

# Dynamic of Rules

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# Broad goals of the project

- How do institutional rules evolve over time?
- What are the conditions in which groups craft effective informal and/or formal institutional arrangements that fit ecological dynamics?
- Developing agent-based models of institutional change -> using experiments to test models.

- Rules are defined as shared understandings that refer to enforced prescriptions about what actions are *required*, *prohibited*, or *permitted* (Crawford and Ostrom 1995). Those rules can be formal (e.g., legislation, administrative procedures, or court decisions) or informal (e.g., religious prescriptions).
- In contrast, norms are shared understandings but are not *enforced* prescriptions, meaning that it is unclear to a third party what to do when a prescription is not met. A norm might be: .do not steal property that belongs to somebody else.. A rule would include .otherwise you will be sentenced to two months in jail..

# Common research questions

Laboratory experiments



Field experiments



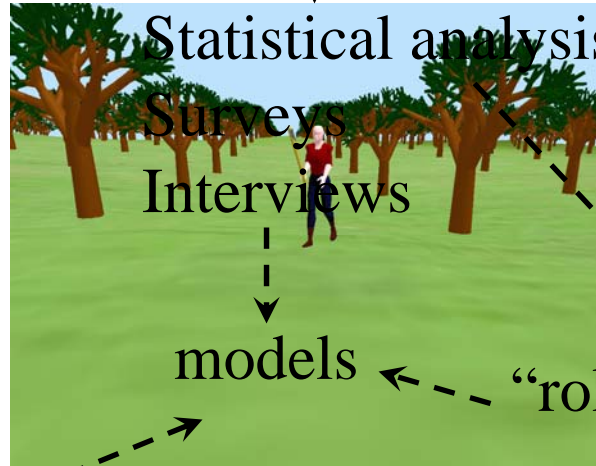
Statistical analysis

Surveys

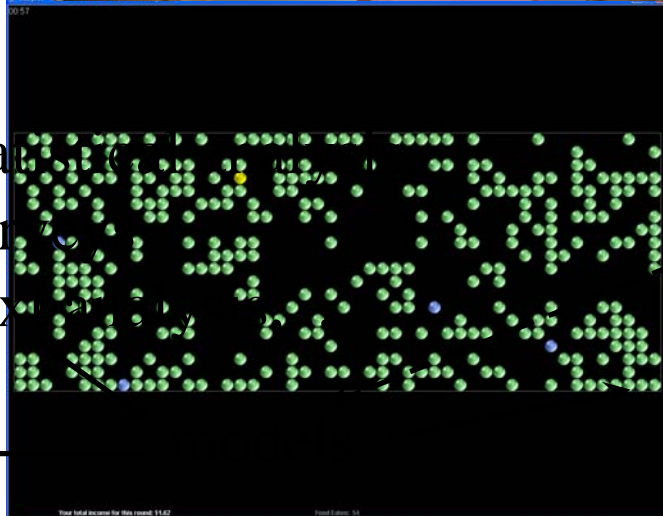
Interviews

models

“role games”



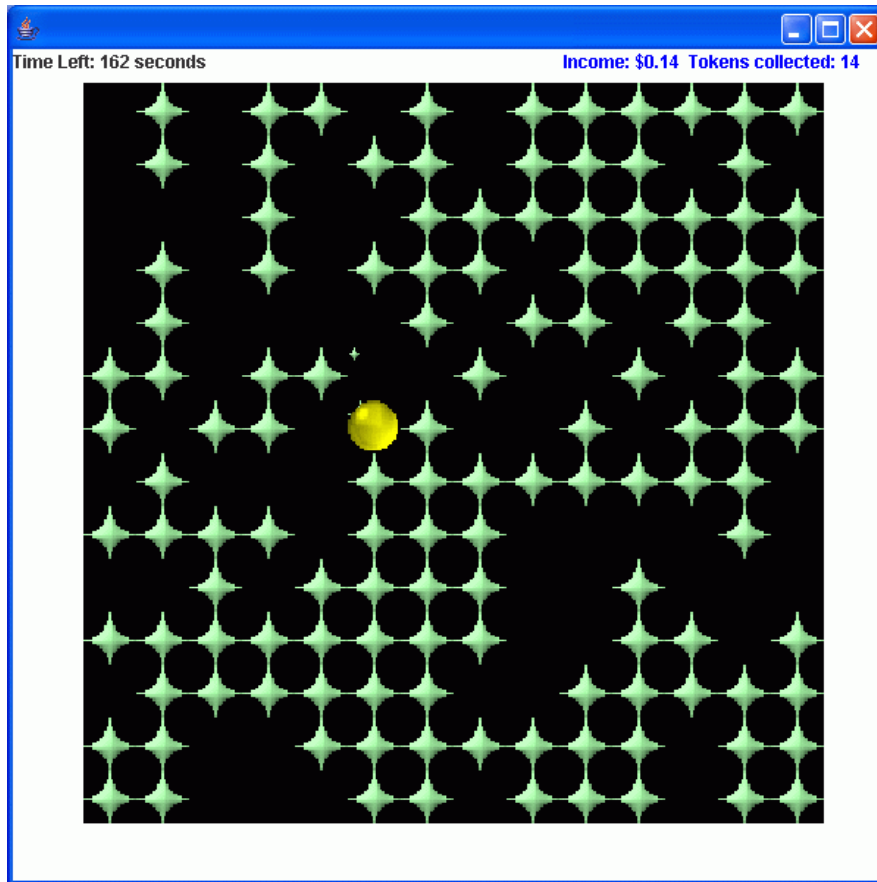
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Artificial worlds

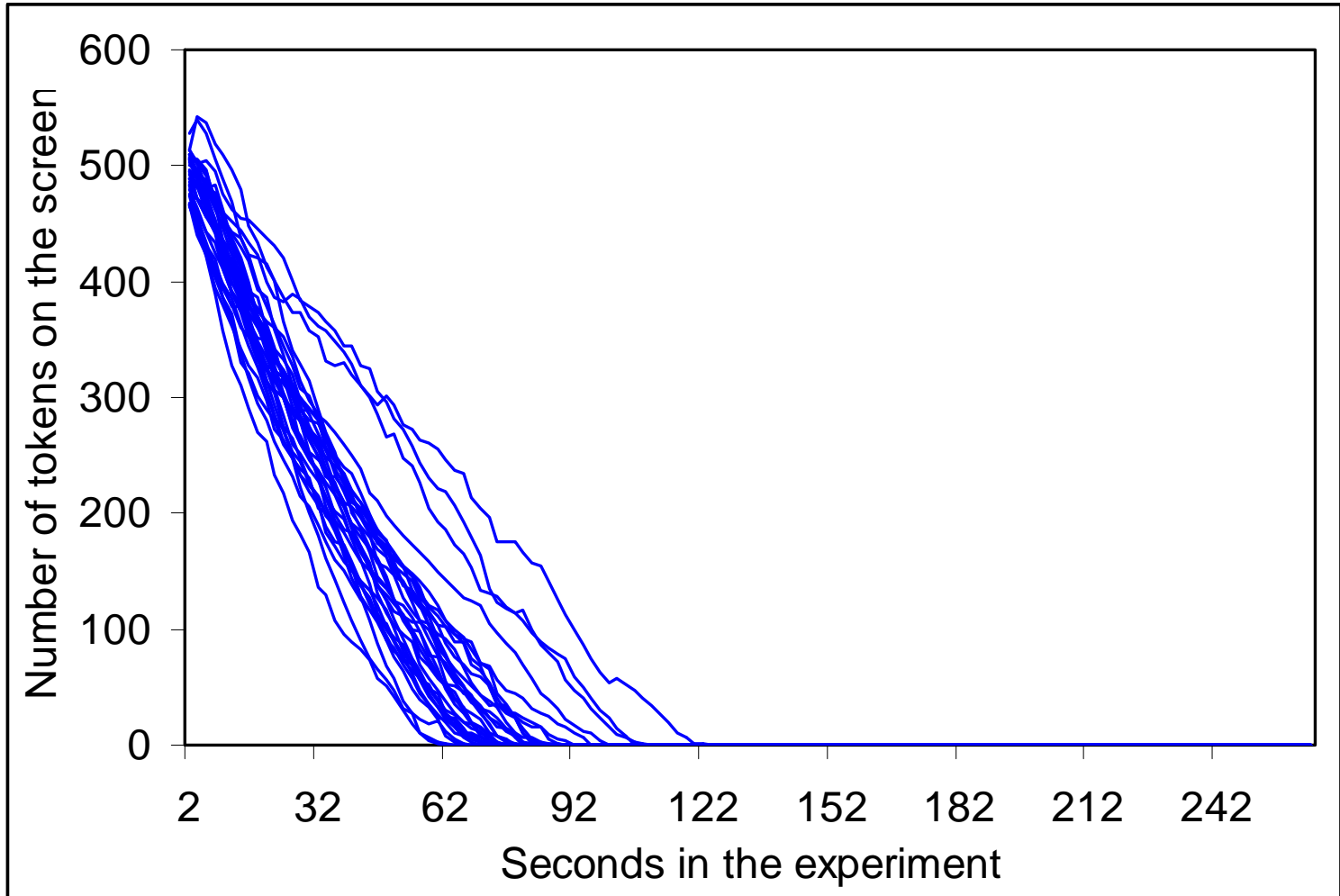


# Real-time virtual common resources



- Exploring effects of communication (text chat), costly sanctioning, different ecologies.

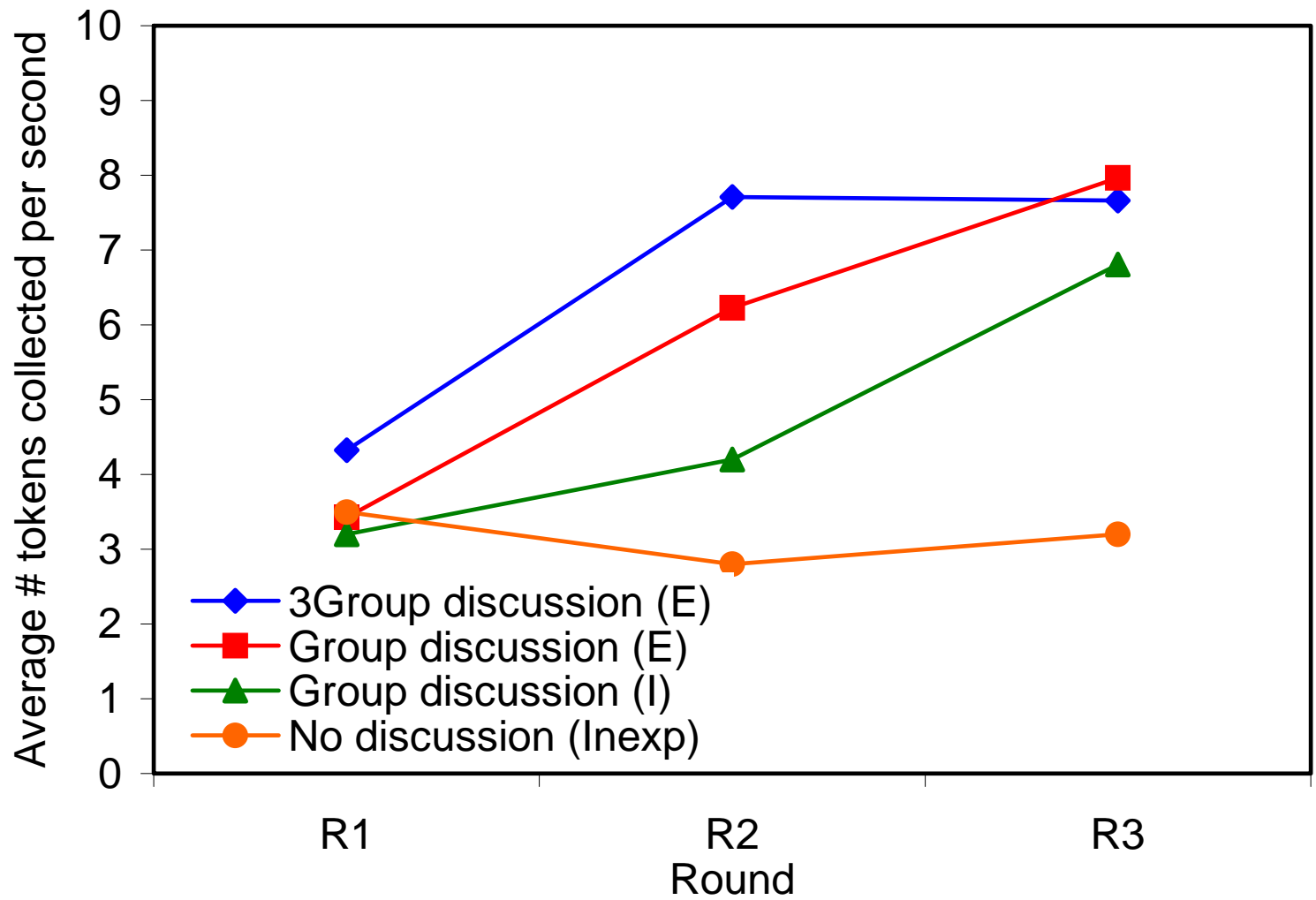
# Round 1



33 groups

# Experiences

- Rôle de la discussion
- Rôle de l'expérience des joueurs
- Rôle de l'écologie (ressources poussent plus ou moins vite, différences de dynamiques de ressources dans l'espace)
- Rôles respectifs de la sanction et de la communication
- Rôle de l'outil



# Rule innovation

- Observations from discussions:
  - Crucial whether one or two subjects act as a leader in a group.
  - Most discussions focused on how to slow down harvesting or divide the space.

# Using text chat

- Benefit: analysis all communication content
- Coding the text: kind of rules, making sure people understand agreement, off-topic chat, meaning of experiment, etc.
- Is there a relation between the type of conversation and the performance of the group?
- We would expect that groups who are more explicit on the rules and make clear people understand it do better.

# Initial results

- Communication increases earnings of the group more when:
  - More messages are exchanged
  - Equal contribution to chat
- High growth groups focus on explicit mode
- Low growth groups focus on time (waiting)
- Mixed growth on allocating the space

# Experimental design

Name	Number of groups	Rounds 1-3	Rounds 4-6
OA-SC	6	Open access	Costly sanctioning plus text chat communication
SC-OA	6	Costly sanctioning plus text chat communication	Open access
OA-S	5	Open access	Costly sanctioning
S-OA	6	Costly sanctioning	Open access
OA-C	5	Open access	Text chat communication
C-OA	5	Text chat communication	Open access

# Results—Payoffs

Name	Rounds 1-3	Rounds 4-6
OA-CS	292.89 (30.63)	451.39 (58.84)
CS-OA	402.22 (71.81)	331.22 (82.87)
OA-S	265.00 (17.54)	247.67 (16.38)
S-OA	280.39 (46.15)	256.72 (18.23)
OA-C	274.07 (34.22)	411.60 (79.86)
C-OA	441.33 (51.98)	415.47 (80.78)

# Conclusions

- Sanctions Alone Have Little Effect; Might Even Decrease Earnings (Cost)
- Chat Accounts for Most of Increased Payouts
- Resource Depletion Occurs Faster Over Time With No Communication
- Communication Dramatically Reduces the Rate of Resource Depletion

# Contributions

- New type of experiments with more relevant dynamics of resource dynamics. (see also Marty's presentation)
- Content of communication does not explain differences between group (but amount and distribution of messages do).(but see presentation of Robert Tobias)
- Communication more effective than costly sanctioning (see presentation Rob Holahan).

# Planned future work

- Focus on crafting formal rules:
  - Discuss what they want to do
  - Different rules to change the rules (majority vote, unanimity, “leader”)
  - They have to make choice on enforcement (one person is paid monitor, rotate monitoring, costly sanctioning)
- Different ecologies (space, dynamics, visibility)

# Field Experiments

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In cooperation with:

**Thailand:** Francois Bousquet, Kobchai Worrapimphong

**Colombia:** Daniel Castillo

**Indiana University:** Elinor Ostrom

# Field experiments

- 3 types of games in 3 types of villages in Thailand and Colombia (and with students in Bogota & Bangkok)
- Pencil and paper experiments
- First 10 rounds: open access
- Voting round: 3 types of rules: lottery, rotation, private property
- Second set of 10 rounds with chosen rule
- Survey
- In depth interviews with a few villagers

# Colombia

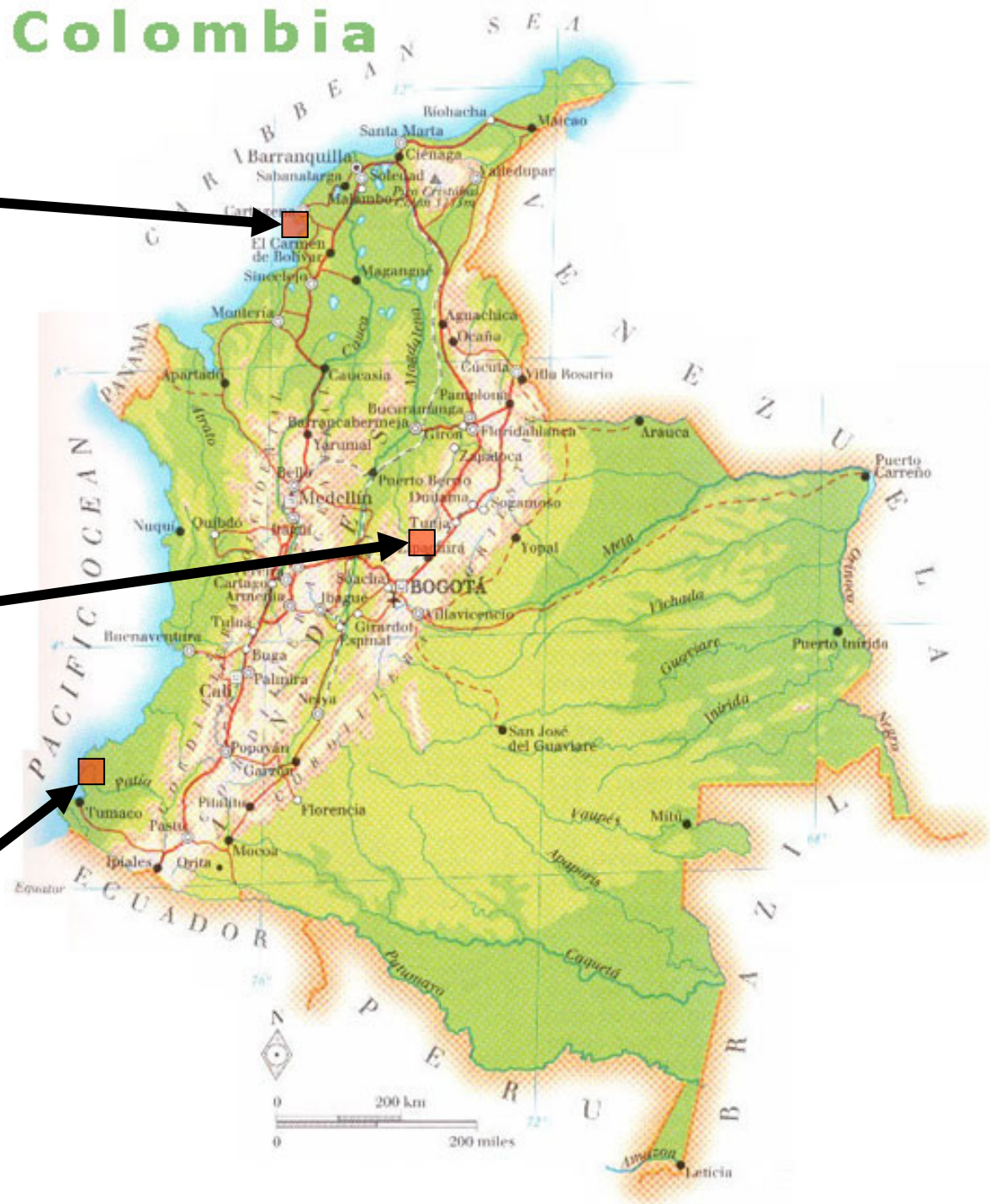
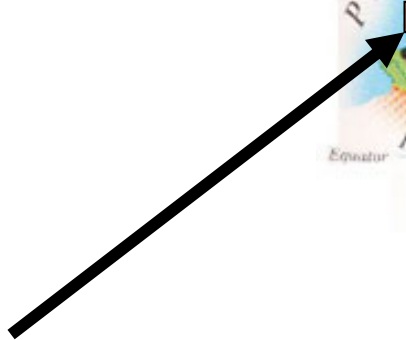
Fishery village  
(Baru)

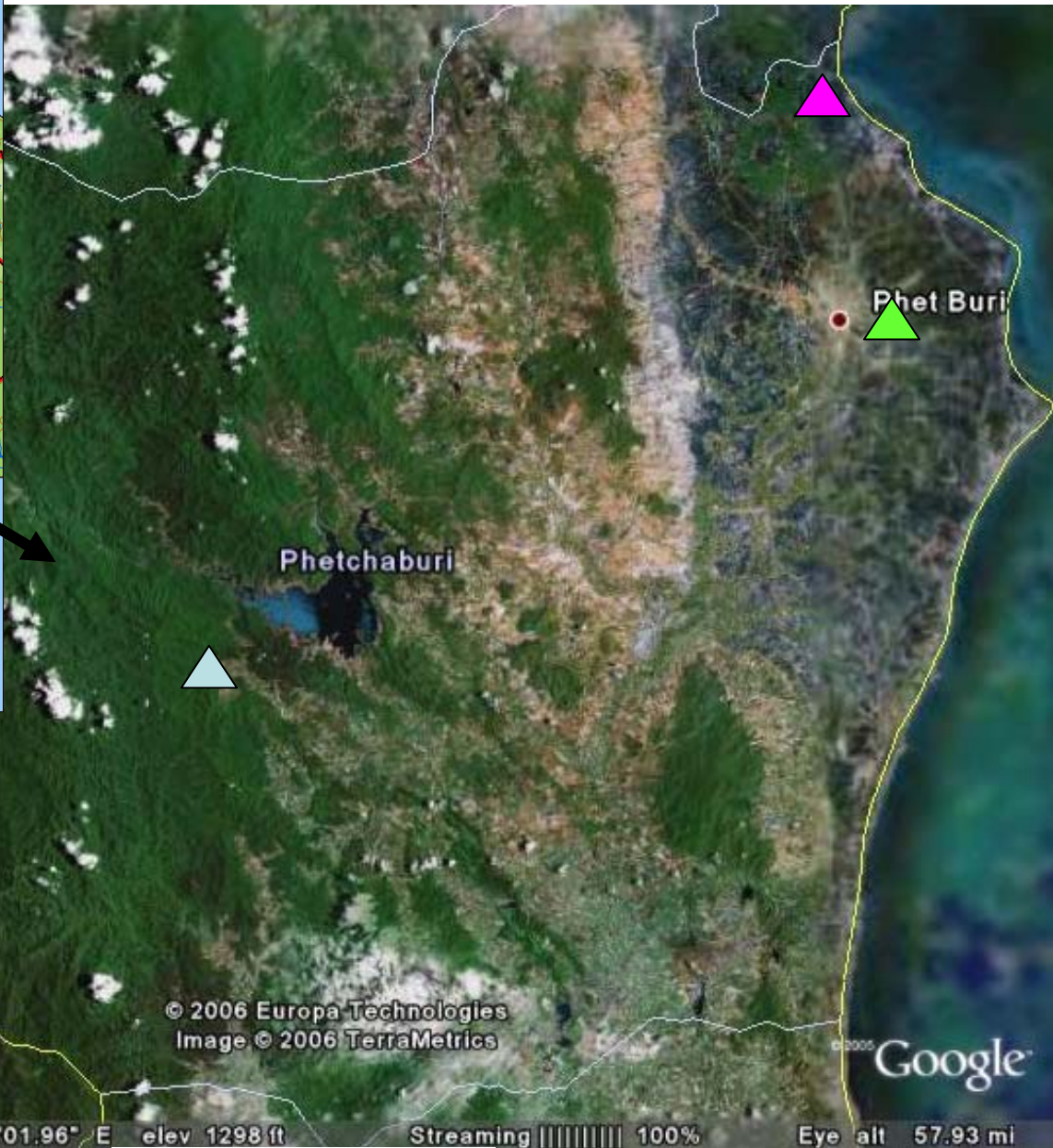
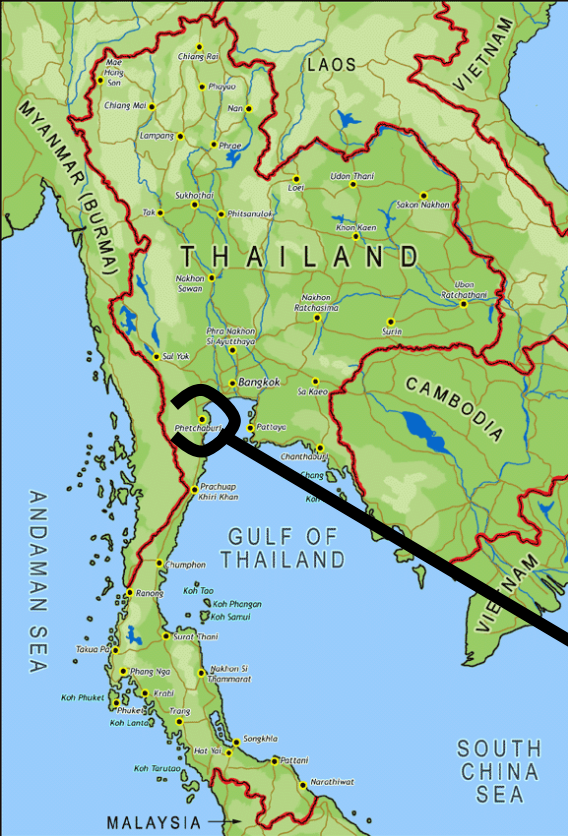


Water irrigation village  
(Lenguazaque)



Logging village  
(Salahonda)





Phetchaburi river



Forest village

Irrigation village



Fishery village

# Experimental Behavior (N= 360 Villagers)

Descriptive results

# Field experiments (2)

- Fishery game:
  - where to fish (A,B)
  - how much effort
- Irrigation game (different position; upstream):
  - How much investment in public good (water)
  - What amount to take from (remaining) water
- Forestry game:
  - How much harvest

Sample	Fishery Village	Irrigation Village	Forestry Village	Students	TOTAL
<b>Fishery game</b>	20 Colombia 20 Thailand	20 Colombia 20 Thailand	20 Colombia 20 Thailand	20 Colombia 20 Thailand	<b>160</b>
<b>Irrigation game</b>	20 Colombia 20 Thailand	20 Colombia 20 Thailand	20 Colombia 20 Thailand	20 Colombia 20 Thailand	<b>160</b>
<b>Forestry game</b>	20 Colombia 20 Thailand	20 Colombia 20 Thailand	20 Colombia 20 Thailand	20 Colombia 20 Thailand	<b>160</b>
<b>TOTAL</b>	<b>120 people 24 sessions</b>	<b>120 people 24 sessions</b>	<b>120 people 24 sessions</b>	<b>120 people 24 sessions</b>	<b>480 people 96 sessions</b>

# Forestry Experiment

- Initially 100 resource units
- Each player can take up to 5 units per round.
- Regrowth is 1 unit per 10 units after harvest

Maximum harvest table	
Current Resource Level	Individual Maximum harvest level
25-100	5
20-24	4
15-19	3
10-14	2
5-9	1
0-4	0

# Forest game

# The magnets

Time step

รอบที่

เกมป่าไม้

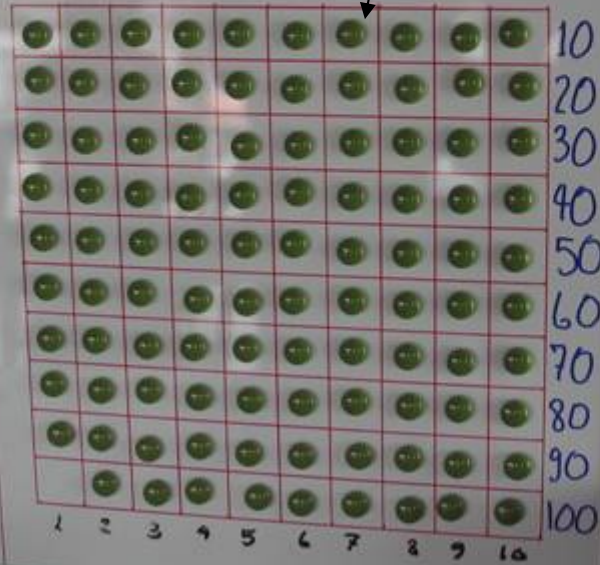
ไม้ในรอบปัจจุบัน

Total magnets

ไม้ในรอบปัจจุบัน

Total harvest

ยอดรวมใช้ไม้



# Forestry Game (Benchmarks)

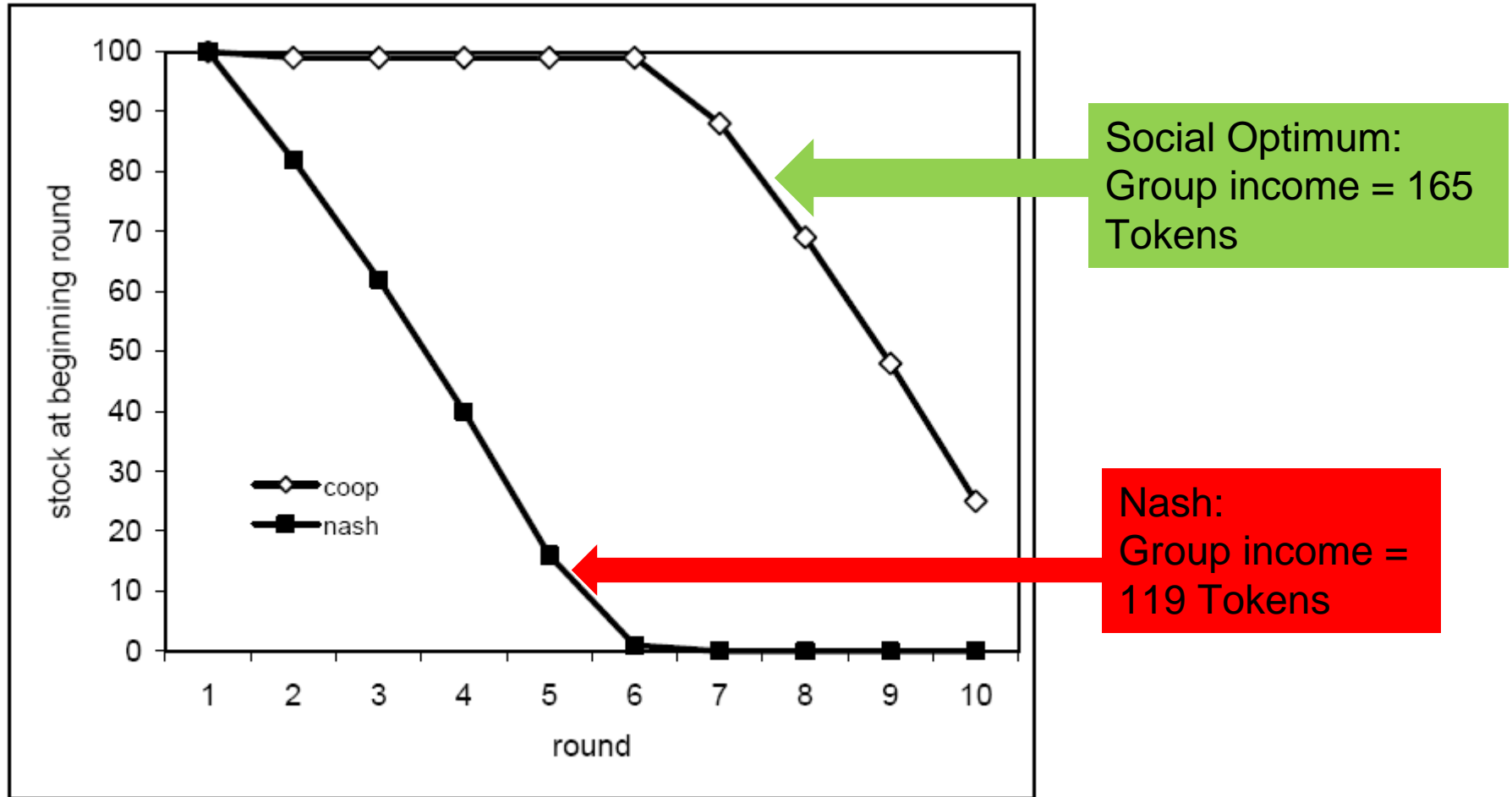
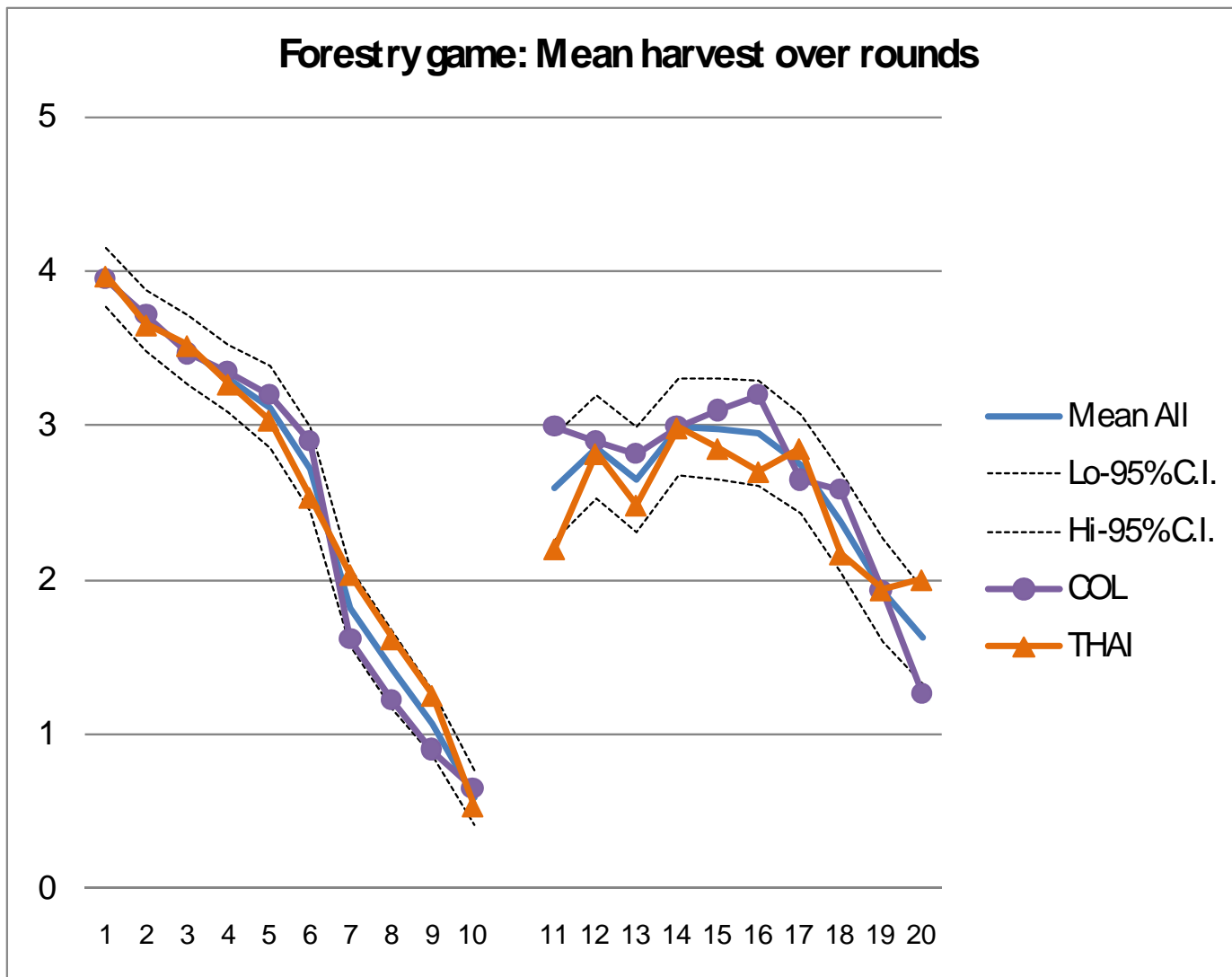


Figure 1: Cooperative optimum and Nash equilibrium (Forestry game).

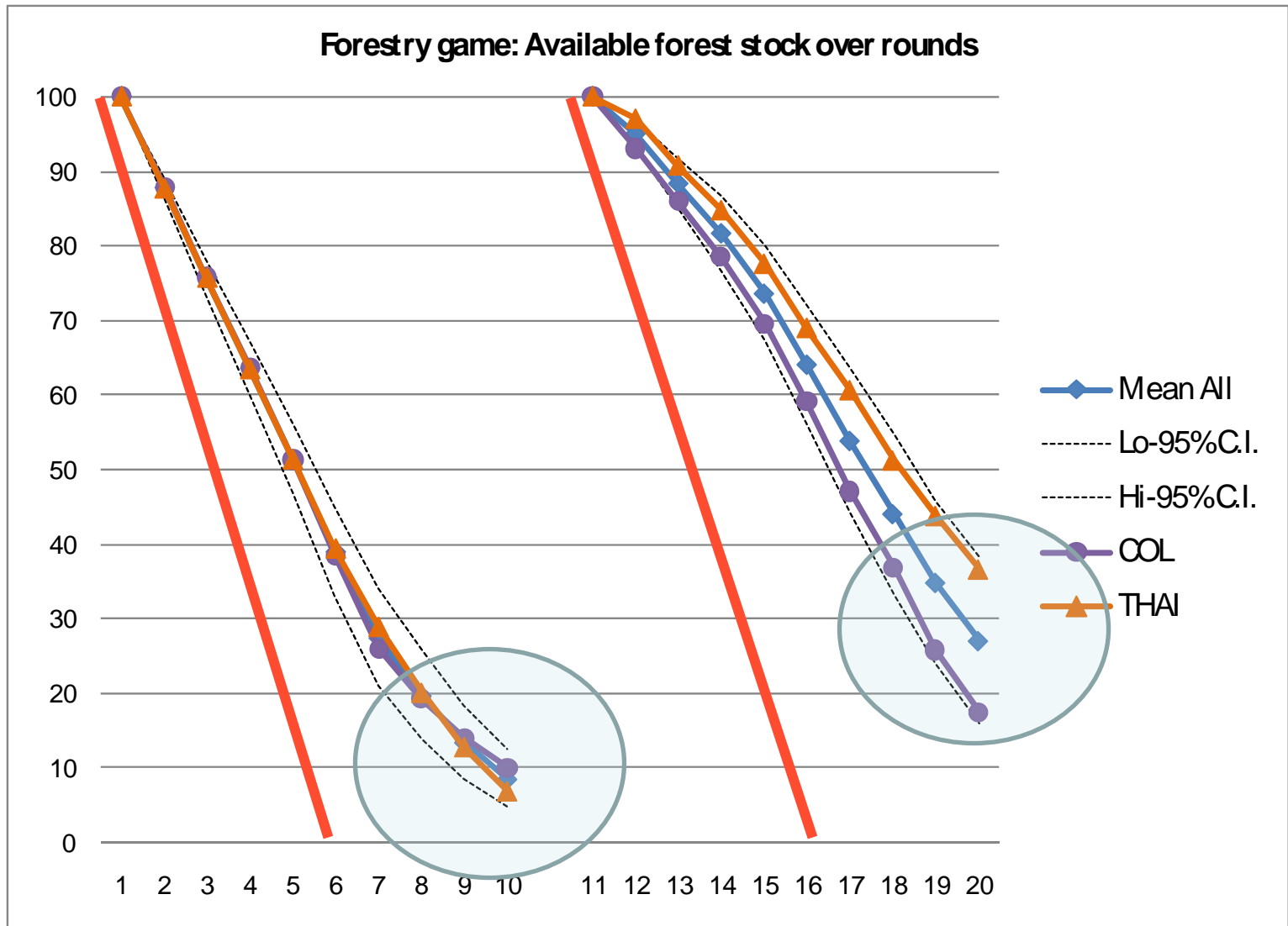
# Rules

- **Rule 1 (Lottery).** Each round two participants are drawn who can harvest. If somebody harvest when (s)he is not allowed to do so, a penalty may be received. Each round a dice is thrown, and when a six is through, an inspector comes and rule breakers get a penalty. The penalty consists of paying back the harvested amount plus an extra 3 tokens.
- **Rule 2 (Rotation).** A fixed schedule is defined which two participants are allowed to harvest each round are able to harvest. In round 1 A and B can harvest, then C and D, then E and A, etc. The same mechanism of monitoring and sanctioning is used as rule 1.
- **Rule 3 (Property).** Everybody has the right to harvest 0, 1 or 2 units per round. If a higher amount is harvested, a dice determine whether the participant is caught, pays back the harvest plus 3 tokens.

# Forestry Game (Extraction ~120-130 tokens)



# Forestry Game (Available Stock)



# Fishery game

- There are two locations A and B
- High or low effort.
- The payoff table is the same for both locations.
- The initial state of the resource is the high fish availability.
- If the total effort in a location is five or more units, the state of the fish stock will move to the low availability.
- A location in a low availability state can only move back to high availability when in two consecutive rounds not more than one unit of effort is invested in that location.

Payoff table			
Fish available in location	Fishing effort		
	0	1	2
High	0	7	8
Low	0	2	3

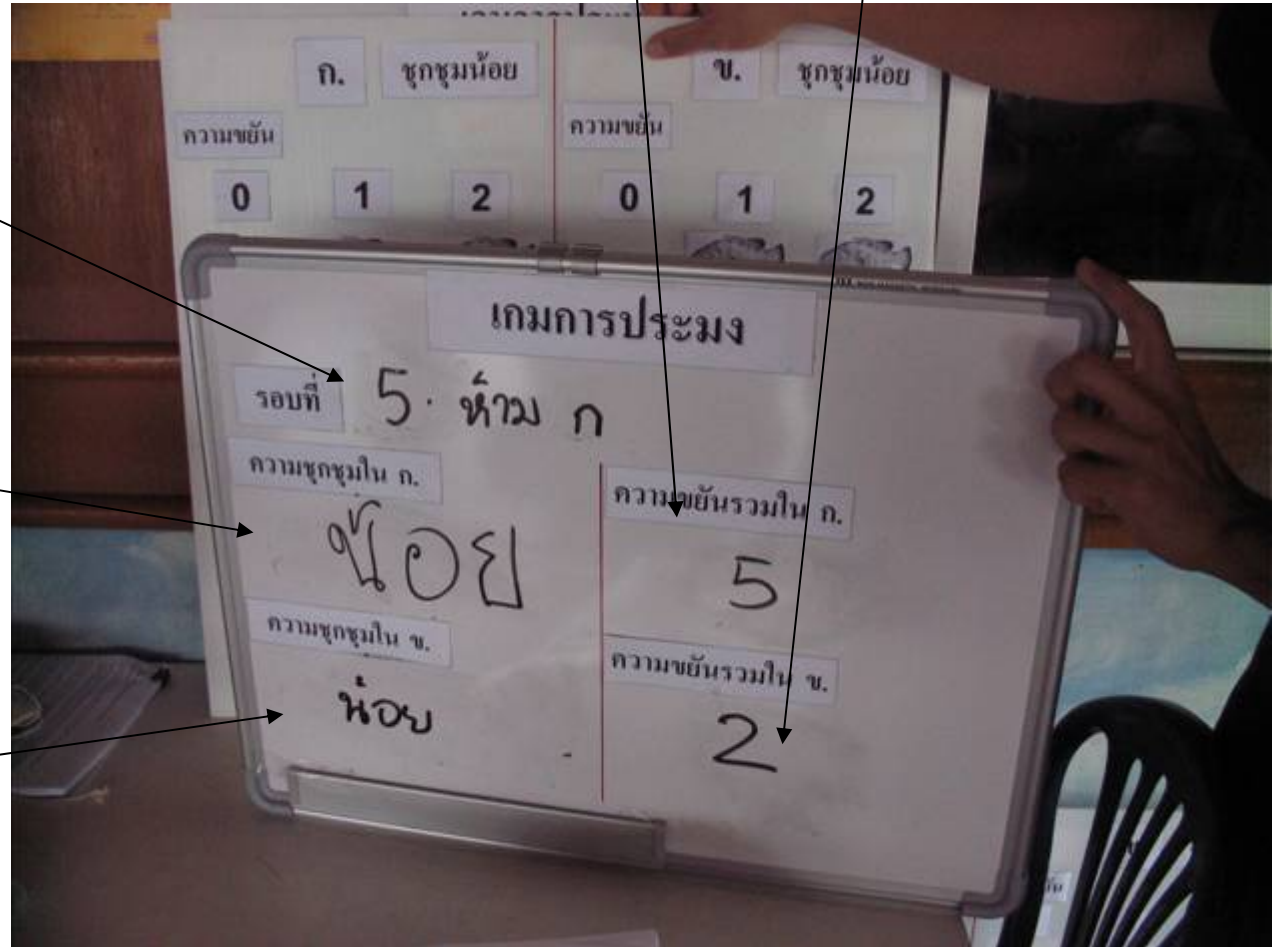
# Fishery game

Effort zone A    effort zone B

Time step

State zone A

State Zone B

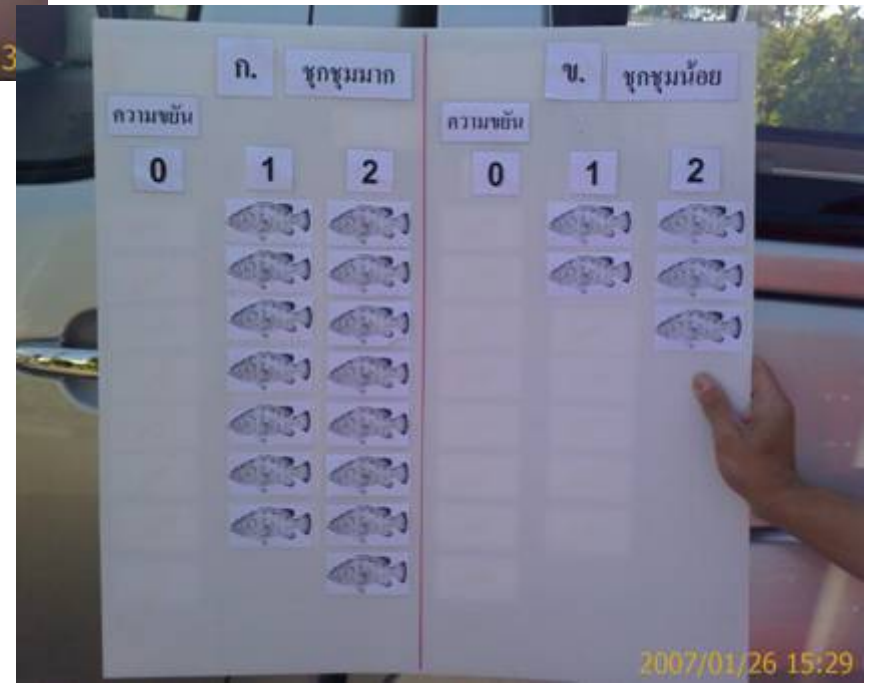


# Fishery game

A high, B, low



A High, B High



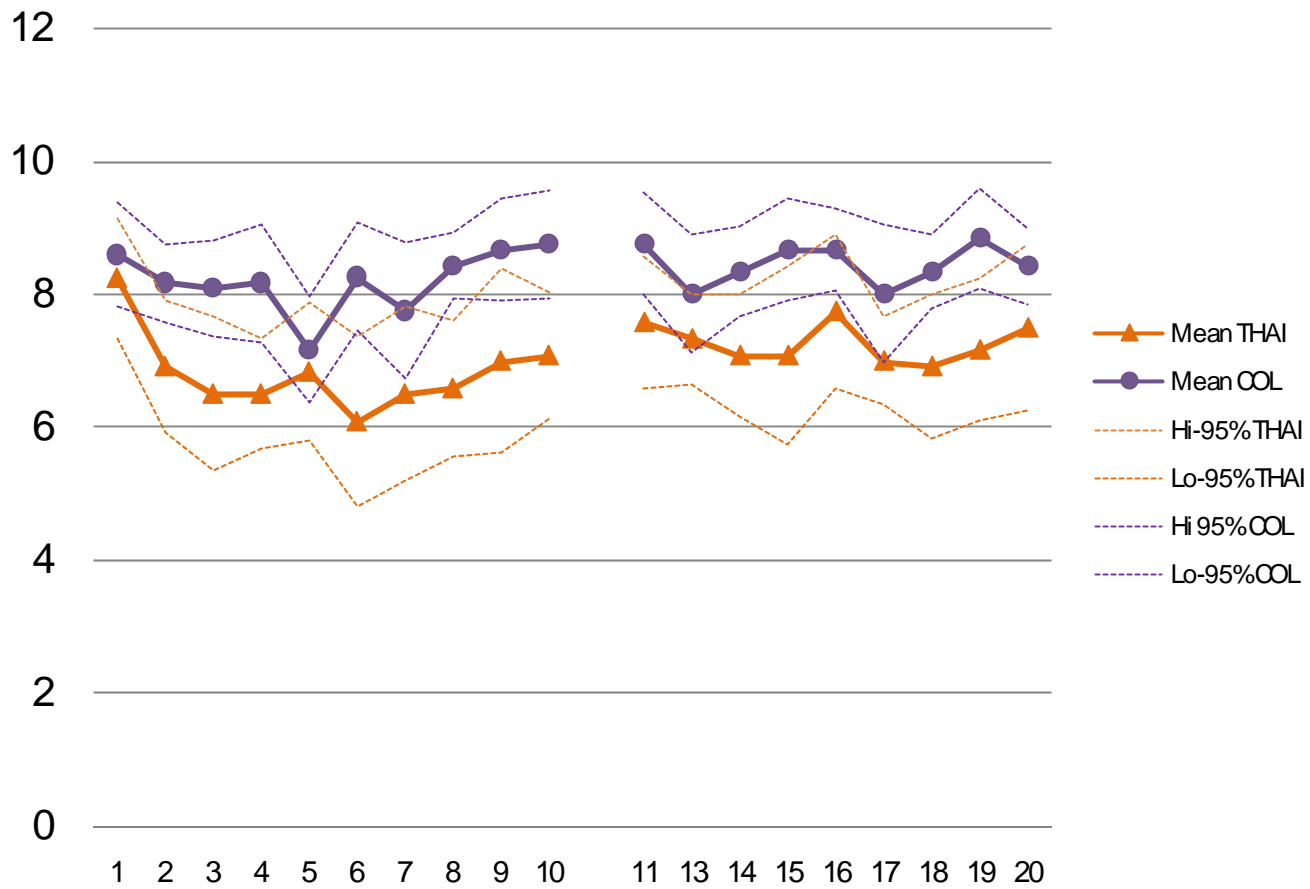
# Theoretical solutions

- Nash equilibrium: They move to the low state of both resources in two rounds, and get stuck in that situation for the remainder of the rounds. For a sequence of 10 rounds, this opportunistic behavior will result in **200** tokens for the 5 participants together.
- Cooperative equilibrium: If they would be able to coordinate their efforts the cooperative solution leads to **382** tokens by spreading the effort equally over the two resources where at least two people have not a maximum effort.

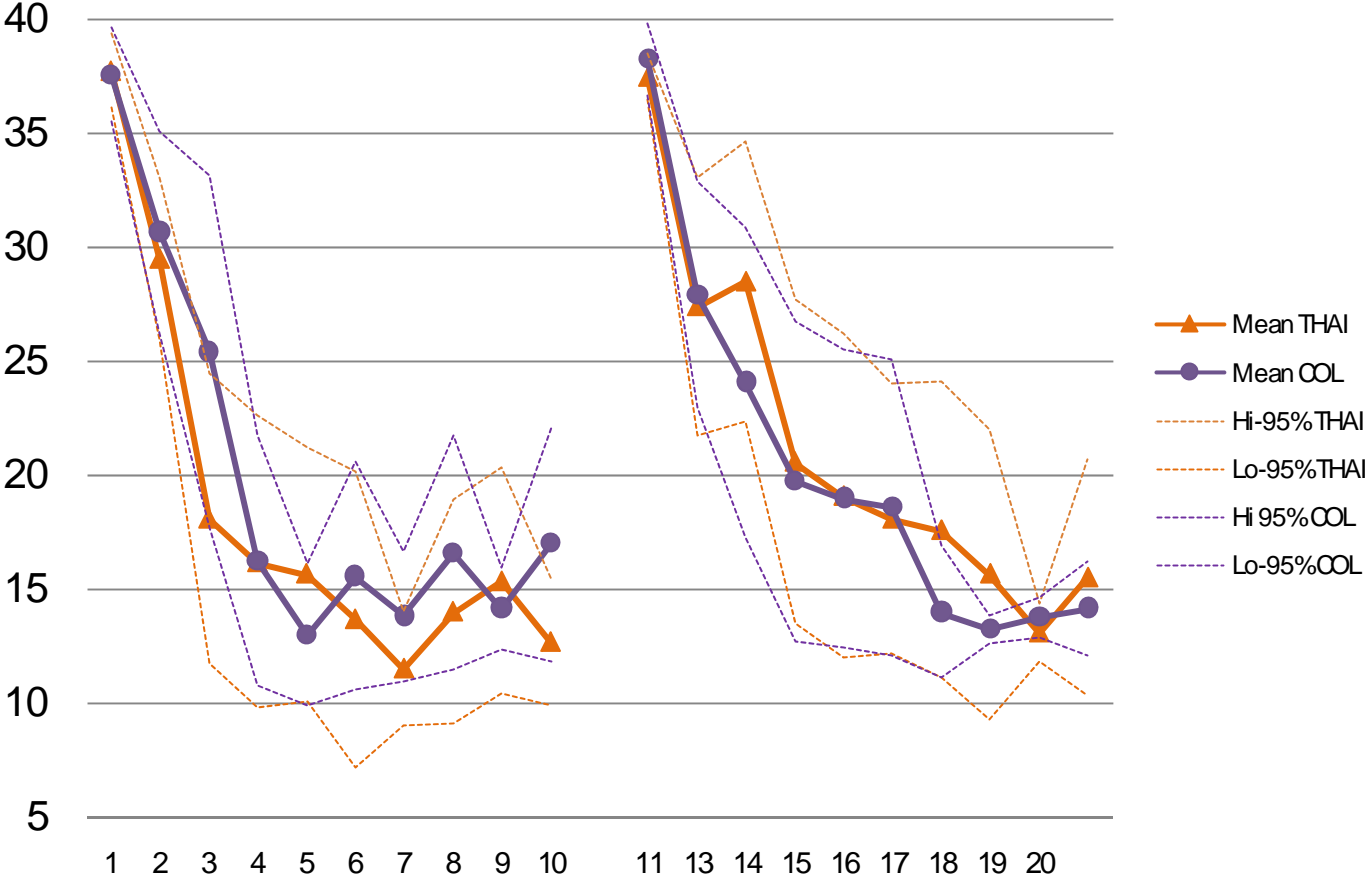
# Rules

- **Rule 1 (Lottery).** Each round the location where each of the participants is allowed to fish is randomly determined by throwing a dice for each participant. When a participant harvest in a location illegally, a throw of a six of the dice leads to paying back the harvest points.
- **Rule 2 (Rotation).** Each round one of the location is banned from fishing: A in rounds 1 and 2, B in rounds 3 and 4, etc. If a participant is caught fishing illegally the harvested amount need to be returned.
- **Rule 3 (Property right):** Each participant can exert an effort of 0 or 1 per round. In case a participant is caught putting two units of effort, the participant need to pay back the harvested amount.

# Fishery Game: Group Fishing Effort



# Fishery Game: Group Returns(tokens)



# Irrigation experiment

- Irrigation game. (different position; upstream):
  - Five persons in positions A-E: A upstream, E downstream.
  - Each round two decisions:
  - How much investment in public infrastructure (water)
  - What amount to take from (remaining) water. Here decisions are made in order of access.

## Water production as a function of units invested in public infrastructure

Table of available water quantity	
Total units invested by all 5 players	Water available
0-10	0
11-15	5
16-20	20
21-25	40
26-30	60
31-35	75
36-40	85
41-45	95
46-50	100

# Irrigation game



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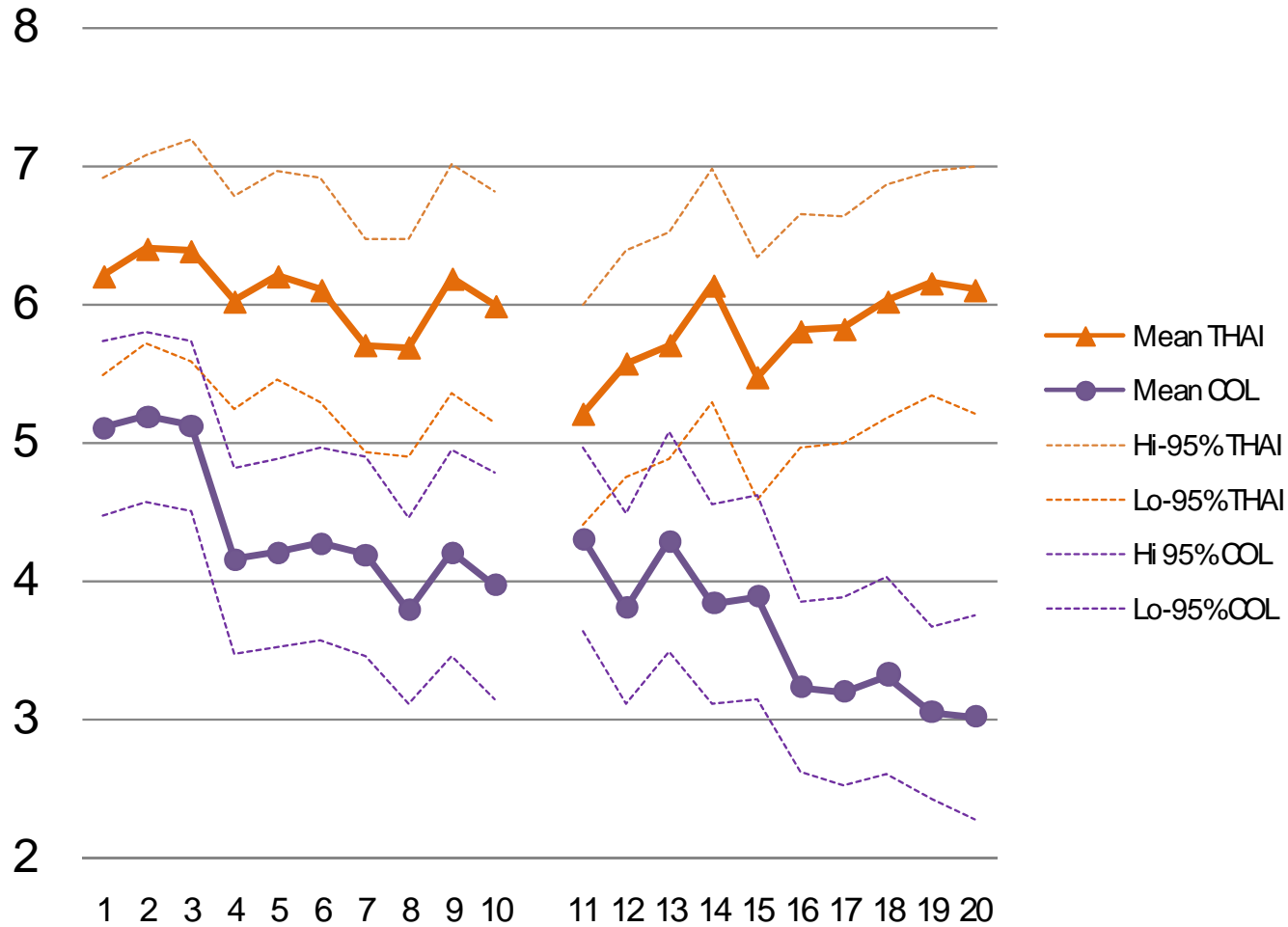
# Theoretical Solutions

- Opportunistic result. Assuming first player (A) takes everything, nobody will invest in public infrastructure: each player earns 10 tokens per round.
- Cooperative solution: What if everybody invest maximum and shares equally? Each player earns 20 tokens per round.

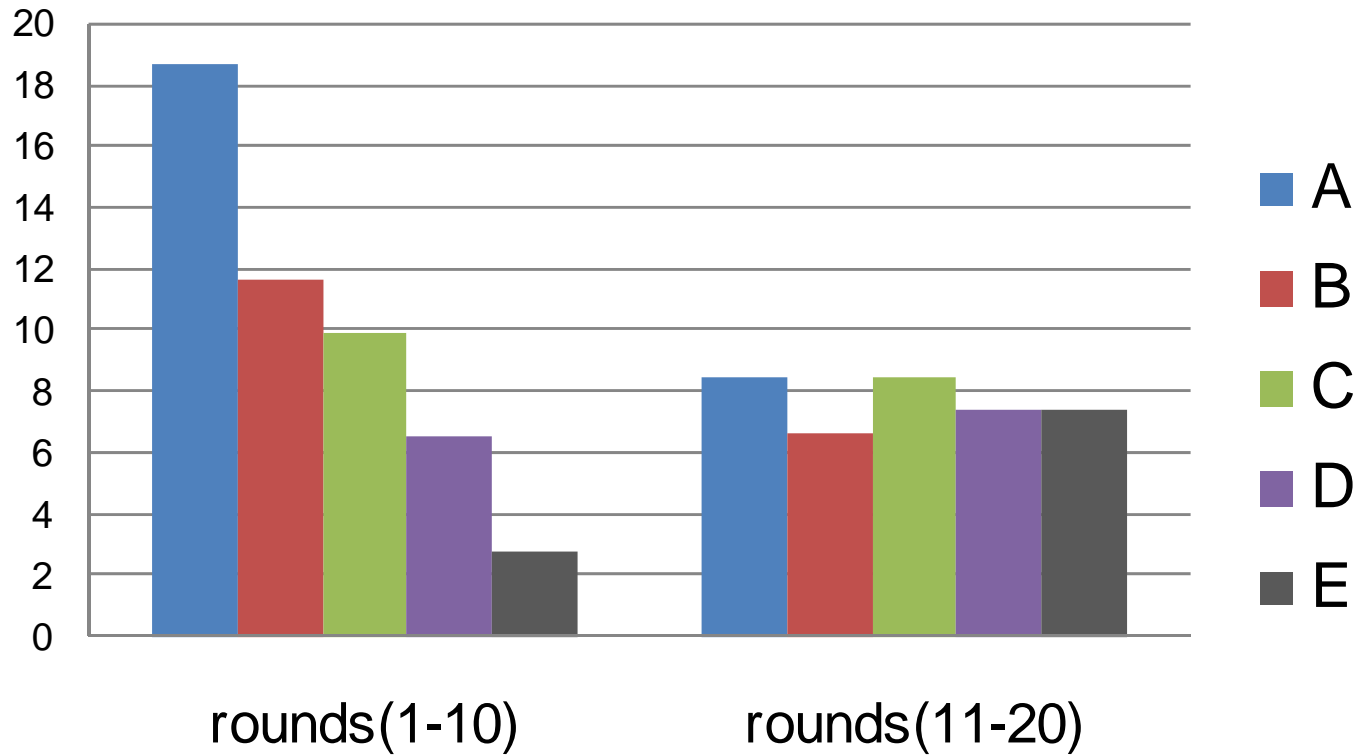
# Rules

- **Rule 1 (Lottery).** Each round the order in which participants can collect from the common resource is randomly drawn after everybody has made their decision how much to invest in the water provision.
- **Rule 2 (Rotation).** There is a fixed rotation system of the order in which people can collect from the common resource, starting with ABCDE in round 1, then BCDEA, etc.
- **Rule 3 (Property rights):** Each participant receives the right to use 20 percent of the common resource. The order to extract water remains the same for all the rounds: ABCDE. A dice is thrown in each round. When 6 is thrown, participants who collect a higher amount than the share of 20 percent have to pay back the excess water harvested, and also pay a penalty of 6 additional tokens.

# Water irrigation game: Mean contribution to the public fund over rounds



# Water Irrigation Game Extraction by Player's Position



# Statistical Analysis

- multinomial logistic regression:
  - Country,
  - Round,
  - Irrigation Village,
  - Position,
  - Gender,
  - Age,
  - Education,
  - Married,
  - farmer (time spend),
  - years ancestors,
  - fraction of water (t-1),
  - Volunteer in Governance,
  - opinion questions

# What affects contribution at group level?

- At the group level:
  - Thailand participants invest more
  - Inequalities in contributions of the last round reduces investment levels
  - Over times people invest less

# Contributions at individual level

- Thai invest more
- In later rounds less is invested
- Downstream invest less
- Married persons invest more
- Educated person invest less
- People who volunteer time in governance invest less

# What share do people take compared to fair share of available water?

- Upstream players take more
- More educated players take more
- Married players take less
- over time players take more
- woman take more

# ANALYSIS OF EFFECT OF RULES

# 3 types of rules

- Rule 1: (lottery) Random assignment of who has the right to harvest
- Rule 2: (rotation) Rotation scheme to assign who has the right to harvest
- Rule 3: (property rights) Limited amount of units that can be harvested

Comparing “experienced”  
villagers in that resource

Does the context and experience  
matter?

# Forestry stock over time

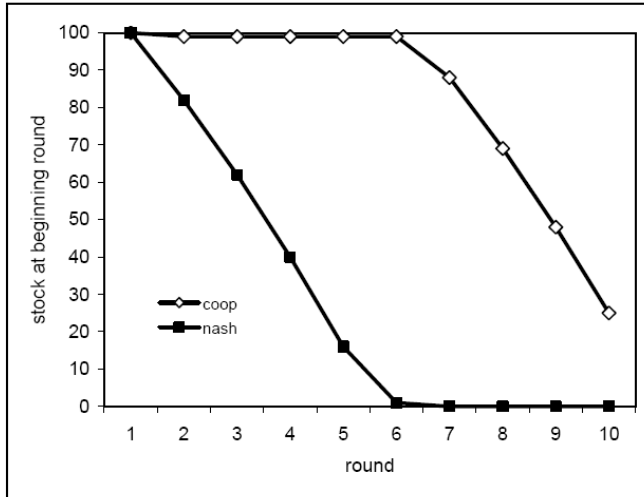
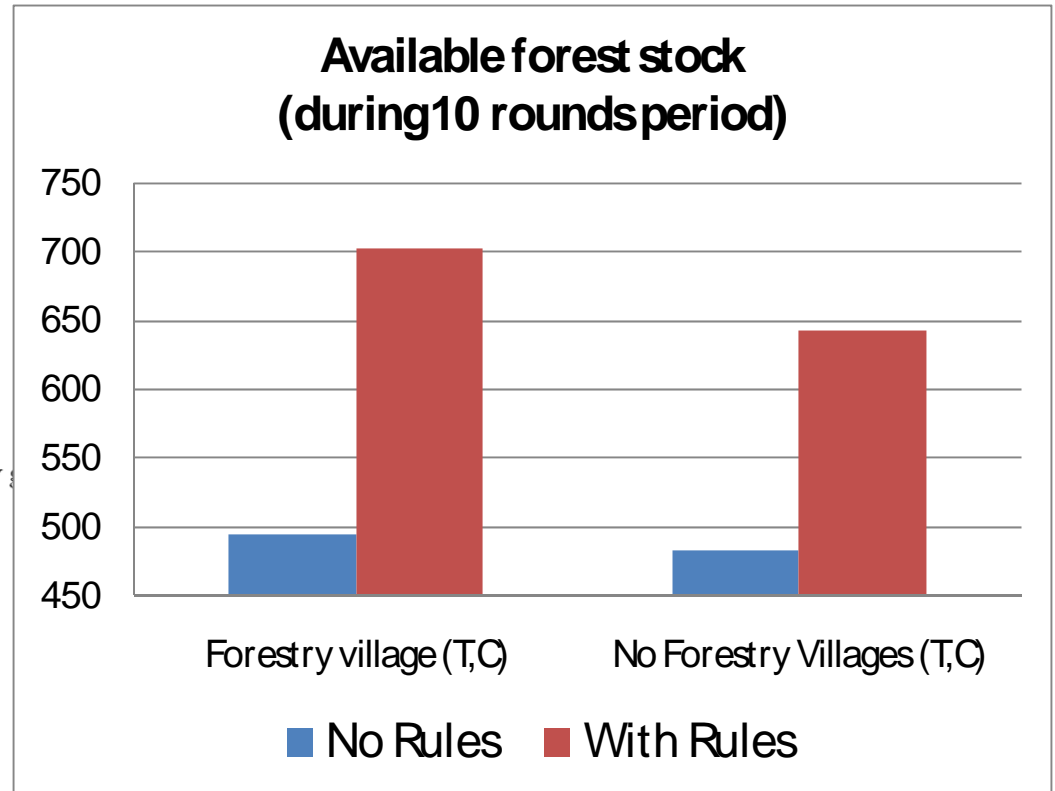


Figure 1: Cooperative optimum and Nash equilibrium (Forestry)

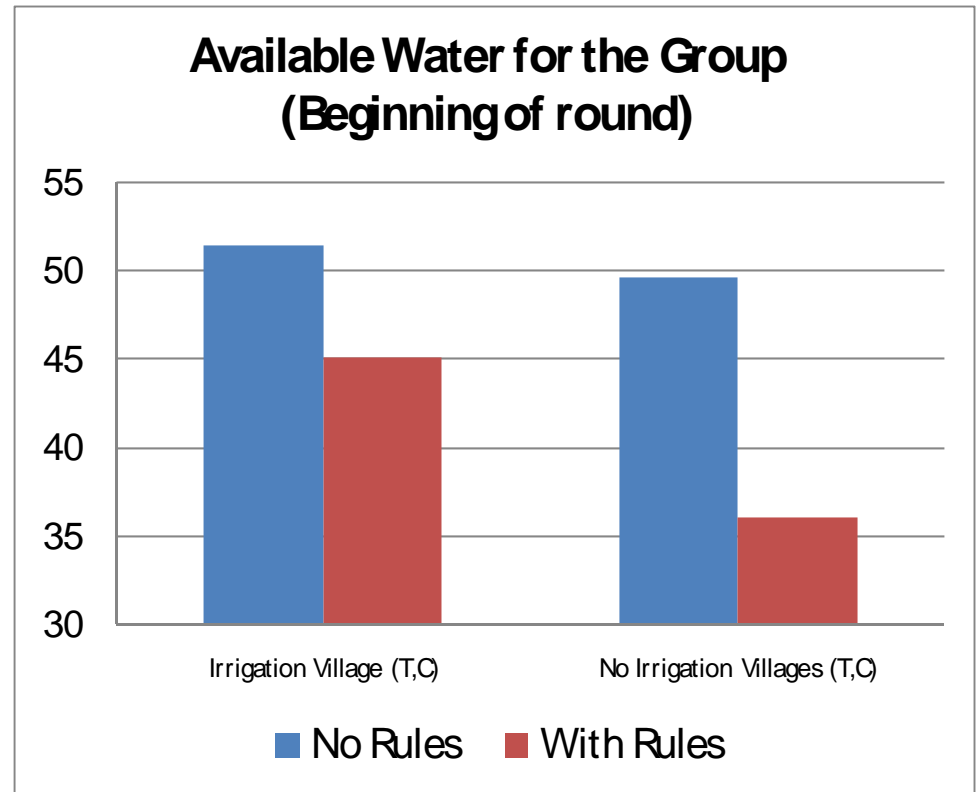
**No Rules: Rounds (1-10)**

**With Rules: Rounds (11-20)**



# Water Irrigation

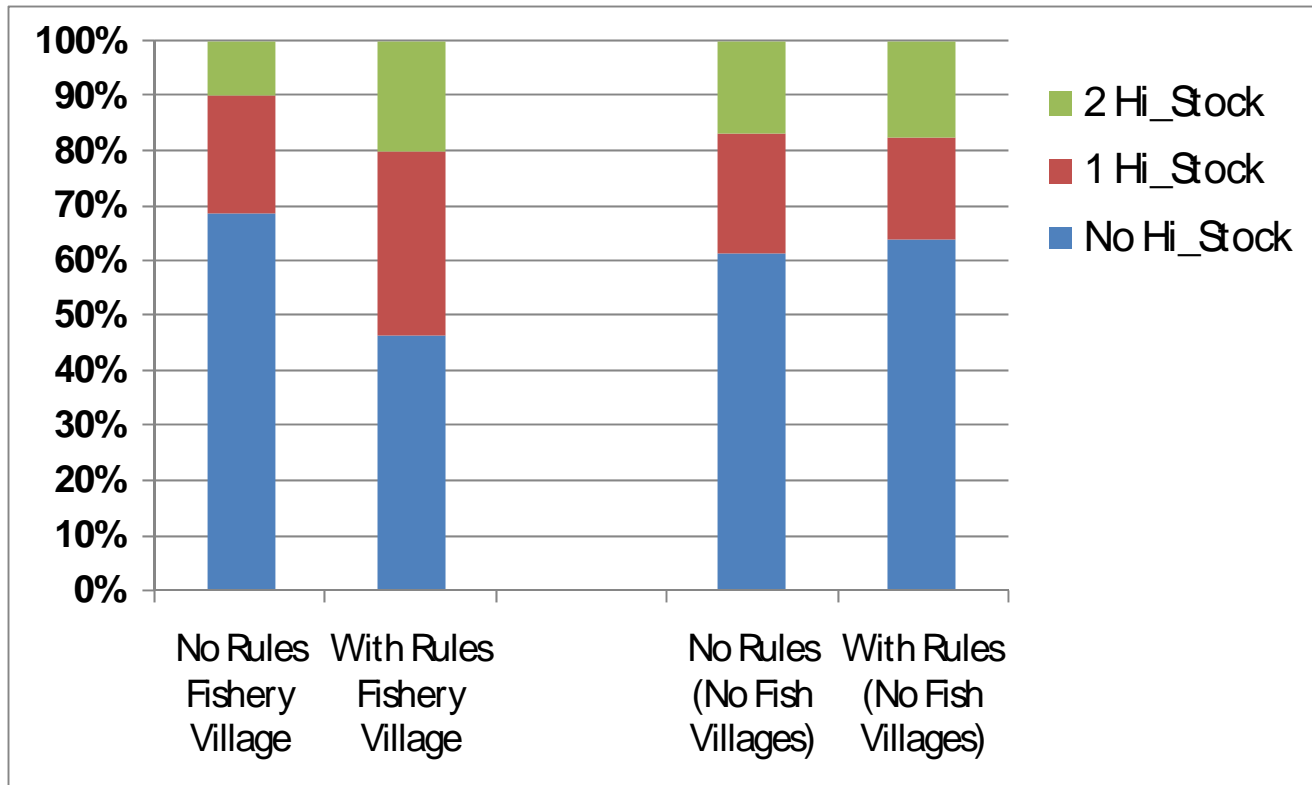
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46-50	100



**No Rules: Rounds (1-10)**

**With Rules: Rounds (11-20)**

# Fishery: Frequencies of sites with High Stocks



# Role-playing games

# Why?

- Initial project « *In these board games, the subjects are asked to play resource users and craft rules to govern their common resource. During the games discussions in these groups of players will be recorded and analyzed to identify the pattern of which type of rules are developed during the role game [...] The information gathered during the role games will be used to test the differences in rule sets and rule-crafting for the three types of resources.* »
- Complementarity with field experiments:
  - Come after the experiments
  - Discussions, modifications are allowed.
- Objective: To place people in the position of modifying the « experimental settings » and observe what they do.

# Method

- Feedback on the experiments
- Propose to create a RPG from the experiment, discuss on the objective
- Select 5-10 people, help them to create the RPG (on resource at stake in the village)
- Once the game ready, invite other villagers to test the game

# Observations

- Objective of the game and the target people
- Sequence of modifications
- Rules and type of rules
- Actual modifications (to be compared with expected modifications)

# The workshops

- Fishery and forest in Colombia, fishery, forest and irrigation in Thailand

# Fishery

- Objective:
  - Colombia: to facilitate the negotiation among Baru fishermen and other stakeholders, use the game during a meeting with Natural Park authorities (already planned)
  - Thailand: to play with the department of fisheries to let them understand what their life is and problems are: underlying idea is that the fishery department may help them by restocking with fish and shrimps
- Both cases: Negotiation on management with external actors



TOPIC	EXPECTED CHANGES	Thailand CHANGES	CHANGES IN BARU
<b>Changes in resource settings</b>			
Resource diversity	Difference kind of target species	NO.	NO.
Season to fish	Different seasons or climate restrictions according season	NO.	NO.
Differences due to the context in Thailand and Colombia	Differences- Aquaculture (much more in Thailand) and Conservation area (Colombia)	NO.	YES
Fishery spots	More realistic fishery places (number and names)	YES.	YES.
Condition of fishery spots	No hypothesis	YES.	NO.
<b>Individual decision making</b>			
Species choice	Possibility to switch from one target specie to another one	NO.	NO.
Price	Taking into account the price at market.	NO.	NO.
Fishery spots choice	Different areas to fish which can be grouped into coastal zone, far zone	NO	YES
Fishery gear	No hypothesis	NO	YES
Incentives structure	No hypothesis	YES	NO
Effort	No hypothesis	YES.	NO.
<b>Collective decisions</b>			
Rules	Rules would be negotiated	NO.	NO/YES
Sanctions	sanctions would be more probable	NO.	NO.
Roles	integration of new roles	NO.	YES..

# Miscellaneous observations

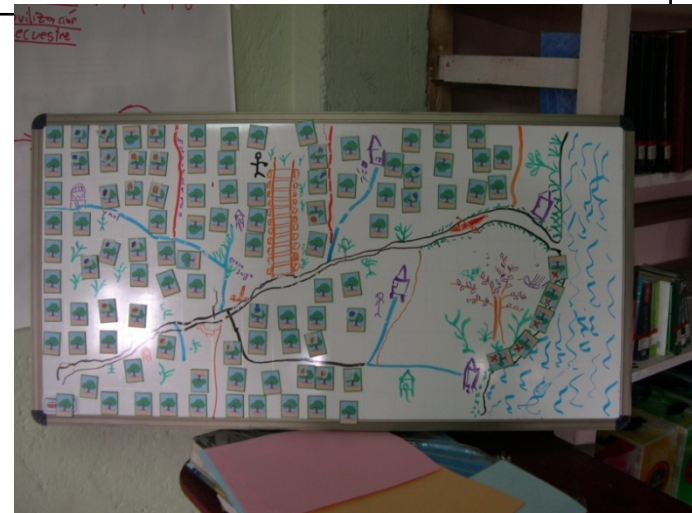
- Spatial setting is the first modification in both cases
- Monitoring is important (spatial & catch)
- Very clear agreement in Thailand to refuse to include any regulation arena
- In Colombia there is an arena for negociation but no rules are pre-identified

# Forestry

- Note: Logging is not allowed any more in Thailand. Players considered that the experiment is similar to Non timber forest product.
- Objective:
  - Colombia: Planning “*A game for the sustainable use of timber, fisheries and other activities*”.
  - Thailand: to gain knowledge and teach conservation at school
- Planning (awareness), Learning and teaching, Internal

# Forestry

Rank	Thailand	Colombia
1	Resource variety (bamboo shoot, bamboo trees)	New roles: Sawmill owners, environmental authority officer, one local social organization and an environmental NGO.
2	Rule (access rule) : no more than three cells	Spatial organization of the forest (7 individual plots and a coastal zone with mangroves). Heterogeneous forest with most conspicuous geographic characters (River, paths, coast).
3	Player needs	Rule (extraction): Sawmills need a license in order to hire loggers to go to the forest.
4	New role (trader)	Resource variety: 4 species (Cuangare ( <i>Dyalianthera spp</i> ), Garza ( <i>Tabebuia spp</i> ), Sajo ( <i>Camptosperma panamensis</i> ) and Sande ( <i>Brosium utile</i> ))
5		Definition of the growth rate for each species.
6		Meaning of one round: each round represents a season in the forest (4 days in average)



<b>TOPIC</b>	<b>EXPECTED CHANGES</b>	<b>Thailand CHANGES</b>
<b>Changes in resource settings</b>		
	Difference kind of target species	NO.
	Difference size of tree	Yes. Bamboo shoots and bamboo trees
	Map of the forest	NO. There was no reason to consider the spatial settings
<b>Individual decision making</b>		
	Charcoal burning	NO. As they decided that the resource will be the bamboo
Price	commercial logging	YES. The role of the trader was introduced
<b>Collective decisions</b>		
	Rules would be negotiated	YES. crafted
	Interaction between villagers and National Park	NO. Bamboo is managed at the village level

TOPIC	EXPECTED CHANGES	CHANGES IN SALAHONDA
Changes in resource settings		
Resource diversity	Difference kind of target species	YES.
Resource regeneration	Difference in tree species growth rates	YES.
	They will transform the experiment board in a more realistic representation of the territory	YES.
	At least two different zones: one close to the river and the other deeper in the forest	NO
	Enlargement of the experiment board in more comprehensive space enough to include extraction zones for the players	YES
	Establishment of different land use units in the forest	NO
Individual units size	Difference in trees size it is possible to cut.	NO.
Individual decision making		
Species choice	Possibility to switch from one target specie to another one	YES.
Price	Taking into account the price at market. They will convert trees in commercial units they use, which are sections of a tree.	YES.
Spatial choice	Enlargement of the experiment board in more comprehensive space enough to include extraction zones for the players	YES,
Incentives structure	No hypothesis	The payoff structure of the experiment was not taken into account at all. Each player negotiated the price of timber with the sawmill owners.
Effort	No maximum level of extraction	YES
Collective decisions		
Rules	Rules would be negotiated	NO.
Sanctions	Sanctions would be more strict	NO.
Roles	Integration of new roles Sawmill owner character and Environmental local agency	YES.

# Miscellaneous comments

- Very different in Thailand and Columbia
- Common points:
  - Introduce trade
  - Regulation through trade

# Irrigation

- This was not possible in Colombia. *“people don’t want more workshops, researchers and external projects in the zone, because they don’t help, they just take what they need ».*
- Objective in Thailand: this game is for anyone who wants to know the benefit of sharing
- Teaching objective. No negotiation nor really learning. They consider they already know

# Modifications

1. Introduction of a variety of land use (fish pond, rice)
2. New role (head of canal) and allowance to negotiate and set rules
3. Player (crop water) needs & damages
4. New role: irrigation department

TOPIC	EXPECTED CHANGES	Actual CHANGES
<b>Changes in resource settings</b>		
	quantity of water per crop	YES They consider that 5 units of water are necessary (not more) and problems will occur in case of water shortage, depending also on the time step
	the plot size and position of plot	NO. All plots have the same size
	the concrete representation of available water and extraction instead number on the paper	NO. This is a theoretical number
<b>Individual decision making</b>		
	the last farmer may not extract all of the rest water	YES. They try to leave water in the canal and explained why.
	ability to see who is getting the water	YES. This is the first thing they discuss
<b>Collective decisions</b>		
	Canal chief (in Thailand), to contact between farmer and government and also take care the way to transport water	YES
	Irrigation department	YES but late in the process of game crafting

# Miscellaneous comments on irrigation

- Lessons on the negotiation with external people: not possible/not necessary.
- Multiple-levels relationship is the problem
- Negotiation for rules is part of the system. The negotiation system is given, endorsed, no need to reorganize it.
- In Thai case, no investment for water



# General comments

- Rule crafting is considered when the objective is learning and teaching, but not for negotiation. For negotiation the objective is to show a situation and sensitize the external actors
- No pre-set rules like in the experiments. It's not a matter of rule-choice (vote). What is set is either imposed rules or the possibility to interact letting the rules emerging from interaction.
- No sanctions
- RPG changes the focus and the range of local problematics, regarding the dynamic of rules topic
- Problem of RPG crafted by local people : social pressure is high.

# Open questions

- What did we learn from the RPG exercises which we did not know after the experiments/interviews?
- What did we learn from the RPG exercises which can be linked to questions raised by the lab-experiments?
- What did we learn from the RPG exercises which can be linked to questions raised by the field-experiments?

# What did we learn from the RPG exercises which we did not know after the experiments/interviews?

- Context
  - Ecological
  - Economic
  - Social
- The underlying mental model of the players related to the experiment
- How rules are implemented

# RPG-Lab. Experiments

- Allocate space rather than quantity.
  - Fishery regulation is spatialized in both cases,
  - Economic transaction key driver for the forestry
  - Water amount for the irrigation system
- Amount and distribution of messages more important than the content <-> Players set different systems for communication but not the content of communication

# RPG- field experiment

- Irrigation: equity (sharing water) among farmers is not the problem
- Experiment rules were not used
- RPG does not give any explanation on the differences between Colombia & Thailand

# Et maintenant?

- Analyses sur:
  - la question des règles (trust, compliance, like) et leurs relations à l'état de la ressource.
  - Le thème général equity-efficiency-sustainability
  - Influence de l'expérience
- Avancées méthodologiques:
  - Qu'apportent chacune des méthodes (expériences, enquêtes, interviews, JDR)?
  - Méthodologie intégrée (18 Mars avec Stefano Farolfi)
- Thèse de Daniel sur modèles mentaux et institutions
- Nouveau projet pour l'accompagnement