

## **Online Appendix**

# **EFFECTIVE INFORMATION INFRASTRUCTURES FOR COLLABORATIVE ORGANIZING: THE CASE OF MAASAI MARA**

**Appendix A:** Additional pictures

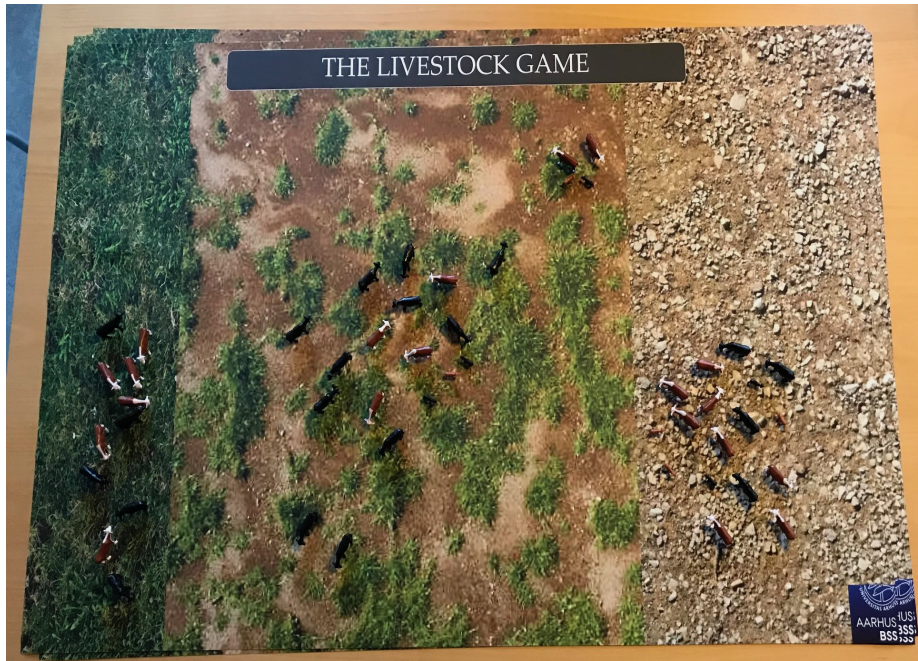
**Appendix B:** The Livestock Game model

**Appendix C:** Initial values for the Livestock Game

**Appendix D:** Instructions for running the Livestock Game

## Online Appendix A

Additional pictures



**Picture A1:** The Livestock game board, illustrated with plastic figurine livestock



**Picture A2:** Participants allocating plastic figurine livestock to the game board.

## Online Appendix B

### The Model

We outline the main equations and relationships in the model below. Starting by defining the shared resource, the grass, in each of the areas

$$G_n^t = G_n^{t-1} + P_n A_n f_n(\alpha_n^t) - \text{Min}(\beta CC_n^t, G_n^t), \quad n=1, 2, 3 \quad (1)$$

$$CC_n^t = Cows_n^t + Calves_n^t \quad (2)$$

Where  $G_n^t$  is the grass in area  $n$  at time  $t$ . The amount of grass produced is  $P_n$ , determined by a constant that represents the “normal” grass production per unit of land in area  $n$ ,  $A_n$  is the size of area, and  $f_n(\alpha_n^t)$  is nonlinear function of the (relative) consumption in area  $n$ . The consumption of grass in a period is given by the ideal consumption per animal (cows and calves)  $\beta$ , the number of animals in the area  $CC_n^t$ . The *Min* function ensure that the animals cannot eat more grass than there is, if the ideal consumption and the number of animals are more than the available grass.

$$Cows_n^t = Cows_n^{t-1} + Mat_n^t - CD_n^t - CS_n^t \quad (3)$$

The number of cows at time  $t$ , is equal to cows at time  $t-1$ , plus  $Mat_n^t$ , the calves that have matured, subtracting the number of cows who have died,  $CD_n^t$  and the number who have been sold  $CS_n^t$ .

$$Calves_n^t = Calves_n^{t-1} + Birth_n^t + CaB_n^t - CaD_n^t - Mat_n^t \quad (4)$$

The number of Calves increases by  $Birth_n^t$  and by the number of Calves bought,  $CaB_n^t$ . It decreases by the death of calves,  $CaD_n^t$  and the calves that mature,  $Mat_n^t$ .

$$Mat_n^t = \frac{C_n^{t-\lambda}}{\lambda} \quad (5)$$

Where  $\lambda$  is the maturation time. The dead of cows and calves is defined as the sum of the death in each area:

$$CD_n^t = \sum_{\#} CD_n^t \quad (6)$$

$$CaD_n^t = \sum_{\#} CaD_n^t \quad (7)$$

$$Birth^i = \sum_{\#} Birth_{\#}^i \quad (8)$$

The birth in each area defined as

$$CD_{\#}^i = Cows_{\#}^i \mu f_{\#}(\Phi_{\#}^i) \quad (9)$$

$$CaD_{\#}^i = Calves_{\#}^i \delta f_{\%}(\Phi_{\#}^i) \quad (10)$$

Where  $\mu$  and  $\delta$  are constants that represent the normal death rate among cows and calves respectively.  $f_{\#}$  and  $f_{\%}$  are nonlinear functions where  $\Phi$  represents the cows and calves actual to optimal consumption.

$$\Phi_{\#}^i = \frac{\&((\#\$)}{\&((\#\$)} \quad (11)$$

We define the birth-rate as:

$$Birth_{\#}^i = Cows_{\#}^i \Omega f_{/}(\Phi_{\#}^i) \quad (12)$$

Where  $\Omega$  is the normal birthrate and  $f_{/}$  is a nonlinear function of the availability of grass.

## Online Appendix C

### *Initial conditions*

Below are the initial conditions used in the game in Maasai Mara.

|        | <i>Size</i> | <i>Initial grass</i> | <i>Growth factor</i> |
|--------|-------------|----------------------|----------------------|
| Area 1 | 40          | 85                   | 0,95                 |
| Area 2 | 80          | 55                   | 0,75                 |
| Area 3 | 60          | 45                   | 0,70                 |

Table A1. The size, initial grass and the grass growth factor for the three areas in the game.

| <i>Group</i> | <i>Cows</i> | <i>Calves</i> | <i>Balance</i> |
|--------------|-------------|---------------|----------------|
| 1            | 20          | 20            | 500            |
| 2            | 20          | 20            | 500            |
| 3            | 20          | 20            | 500            |
| 4            | 20          | 20            | 500            |

Table A2 Initial allocation of cows, calves and money between groups.

| <i>Parameter</i>            |      | <i>Explanation</i>                         |
|-----------------------------|------|--|
| Rounds                      | 12   | 12 rounds in the game                      |
| Normal reproduction rate    | 0,5  | A cow on average gives birth every 2 years |
| Maturation time             | 2    | Time for Calves to mature                  |
| Normal livestock death rate | 0,04 | 4% of livestock die in an average year     |
| Price of calf               | 100  | The price of one calf                      |

Table A3 selected parameters in the Livestock game

# **The Livestock Game**

*Understanding the Tragedy of the Commons*

*By: Erik Larsen and Dorthe Døjbak Håkonsson*

Version 1

(Version for *Maasai Mara* Experiment)

## Instructions for Running the Livestock Game

Make sure that you have

- *Game board*
- *Cows*
- *Record sheets*
- *Handout to participants*
- *Pens*
- *The game (on computer!)*
- *Briefing (on computer)*
- *Debriefing (on computer)*
- *An excel sheet (on computer) prepared to be updated as the game progress.*

Setting up the Livestock game on your computer

- Name the game (in a meaning full way, e.g. group, data, special conditions)
- Check the initial conditions
  - Normal yearly production of grass from 0.9
  - Grow factor
    - Area 1 - 0.95
    - Area 2 - 0.75
    - Area 3 - 0.7
  - Calves 20
  - Cows 20
  - Balance 500
  - Rounds 12
  - Price of one calf 100
- Go to the start screen
- Open the (empty) excel sheet for recording the decision and outcomes
- Rename the excel sheet with the name for the game

*Setting up the game*

- Note the starting position on the record sheet i.e., the # of Cows, # of Calves, amount of money, average weight
- Write group numbers on record sheet (1 to 4), game identifier, date
- Keep a second record of information that links the game identifier to location, time. Any information about the participants
- Lay out the game board and the cows – you can put the right number of initial cows on the area
- Add the slide that shows that different types of cows count for different numbers (brown and white = 1, black = 5, and black and white = 10)



## Briefing for the game

- Welcome participants
- ***Make the teams; make sure that there is at least three people in each group. Also try to have one person who can read and write in each group***
- Introduce yourself and anybody helping you
  - The game has been developed by XX (to help preserve anonymity in the review process)
- Explain what will happen and set expectations
  - playing a game of managing livestock. Essentially, what we will ask you to do is to behave more or less as you do in your ordinary lives.
  - A few words: buy calves, sell cows, and assign your calves and cows to the different areas on this game board
    - Explain the three zones:
    - Area 1: Relatively small but with very good grass and rain in an average year.
    - Area 2: The biggest area, where the grass is OK, but not plenty and will recover slowly
    - Area 3: with a size in between areas 1 and 2; where the grass is not good - there is grass just less of it.
- The game is deliberately simplified – wherefore it does not represent a replica of your daily lives (as you can see, the grazing areas are different – just as you will find that the cows are different). Instead, the game represents some of the broader ideas of livestock grazing – particularly relating to grazing and subsequent growth of livestock and regeneration of grass.
- Steps of the game
  - The game consists of 12 rounds – equalling a period of time, this could be a month, a year, a season. For each round of the game, your group needs to decide on where they want to let their livestock graze.
- **It's your own decision where you want to let your livestock graze.**

There are however, a number of 'natural' land use restrictions provided by the weather conditions and subsequent growth of grass, as well as the extent to which the grazing lands were exploited. These conditions and their interrelationships are all included in a computer program on my computer. For each round, you will be interacting with me on a piece of paper where you will record your decisions for the next round. I will punch these numbers into my computer and, based on your decisions, the computer program will provide you with the results of your previous decisions.

- While each of the four groups make their own decisions about where they want to allocate their livestock –the groups are also interdependent insofar as their decisions will influence the amount of grass available.
- The groups are allowed to talk to the other groups.

- We will help you throughout the game, but let's start as learning by doing may be the easiest.

(Ask them to gather around the board game, and use the record sheet to illustrate)

1 For each round, your group needs to decide whether it wants to:

2 Buy Calves – to buy you will need to have money. Note that you have a bit when you start (fictive money).

3 Decide if you want to sell cows – can ONLY SELL THE COWS that they already have.

4 Calculate the number of cows and Calves you have left (to allocate).

5 Allocate the cows and Calves you have to the different areas (you need to allocate all) and note that you do not need to distinguish between cows and Calves for the allocation (i.e. Cows + Calves = C&c in area 1 + C&c in area 2 + C&c in area 3)  
Remember that you have to allocate all livestock (i.e. you cannot keep any at "home")

6 Record your decision on the paper and hand it in to me

7 Place the number of cows and Calves on the board as you have decided

- This enables you to see the total amount of livestock allocated into the three areas (for all groups)

#### **THE OBJECTIVE**

- Maintain the grassing areas.

#### ***Running the game***

- Make sure that the four groups have the record sheet and they are aware which group they are
- Ask them to look at the sheet and begin to decide where they want to allocate their cows across the three areas
- Tell them that we take a bit more time in the first round to make sure that all understand what they have to do
- Take a round and check with each group that they understand what was said in the briefing and the idea that they have to allocate the cows
- Depending on the time available give them notice that they will need to make the decisions in 2 minutes (that is after you have taken the round and you feel that there is a reasonable understanding of what it is all about)
- Call for the groups to finish the allocation and to hand in the record sheets – and ask them to allocate the cows as they have decided on the game board (remind them that different

kinds of plastic figurine cows represent different numbers on the board as shown in the briefing)

- Input the number in the program and step forward. Then record the output from the program on each record sheet for the appropriate group and hand the record sheets back to the groups.
- Inform the participants about the weather
- Update the record sheet with information from the operator's report
- Remove all the livestock from the game board (to be ready for next round)
- Take another round to check that all understand the output
- Then repeat the steps above until the desired number of rounds
- **Note**
  - Make sure that people have enough but not too much time (push if necessary). Most likely the first round will take 10 to 12 minutes as you need to take a round and check that all groups understand what they have to do and answer any questions they might have. Each round should be more than 1 minute they need to discuss (if it is too short then they do not really think about the decision)
  - Expect that rounds should move faster as you go through the game
  - Keep an eye on the evolution of the system

## ***Debriefing the game***

*Note: the debriefing might depend on which participants you are working with. You should only use the slides that suit your purpose and learning objectives. Below are comments to the most frequently used slides in the pack.*

- **Start by reviewing the results from the game** (show the graphs from Excel). What to say depends on the results.
  - Depending on the results if there is no grass left, everybody lost
  - Do groups have more or less cows now than when they started?
  - What were the most cows they had at any point during the game?
  - What happened?
  - How did they decide to allocate the cows across the areas?
  - Did they think about how other groups did it – did it influence their decisions?
  - Did they change “strategy” during the game?
  - Did they sell any cows – why or why not?
  - What would they do differently if they played again?

- Review and make appropriate comments on the total number of Cows and Calves
- Look at the distribution of cows and calves across the 3 areas.
- Compare the previous graph with the graph showing the level of grass in each area and comments on the connection – did some areas recover etc.?
- Finally show the total death and birth for the game.

### **Slide 2** What happened

Wrap up the discussion from above – and make the link to the tragedy of the commons  
Depends a little bit on the results and discussion above

### **Slide 3** Origins

- ToC was first described / discussed in connection with the British villages as written on the slide
- Explain how the tragedy in the TOC paradigm is not only based on the fact that the common is destroyed, but more so on the fact that it is destroyed because individuals actually behave rationally – I could let my cows refrain from grazing tomorrow – but that would only allow your cows to eat more. So, there's no incentive not to overexploit the commons.
- Mention how TOC doesn't just happen in Maasai Mara, but in many places where humans have to share a commons
- Discuss how we've only talked about cows – but how about e.g. shoats?

### **Slide 4** Livestock in the Mara Ecosystem

- As we can observe in the two graphs there has been a relative big variation in the cattle population over the last 50 years where it has varied from around 100K to close to 275K a variation of more than 100%.
- If we look at the population of sheep's and goats, we can observe an even more dramatic evolution, where there has been a very rapid growth in the population from 1985 onwards from around 100K in 1985 to more than 500K in 2015.
- Is this a sustainable evolution – what consequences might this have? Try to have a discussion of this as see where that goes

### **Slide 5** Dealing with the Tragedy of Commons

- Dealing with these issues is exactly why we have the conservancies working on management of grazing schemes etc.
- Theory tells the following strategies can be useful:  
A number of potential strategies to try to avoid the ToC
  - making the structure clear – explain etc – most likely not effective
  - Educate - both needs strong community spirit and some kind of enforcement, could

maybe be social norms

- Control – used in many cases e.g., regulating fishing, milk production in the EU until 2014
- Legislate – same as above – both need enforcement to work
- Closing the commons. Happens in fishing herrings in the North Sea or whales globally