Dynamic Decision Support System (D^2S^2)

Kathleen O'Neil, PBS&J

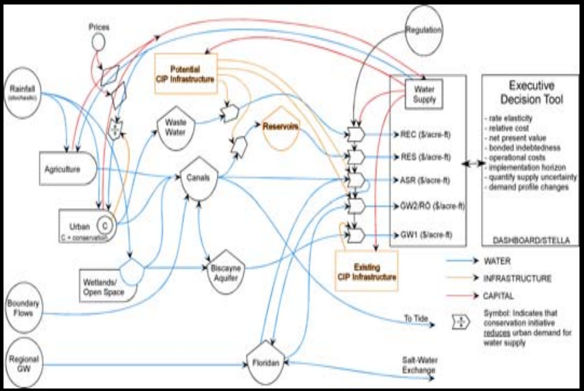
Helping Water Managers Plan for the Future

PBSJ with University of Florida and SEI

Dynamic Decision Support System (D2S2)

American Water Works Association Research Foundation (AwwaRF)

Tailored Collaboration (TC) Project



Team:

- University of Florida, Water Institute
- Stockholm Environment Institute (SEI-US)

Scope:

Develop a systems-based planning tool integrating water supply, economic, and social variables.

Dynamic Capital Improvement Planning Tool

Dynamic Feasibility Study

UF Teaming Partners

Dr. James W. Jawitz, P.E.
Associate Professor, Environmental Hydrology
Soil and Water Science Department

Dr. Gregory Kiker
Assistant Professor
Agricultural and Biological Engineering Dept.

Dr. Burcin Unel
Post-Doctorate Research Associate
PURC

Dr. Sanford Berg, Distinguished Service Professor of Economics
Director of Water Studies, PURC

Dr. Mathew Cohen
Assistant Professor
Forest Water Resources, Hydrology

Julie Padowski
NSF IGERT Fellow
Soil and Water Science Department

D^2S^2 What is it?

Dynamic Scenario Testing

+

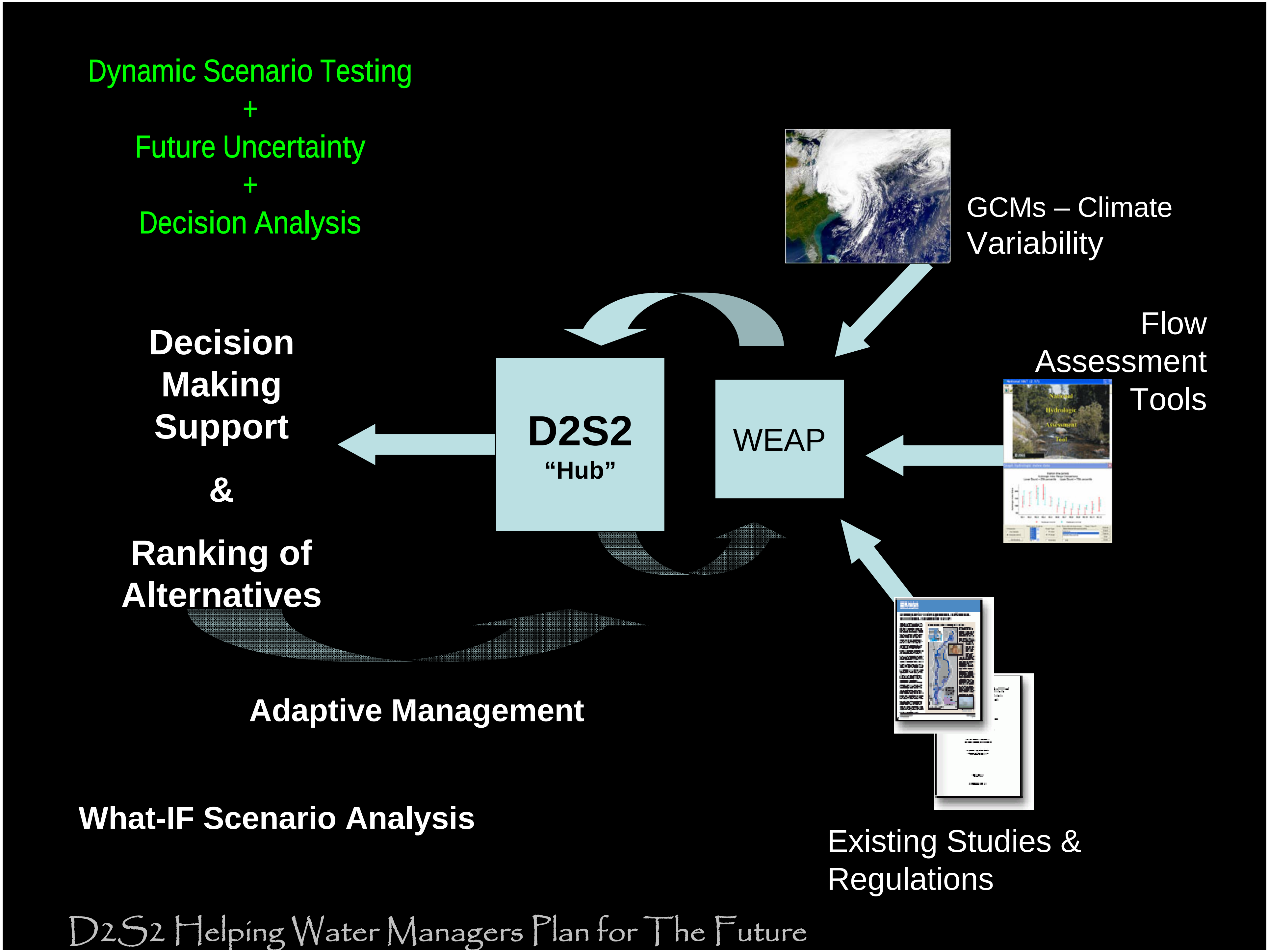
Future Uncertainty

+

Decision Analysis

With:

- Climate Change Projections,
- Impact Assessment,
- Focusing Tool for Data Assessment & Monitoring,
- Triple Bottom Line Accounting Criteria,
- Research in Conservation Pricing, Decision Modeling & Stakeholder Scenario Analysis


Dynamic Scenario Testing
+
Future Uncertainty
+
Decision Analysis
GCMs – Climate Variability
Flow Assessment Tools
Decision Making Support
&
Ranking of Alternatives
D2S2
"Hub"
WEAP
Adaptive Management
What-IF Scenario Analysis
Existing Studies & Regulations
D2S2 Helping Water Managers Plan for The Future

Dynamic Scenario Testing

Dynamic Scenario Testing
+
Future Uncertainty
+
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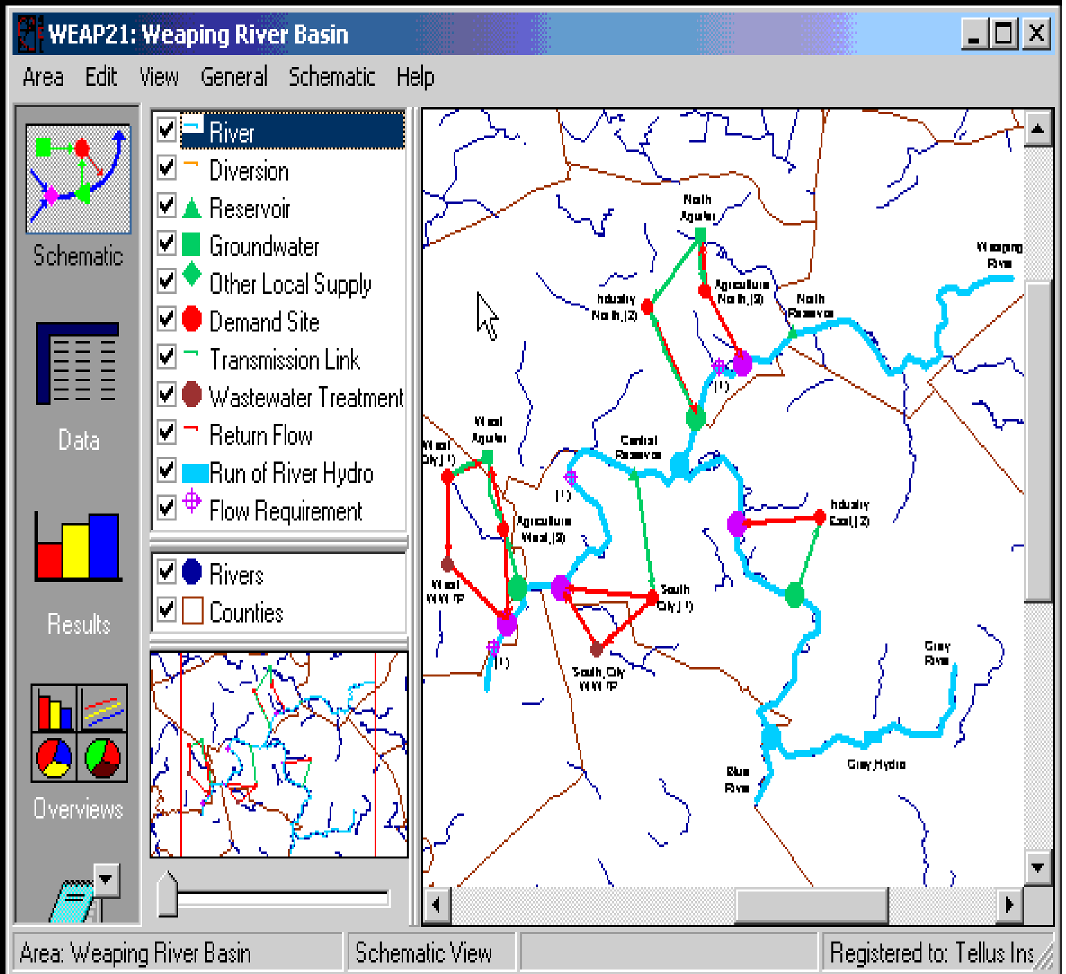
Stockholm Environment Institute – US (SEI-US) Water Evaluation and Planning (WEAP) Tool

- Built-in models for: Rainfall runoff and infiltration, evapotranspiration, crop requirements and yields, surface water/groundwater interaction, and instream water quality
- GIS-based, graphical "drag and drop" interface
- Model-building capability with a number of built-in functions
- User-defined variables and equations
- Dynamic links to spreadsheets and other models
- Embedded linear program solves allocation equations



Networked Research

Cutting Edge Integration and Results with:

- Reservoir Yield Analysis and Dynamic Downstream Flow & Impact Assessment
- New Impact Assessment tools – TNC Indicators of Hydrologic Alteration (IHA)
- Energy –Water Inter-relationships – LEAP worldwide leader in energy scenario analysis
- Climate Change Impacts on Water Management Alternatives – NCAR-SEI
- Uncertainty Analysis in Water Management Strategies – PBS&J, UC, RAND, TUFTS
- Decision Analysis in Stakeholder Visioning and Scenario Planning – PBS&J

Scenarios vs Forecasting

Incorporating Future Uncertainty Into the Decision Making Process

The uncertainty in forecasts is often buried and kept from decision makers. Scenarios directly address uncertainty.

How Do Scenarios Relate to Uncertainty?

Dynamic Scenario Testing
+
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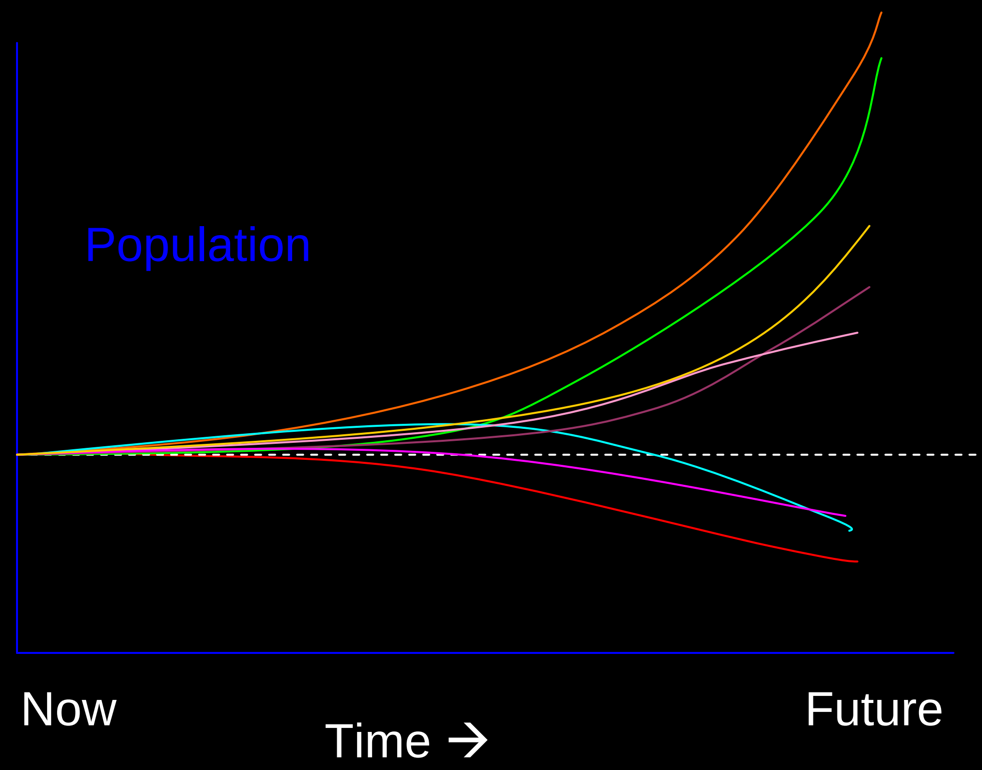
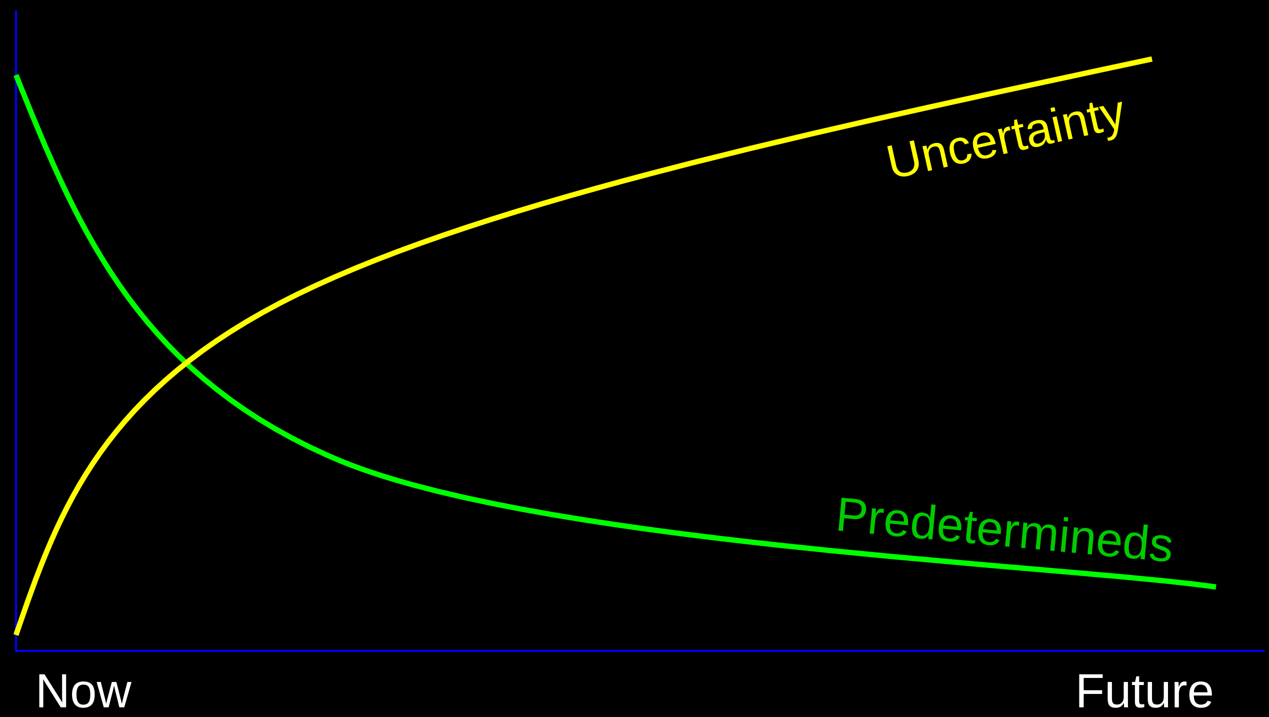
- Checking every permutation isn't productive for decision-making.
- Can we bound the uncertainty in a scenario?



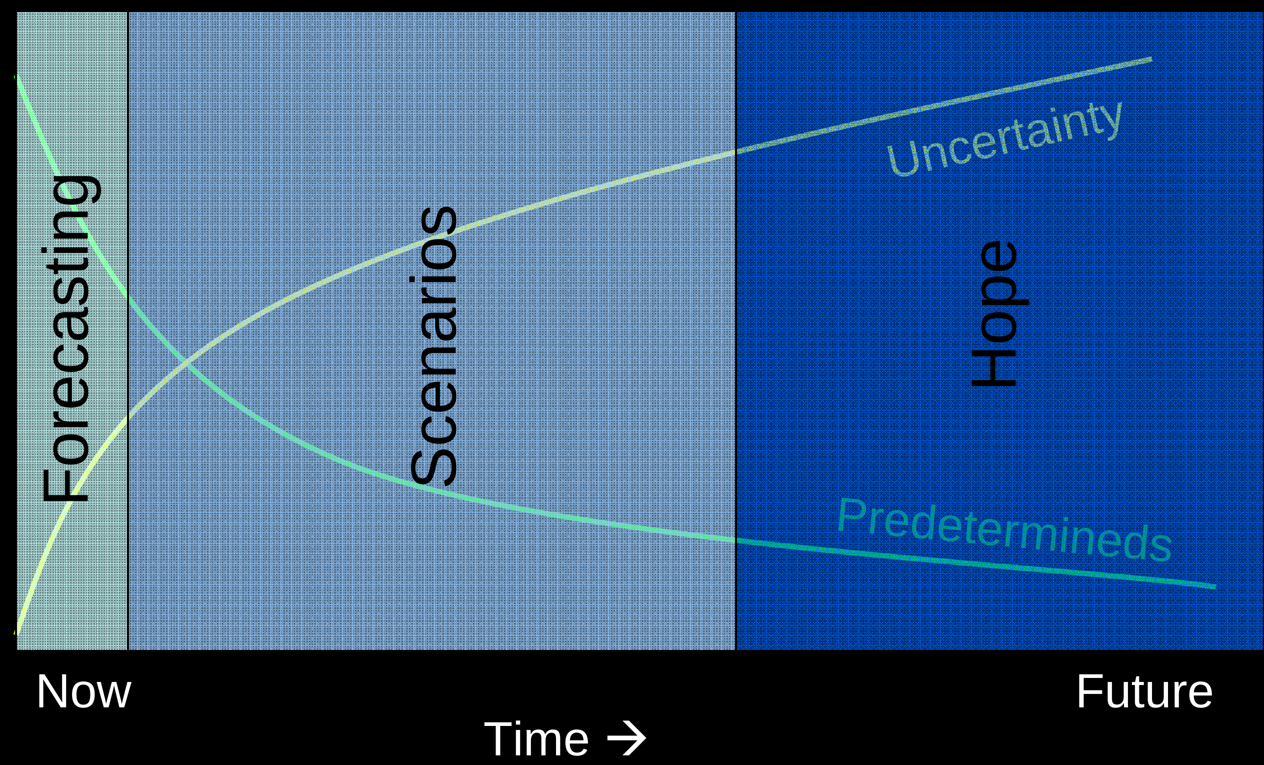
Balance of Predictability and Uncertainty



Things that we can actually forecast decrease as we go into the future.

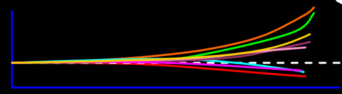
After Van Der Heijden, 2005

Preferred Planning Mode



After Van Der Heijden, 2005

Future Uncertainty



Climate Change

Traditional Models:

- Use historic trends to forecast into the future

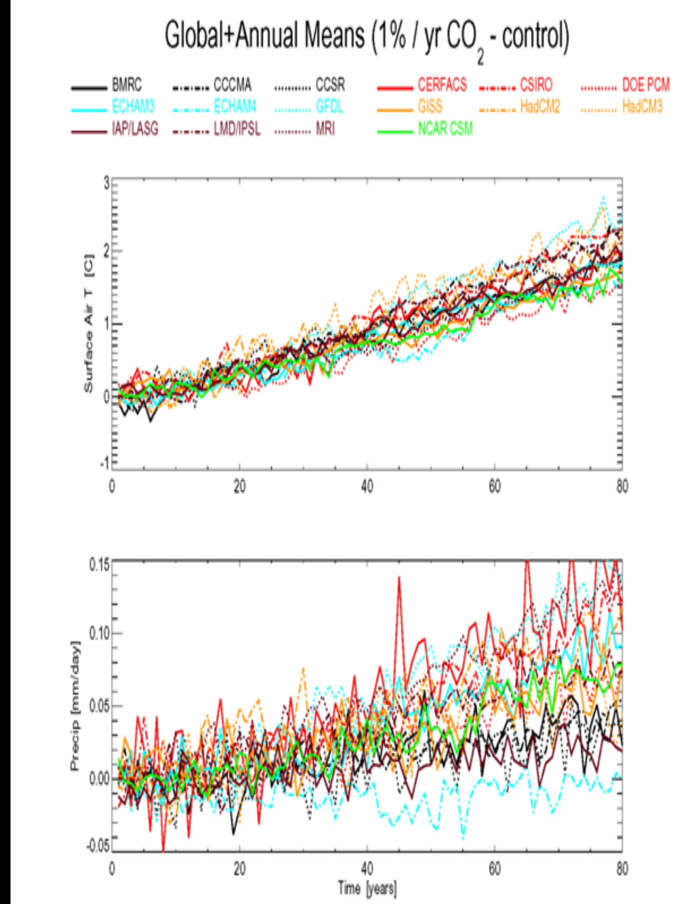
Scenario Analysis:

- Does not assume that the trends will repeat
- Identifies key driving variables and plausible future trends
- Looks at 'what-if' analysis over a range of possible futures

Model Inter-comparison Project (16 models)

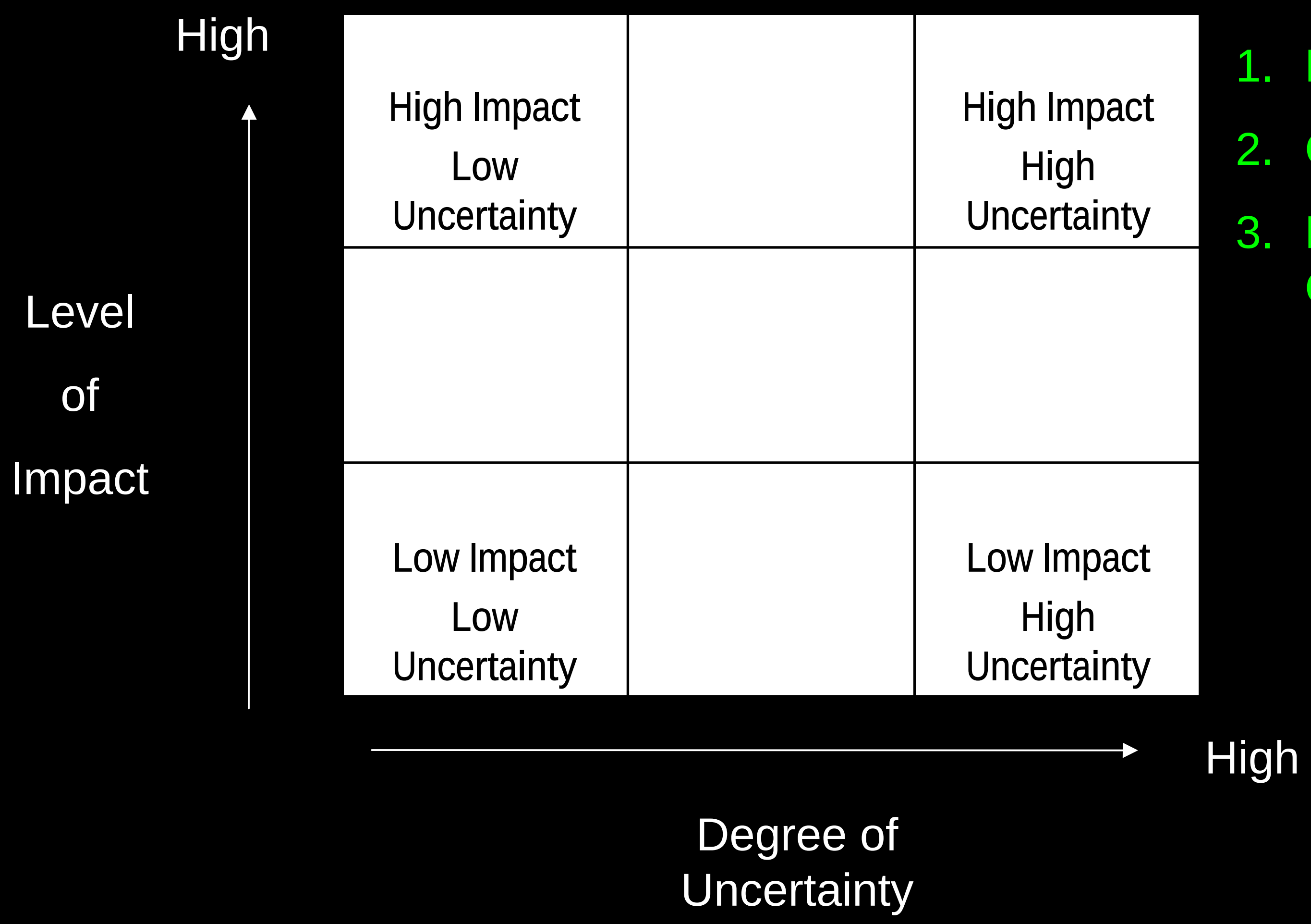
80 yr. Temp. Rise

80 yr. Precipitation Trend



Source: David Yates, NCAR

Driving Force Ranking Space



1. Population
2. Climate
3. Regulatory Changes

Standard Hydrologic Models vs. Planning with Uncertainty (WEAP)

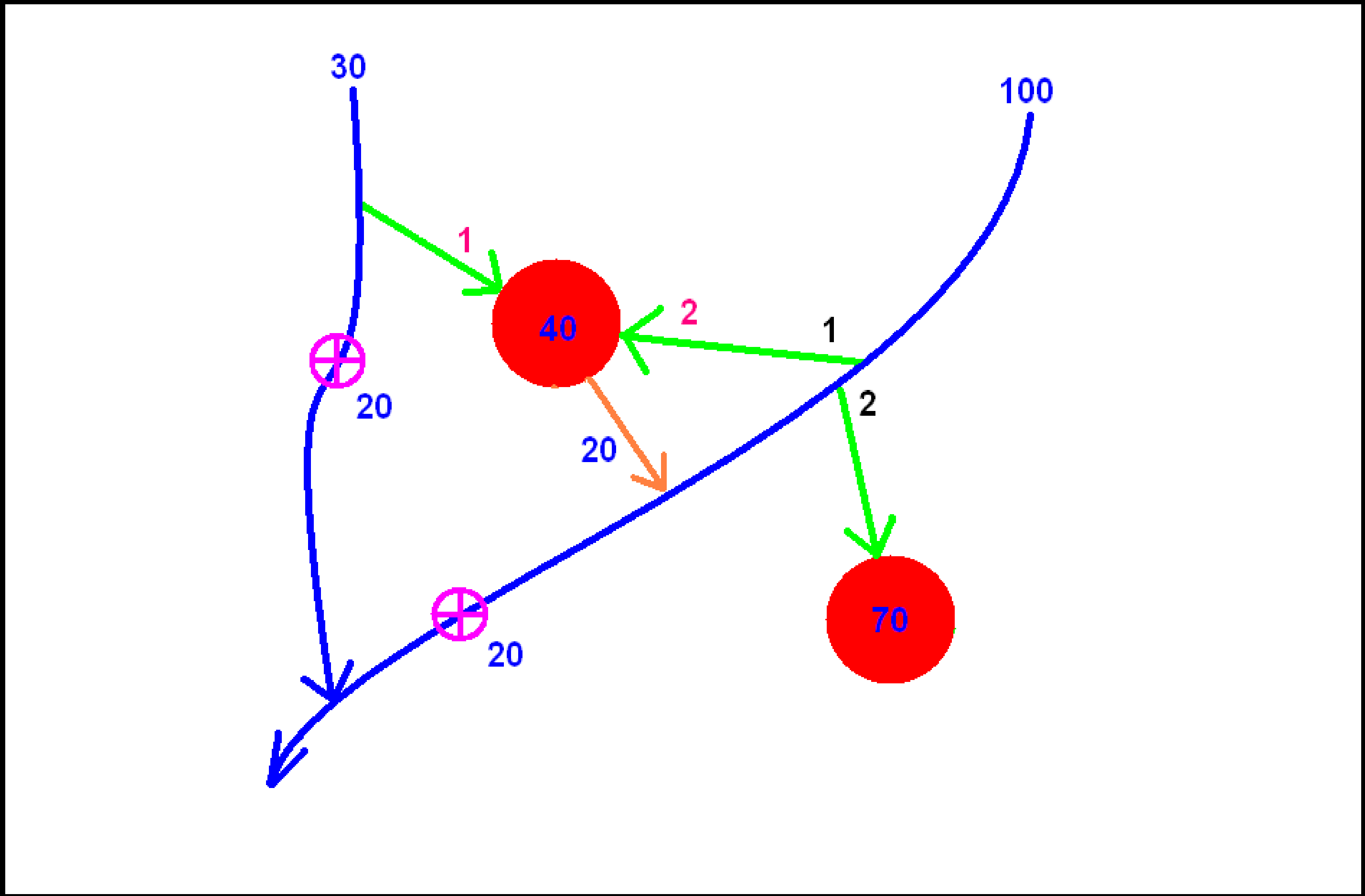
Integrated Basin Models –

- dynamic allocation or ‘water budget’ optimized under set constraints and objectives
- Recreates the ‘perfect drought’ but uses past records to predict the future

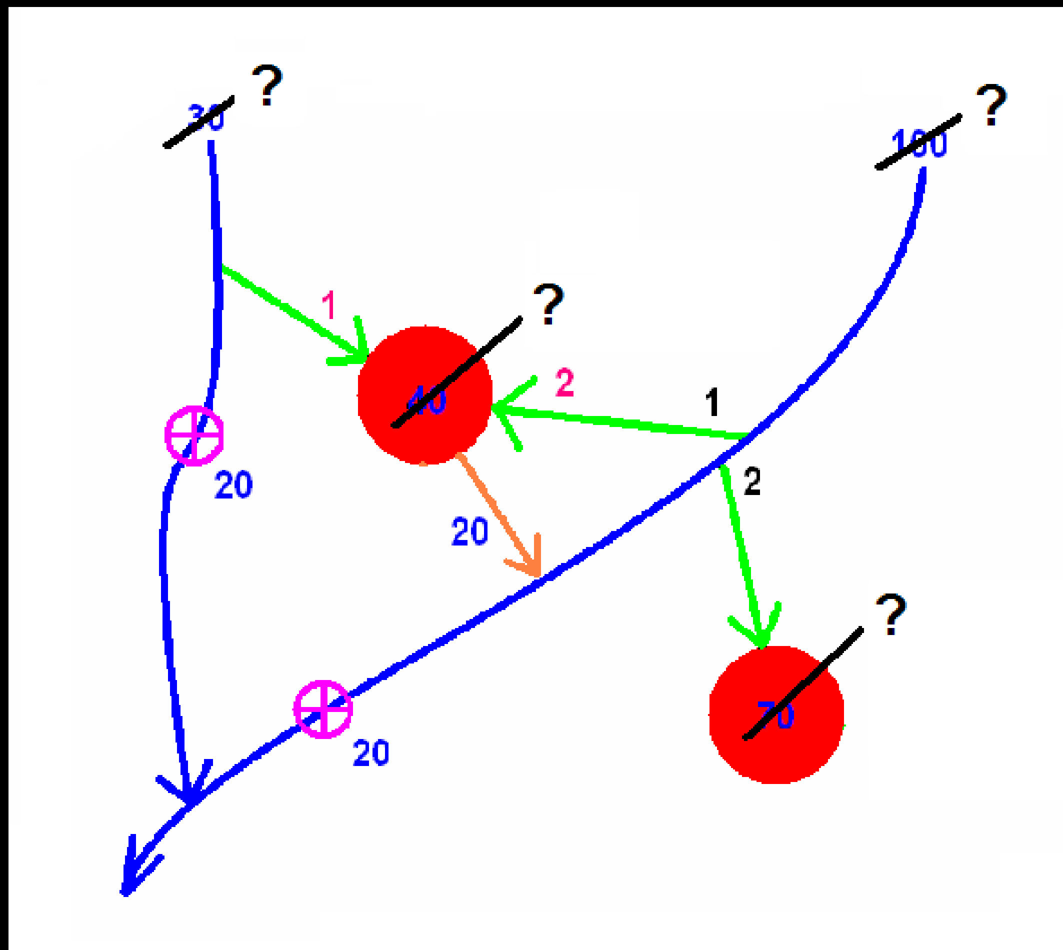
WEAP –

- Hydrology-driven planning with uncertainty about future climate patterns
- What-if precipitation, demands, and flows don’t follow historic trends?

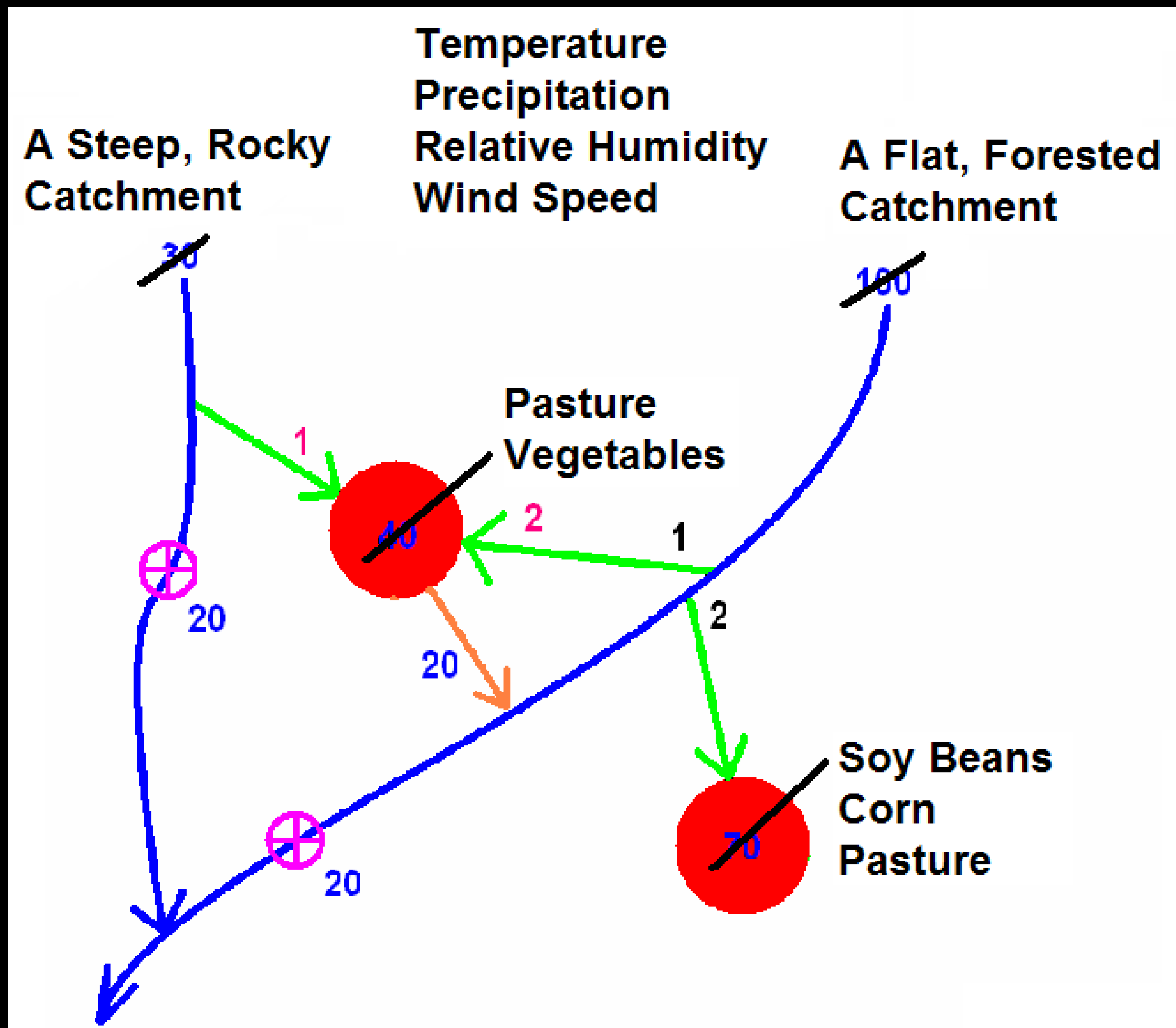
A Simple Planning Model



What do we do now?



ADD HYDROLOGY!



Related Research - NCAR

Principal Researcher: Dr. David Yates, NCAR

Parallel AwwaRF TC Project

NCAR-SEI Downscaling GCMs to Local Scale, Mapping to Local Trends & Projecting New Climate Futures for Utilities

Dynamic Scenario Testing
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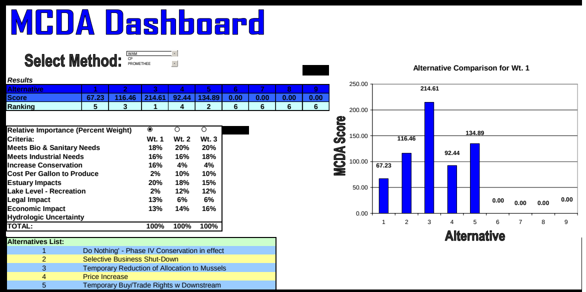
Decision Analysis Linked to Scenario Analysis



PBC Water Mission:	Best Water				Best Service			Best Environmental Stewardship			
	Increase Water Available (Increase Storage or Re-Use)				Long-Term Impacts, Viability & Sustainability			Benefit to Regional System	Carbon Footprint	Estuarine Systems	Wetland Systems
Measured Variable	Water Available Net of Demand	Mitigate localized wellfield impacts – recharge	Incr. Annual Storage	Decr. Loss to Deep Inj.	Regional Solution - Flexible & Future	Long-Term Capital & Permit Risks	$ /gal price or cost	Decr. Net Reg Sys Water Used in Drought	Energy Needs	Decr. Loss to Tide	Incr. Wetland Acreage
Units	Mgd	Ac-ft/yr	Ac-ft/yr	Ac-ft/yr	L, M, H	L, M, H	$ / gal	Ac-ft/yr	L, M, H	Ac-ft/yr	Acres
Source of Data	WEAP	WEAP	WEAP	WEAP	Project Description	Relative Estimate	WEAP	WEAP	Relative Estimate	WEAP Canals	CIP
Baseline (B) Existing Infrastructure											
B + CIP											
B + CIP + L-8											
B + CIP + Site 1											
B + CIP + Wetlands											
B + CIP + Enhanced Recharge w Reuse											
Triple Bottom Line Criteria:	Social				Economic	Risk	Cost	Environmental			
Notes:											

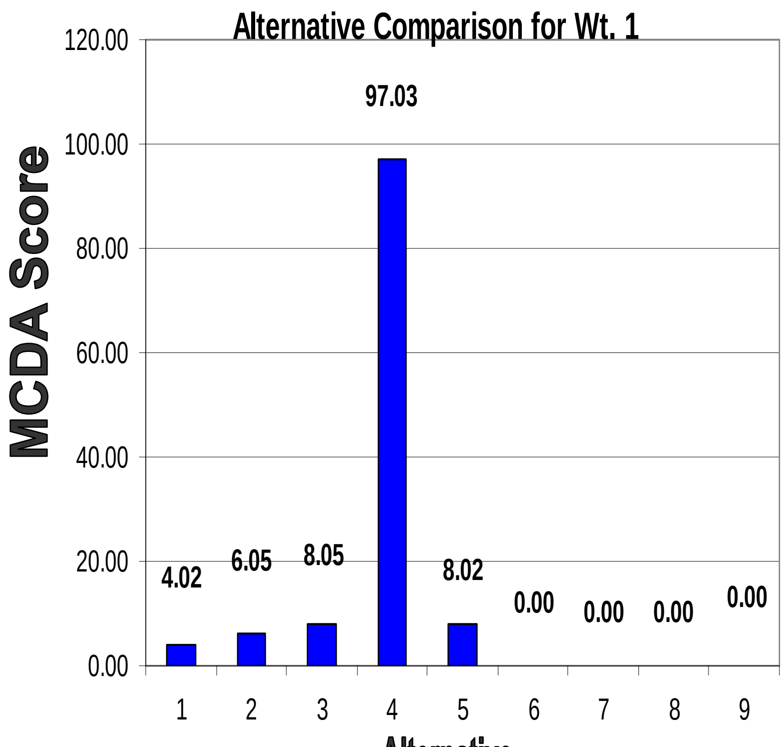
D2S2 Helping Water Managers Plan for The Future

Interactive Decision Analysis

Results

Alternative	1	2	3	4	5	6	7	8	9
Score	4.02	6.05	8.05	97.03	8.02	0.00	0.00	0.00	0.00
Ranking	5	4	2	1	3	6	6	6	6

Relative Importance (Percent Weight)			
Criteria:	Wt. 1	Wt. 2	Wt. 3
Meets Basic Sanitary Needs	1	1	1
Meets Industrial Needs	1	1	1
Increase Conservation Measures	92	1	1
Production Cost	1	1	1
Estuary Impacts	1	1	1
Lake Level - Recreation	1	1	1
Legal Challenge	1	1	1
Economic Impact	1	1	1
Hydrologic Uncertainty	1	1	1
TOTAL:	100	9	9



1 Reference "No-Action"
2 Local Reservoir
3 Regional Reservoir
4 Local Reservoir & Conservation
5 Interconnect to Regional Supplier

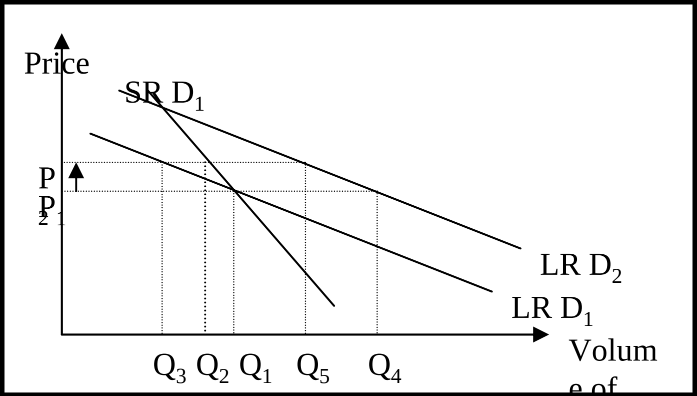
D2S2 Helping Water Managers Plan for The Future

UF Research - Economics

Principal Researcher:
Dr. Sanford Berg, Distinguished Service Professor of Economics
Director of Water Studies, PURC (University of Florida)

- Scenario Analyses for Different Risk and Investment Strategies
- Recognizing the Possibility of Obtaining Bulk Water through Trades or Off-sets: a Utility should not turn to high cost sources unless all feasible alternatives are considered.
- One Alternative: Water Conservation Programs (Information and Conservation Pricing)
- Task: Econometric Analysis of the Role of Information and Rate Structures on Consumption

UF Research - Economics



Dr. Burcin Unel

Post-Doctorate Research Associate PURC

Conservation Through Pricing

- Econometric Analysis of the Role of Information and Rate Structures on Consumption

- Examining the Importance of Consumer Awareness of Rates and the Availability of Substitutes

UF Research – Soil & Water Science

Dr. James W. Jawitz, P.E.
Associate Professor
Environmental Hydrology

Julie Padowski
NSF IGERT Fellow
Ph.D. Student

Results Table

SCENARIO 4 WAM	Stakeholder 1		Stakeholder 2		Stakeholder 3		Stakeholder 4		Stakeholder 5		Stakeholder 6	
Alternatives	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Reference (Existing Infrastructure)	57.29	6.00	59.60	6.00	64.48	6.00	60.65	6.00	62.17	6.00	64.48	6.00
Capital Improvement Plan (CIP)	91.53	4.00	94.37	3.00	102.46	3.00	96.21	4.00	98.69	3.00	102.46	3.00
CIP + L-8 Project	135.99	1.00	140.42	1.00	151.75	1.00	142.32	1.00	146.04	1.00	151.75	1.00
CIP + Site 1 Project	75.65	5.00	77.99	5.00	84.67	5.00	79.54	5.00	81.57	5.00	84.67	5.00
CIP + New Wetlands Project	117.94	2.00	121.54	2.00	132.12	2.00	124.14	2.00	127.31	2.00	132.12	2.00
CIP + Enhanced Recharge Project	91.91	3.00	94.31	4.00	101.32	4.00	96.51	3.00	98.68	4.00	101.32	4.00

UF Research – Soil & Water Science

Julie Padowski:

Verification of Models Using Historic Data in Decision Models

Small Scale: Wakodahatchee Wetlands

http://www.pbcgov.com/waterutilities/wakodahatchee/tour.htm

Large Scale: Tampa Bay

http://www.pinellascounty.org/CCNews/12_12_03.htm

UF Research – Stakeholder Facilitation

Dr. Gregory Kiker
Assistant Professor
Agricultural and Biological Engineering Dept.

Facilitator Dr. Greg Kiker (UF) Takes Questions From Stakeholders

PBS&J Research

Kris Esterson

HydroGeoChemist

Effects of Climate Change and Sea Level Rise in Florida

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With:

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Thank You

Nothing in the world
Is as soft and yielding as water.
Yet for dissolving the hard and inflexible
Nothing can surpass it.
The soft overcomes the hard;
The gentle overcomes the rigid.
Everyone knows this is true,
But few can put it into practice
(Lao Tzu, 560 BC)