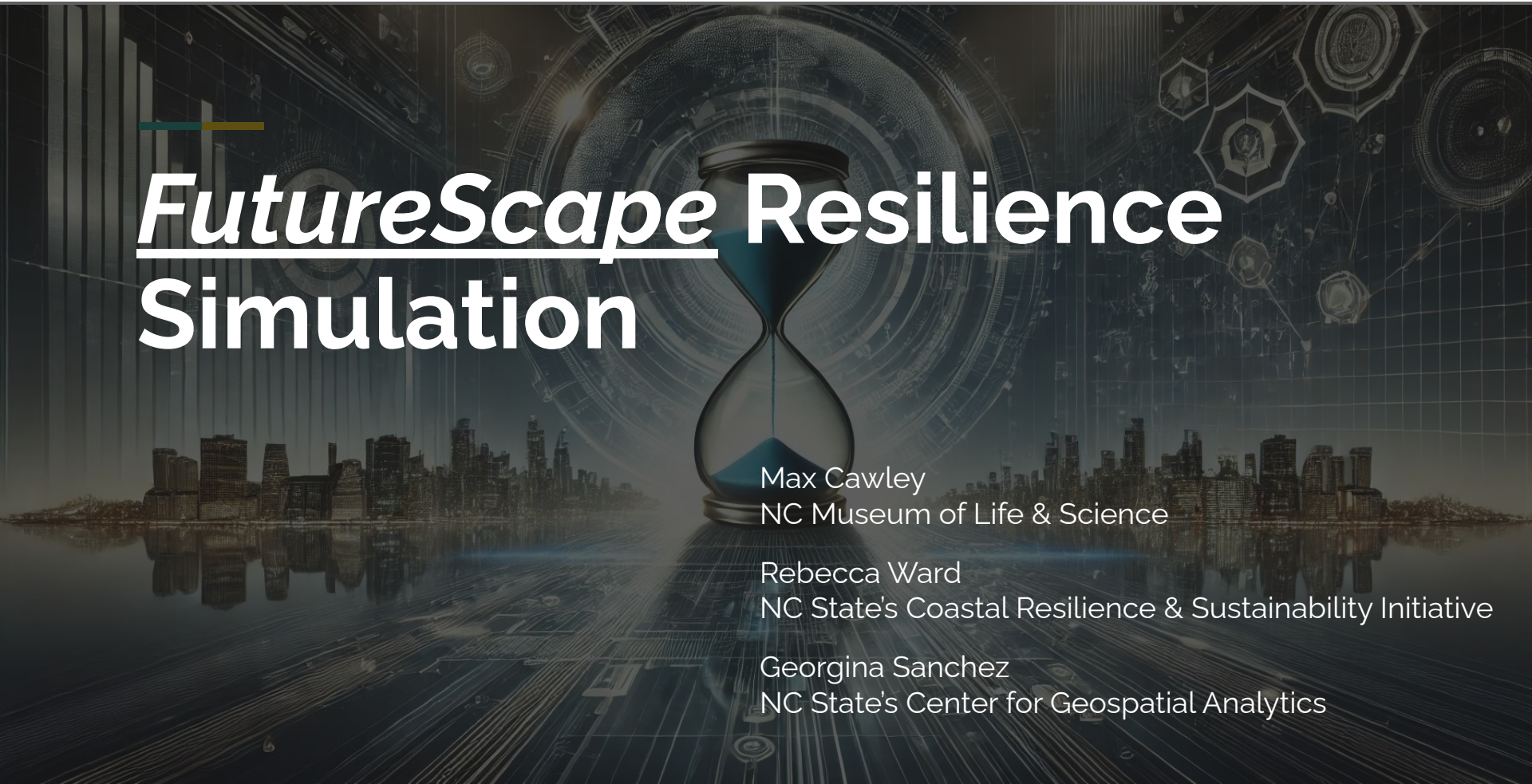


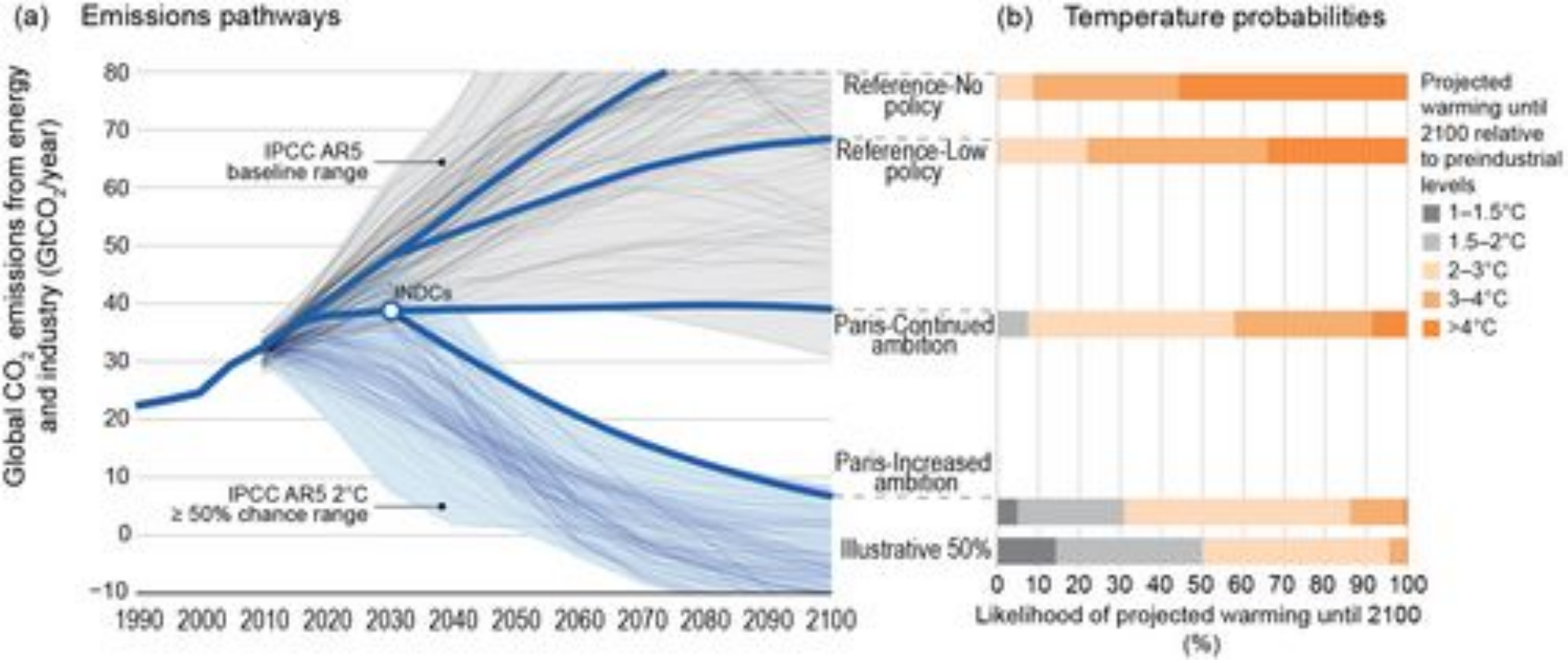
FutureScape Resilience Simulation

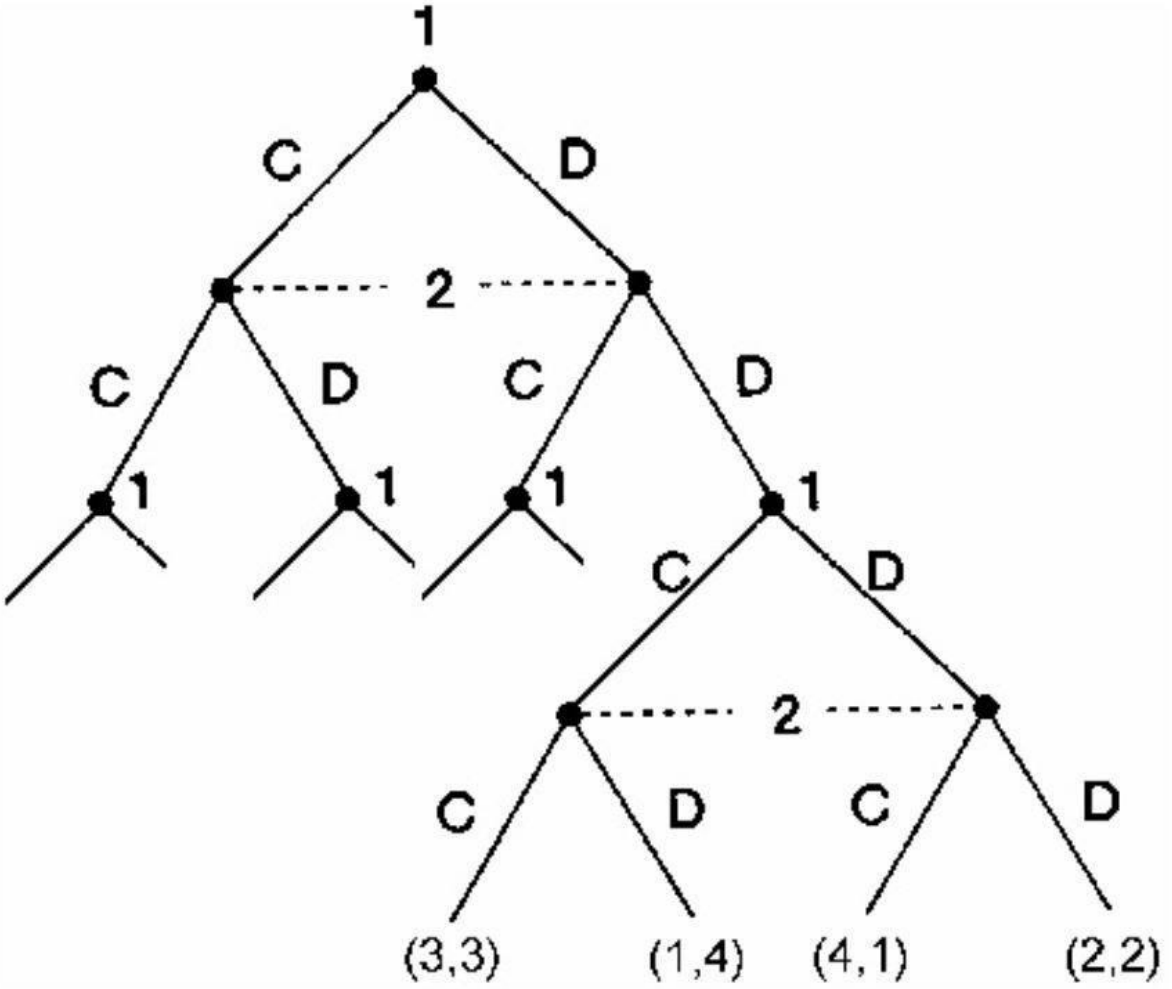
Max Cawley
NC Museum of Life & Science

Rebecca Ward
NC State's Coastal Resilience & Sustainability Initiative

Georgina Sanchez
NC State's Center for Geospatial Analytics

The game theory behind *FutureScape* design


(a) Emissions pathways
Global CO_2 emissions from energy and industry ($GtCO_2$/year)
80
70
60
50
40
30
20
10
0
−10
IPCC AR5 baseline range
INDCs
IPCC AR5 2°C ≥ 50% chance range
1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100
(b) Temperature probabilities
Reference-No policy
Reference-Low policy
Paris-Continued ambition
Paris-Increased ambition
Illustrative 50%
Projected warming until 2100 relative to preindustrial levels
1–1.5°C
1.5–2°C
2–3°C
3–4°C
>4°C
0 10 20 30 40 50 60 70 80 90 100
Likelihood of projected warming until 2100 (%)


1
C
D
2
C
D
C
D
1
1
1
1
C
D
2
C
D
C
D
(3,3)
(1,4)
(4,1)
(2,2)

MENU

nature

Commentary | Published: 30 April 1992

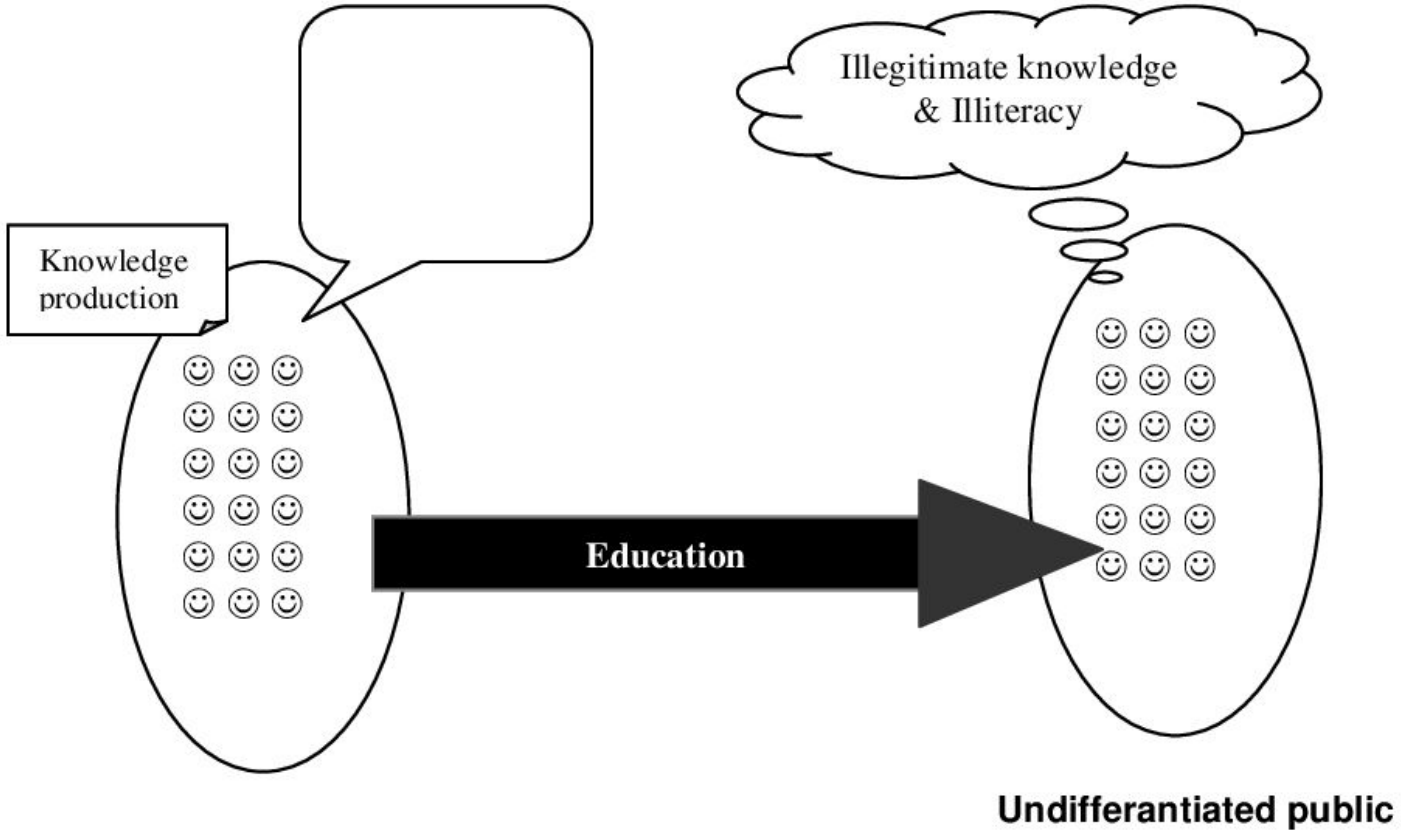
The growing inaccessibility of science

Donald P. Hayes

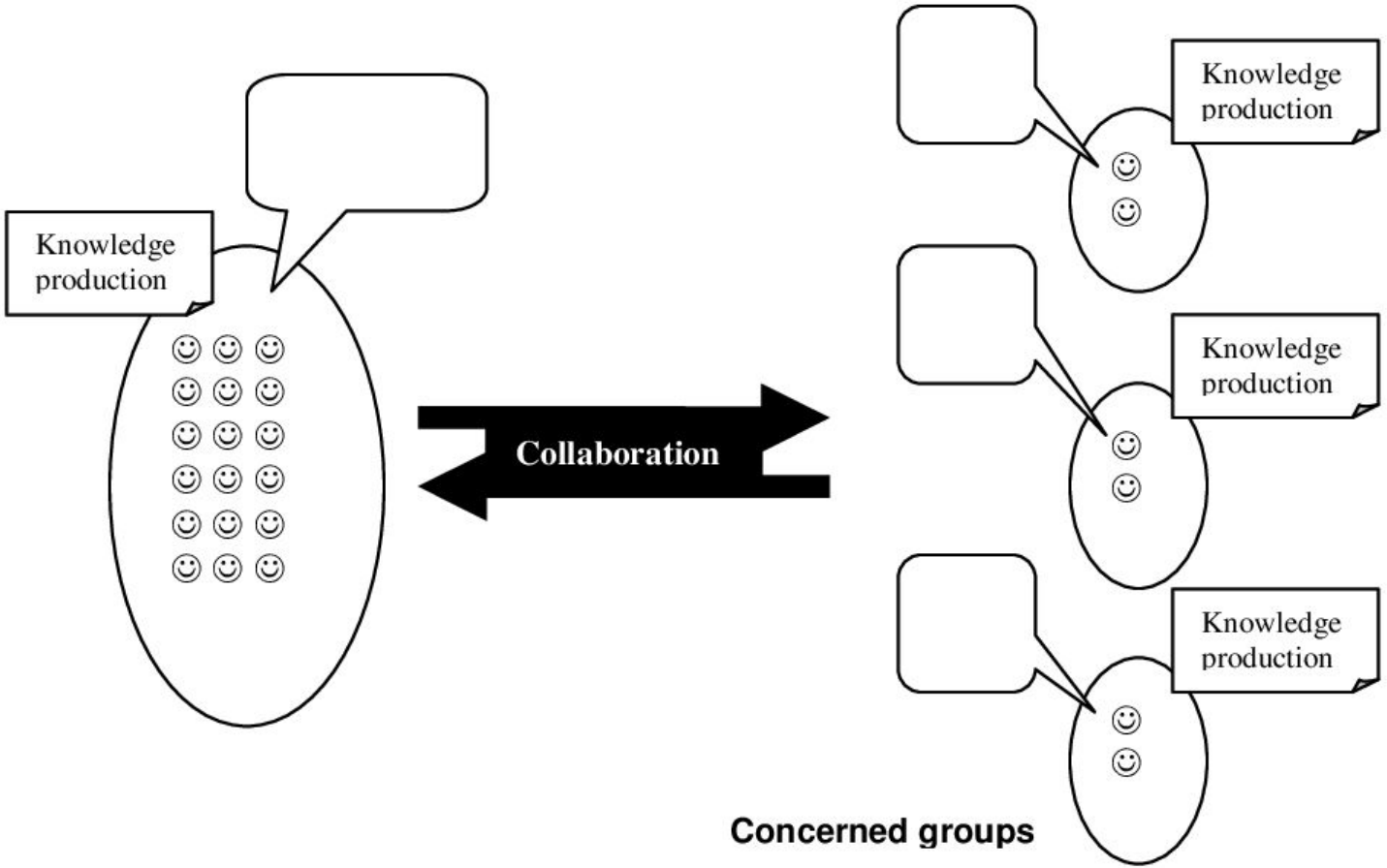
Nature **356**, 739–740(1992) | Cite this article

Access options

Deficit Model



Co-production of Knowledge Model



Accuracy of forecasts, combined data [a]

Percent correct [b] (number of) forecasts

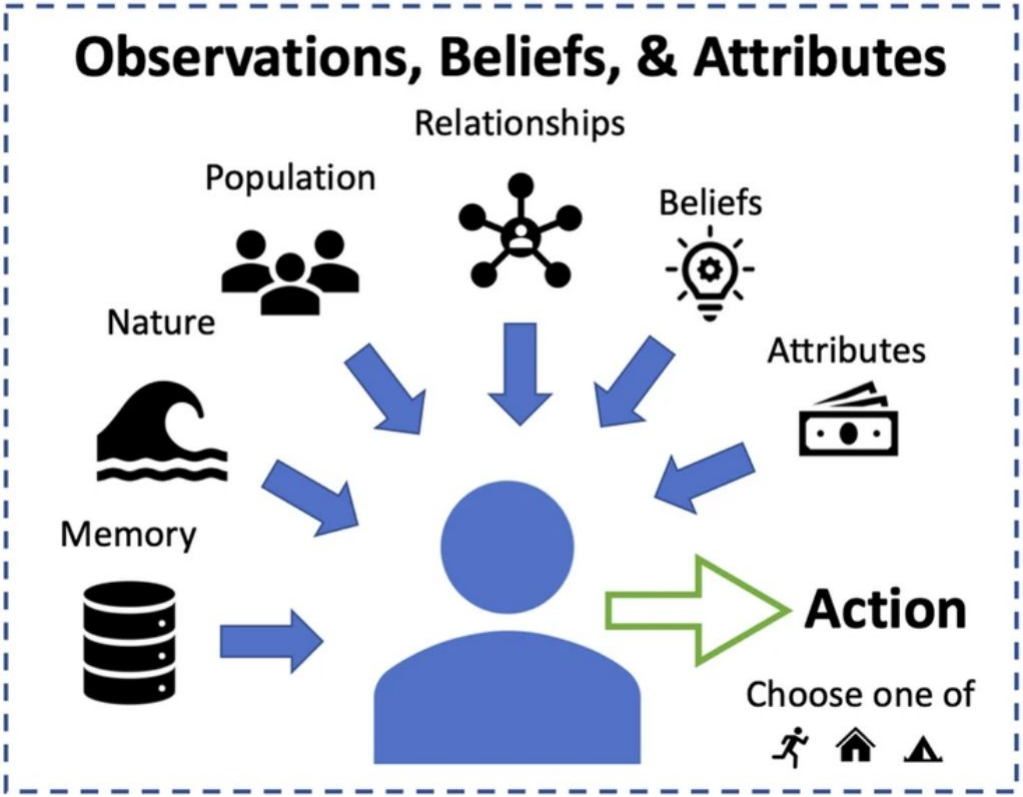
	Chance	Unaided judgement by novices		Game theory experts		Simulated interaction with novices	
Artists Protest	17	5	(60)	6	(17)	**29**	(14)
Distribution Channel	33	15	(68)	23	(13)	**75**	(12)
55% Pay Plan	25	16	(38)	29	(17)	**60**	(10)
Telco Takeover	25	29	(34)	0	(7)	**40**	(10)
Personal Grievance	25	35	(31)	43	(7)	**60**	(10)
Zenith Investment	33	36	(43)	22	(18)	**59**	(17)
Water Dispute	33	51	(35)	75	(8)	**90**	(10)
Nurses Dispute	33	65	(45)	50	(14)	**82**	(22)
Averages (unweighted)	28	32	(354)	31	(101)	**62**	(105)

[a] Includes data from Green (2002) and Green & Armstrong (2004).

[b] Figures in bold indicate the most accurate forecasts for each conflict.

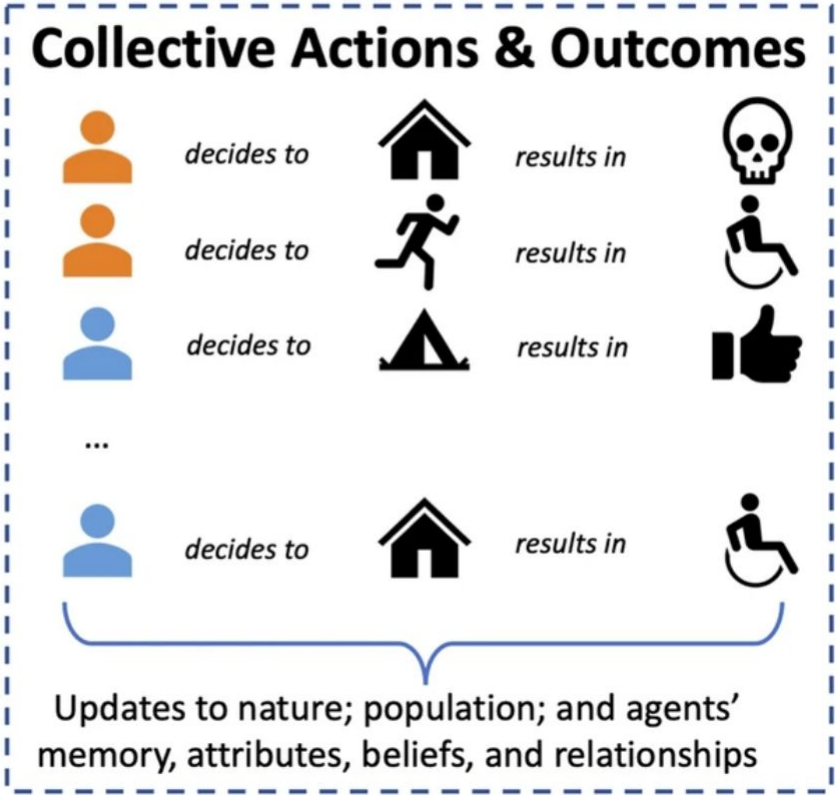
1. What will an agent do right now?

Learns the agent decision function from past observations



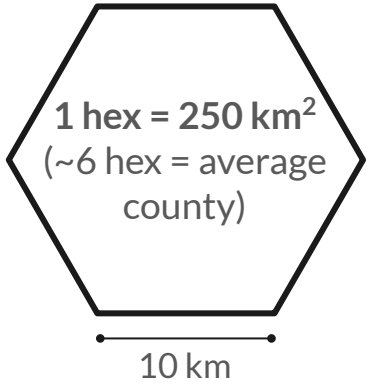
2. What is the next state of the world?

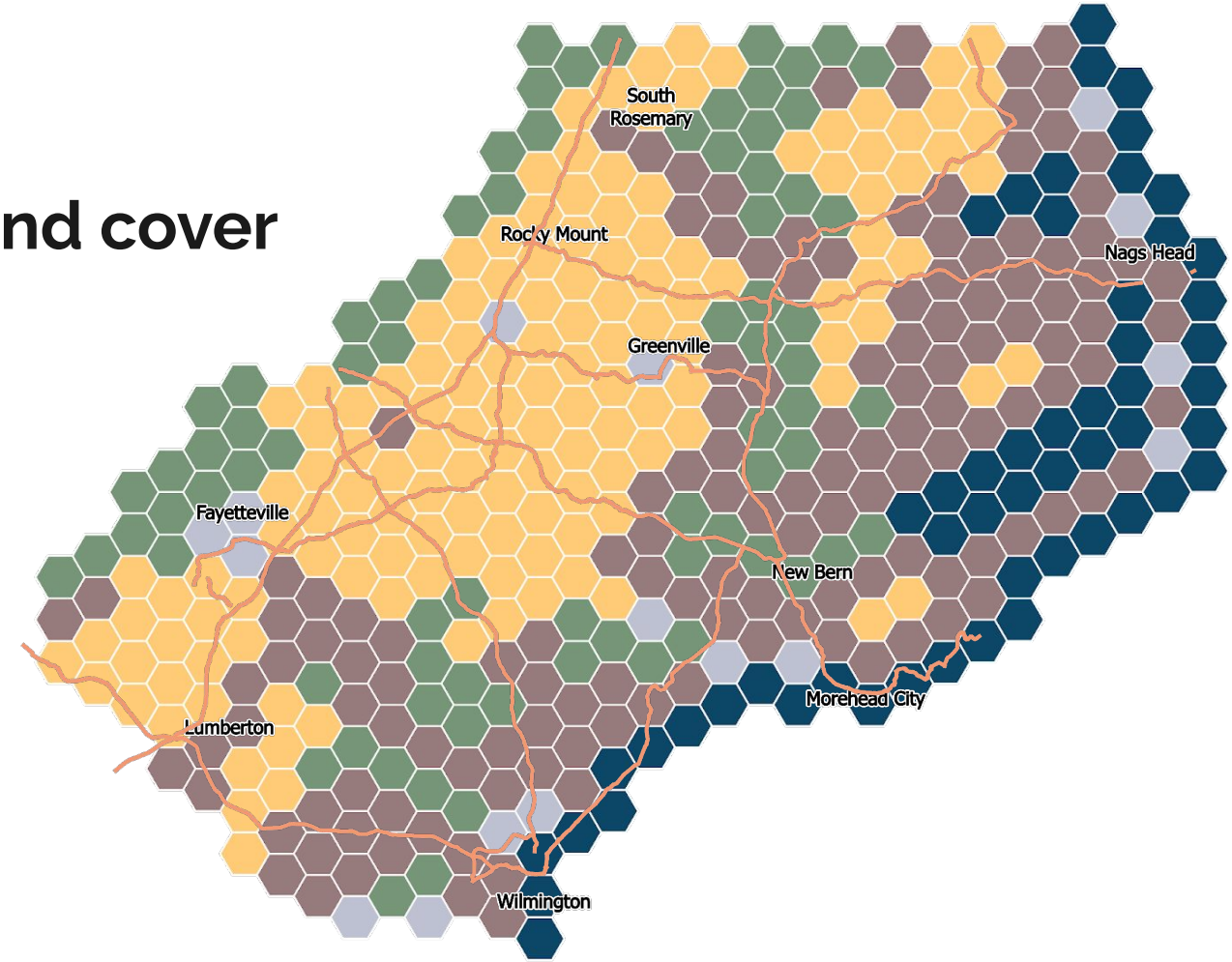
Determines outcomes and steps the simulation



The science behind *FutureScape* design

Land use land cover





- Developed
- Forest
- Agriculture
- Wetland
- Water

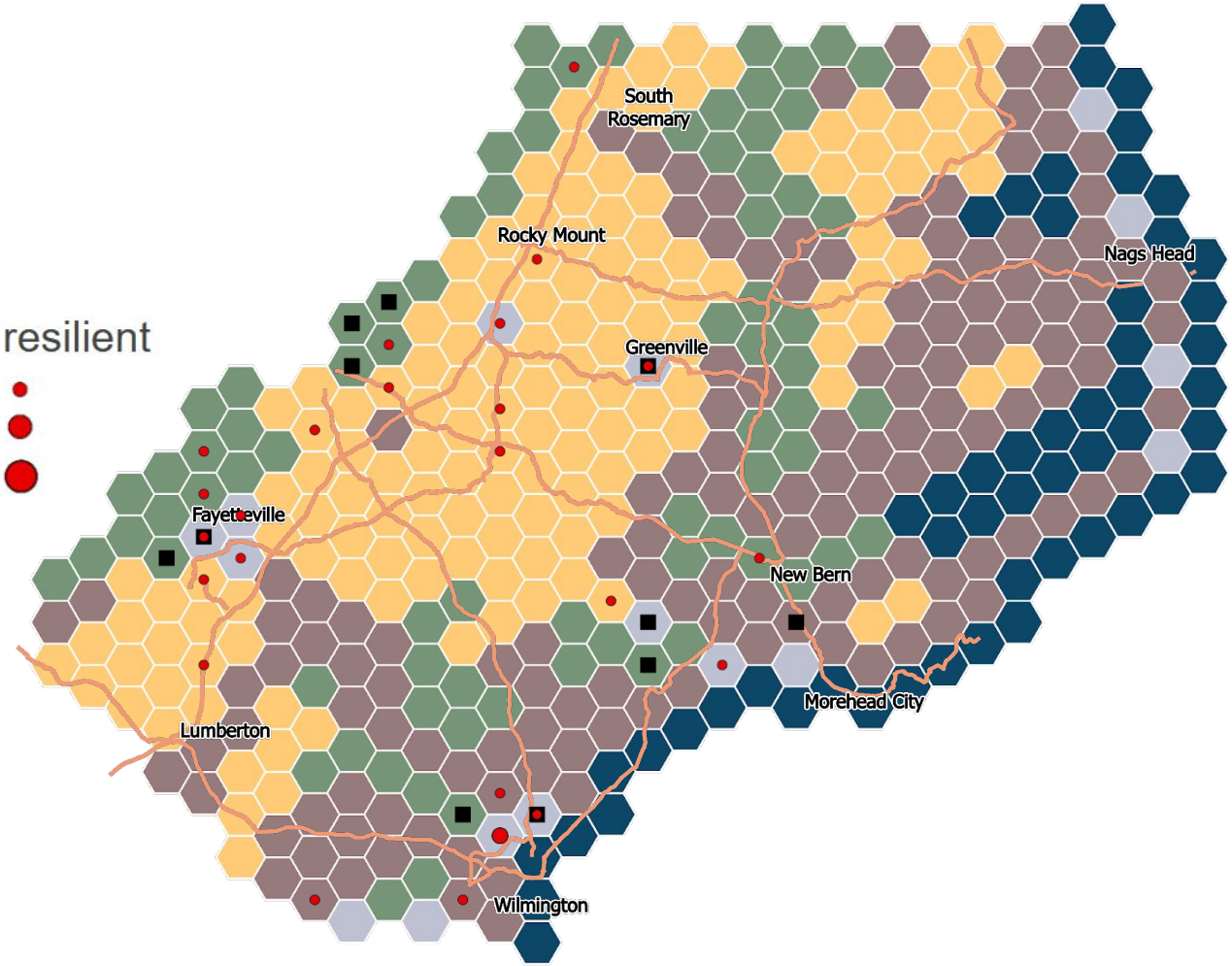
Population

More resilient Less resilient

<20k

20-59k

>60k



Sea level rise

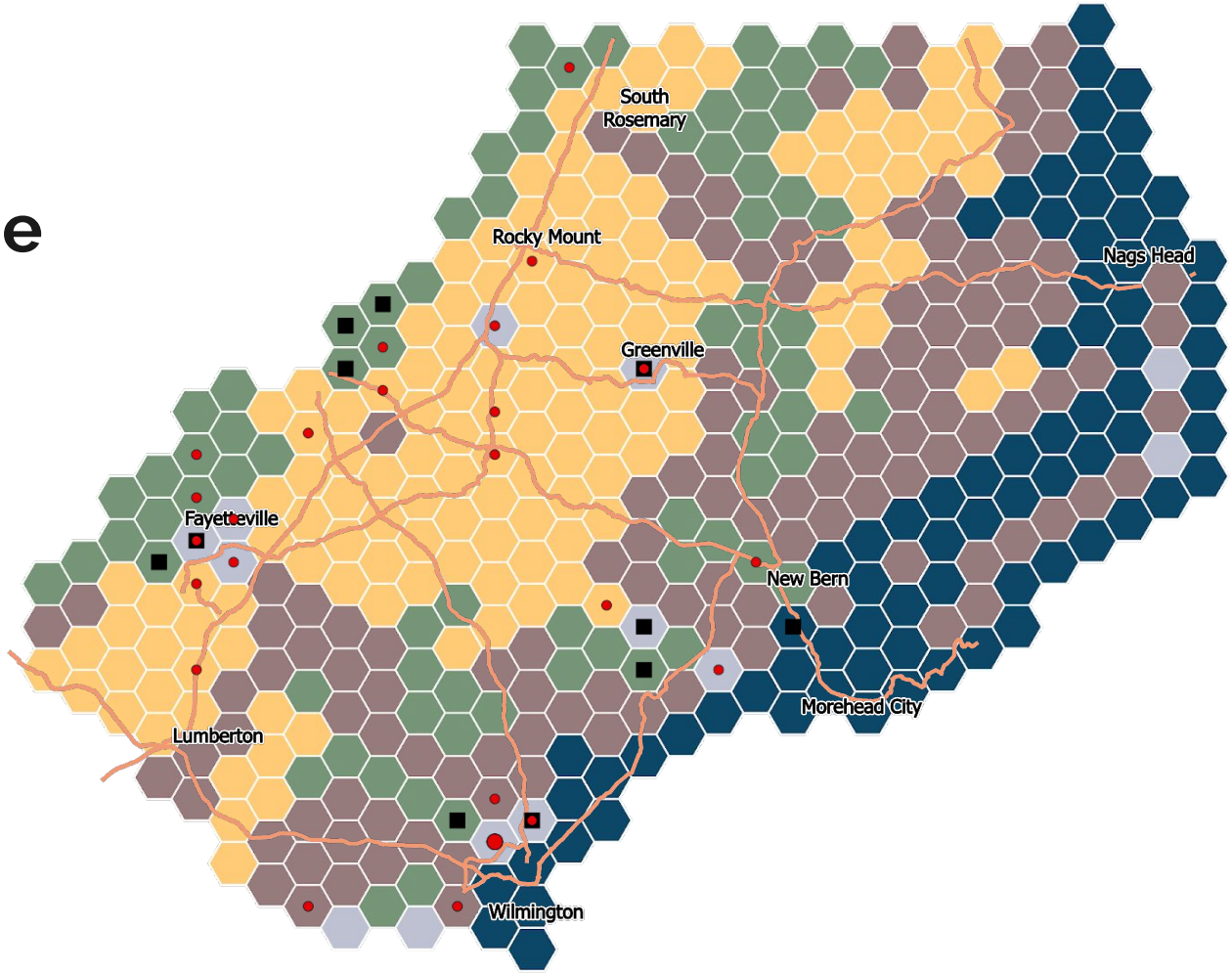
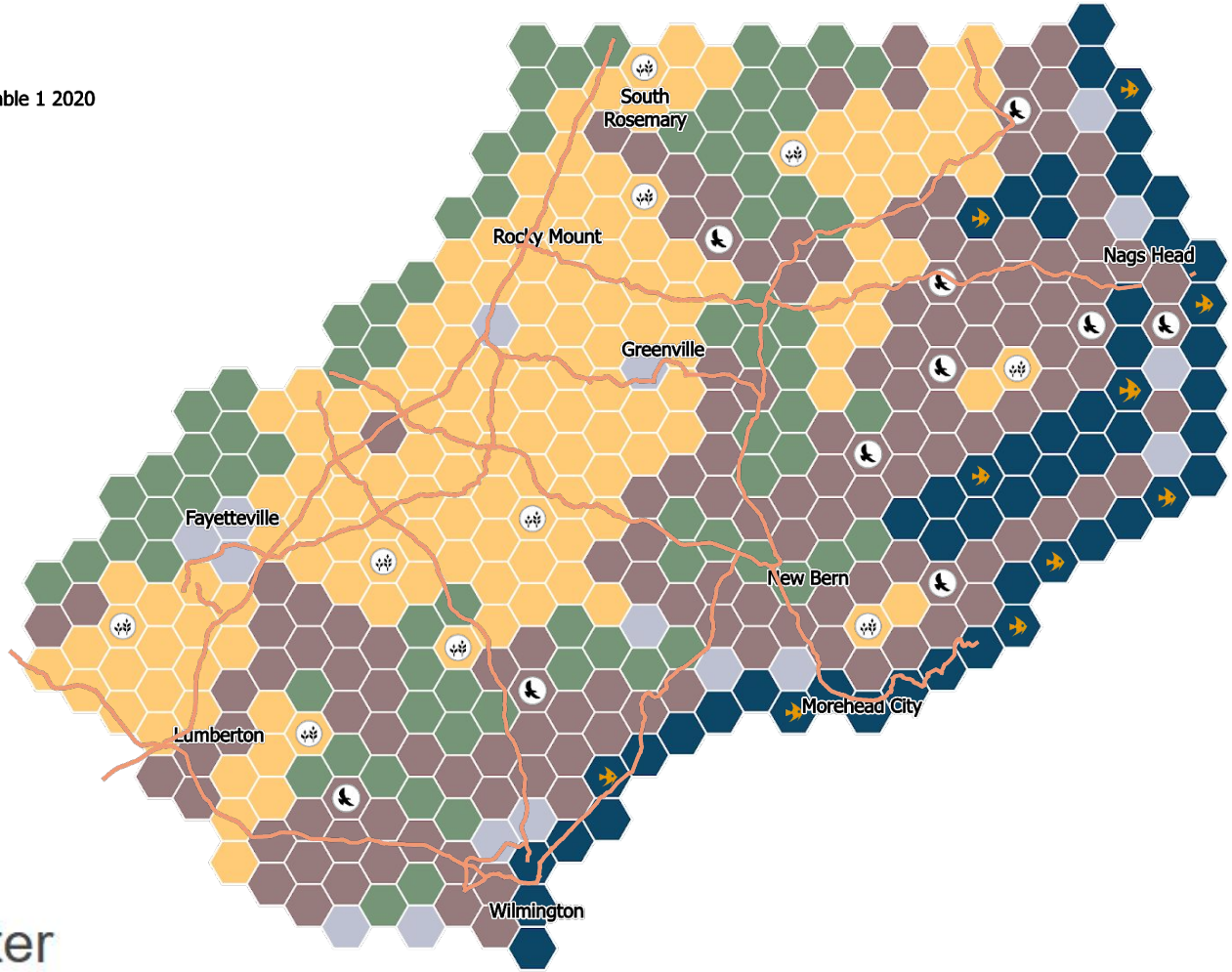


Table 1 2020

Assets



- Marine life
- Wildlife
- Agribusiness center
- Military installation

The paradoxes in *FutureScape* design

simple —---------- not reductive
rigorous —---------- not exhausting
degree of strategy — degree of chaos
enjoyable —---------- challenging
transdisciplinary —---------- playable
inclusive —----- personally stimulating
accurate —---------- changeable

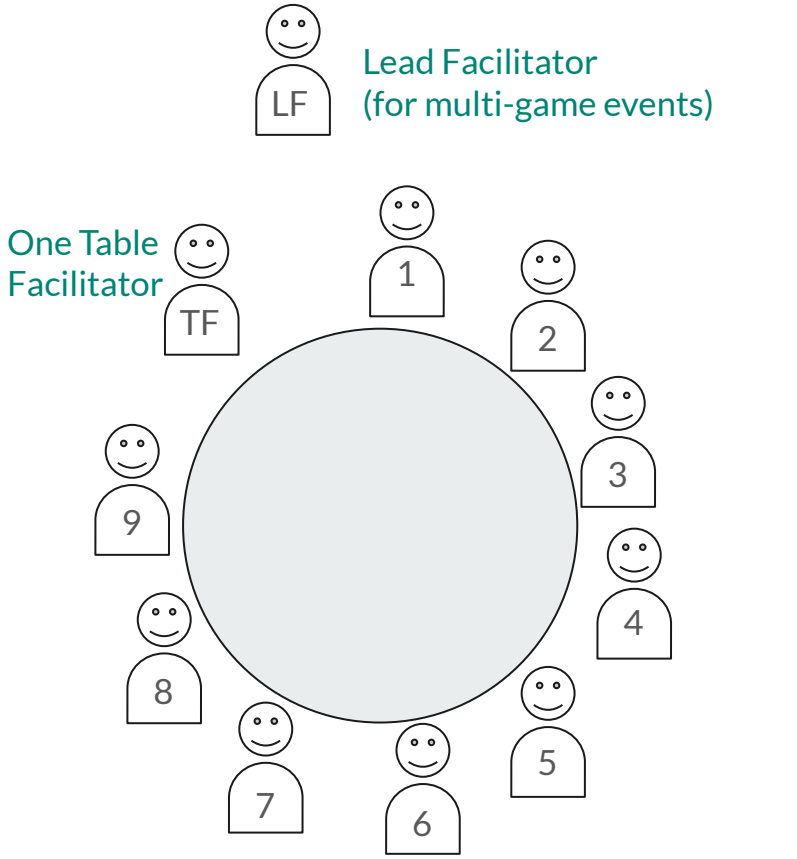
‘ability to recognize the things you can control, and accept what you cannot.’

Implementation at the Envisioning Transformations Workshop (April 24, 2024, in Raleigh, NC.)

FutureScape

Turn 1 **2030**	Action Phase	10:00
	Environment Phase	5:00
Turn 2 **2040**	Action Phase	
	Environment Phase	
Turn 3 **2050**	Action Phase	
	Environment Phase	

. . .



FutureScape

Turn 1
2030

Action Phase

Environment Phase

Turn 2
2040

Action Phase

Environment Phase

Turn 3
2050

Action Phase

Environment Phase

. . .

3-9 actions available each turn

3 Categories of Actions

Resist Actions: invest in resisting changes caused by climate change

Accept Actions: invest in accepting changes and finding alternative solutions

Direct Actions: invest in directing where, how, and when changes occur

Actions & investments require majority consensus

FutureScape

Turn 1
2030

Action Phase

Environment Phase

Turn 2
2040

Action Phase

Environment Phase

Turn 3
2050

Action Phase

Environment Phase

. . .

Time passes, landscape changes (e.g., SLR)

Experience events (e.g., hurricanes, droughts)

Budget resets


FutureScape


Sticklies
tickable easel pad
Bank
Lost Resources
FuturesScape
Elevate Transportation Infrastructure
5 chips


Bank
Lost Resources
Human Population Growth & Migration
Key Messages
Current Context: 2024
FutureScape Cheat Sheet

Access FutureScape:
zenodo.org/records/13538978

Results from Envisioning Transformations Workshop (April 24, 2024, in Raleigh, NC.)

Event-level analysis

- 10 tables with 10 players each
- Players profile:
  - ~80% faculty, researchers, and domain experts
  - ~20% graduate students
- Objectives:
  - visualize outcomes
  - analyze space-time trends and patterns
  - analyze strategy selection preferences
  - explore changes in assets

Digitizing game outcomes

Mapped the distribution of:

- Population (more and less resilient)
- Assets (economic drivers, wildlife, and aquatic life)
- site-specific interventions (R-A-D)

2030

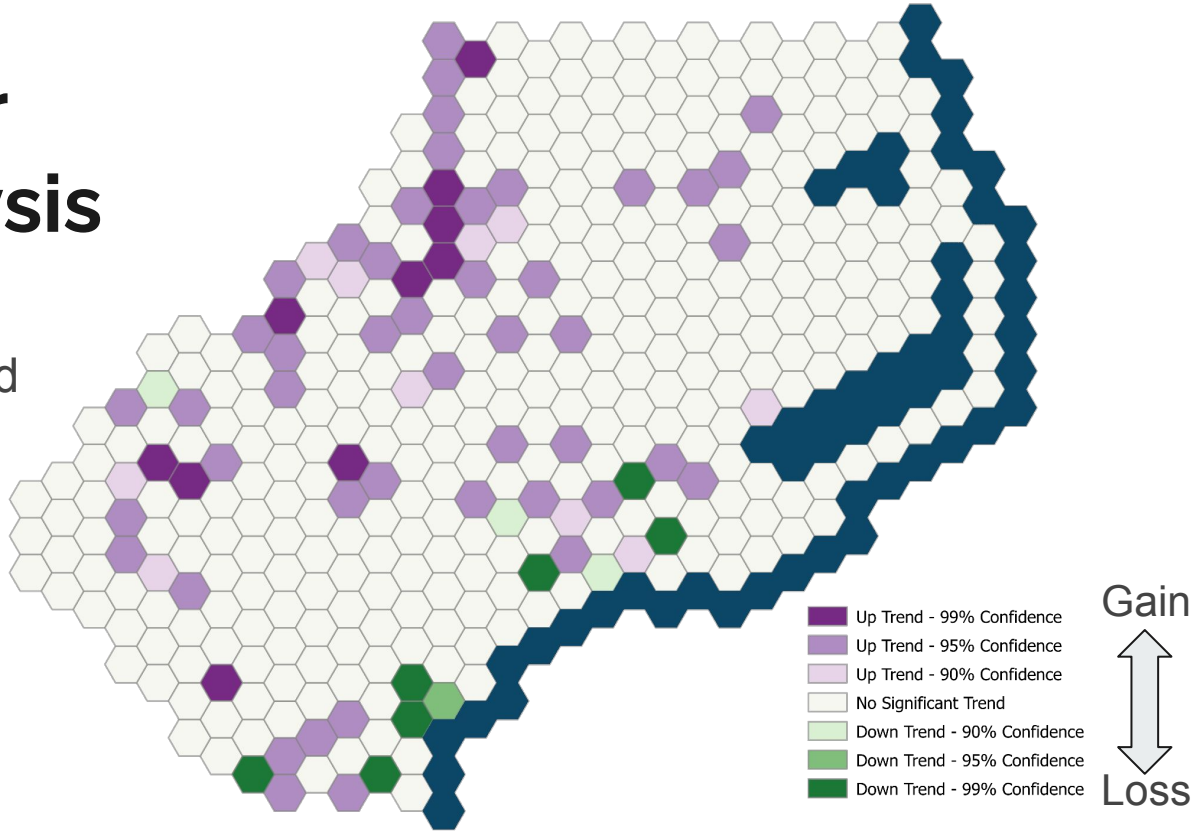
At each turn

2040, 2050, 2060

2070

Space-time clustering for pattern analysis

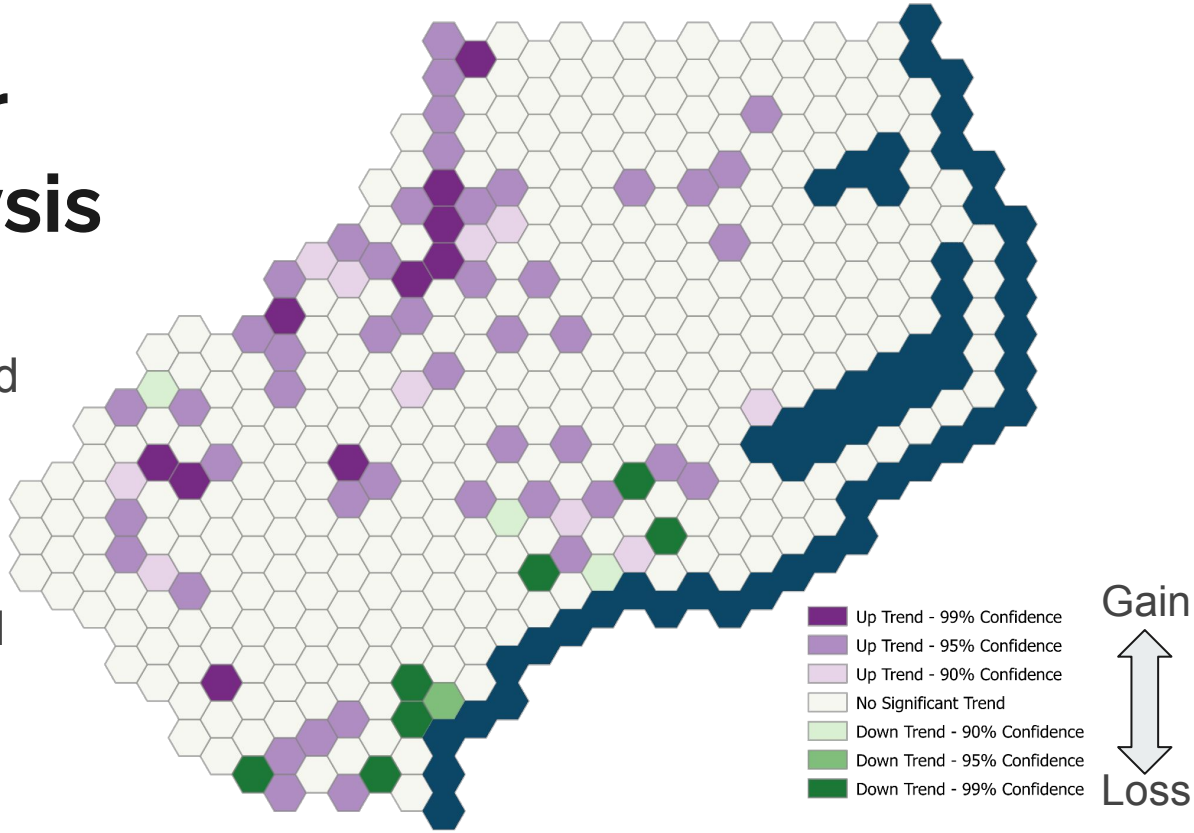
Which areas experienced total population losses and gains?



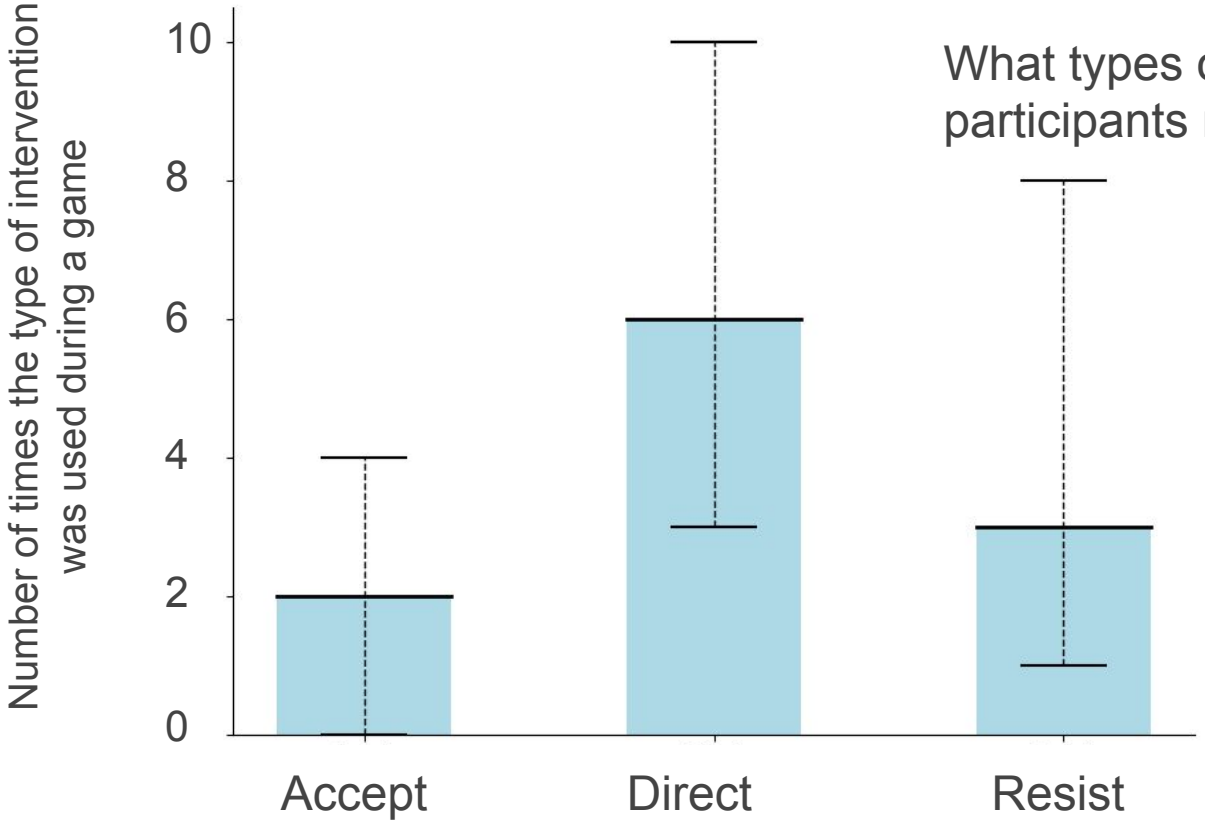
Space-time clustering for pattern analysis

Which areas experienced total population losses and gains?

We observe both coastal retreat and growth

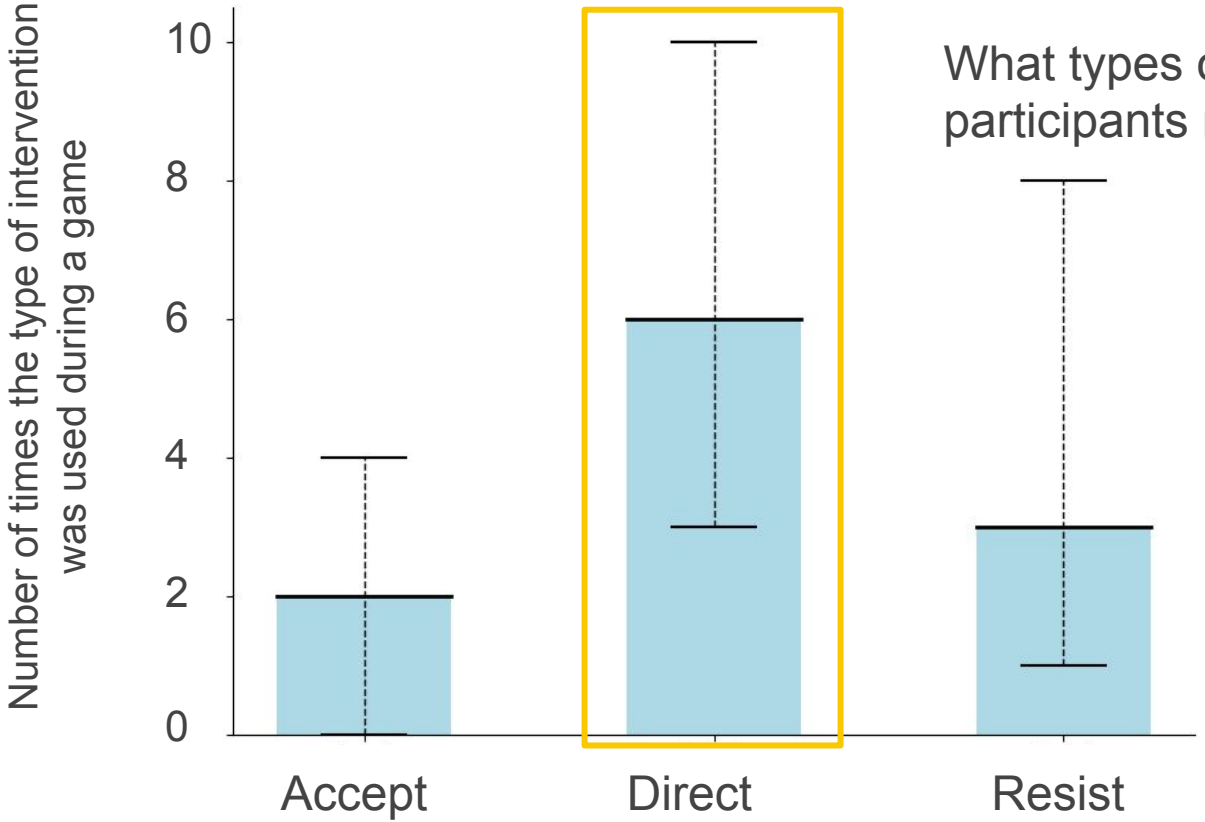


Strategy selection preferences



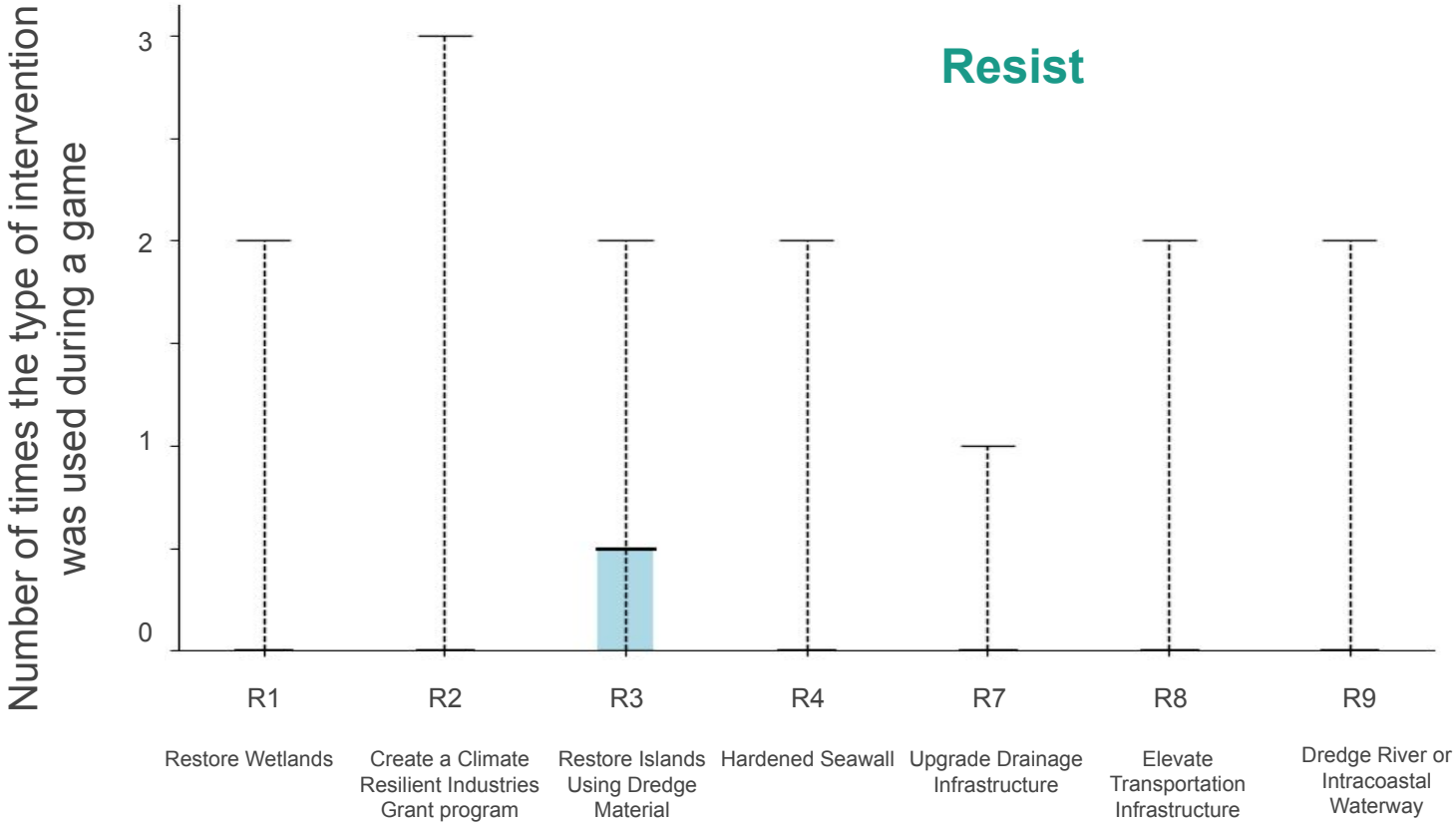
What types of actions were participants more likely to invest in?

Strategy selection preferences

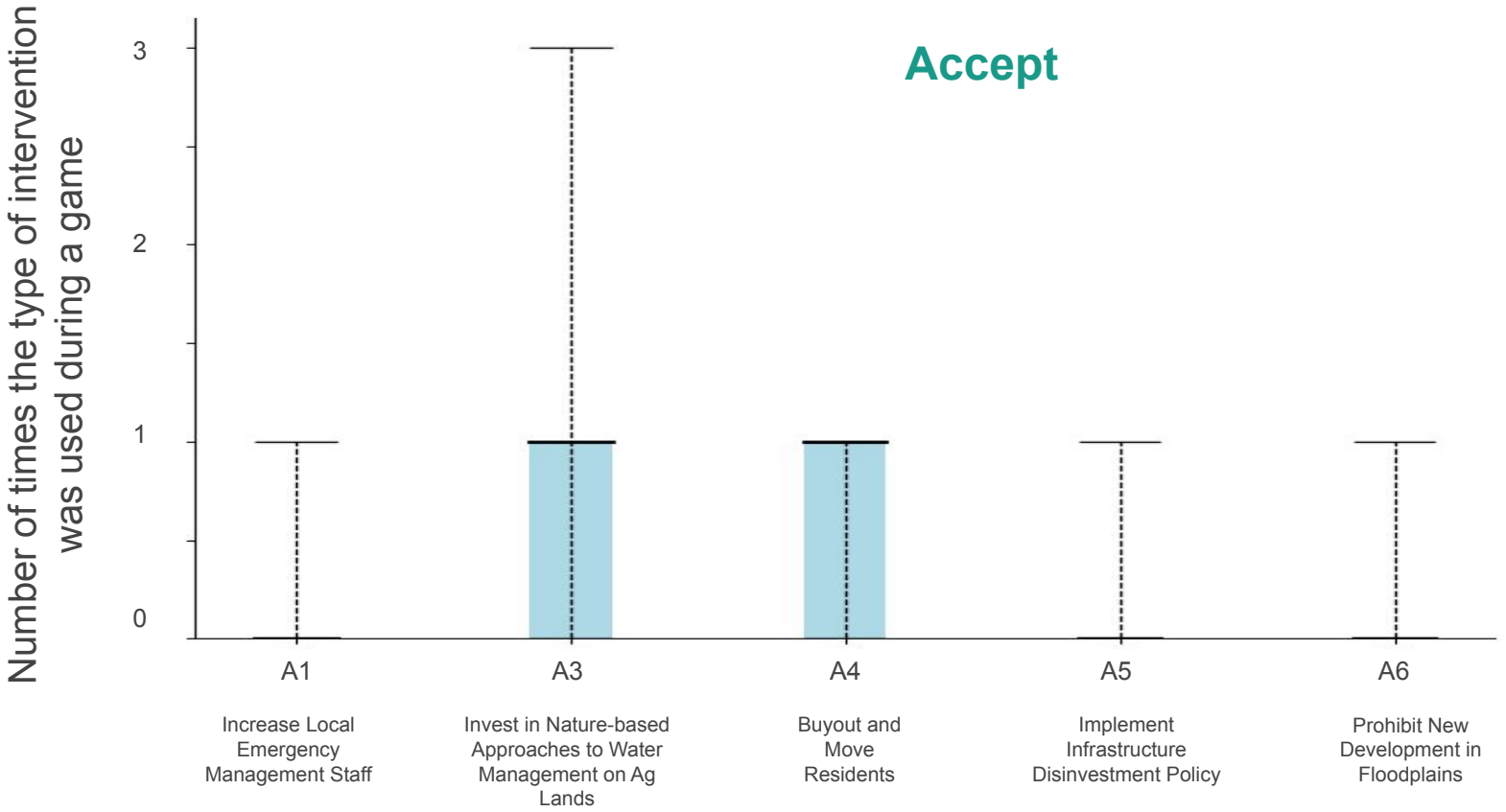


What types of actions were participants more likely to invest in?

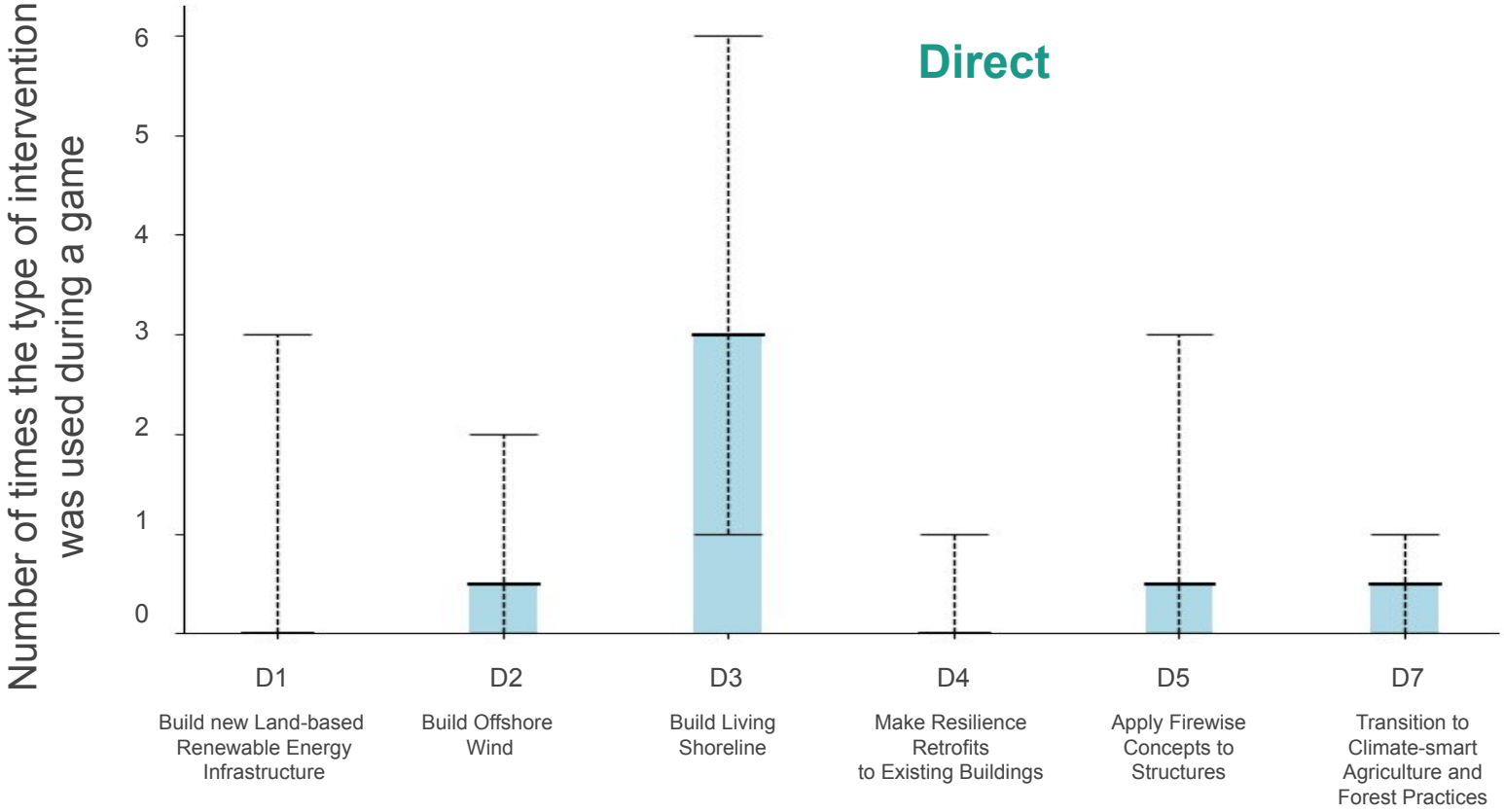
Strategy selection preferences (breakdown)



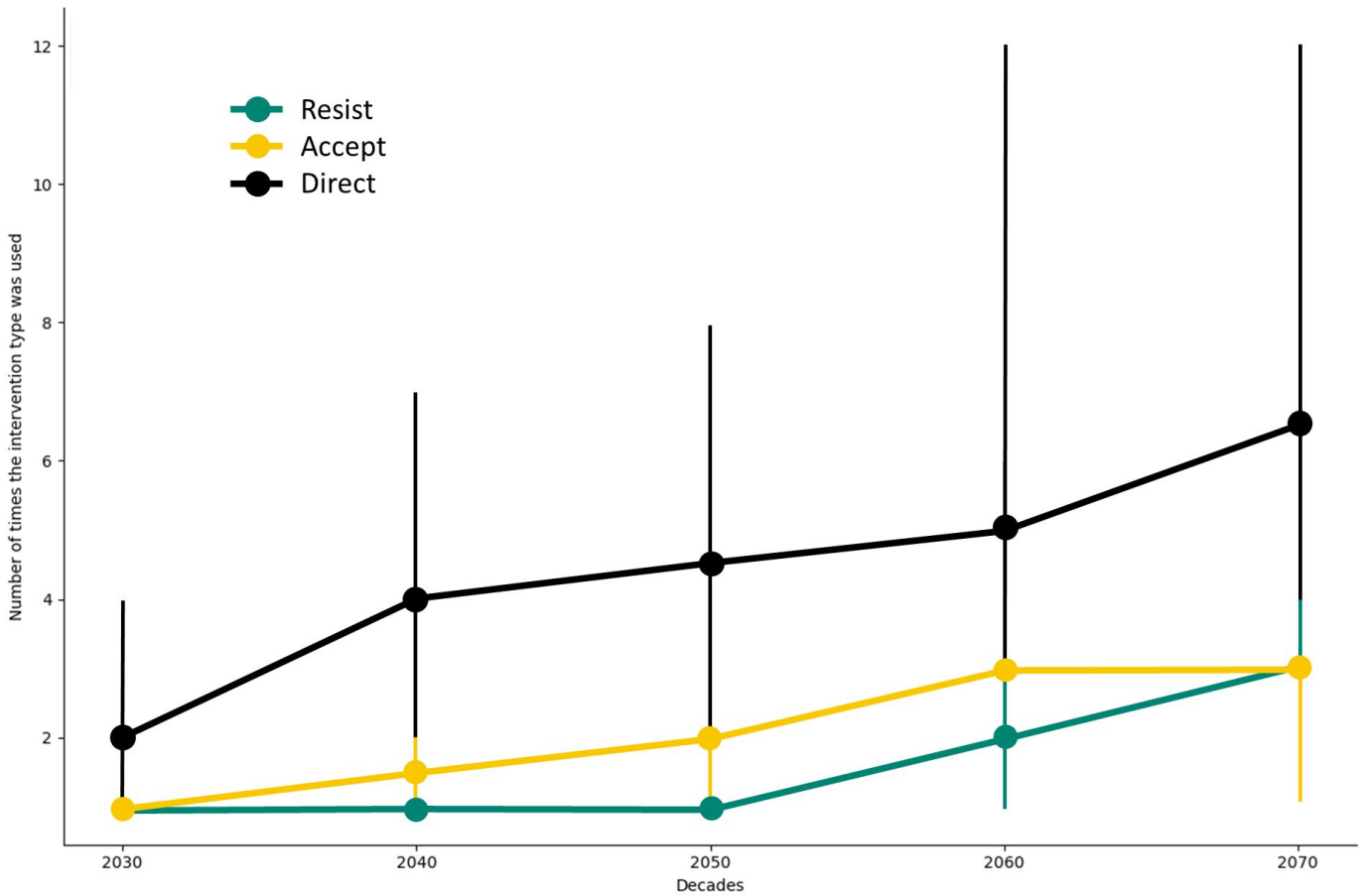
Strategy selection preferences (breakdown)



Strategy selection preferences (breakdown)



Strategy selection preferences (through time)



Strategy selection preferences

Top 4 used actions:

1. **D3: Build living shoreline**
2. A3: Invest in nature-based approaches to water management
3. D5: Apply firewise concepts to structures
4. R3: Restore islands using dredge material

The New York Times

Used at least once by each table to protect coastal cities

INVESTIGATES

D3 was added up to three times around Wilmington

Changes in assets