Modeling, Learning and Planning Together

Addressing Big Questions with Data, Models, and Participatory Exploration

Moira Zellner
Associate Professor, UPP
Research Associate Professor, IESP
Director, UDVL

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THE UNIVERSITY OF ILLINOIS AT CHICAGO
UIC

Motivations

Source: sanfrancisco.cbslocal.com

Source: http://www.greenpeace.org

Questions I: Tools for modeling

- Sustainable growth
- Effectiveness of green infrastructure
- Local economic interests v. regional environmental goals
- Managing flooding and drought in agriculture

Modeling coupled human-natural systems

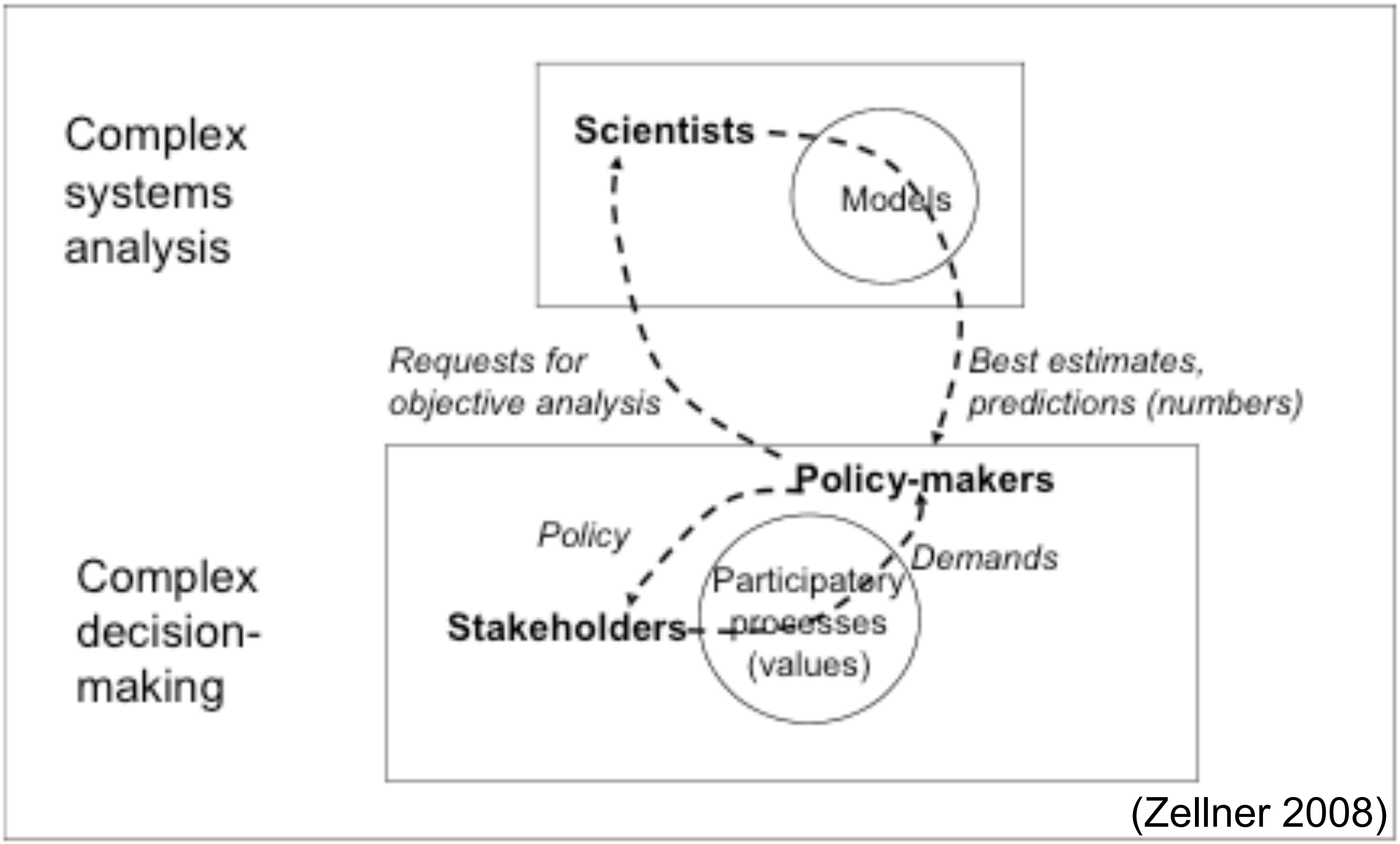
Demo

- SOME model

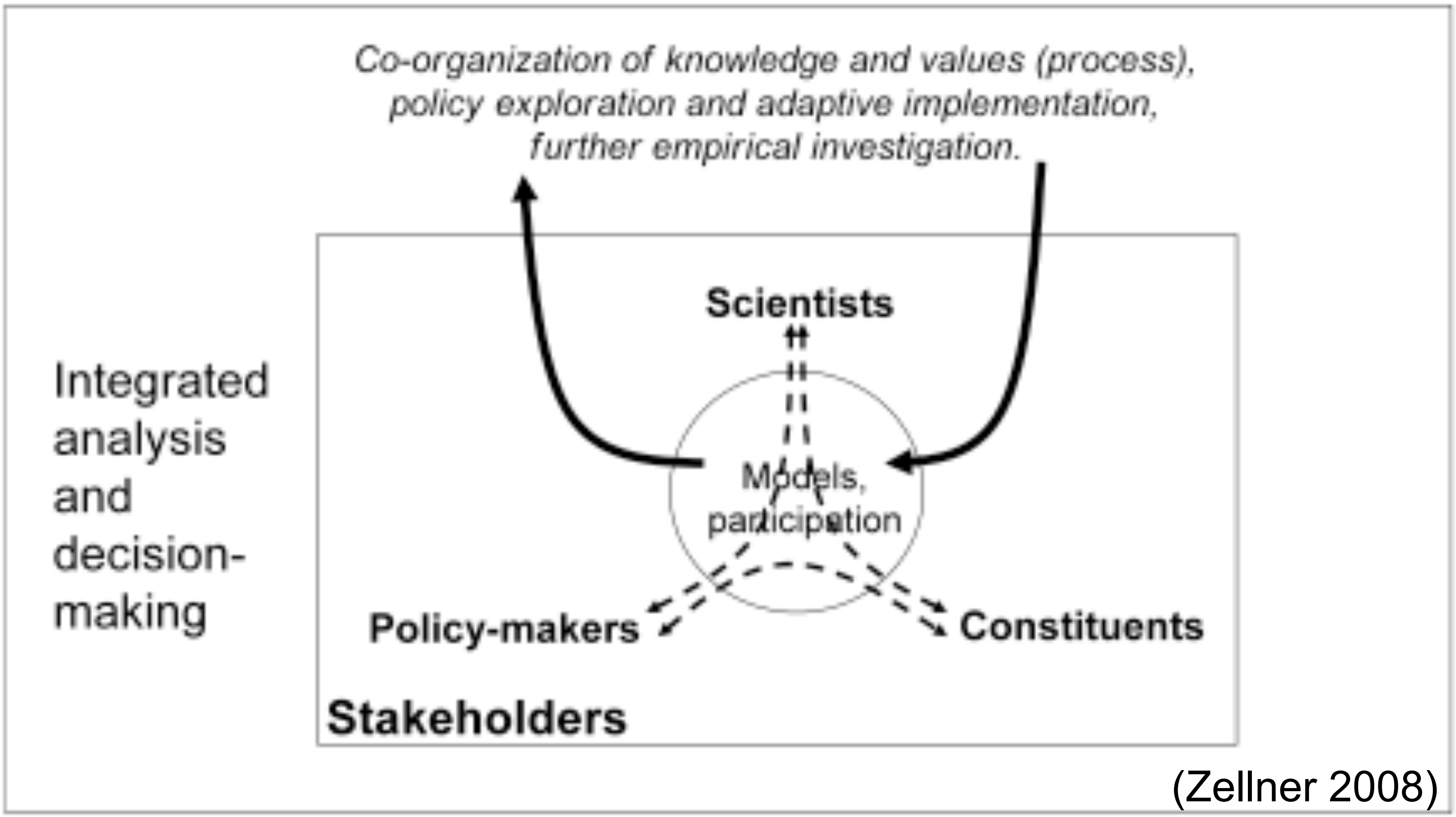
Answers I: Tools for modeling

- Growth is not sustainable(.)
  - Zellner and Reeves (2012)
- Green infrastructure: Thresholds and layouts
  - Zellner et al. (2016)
- Collaborative conservation can arise under development pressure
  - Zellner et al. (2010)
- Adaptation can reduce crop losses but exacerbate flooding
  - Zellner et al. (2019)

Conventional planning and modeling



“Unconventional” planning and modeling



(Zellner 2008)

Challenges

- Communication across expertise
- Spatial thinking and computer modeling
- Confirmatory bias
- Consensus-building and generalization

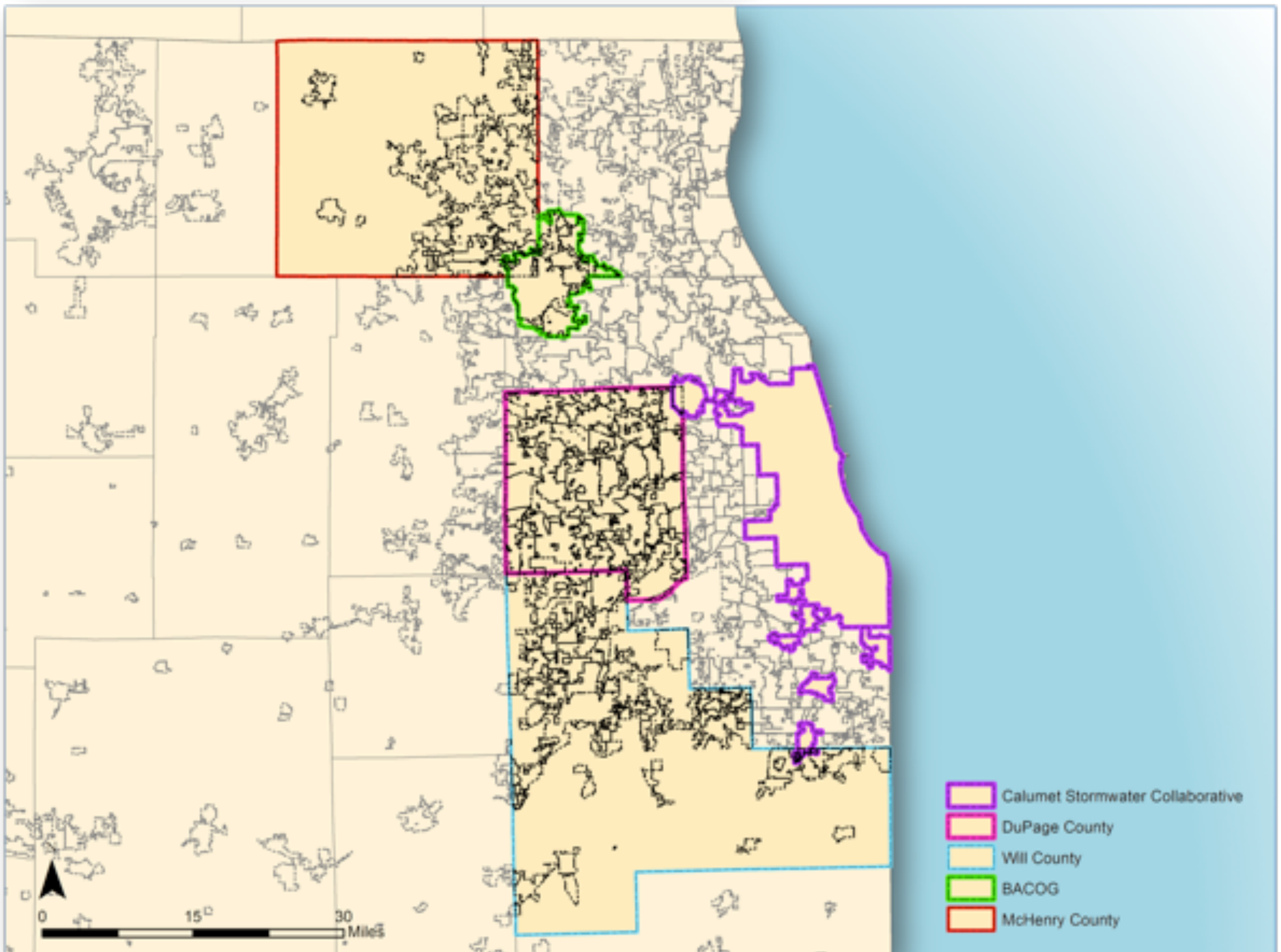
Questions II: Tools for participation

- How can complex systems modeling help us learn?
- How does learning lead to better planning deliberation and decision-making?

What we’ve learned

- It supports learning and innovation
- It’s hard!
- It’s deeply human
- Two stories:
  - Small is beautiful
  - Making the invisible visible

Water Sustainability in NE Illinois

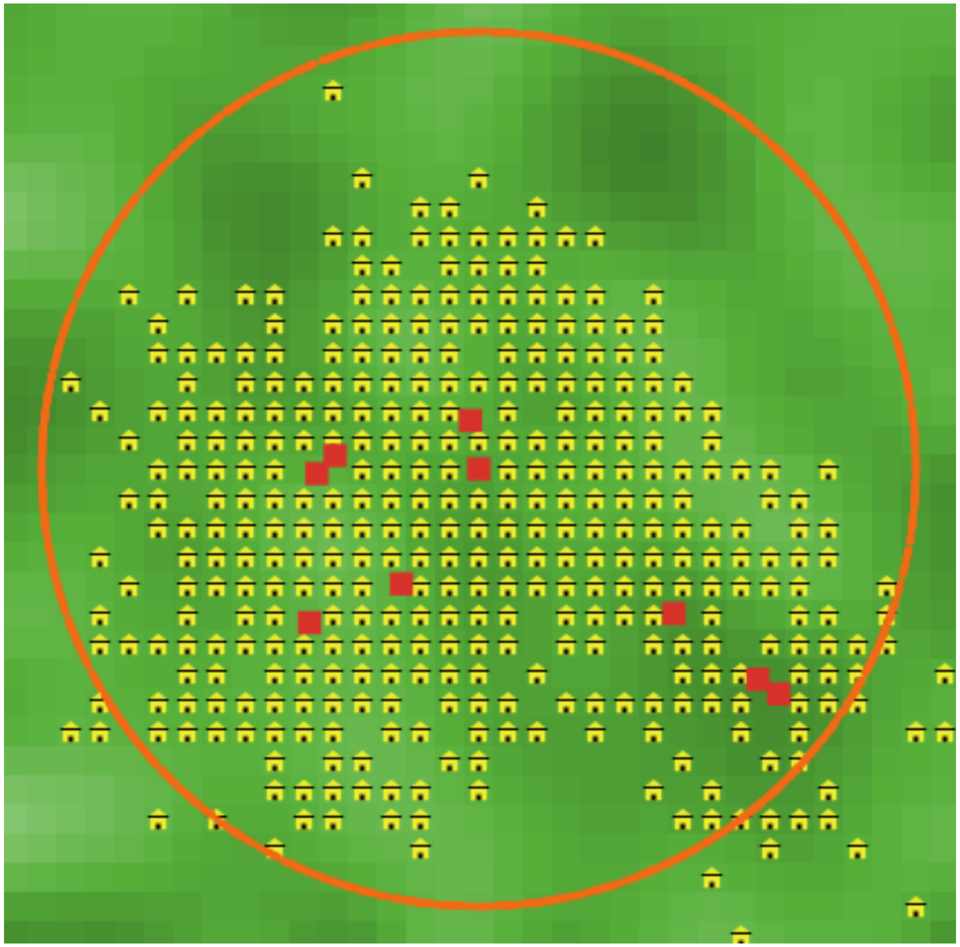


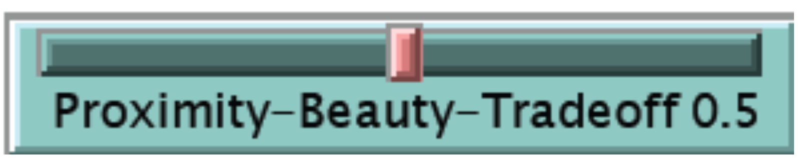
Small is beautiful

Groundwater supply

SOME Model

(SLUCE Project)

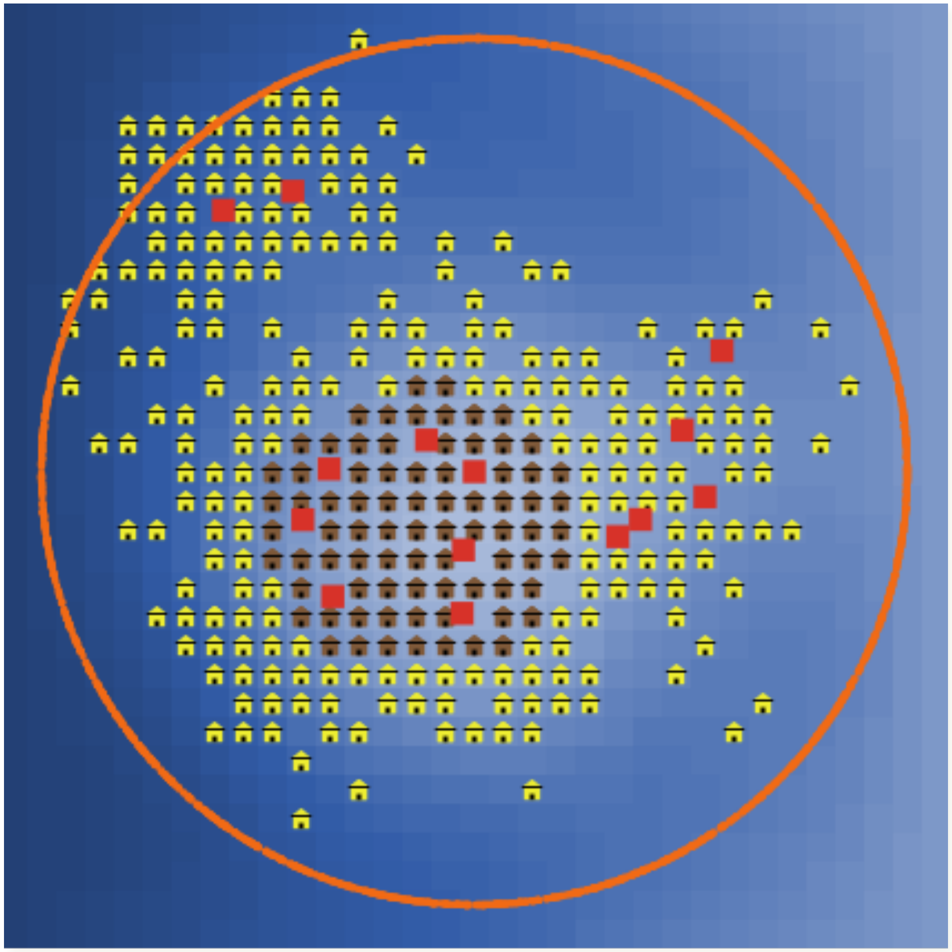




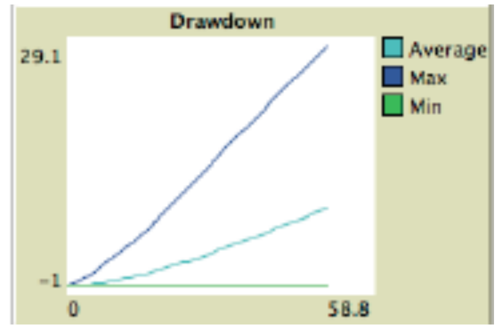
(Zellner et al. 2012)

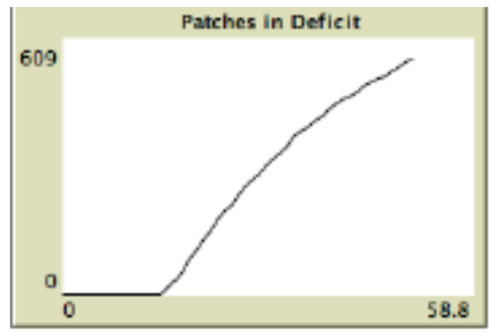
SOME Model

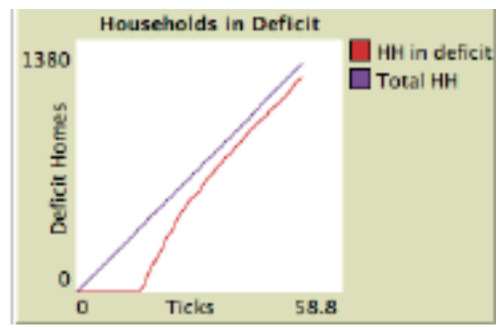
(Zellner et al. 2012)



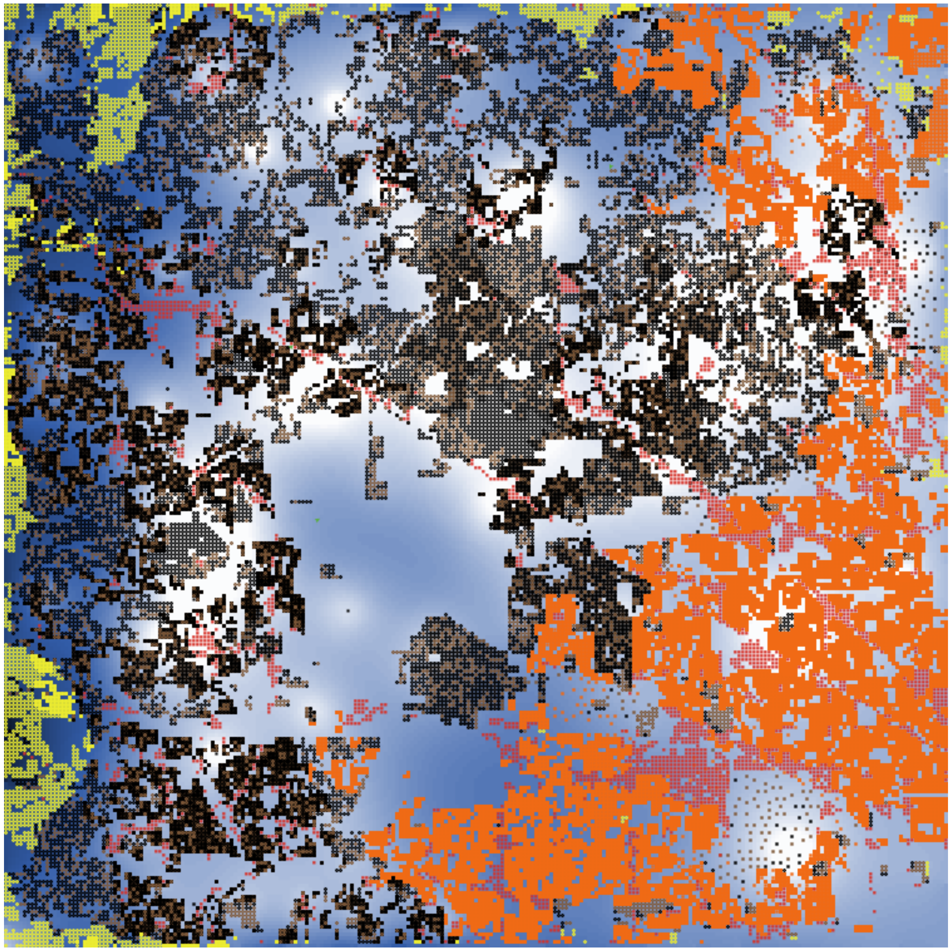
SOME-GW Model

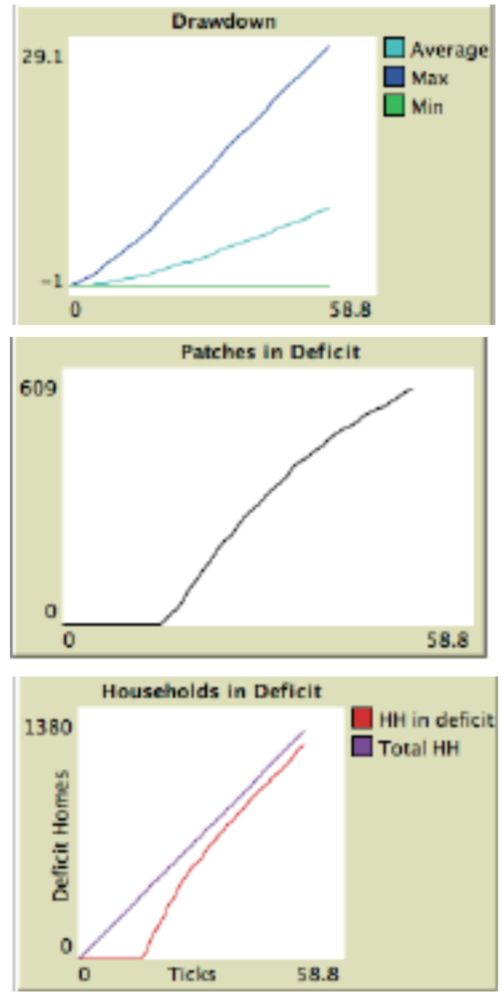






Detailed Model





Learning, innovation and resistance

- Transparency of assumptions

  There is no residential growth here… except in…

  "If water is not a problem, then why are communities doing conservation?"

- Mental modeling

  Lake Michigan water and groundwater effects

- Favored approaches won't work

  "There's the idea that… we're gonna have such a big impact and it really doesn't't"

  *Couldn't isolate themselves from the impact of grow*th

- Specificity of alternative solutions

  "Do we create giant recharge areas that will assist the whole region?... "

  "I think we're learning that {regional water management} is essential for all of us"

  "I'd never bring this up in a public meeting…" but what about injection?

- And yet… rejection (Hoch et al. 2015)
  - Inaccuracy

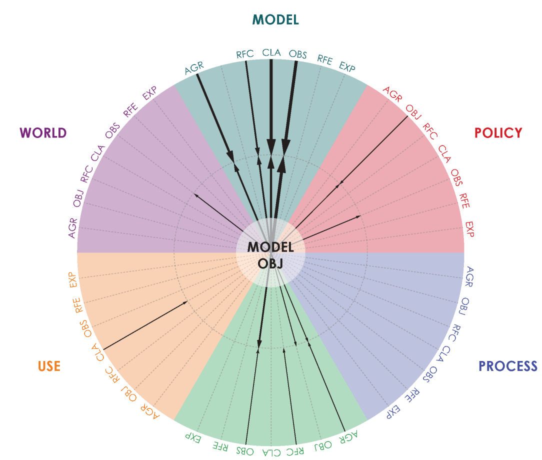
Discourse analysis I

Model – Policy – Process – Use – World

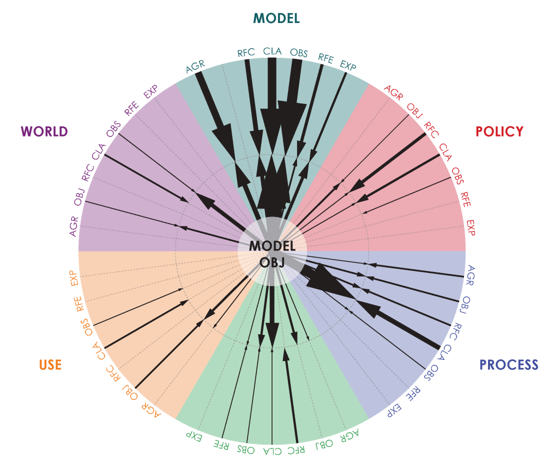
(Radinsky et al. 2016)

Discourse analysis II

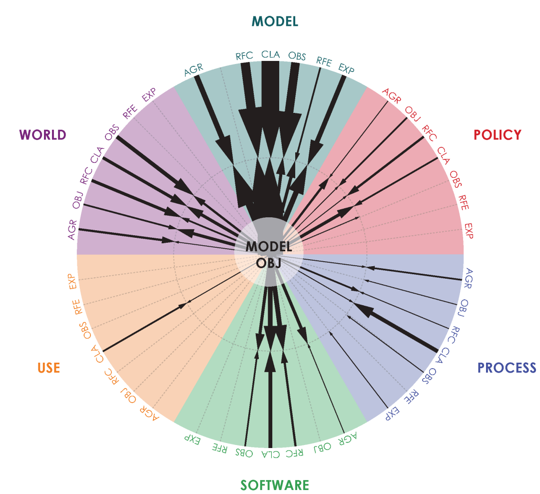
MEETING 1



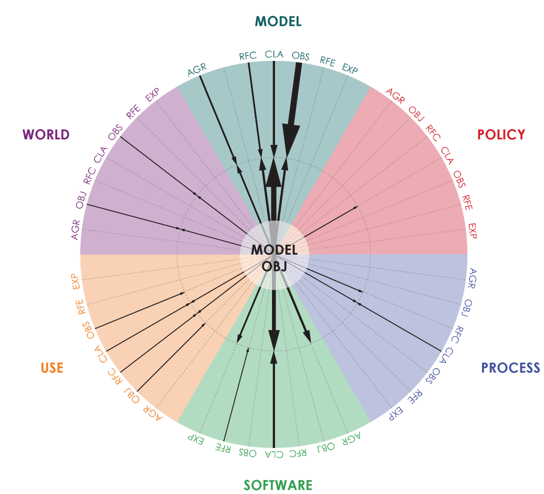
MEETING 2



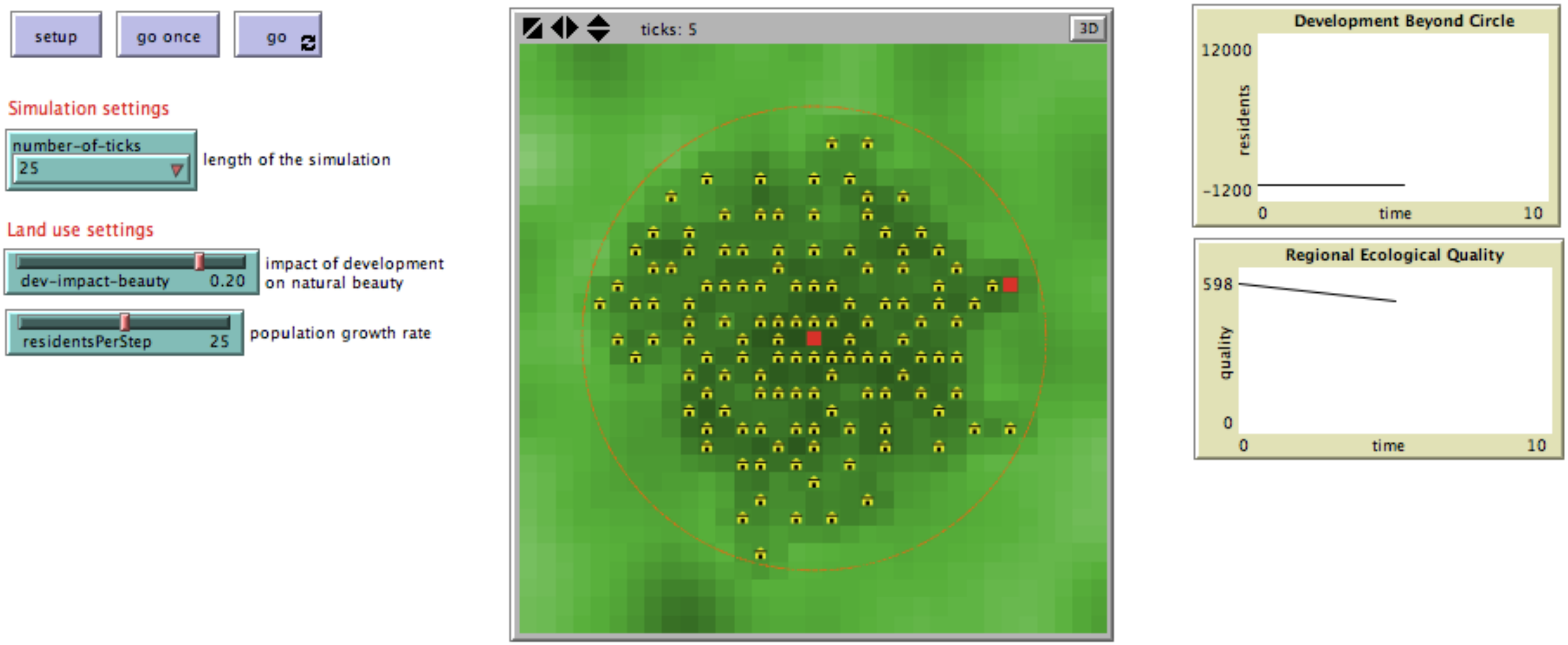
MEETING 3



MEETING 4

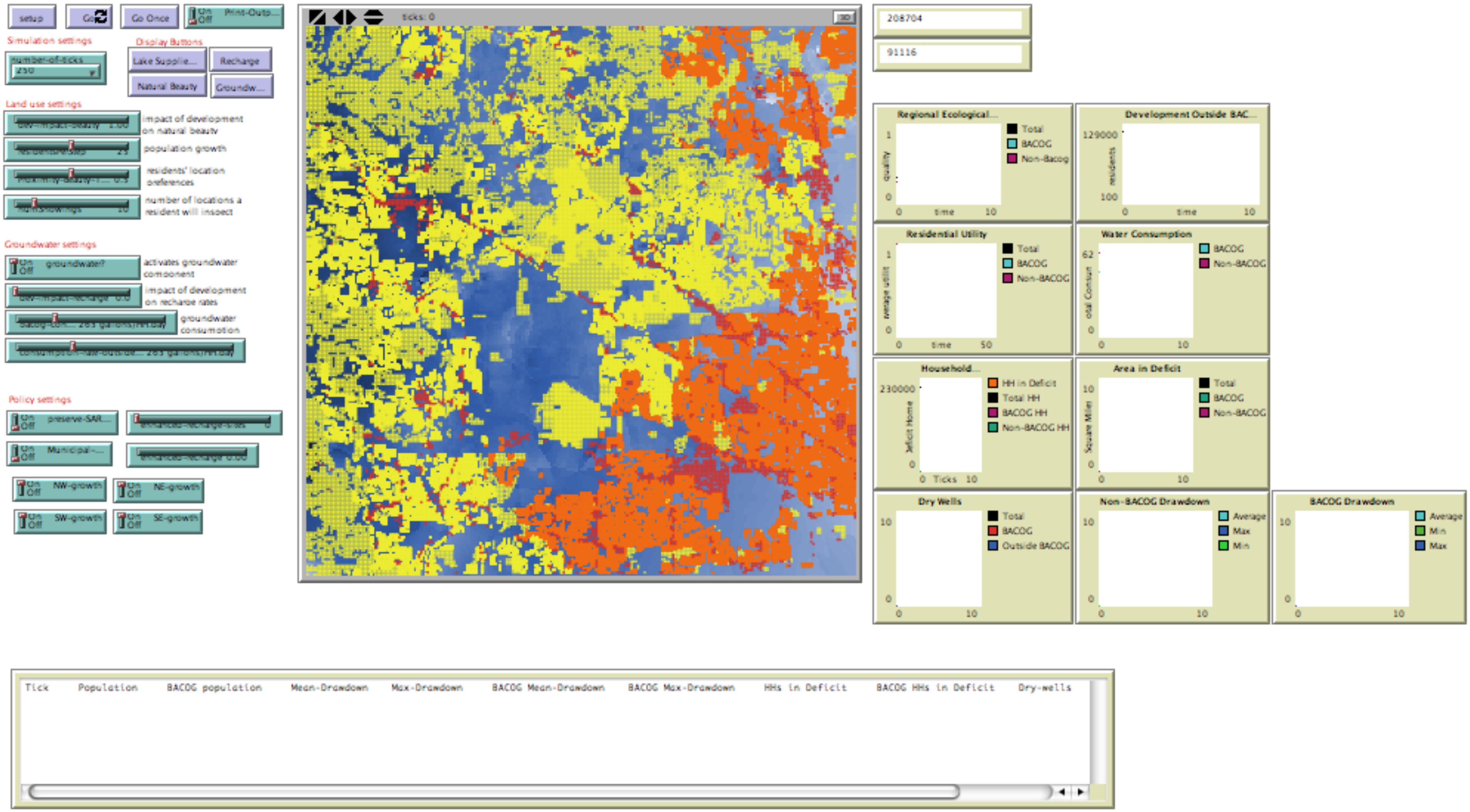


Simple interfaces...



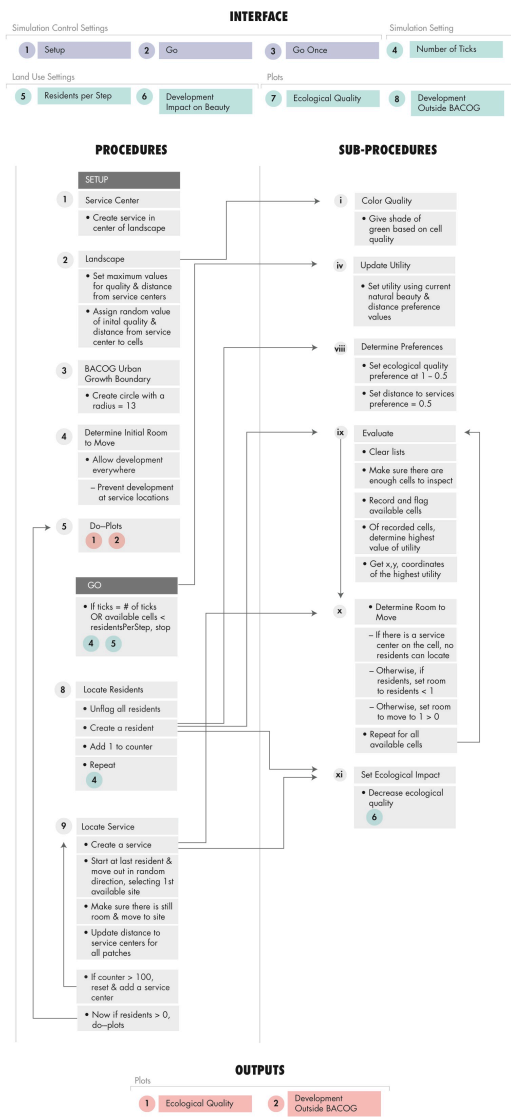
(Zellner et al. In progress)

To detailed interfaces

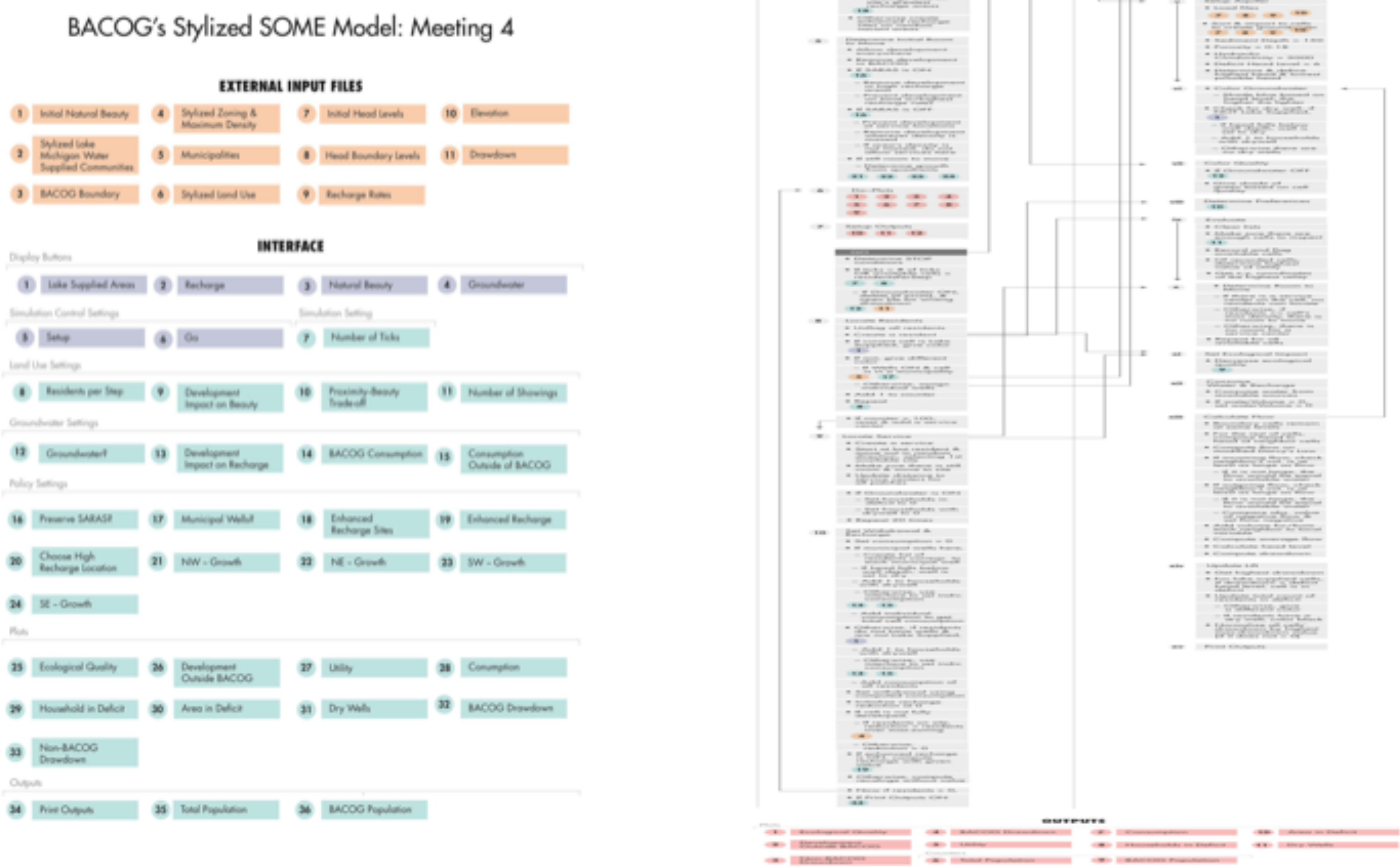


Simple processes…

BACOG's Stylized SOME Model: Meeting 1



To detailed pr



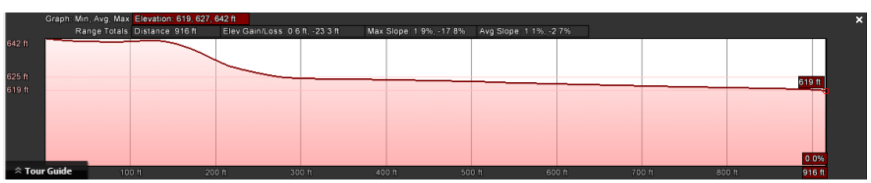
Lessons

- Keep it simple
- Use intermediate tangible user interfaces (TUI)
- Interactive exercise versus instruction
- Start with more visible problems

Making the invisible visible

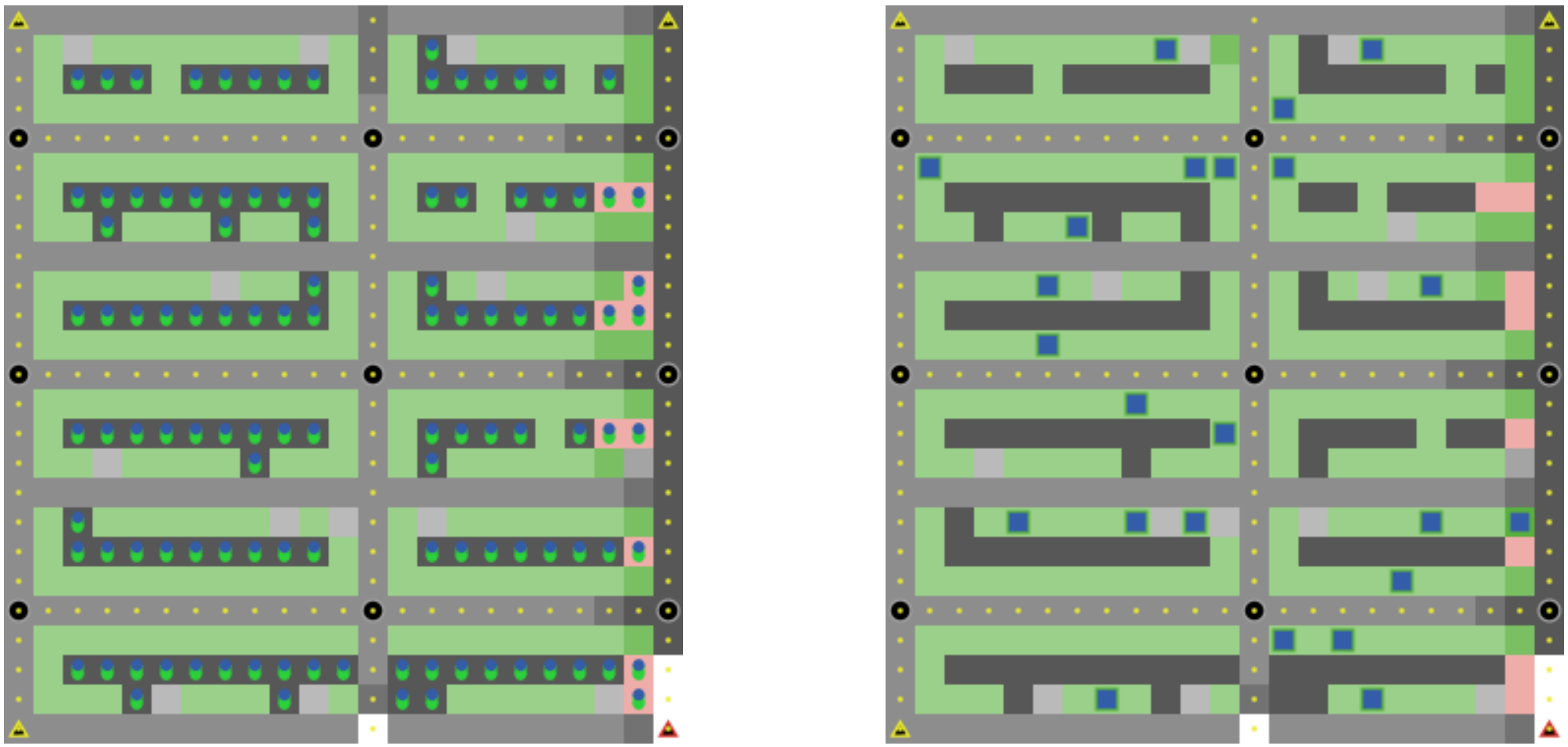
Flooding

An illustration in flooding



L-GrID model
(Zellner et al. 2016)

An illustration:
Rain barrels or bioswales?

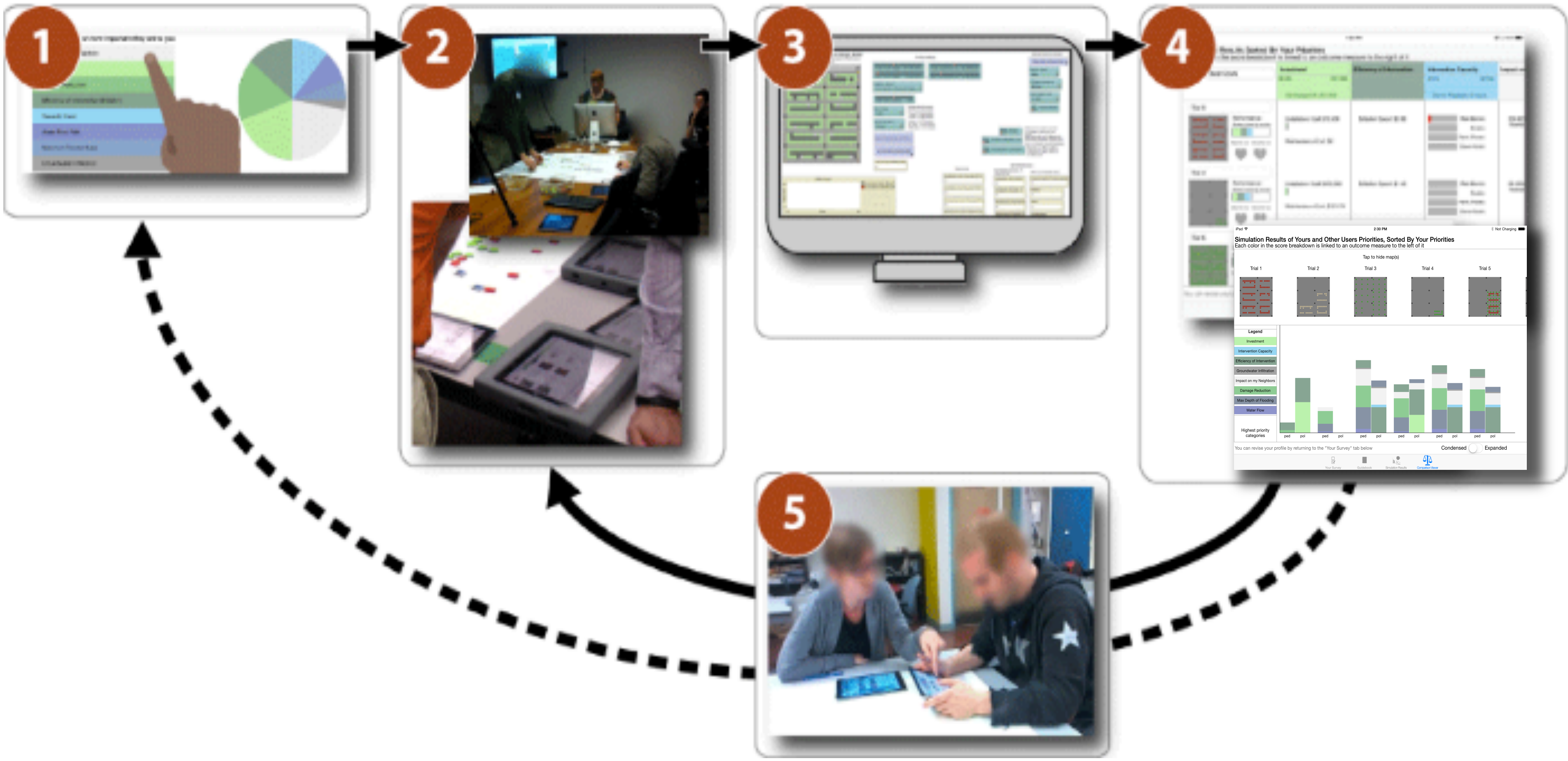


	Baseline	Rain barrels	Bioswales
Installation cost	$0.00	$14,250.00	$350,168.79
Damages	$39,062.90	$38,837.74	$34,495.24
Outflow	0.62	0.62	0.56

Things to consider

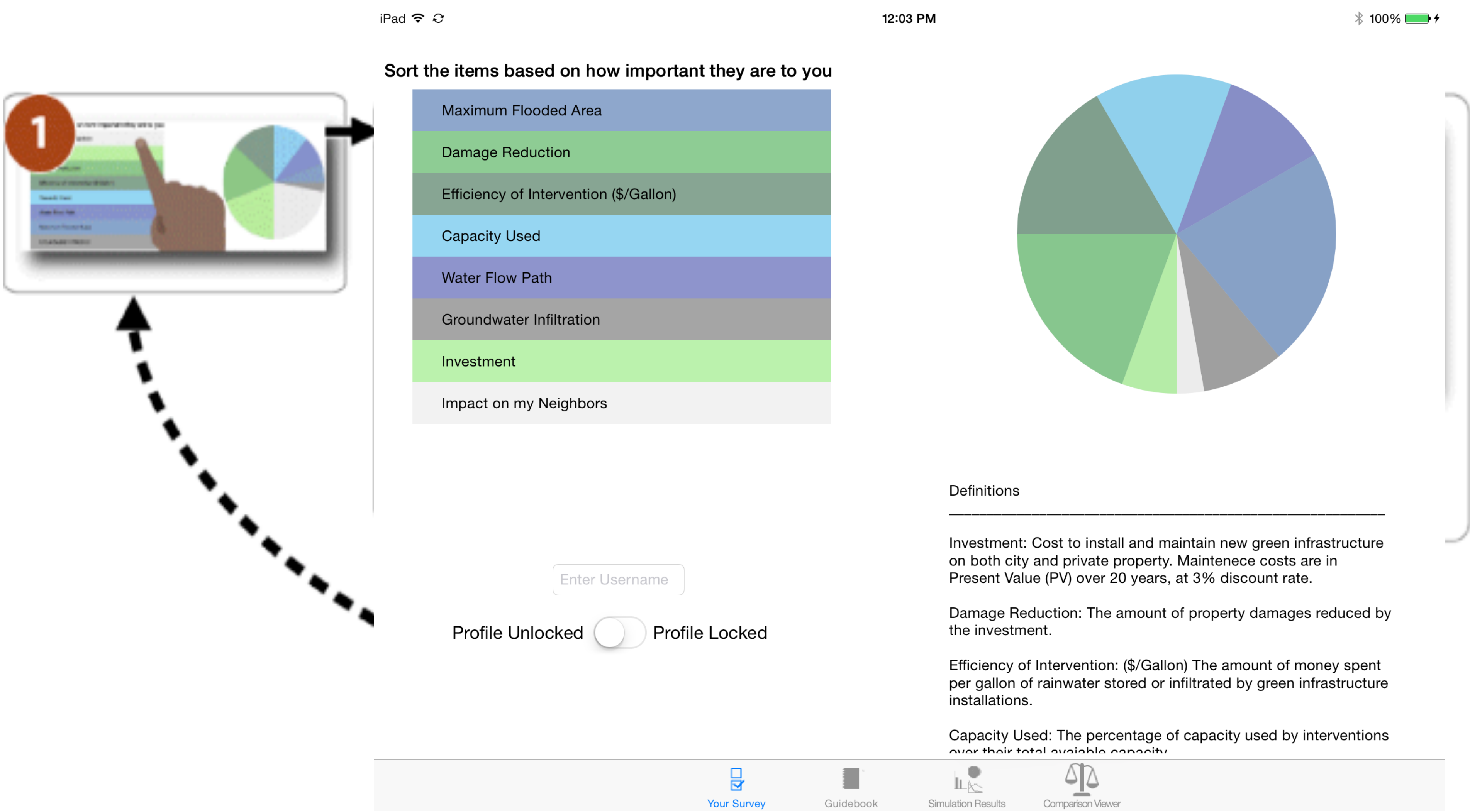
- Simulations alone are not enough
  - Tradeoffs
  - Costs and distribution
  - Spatial constraints
  - Diverse stakeholder interests
- Solution-building AND compromise
  - Awareness of preferences
  - Addressing diverse needs
    - metrics, evaluation, exploration

Workshop setup

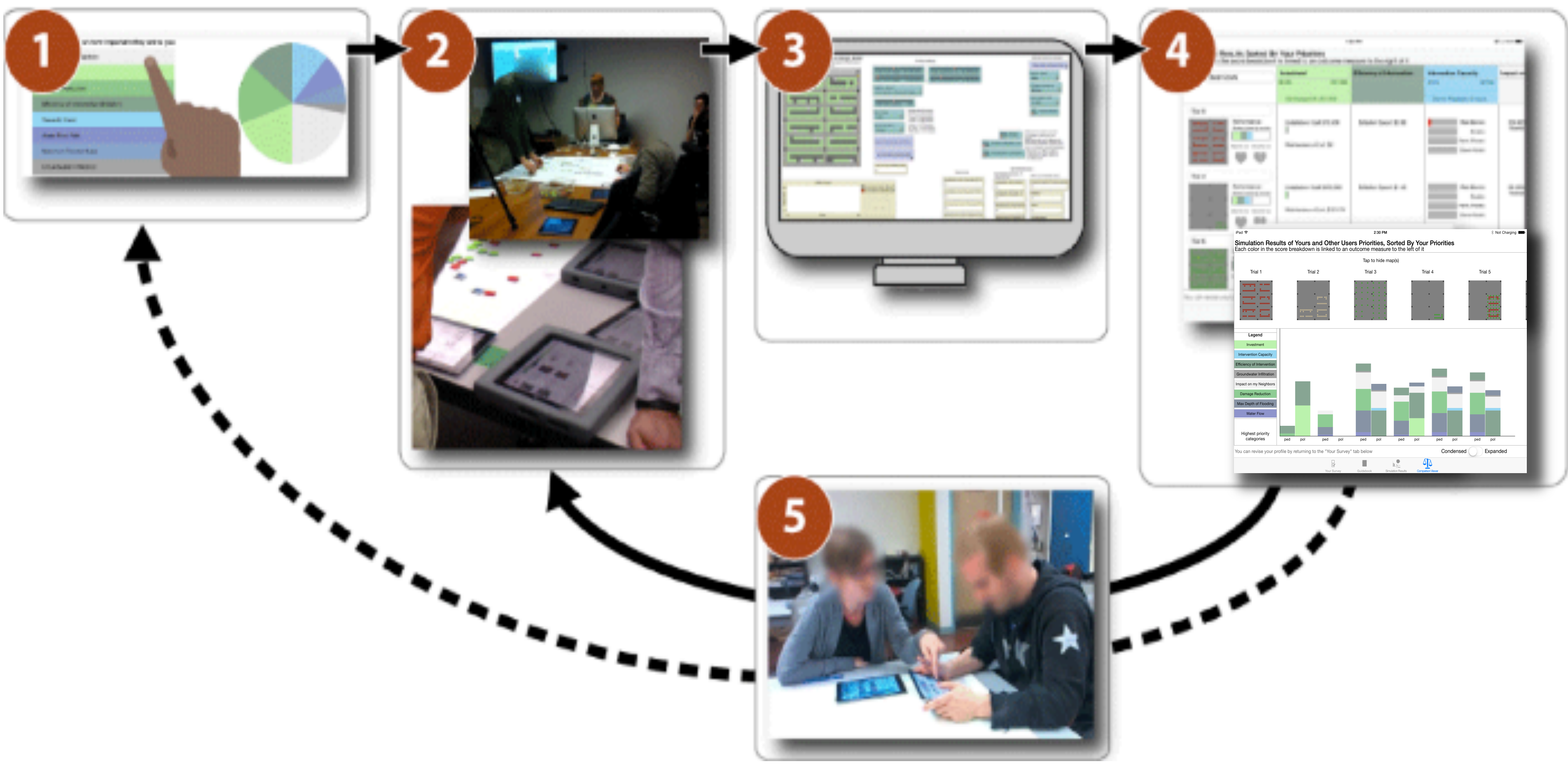


(Zellner et al. in press)

Concern profile



Workshop setup



Workshop setup

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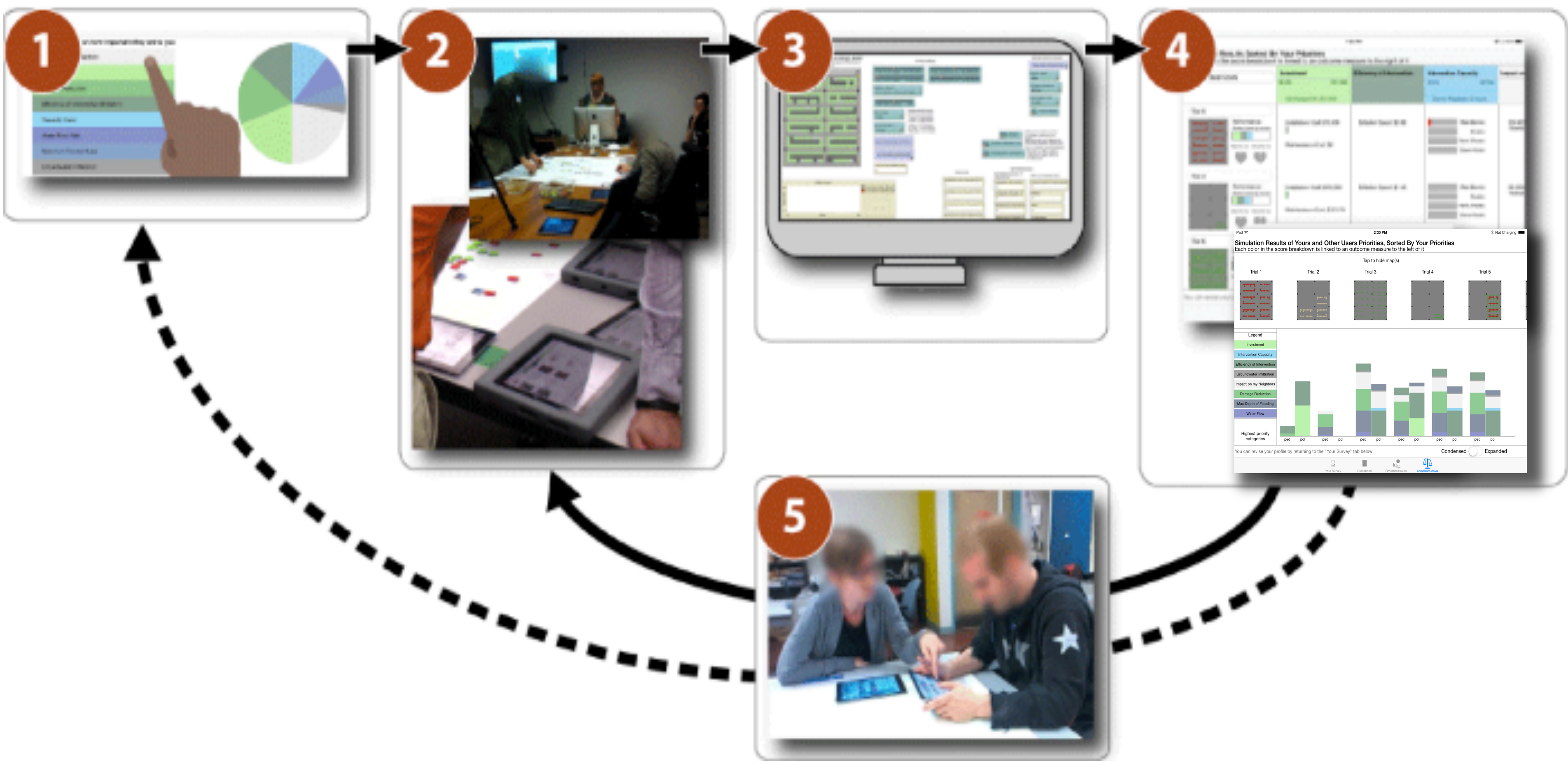
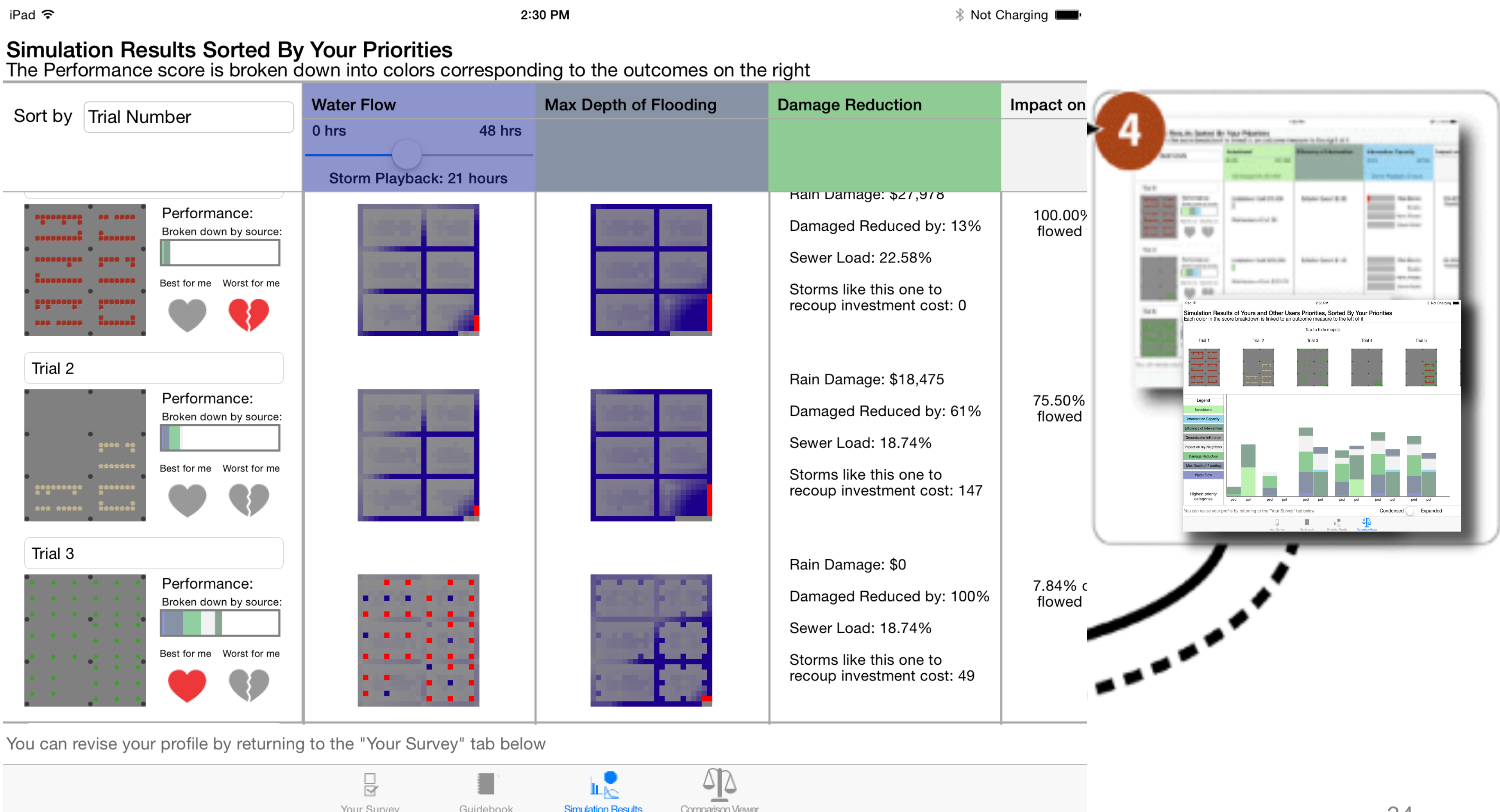
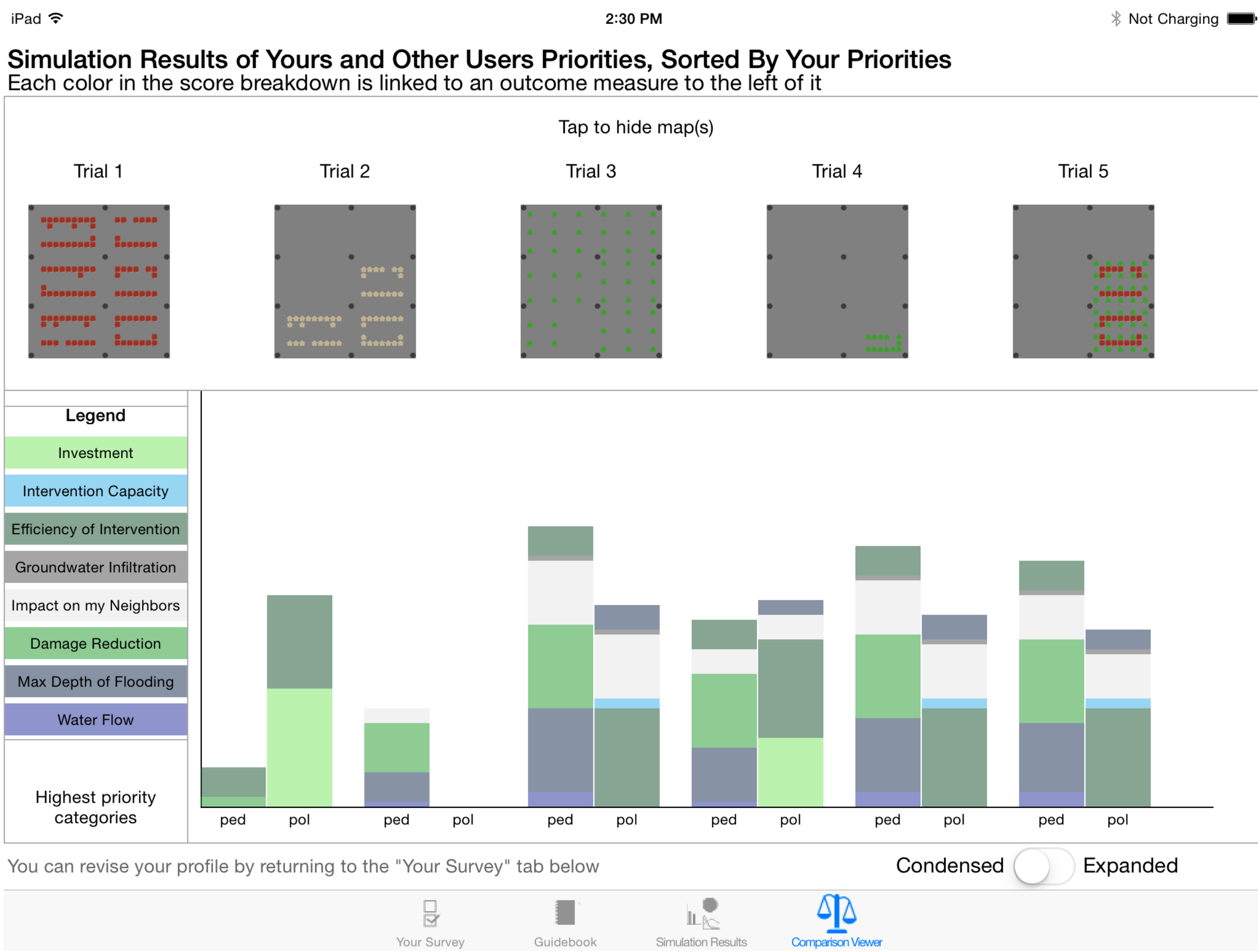


Sorted simulation results



Social viewer



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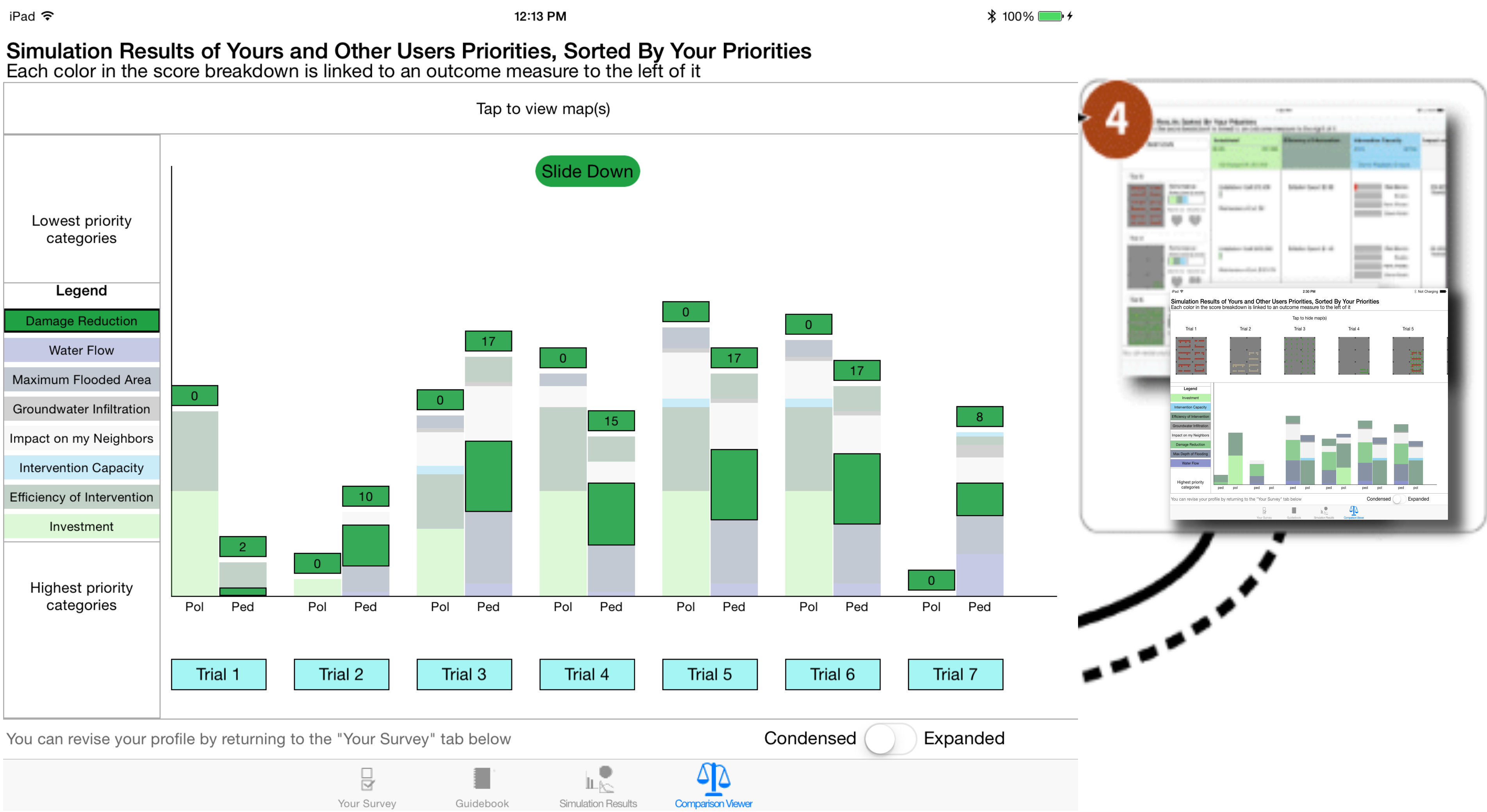

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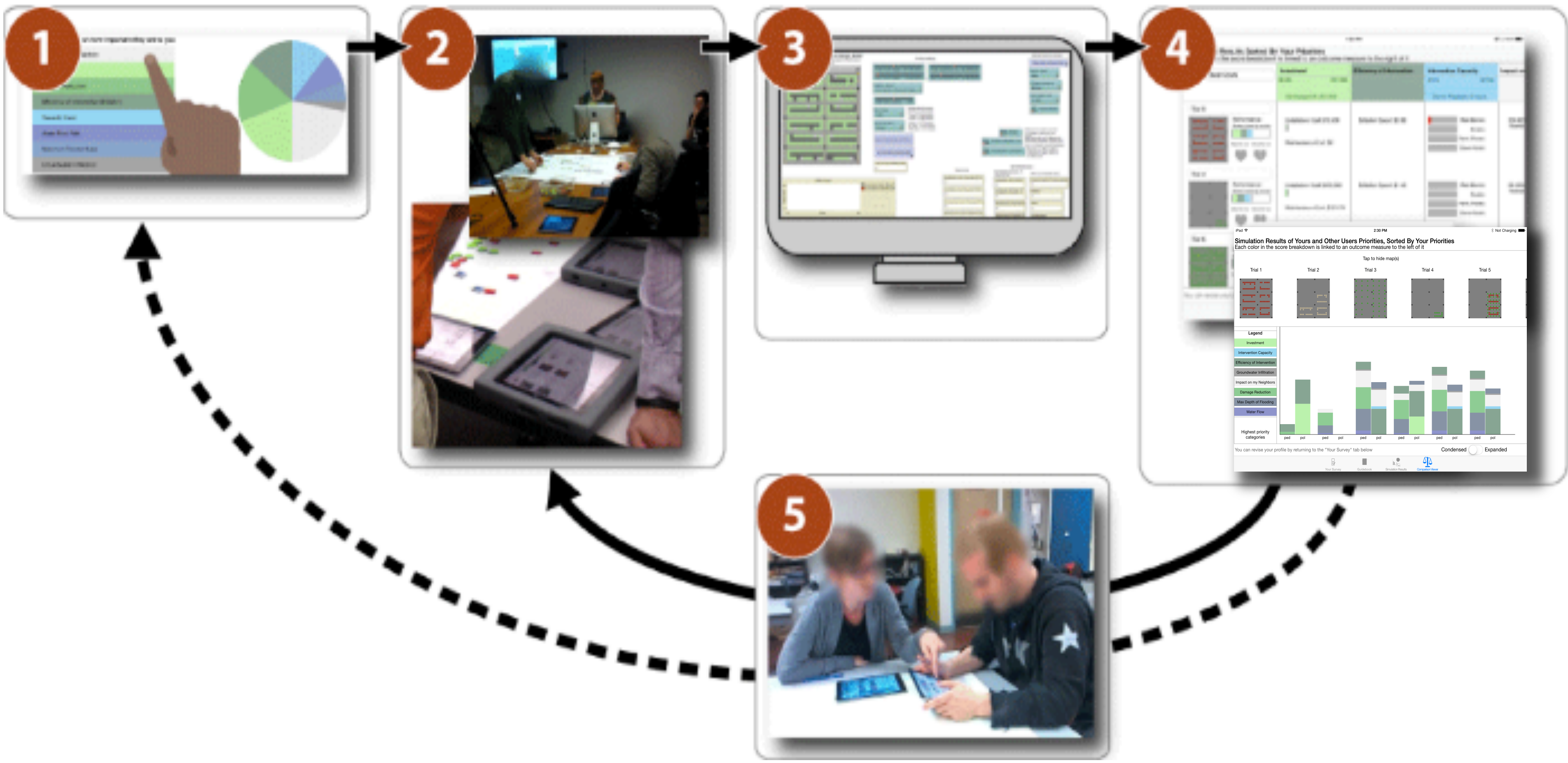

Learning, innovation, compromise

- Transparency of assumptions and tradeoffs

  Jo: "Oh wow, that's much better…for you."

  Nina: "I guess it matters what your priorities are!"

  Kevin: "Damage was reduced by 87%…but we were over budget by 1.2 million."

- Systematic exploration

  "Let's start by going crazy, putting a lot of stuff on here, and then pare back from there."

  "We can run multiple simulations, so let's run this one and then try that"

- Gesturing and mental modeling

  Following the flow

  Imagining different performance

- Green infrastructure cannot locally solve the problem

  "Perhaps we need to think of moving the houses out of there"

  Green AND gray infrastructure

  Coordination with other communities

Answers II: Tools for participation

- Collaborative design
- Facilitation for synthesis
- Consensus or compromise?
- Participatory modeling as a point of entry
  - to the problem,
  - to other tools,
  - to diverse interests
  - to other problems

APA Academic Tech Innovator Award 2017
(Zellner et al. in press)

Future plans

- Refining and extending participatory modeling and visualization
  - New domains: energy, food, air and water quality
  - New contexts: South America, Australia, Middle East
  - New tools and approaches: scaling up, data life cycle
- Contributing to communities
  - Scholarly: ComSES, CSDMS
  - Decision-making: US and State Congress, NCSE
- Interdisciplinary teaching

Why do this?

- Changing established heuristics
- Supporting the evolution of understanding and valuation
- Technology as a prosthetic device for decision-making
- Innovation is critical for <u>resilience</u> and <u>sustainability</u>

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Moira Zellner

mzellner@uic.edu

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