

smart
infrastructure facility

University of Wollongong



ABM course, University of Sydney, July 2011

**The Power of Agents: from Integration to Interaction
or
Why do mathematicians and sociologists love to hate me?**

Prof. Pascal Perez

The National Centre for Infrastructure Solutions

Prologue

A tale of two worlds



Peter Pan

Neverland
No dualism
Confident
Happy

Totally psychotic!



Alice

Wonderland
Strong dualism
Undermining
Traumatized

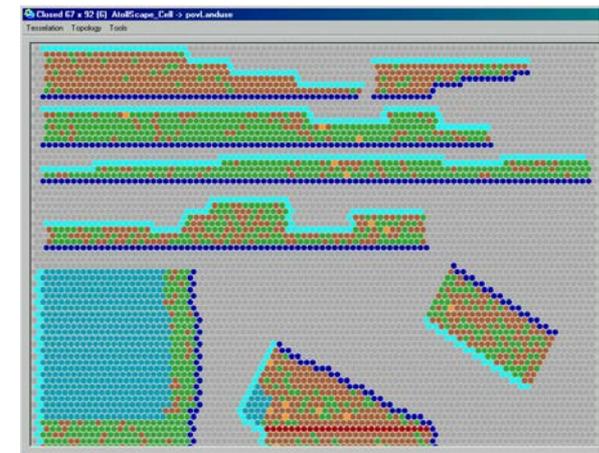
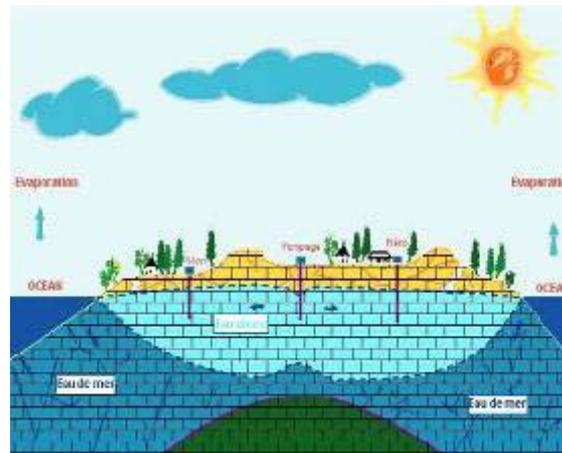
Totally neurotic!

🕸 What kind of modeller are you?

- Actual human ecosystems are often **complicated**.
- They can be described as **complex and adaptive systems (CAS)**.
- CAS models are just conveniently selected **metaphors**.
- Modelling outputs belong to the **end-users**, not to the **designers**.
- Particularly true if models include **management decisions** or **social responses**.
- In these cases, **collective design** and **social validations** are highly recommended.

AtollScape

Water distribution in Tarawa



Empirical stage
(Domain model)

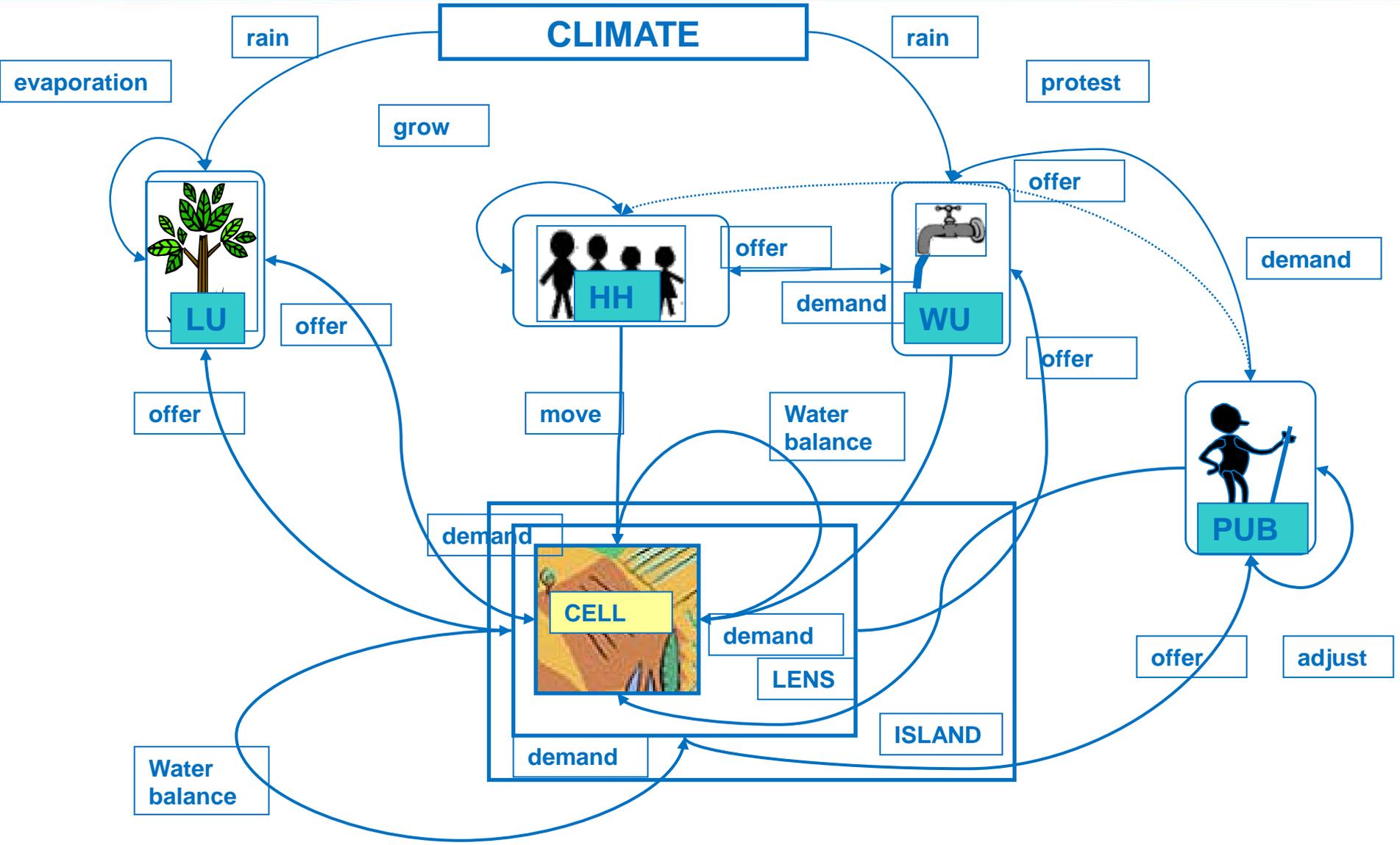
Conceptual stage
(Conceptual model)

Implementing stage
(Simulation model)

Perez P., Dray A., White I., Le Page C., Falkland T. (2003). AtollScape: Simulating Freshwater Management in Pacific atolls, Spatial processes and time dependence issues. In: Post D. (Ed) Proc. of the International Congress on Modelling and Simulation (Townsville, Australia, 14-17 July 2003). MSSANZ., vol 4, 514-518.

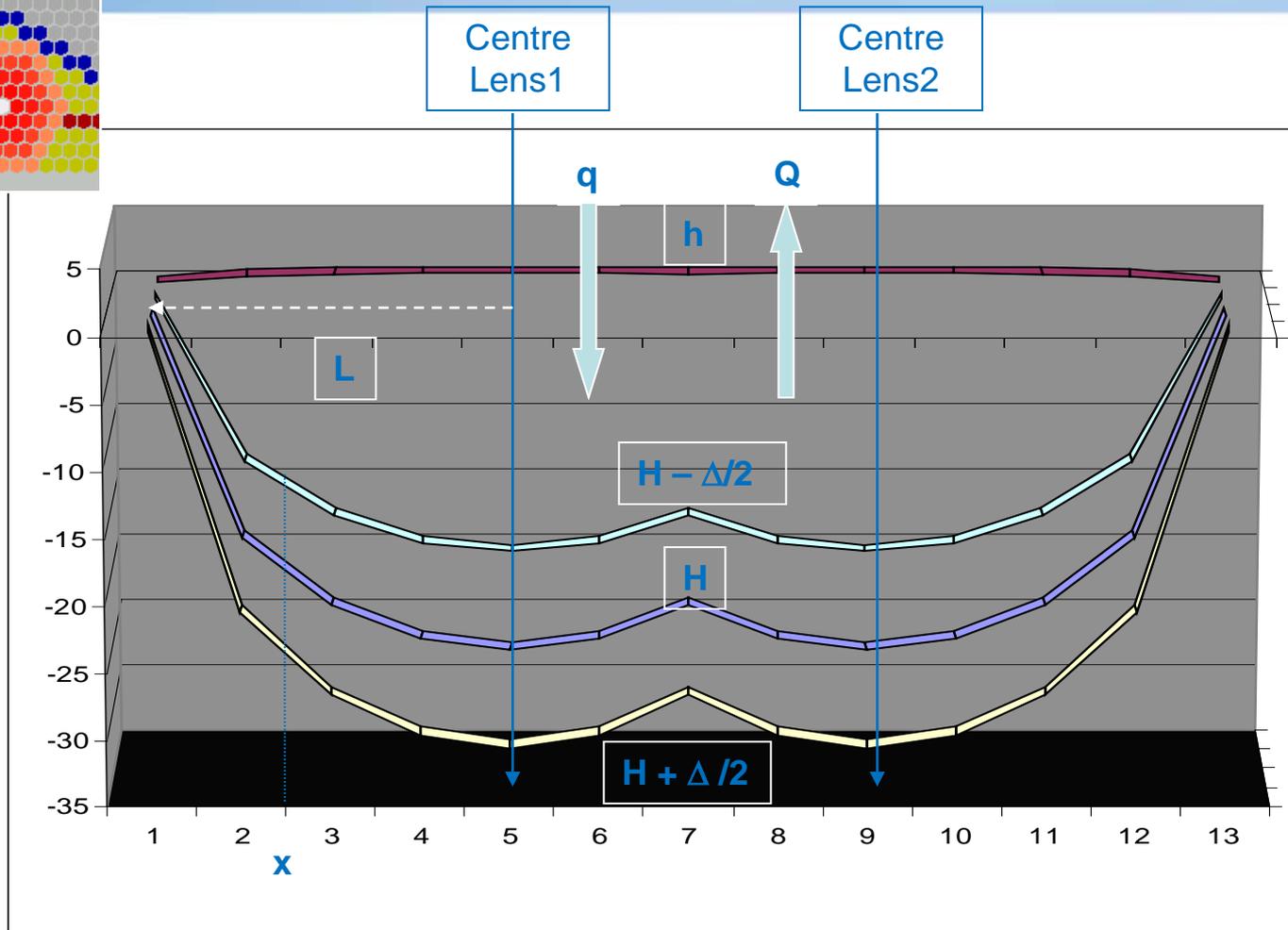
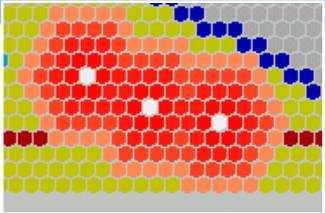
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Integrating information with ABM



AtollScape

The power of ABM paradigm



$$H^2 = (q_0 - Q_0) \cdot (L^2 - x^2) \text{ with } q_0 = f(q) \text{ and } Q_0 = f(Q)$$

$$\Delta = [\lambda^{-1/2} \cdot (L \cdot (q_0 - Q_0)^{-1/2}) \cdot (L^2 - x^2)^{1/2} / x] \cdot [1 - (L^2 - x^2)^{1/2} / L]^{1/2}$$

Volker's Steady State Equations

AtollScape Knowledge elicitation & engineering



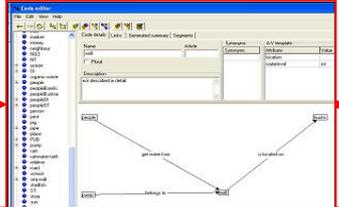
1. Ethnographic interview

Topic A. Demography, Landuse and landownership

- Population has increased from the 60s and water is more consumed. Water is used for cooking, washing
- I arrived on this place in 1986, I dug a well 15m away from the shore. The reserve was already there, it was created in 1967
- It's the people coming from the outer islands that created the problem. They were looking for money and jobs.
- No there is no limit, it is democratic to let people move

people
water
land
well
water reserve
beach
people
of
money
job
people
water

2. Transcript analysis

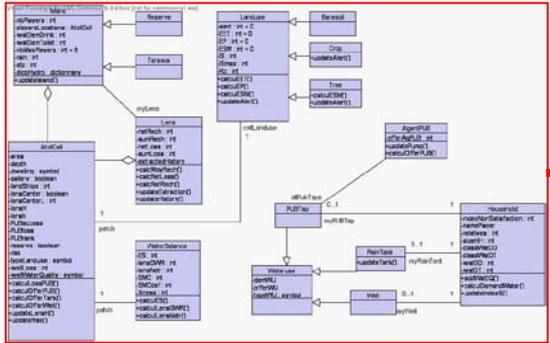


3. Associative networks

Qualitative Analysis
(Qualrus, Protégé, NVivo)



4. Domain model



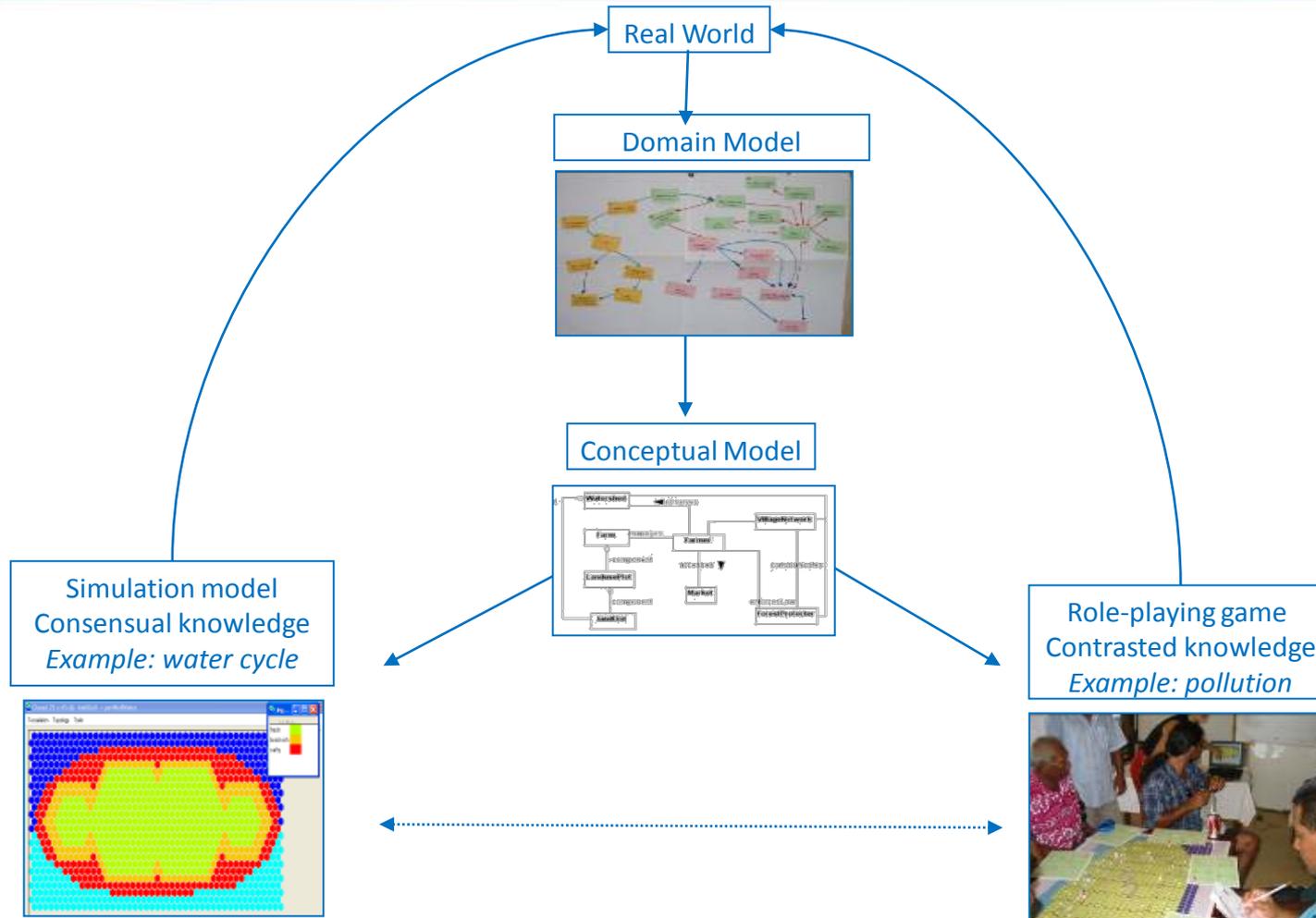
5. Conceptual model

Other interviews



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From integration to interaction



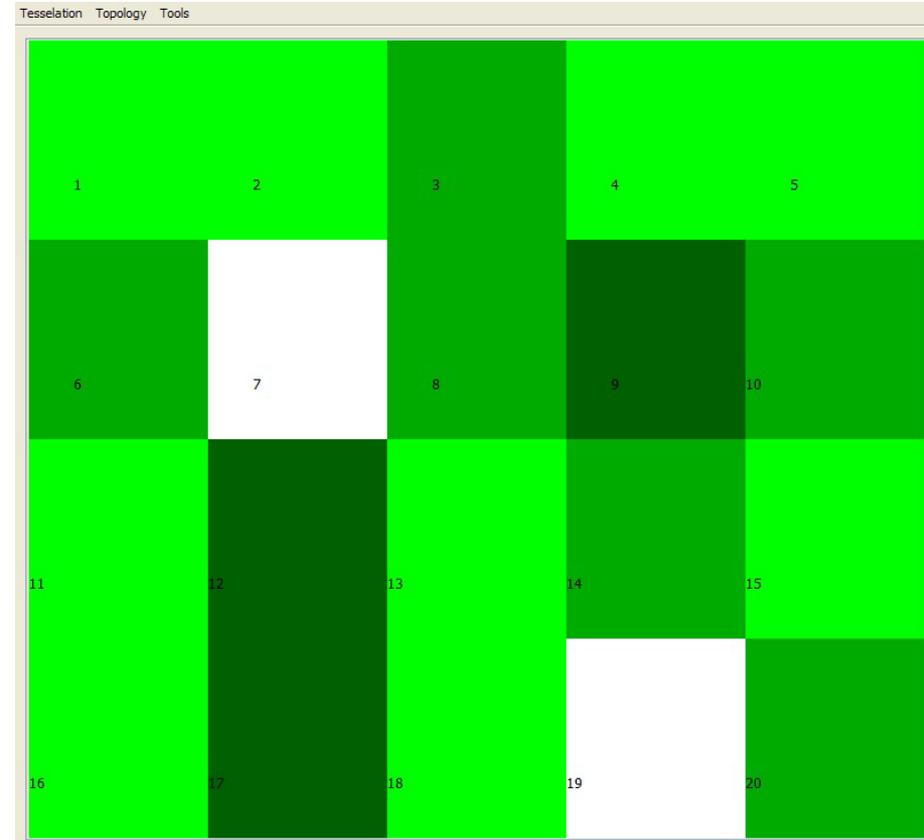
Dray A., Perez P., Jones N., Le Page C., D'Aquino P., White I., Auatabu T. (2006). The AtollGame experience: from Knowledge Engineering to a Computer-assisted Role Playing Game. *Journal of Artificial Societies and Social Simulation*, vol. 9-1, [online: <http://jasss.soc.surrey.ac.uk/9/1/6.html>]

Live Demonstration!!

ReHab: game board

- Each green square holds some **biomass**, the darker the more.
- The biomass level ranges from 0 to 3.
- The resource has a specific renewing process.

Level of biomass



2 roles: Harvester and Park Manager

Harvester:

- each player controls up to three harvesters
- objective: maximizing your final harvest

Park Manager:

- one pair of players
- objective: protecting an endangered species

Each round represents **one year**.

One round unfolds as follow:

- *birds settle*
- park managers decide on protected areas (from round 2)
- harvesters select their exploitation grounds
- *birds reproduce*
- results are communicated
- *resource biomass is updated*

Each scenario is made of five rounds.

- scenario 1: no communication
- scenario 2: with communication

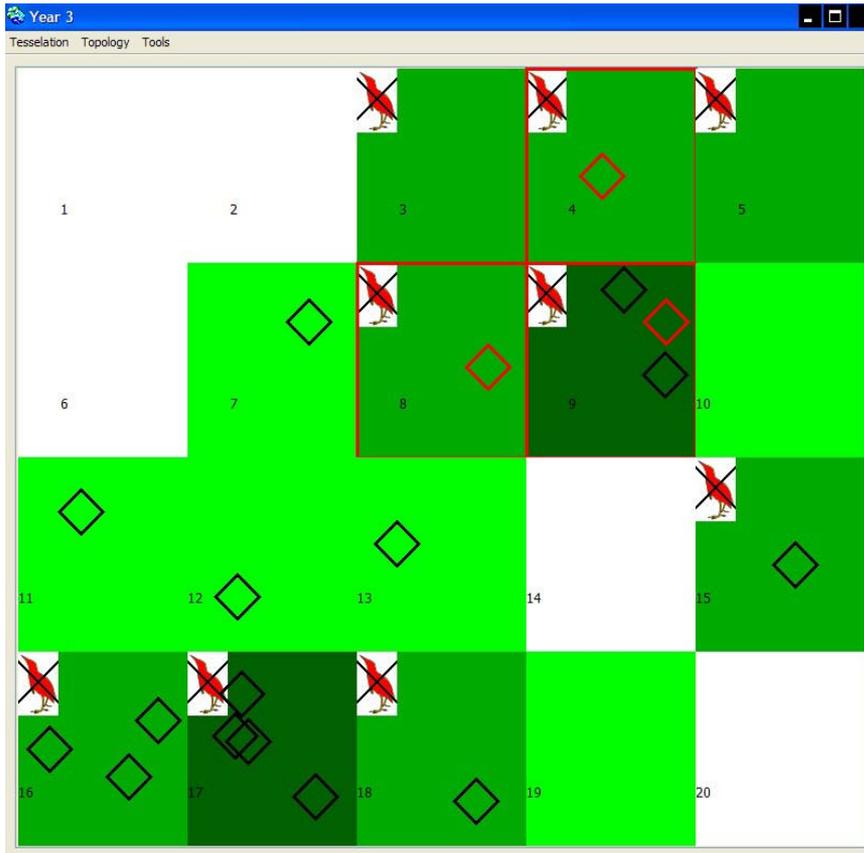
Let's Play!

1. Instant Replay of the Game



- Cormas stores and exports **snapshots** of the game
- In **RED**: 3 harvesters of a specified Clan Leader (player)

2. Analysing player's decisions



- Confirming sequences of individual actions
- Identifying changes in individual strategies
- Linking strategy changes to pay-offs

Example: profit **maximizing** strategy and **poaching** behaviour. Weak link to pay-off

3. Typology of harvester's behaviours

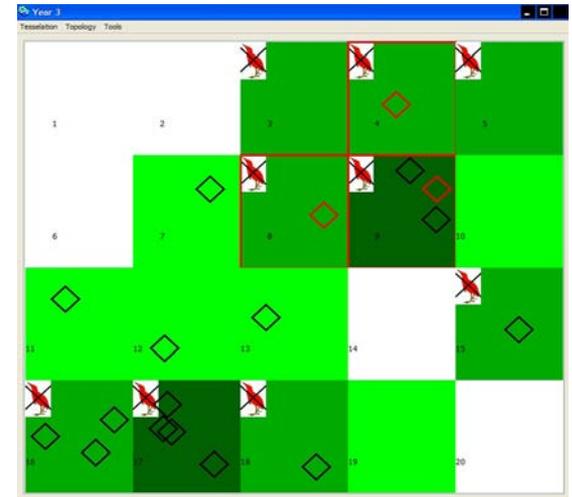
- a. **Maximizer:** targeting cells with high level of biomass
- b. **Lone Rider:** avoiding cells with high level of biomass
- c. **Explorer:** harvesting effort spread across biomass levels
- d. **Poacher:** targeting PA cells regardless of prohibition

Classification of Clan's strategies (25 events):

- Maximizer: 6
- Lone Rider: 9
- Explorer: 10
- Poacher: 8 (overlapping with other strategies)

Link between strategies and pay-offs (average scores):

- Maximizer: 4.5
- Lone Rider: 3.1
- Explorer: 4.1
- Poacher: 4.4



4. Typology of Park Manager's behaviours

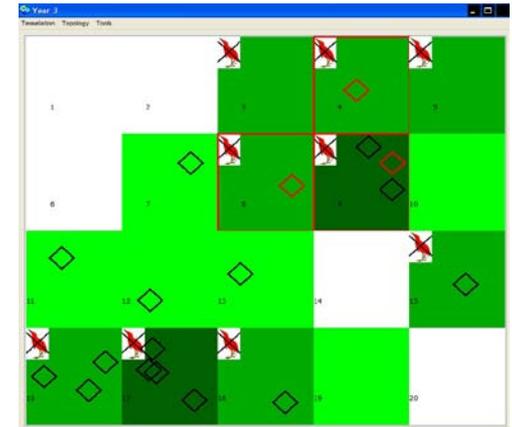
- a. **Crusader:** protecting cells with high level of biomass
- b. **Negotiator:** protecting cells with mid-level of biomass
- c. **Manager:** protecting connected cells (1: high biomass)
- d. **Naturalist:** protecting cells with previous bird landing

Classification of Naturalist's strategies (rounds):

- Crusader: 0
- Negotiator: 0
- Manager: 2
- Naturalist: 3

Not possible to find links between strategy changes and pay-offs.

(only one newborn at round 2!)



5. Creating rules for Agent's behaviour

Strategy	Targeted cell (biomass level)		
	Harvester 1	Harvester 2	Harvester 3
Maximizer	max	max	random
Lone Rider	min	min	random
Explorer	max	min	random

Attitude:

- Poacher or not (Clan level)
- Defined at the beginning of the simulation
- 2/3 Poacher and 1/3 Good Citizen
- Poacher's harvester can access **ANY** cell identified by **Strategy**
- Good Citizen won't let harvester enter a **PA** cell

Decision:

- Option 1: fixed strategy from initial stage (random allocation)
- Option 2: random change between 3 strategies (each time step)
- Option 3: change only when $\text{pay-off}_t < \text{pay-off}_{t-1}$ (random choice)

Epilogue



"Please, draw me a sheep..."

So then I made a drawing.

He looked at it carefully, then he said:

*"No. **This sheep is already very sickly.** Make me another."*

So I made another drawing.

My friend smiled gently and indulgently.

*"You see yourself," he said, "that this is not a sheep. **This is a ram.** It has horns."*

So then I did my drawing over once more.

But it was rejected too, just like the others.

*"**This one is too old.** I want a sheep that will live a long time."*

By this time my patience was exhausted, because I was in a hurry to start taking my engine apart.

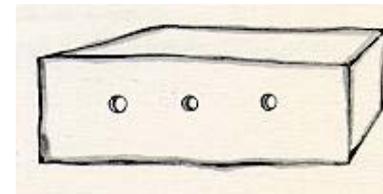
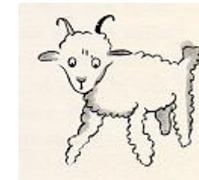
So I tossed off this drawing.

And I threw out an explanation with it.

*"**This is only his box.** The sheep you asked for is inside."*

I was very surprised to see a light break over the face of my young judge:

*"**That is exactly the way I wanted it!** Do you think that this sheep will have to have a great deal of grass?"*



Thank you!

More information:

Perez P. and Batten D. (Eds) (2006), *Complex Science for a Complex World. Exploring Human Ecosystems with Agents*. ANU E Press, Canberra, Australia, ISBN 1920942386.

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