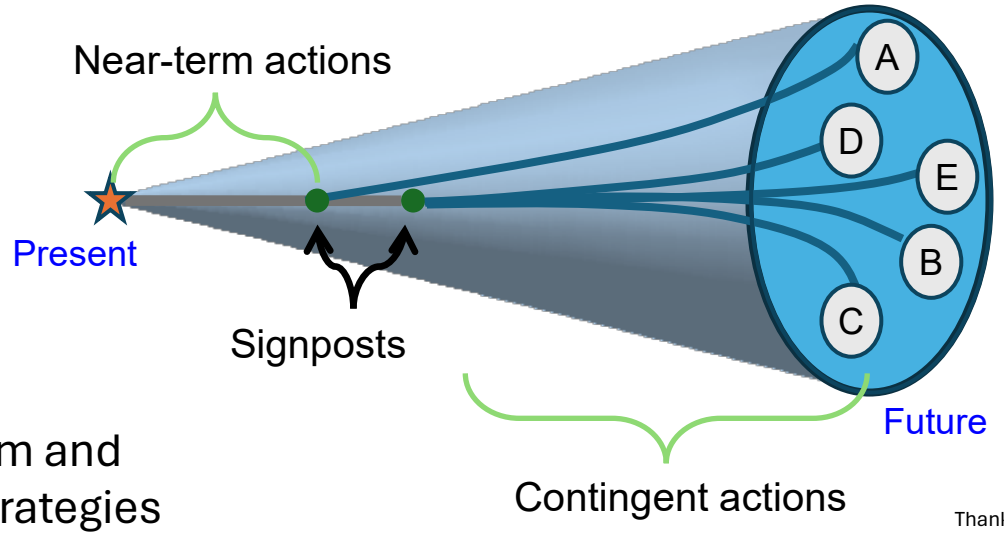
A robust strategy:

- Performs well compared to the alternatives over a wide range of futures
- Trades some optimum performance for less sensitivity to broken assumptions
- Keeps opens open

Robust strategy are often adaptive, with:

- Near-term actions
  - Shaping & hedging
- Signposts
- Contingent actions

Lempert and Collins (2007) Risk Analysis

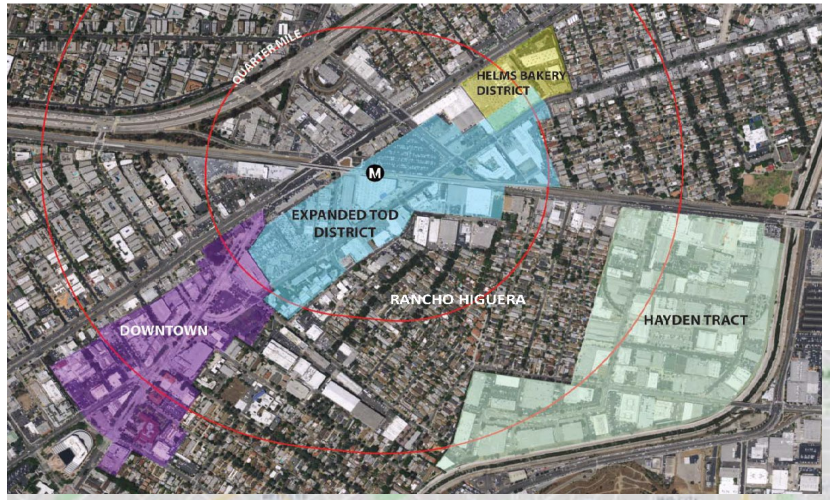


RDM stress tests help inform and evaluate robust adaptive strategies

Thanks to Laurna Kaatz

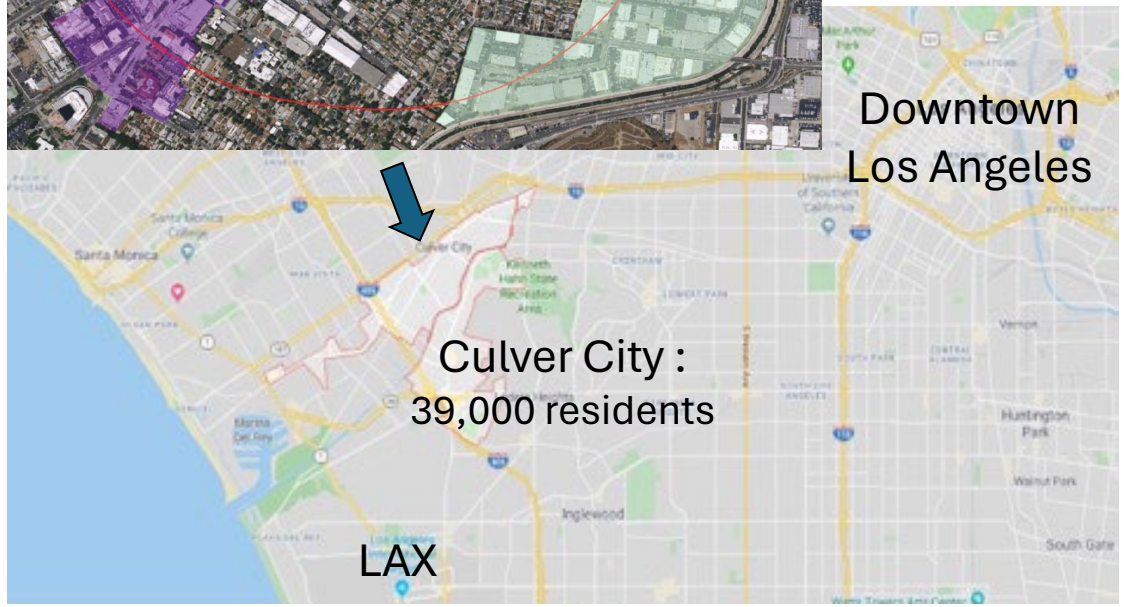
Haasnoot et. al. (2013) Dynamic Adaptive Policy Pathways: A New Method for Crafting Robust Decisions for a Deeply Uncertain World. Global Environmental Change

Culver City Has Bold Plans To Improve Mobility, But Wants to Reduce Risks of Transition

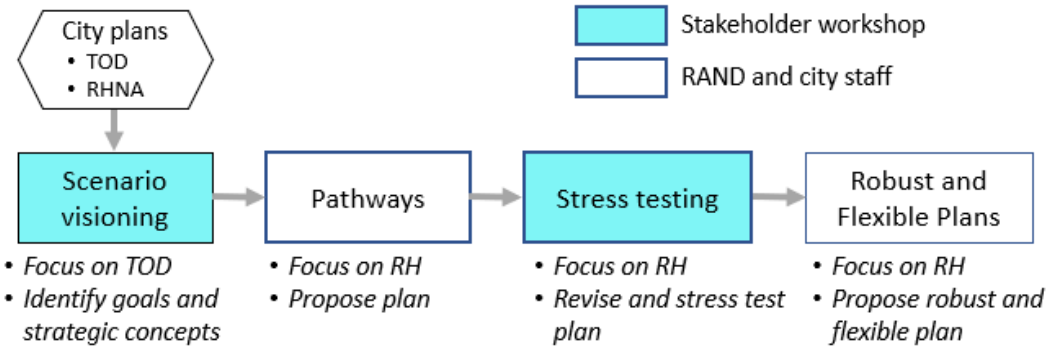


Transit Oriented Development (TOD) visioning study aims to reduce reliance on cars by:

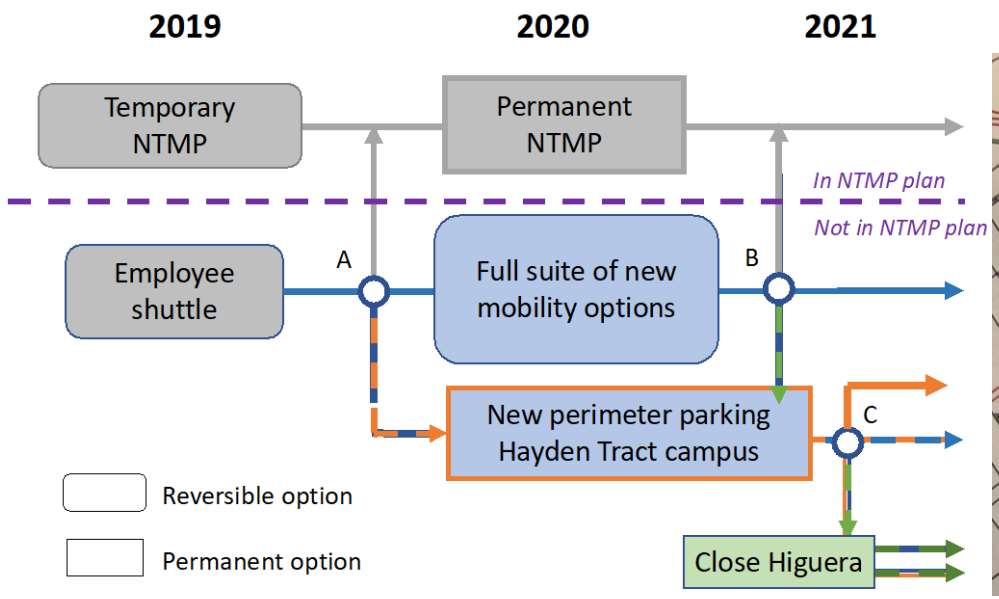
- Reshaping landscape
- Promoting multiple mobility options (walking, transit, bikes)
- Compliment new light rail line

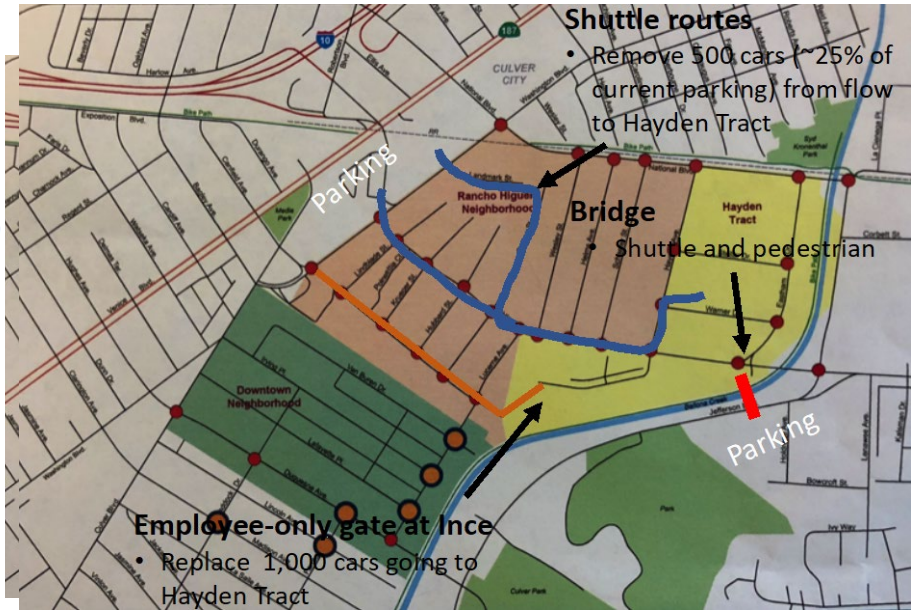


City Conducted a Qualitative DMDU Engagement



Process Helped to Develop an Adaptive Implementation Plan

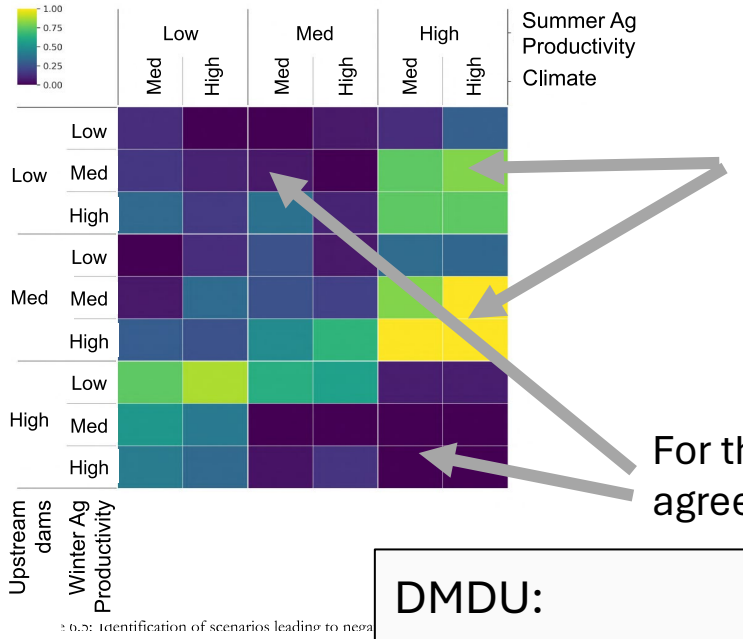




Scenario visioning → Pathways → Stress testing → Robust and Flexible Plans

DMDU Supports Consideration of Equity

Recent analysis considers equity of climate adaptation strategies for 23 districts in Mekong Delta for many uncertainties and alternative ethical frameworks



For these scenarios ethical frameworks disagree

For these scenarios ethical frameworks agree on best strategies

DMDU:

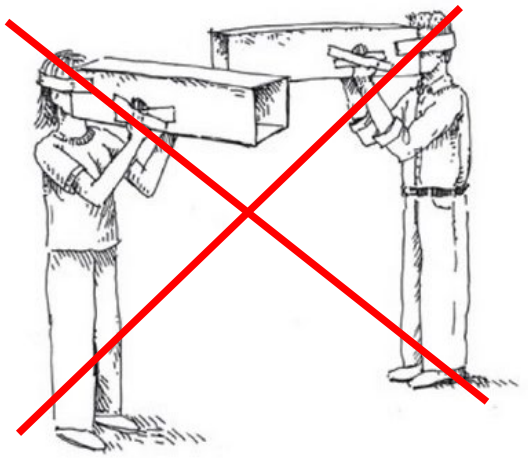
- Avoids premature aggregation over expectations and values
- Makes tradeoffs more transparent and validates multiple points of view
- Can identify strategies that perform well with high confidence across multiple expectations of the future and multiple ways to value to future

Jafino, B. A. (2021). Model-based approaches for supporting equitable delta adaptation planning. Dissertation, TU Delft

DMDU Helps Inform Better Decisions, Not Better Predictions

Basic principles

1. Consider multiple futures, not one single future, in your planning. Choose these futures to stress test your organization's plans
2. Seek robust plans that perform well over many futures, not optimal plans designed for a single, best-estimate future
3. Make your plans flexible and adaptive, which often makes them more robust



Plan over multiple futures

DMDU helps develop plans insensitive to uncertainty:

- Low regrets actions
- Adaptive and flexible plans
- Keep options open
- Actions that shape the future to our liking

QUESTIONS?

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