

# COMPETING FOR SCARCE RESOURCES DURING HUMANITARIAN EMERGENCIES

## Supporting Materials

### Appendix A. System Dynamics Model Documentation

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.Beneficiaries

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Beneficiaries= INTEG (Migration from Neighbor Area - Beneficiaries Served, Initial Beneficiaries)  
~ People

Beneficiaries Previous Period= Beneficiaries + Beneficiaries Served This Period  
~ People

Beneficiaries Served= Min(Max Beneficiaries Served, Desired Beneficiaries Served)  
~ People/Month

Beneficiaries Served Previous Period= INTEG (This Period Outflow-Previous Period Outflow, 0)  
~ People

Beneficiaries Served This Period= INTEG (Inflow of Beneficiaries this Period-This Period Outflow, 0)  
~ People

Desired Beneficiaries Served= Relief Workers Allocated \* Relief Worker Effectiveness  
~ People/Month

Inflow of Beneficiaries this Period= Beneficiaries Served  
~ People/Month

Initial Beneficiaries= 20000  
~ People

Max Beneficiaries Served= Beneficiaries / Min Time to Serve  
~ People/Month

Migration from Neighbor Area= Migration Inflow  
~ People/Month

Migration Inflow= 500  
~ People/Month

Min Time to Serve= 1  
~ Month

Previous Period Outflow= Beneficiaries Served Previous Period / TIME STEP  
~ People/Month

This Period Outflow= Beneficiaries Served This Period / TIME STEP  
~ People/Month

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.Relief Workers

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Confirmed Fired= DELAY FIXED(Firing Decision, Time to Fire, Firing Decision)  
~ People/Month

Confirmed Hired= DELAY FIXED (Hiring Decision, Time to Hire , Hiring Decision)  
~ People/Month

Effect of Beneficiary Density on Effectiveness([(0,0)-(1,200)],(0,0),(1,150))  
~ 1/Month

Fired Leaving= Confirmed Fired  
~ People/Month

Hired Arriving= Confirmed Hired  
~ People/Month

Initial Relief Workers= 20  
~ People

Nominal Funding per Beneficiary= 15  
~ \$/People

Relief Worker Effectiveness= Effect of Beneficiary Density on Effectiveness (Beneficiaries / Initial Beneficiaries)  
~ 1/Month

Relief Workers= INTEG ( Hired Arriving-Fired Leaving, Initial Relief Workers)  
~ People

Relief Workers Allocated= Relief Workers \*Worker Allocation Decision  
~ People

Relief Workers Idle= Relief Workers - Relief Workers Allocated  
~ People

Time to Fire= 2  
~ Month

Time to Hire= 1  
~ Month

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.Decisions

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Firing Decision= GAME(0)  
~ People/Month

Hiring Decision= GAME(0)  
~ People/Month

Worker Allocation Decision= GAME(0)  
~ Dmnl

\*\*\*\*\*

.Financials

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Actual Funding per Beneficiary= Nominal Funding per Beneficiary - Funding Deduction from Suffering  
~ \$/People

Cash Position= INTEG ( Change in Cash, Initial Cash Position)  
~ \$

Change in Cash= Net Income  
~ \$/Month

Cost of Being Idle= Relief Workers Idle \* Unit Cost of Being Idle  
~ \$/Month

Cost of Firing= Firing Decision \* Unit Cost of Firing  
~ \$/Month

Cost of Hiring= Hiring Decision \* Unit Cost of Hiring  
~ \$/Month

Cost of Operation= Relief Workers Allocated \* Unit Cost of Operation  
~ \$/Month

Funding Deduction from Suffering= Relative Suffering \* Unit Deduction due to Suffering  
~ \$/People

Funding Received= Desired Beneficiaries Served \* Actual Funding per Beneficiary  
~ \$/Month

Initial Cash Position= 4000  
~ \$

Net Income= Funding Received - Total Operating Costs  
~ \$/Month

Total Operating Costs= Cost of Operation + Cost of Hiring + Cost of Firing + Cost of Being Idle  
~ \$/Month

Unit Cost of Being Idle= 250  
~ \$/(Month\*People)

Unit Cost of Firing= 500  
~ \$/People

Unit Cost of Hiring= 1000

~ \$/People

Unit Cost of Operation= 750

~ \$(Month\*People)

Unit Deduction due to Suffering= 1

~ \$/People/Suffering

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.Suffering

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Deprivation Level= Effect of Time on Deprivation Level (Time)

~ Suffering

Effect of Time on Deprivation Level(

[(0,0)-(10,10)],(0,2),(1,2.6),(2,4),(4,7),(6,9),(7.52294,9.82456),(10,10))

~ Suffering

Fraction Allocation to Meet Need= Relief Workers Allocated / Relief Workers

~ Dmnl

Fraction Beneficiaries in Need= Beneficiaries / Beneficiaries Previous Period

~ Dmnl

Relative Suffering= Suffering \* Weighted Need

~ Suffering

Suffering = Deprivation Level \* Fraction Beneficiaries in Need

~ Suffering

Weighted Need=MAX(0,(Fraction Beneficiaries in Need - Fraction Allocation to Meet Need)/Fraction Beneficiaries in Need)

~ Dmnl

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.Control

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Simulation Control Parameters

FINAL TIME = 10

~ Month

~ The final time for the simulation.

INITIAL TIME = 0

~ Month

~ The initial time for the simulation.

SAVEPER =

TIME STEP

~ Month [0,?]

~ The frequency with which output is stored.

TIME STEP = 1

~ Month [0,?]  
~ The time step for the simulation.

## Appendix B. Instructions for the Humanitarian Relief Game

### HUMANITARIAN RELIEF GAME

#### Instructions

#### 1. CONTEXT

Subjects in the “Humanitarian Relief” game play the role of a health NGO providing medical relief to beneficiaries after a devastating earthquake. The earthquake hitting Kaiho, a small developing country, affected two major regions: Lejeme city (Region 1), the epicenter and Prince-de-Paix (Region 2). Beneficiaries in both regions are in dire need of assistance. Health NGOs provide medical assistance by deploying their relief workers to each of the regions. Each period, NGOs decide in which region they will allocate their relief workers and if they would like to hire or fire them.

NGOs have an equal amount of resources (e.g., relief workers) and face the same operating costs. Humanitarian relief provided to beneficiaries allows NGOs to receive funds from donors. Funds can be used to cover the costs of humanitarian relief (e.g., operational costs) and can be used to hire or fire workers.

The game lasts 8 simulated periods. Once a beneficiary receives humanitarian relief, her needs are met and she is out of the system.

#### 2. GAME OBJECTIVE

NGOs must meet the following objective

- Maximize the number of beneficiaries served, while finishing the game with a positive cash position
- (Minimize the suffering of beneficiaries, while finishing the game with a positive cash position)

#### 3. GAME SETUP

At the beginning of the game, each participant takes up the role of one NGO. Each NGO begins with an equal amount of resources (e.g., money and relief workers). Due to higher initial beneficiary density in Lejeme city (Region 1), a humanitarian worker providing relief there is more effective than in Prince-de-Paix (Region 2). That is, humanitarian relief workers can support and assist more beneficiaries per period in Lejeme city (R1) than in Prince-de-Paix (R2). In addition, better infrastructure and logistics access ensures that operating costs are also lower in Lejeme city (R1) than in Prince-de-Paix (R2). At the start of the game, Lejeme city (R1) is more attractive than Prince-de-Paix (R2).

TABLE 1 – BASE PARAMETERS FOR HUMANITARIAN RELIEF GAME

<i>Variables</i>	<b>Lejeme city (R1)</b>	<b>Prince-de-Paix (R2)</b>
Beneficiaries (#)	12'000	8'000
Operating costs (\$/relief worker/period)	750	1000
Donations (\$/beneficiary)	15	15
Relief worker effectiveness (beneficiary/relief worker)	150	90
Inflow of beneficiaries/period	300	200

#### 4. SEQUENCE OF PLAY

The following steps of play capture the core mechanics of play in each round of play (each period or simulated week).

1. Beneficiaries from neighboring areas migrate to R1 and R2;
2. NGOs analyze incoming information (statistics);
3. NGOs allocate relief workers (among regions R1, R2, or idle);
4. NGOs hire or fire relief workers;
5. NGOs record and submits decisions; and
6. NGOs incur operational costs, receive funds and learn about end of period cash.

Each round of play (simulated period), NGOs must make two decisions: (i) the number of relief workers they will hire/fire, and (ii) where they will allocate their relief workers (among regions R1, R2, or idle).

## 5. INFORMATION

### 5.1. Beneficiaries in a Region

Beneficiaries receive humanitarian relief from health NGOs a single time. When this takes place, their needs are met and they leave (exit) the system. In each simulated period, beneficiaries ( $B$ ) from neighborhood areas migrate to the two regions (R1 and R2) to have access to humanitarian relief provided by health NGOs. Hence, the number of beneficiaries of a region at time ( $t+1$ ) is given by the number of beneficiaries in that region ( $i$ ) at a previous period ( $t$ ) minus the outflow of beneficiaries served ( $O$ ) plus the inflow of beneficiaries ( $I$ ) migrating from a nearby area.

$$B_{i,t+1} = B_{i,t} - O_t + I_t$$

### 5.2. Funding

NGOs receive funding based on how many beneficiaries they attend and what is the level of suffering. On default, NGOs will receive \$15 for each attended beneficiary; this does not change if they are in R1 or R2. But, depending on the suffering of the beneficiaries, this value can be reduced.

### 5.3. Hiring and firing

To hire or fire relief workers the NGO must pay an amount per worker – Table 2. The effectiveness of the workers depends on the process. The hiring process is fast: workers hired in period ( $t$ ) will be available in period ( $t+1$ ). The firing process is slow: workers fired in period ( $t$ ) will still be available during periods ( $t$ ) and ( $t+1$ ) incurring the normal costs; the effect of the firing decision will occur in ( $t+2$ ).

**TABLE 2 – BASE PARAMETERS FOR HUMANITARIAN RELIEF GAME**

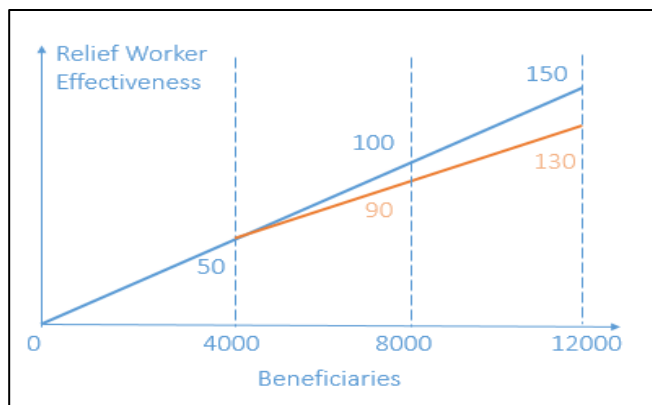
<i>Decisions</i>	<i>Cost (\$/worker)</i>	<i>Effectiveness</i>
Hiring	1'000	after 1 period
Firing	500	after 2 periods

### 5.4. Idle workers

Idle workers are those that are not allocated to Regions 1 or 2. They continue to be part of the NGO, but attend no beneficiaries. The cost of an idle worker is of \$250 per worker per period.

### 5.5. Relief worker effectiveness

As the number of beneficiaries in a region changes, so does beneficiary density, and the effectiveness of relief provided by a humanitarian worker. Figure 1 below captures the relationship of number of beneficiaries in a region and relief worker effectiveness.



**FIGURE 1 – EFFECTIVENESS OF RELIEF WORKERS ACCORDING TO REGIONS**

5.6. **Deprivation**

The level of deprivation of beneficiaries increases as time passes by; it ranges from 0 to 10. The longer a beneficiary endures without assistance, the bigger the level of deprivation. Migrants of the neighborhood entering Regions 1 and 2 have already suffered hardships on the outside; thus, their contribution to the level of deprivation is equal to the contribution of the beneficiaries in the system at that point in time.

5.7. **Beneficiaries Suffering**

The beneficiaries suffering depends on how much deprivation could be avoided in a region considering available workers.



# Appendix C. Microsoft Excel Setup for the Humanitarian Relief Game

## Participant view

1 [https://usi.eu.qualtrics.com/jfe/form/SV\\_22VF1YTF5N7JSZv](https://usi.eu.qualtrics.com/jfe/form/SV_22VF1YTF5N7JSZv)

2 **NGO Overview** Password: business dynamics

Periods		1	2	3	4	5	6	7	8
<b>Staff</b>	Total Available	4	5	7	9	9	9	9	9
	<b>Staff allocation</b>								
	R1	4	5	7	9	5	3	4	2
	R2	0	0	0	0	4	6	5	0
	Idle	0	0	0	0	0	0	0	7
	Total Allocated	4	5	7	9	9	9	9	2
<b>Staff hiring/firing</b>	Hiring	1	2	2	0	0	0	0	0
	Firing	0	0	0	0	0	0	2	0
	Data Validation	True	True	True	True	True	True	True	True

Information		1	2	3	4	5	6	7	8
<b>Beneficiary population</b>	R1	12 000	10 050	8089	6468	4504	3453	2760	2336
	R2	8 000	7 840	7510	6659	6273	4727	3553	2751
	Total	20 000	17 890	15598	13326	10777	8180	6313	5087
<b>Beneficiaries supported</b>	R1	600	628	708	728	281	129	138	58
	R2	0	0	0	0	291	344	228	0
	Total	600	628	708	728	572	473	366	58
<b>Beneficiaries Remaining</b>	R1	9 750	7 789	7 381	4 204	3 153	2 460	2 036	1 810
	R2	7 640	7 310	7 510	6 073	4 527	3 353	2 551	2 414
	Total	17 390	15 098	14 891	10 277	7 680	5 813	4 587	4 224
<b>Suffering</b>	R1	2.7	3.6	5.5	4.8	6.1	7.1	8.3	9.8
	R2	3.2	4.3	6.0	6.5	6.2	7.1	8.1	11.1

Costs		1	2	3	4	5	6	7	8
<b>Cost of Operation in R1</b>		3000	3750	5250	6750	3750	2250	3000	1500
<b>Cost of Operation in R2</b>		0	0	0	0	4000	6000	5000	0
<b>Cost of Staff Being Idle</b>		0	0	0	0	0	0	0	1750
<b>Hiring Cost</b>		1000	2000	2000	0	0	0	0	0
<b>Firing Cost</b>		0	0	0	0	0	0	1000	0
<b>Total Operation Cost</b>		4000	5750	7250	6750	7750	8250	9000	3250
<b>Funding</b>									
	Funds Received	7 092	6 693	6 377	6 198	7 741	6 389	5 447	-67
<b>Net Income</b>		3 092	943	-873	-552	-9	-1 861	-3 553	-3 317
<b>Starting Cash</b>		4000	7 092	8 035	7 642	7 090	7 082	5 221	1 668
<b>Ending Cash</b>		7 092	8 035	7 162	7 090	7 082	5 221	1 668	-1 649

Information about Operation Cost		Information about Funding
<b>Cost of Operation in R1</b>	750	Donations(\$/Ber 12
<b>Cost of Operation in R2</b>	1000	
<b>Idle</b>	250	Deductions from Suffering
<b>Hiring Cost</b>	1 000	
<b>Firing Cost</b>	500	

## Aggregate view

1

2 **Aggregate Period 8** Time = 8

NGO Decisions		NGO1	NGO2	NGO3	NGO4	NGO5	Total
<b>Staff</b>	Total Available	9	4	6	4	18	41
	<b>Staff allocation</b>						
	R1	2	3	1	3	9	18
	R2	0	1	1	0	7	9
	Idle	7	0	4	1	2	14
	Total Allocated	2	4	2	3	16	27
<b>Staff hiring/firing</b>	Hiring	0	0	0	0	0	0
	Firing	0	0	0	0	0	0
	Data Validation	True	True	True	True	True	True

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
13																
14	<b>Information</b>		<i>NGD1</i>	<i>NGD2</i>	<i>NGD3</i>	<i>NGD4</i>	<i>NGD5</i>	<i>Total</i>		<b>Effectiveness</b>	<i>NGD1</i>	<i>NGD2</i>	<i>NGD3</i>	<i>NGD4</i>	<i>NGD5</i>	
15	<b>Beneficiary population</b>	R1	2 336	2 336	2 336	2 336	2 336			R1	29	29	29	29	29	
16		R2	2 751	2 751	2 751	2 751	2 751			R2	38	38	38	38	38	
17		Total	5 087	5 087	5 087	5 087	5 087									
18	<b>Beneficiaries supported</b>	R1	58	88	29	88	263	526		<b>Deprivation</b>	<i>NGD1</i>	<i>NGD2</i>	<i>NGD3</i>	<i>NGD4</i>	<i>NGD5</i>	
19		R2	0	38	38	0	263	338		R1	12,6	12,6	12,6	12,6	12,6	
20		Total	58	125	67	88	525	863		R2	12,6	12,6	12,6	12,6	12,6	
21	<b>Beneficiaries Remaining</b>	R1	1810	1810	1810	1810	1810			<b>Fractional Need</b>	<i>NGD1</i>	<i>NGD2</i>	<i>NGD3</i>	<i>NGD4</i>	<i>NGD5</i>	
22		R2	2 414	2 414	2 414	2 414	2 414			R1	0,5	0,5	0,5	0,5	0,5	
23		Total	4 224	4 224	4 224	4 224	4 224			R2	0,5	0,5	0,5	0,5	0,5	
24																
25	<b>Suffering</b>	R1	9,8	9,8	9,8	9,8	9,8			<b>Fractional Allocat</b>	<i>NGD1</i>	<i>NGD2</i>	<i>NGD3</i>	<i>NGD4</i>	<i>NGD5</i>	
26		R2	11,1	11,1	11,1	11,1	11,1			R1	0,2	0,8	0,2	0,8	0,5	
27										R2	0,0	0,3	0,2	0,0	0,4	
28																
29	<b>Costs</b>		<i>NGD1</i>	<i>NGD2</i>	<i>NGD3</i>	<i>NGD4</i>	<i>NGD5</i>			<b>Weighted Need</b>	<i>NGD1</i>	<i>NGD2</i>	<i>NGD3</i>	<i>NGD4</i>	<i>NGD5</i>	
30	<b>Cost of Operation in R1</b>		1500	2250	750	2250	6750			R1	52%	0%	64%	0%	0%	
31	<b>Cost of Operation in R2</b>		0	1000	1000	0	7000			R2	100%	54%	69%	100%	28%	
32	<b>Cost of Staff Being Idle</b>		1750	0	1000	250	500									
33	<b>Hiring Cost</b>		0	0	0	0	0			<b>Relative Suffering</b>	<i>NGD1</i>	<i>NGD2</i>	<i>NGD3</i>	<i>NGD4</i>	<i>NGD5</i>	
34	<b>Firing Cost</b>		0	0	0	0	0			R1	5,1	-	6,2	-	-	
35	<b>Total Operation Cost</b>		3250	3250	2750	2500	14250			R2	11,1	6,0	7,7	11,1	3,1	
36																
37	<b>Funding</b>		<i>NGD1</i>	<i>NGD2</i>	<i>NGD3</i>	<i>NGD4</i>	<i>NGD5</i>									
38	<b>Funds Received</b>		-67	1 130	73	343	6 243									
39																
40	<b>Net Income</b>		-3 317	-2 120	-2 677	-2 157	-8 007									
41	<b>Starting Cash</b>		1 668	4 551	2 821	6 880	-9 695									
42	<b>Ending Cash</b>		-1 649	2 432	143	4 723	-17 702									
43																

**Appendix D. Humanitarian Relief Game Exit Questionnaire**

- 1) Please insert your name
- 2) What was your group?
  - 1
  - 2
  - 3
  - 4
- 3) What was the objective you were trying to achieve?
  - Maximize NGOs funds
  - Minimize the suffering
  - Maximize quantity of assisted people
  - Maximize NGOs efficiency
- 4) How did you decide how many people to hire/fire?
- 5) How did you decide where to allocate people?
- 6) Did you change your strategy during the game?
  - Yes
  - No
- 7) Does the visualization of the territory influence your decisions? If yes, how?
- 8) Considering the humanitarian relief effort, how do you rank the following factors in the game? (1 - most challenging; 5 - least challenging)
  - conflict of interests
  - limited information sharing
  - tradeoffs in allocating resources
  - competition for scarce resources
  - interaction among different actors
- 9) Do you see any of the factors as equal/similar? If yes, which ones?
- 10) This factor was very challenging.

Factors	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
conflict of interests					
limited information sharing					
tradeoffs in allocating resources					
competition for scarce resources					
interaction among different actors					

- 11) According to your assessment, did the environment lead to competition between NGOs?
- 12) According to your assessment, did the environment lead to coordination between NGOs?
- 13) Did you feel that the environment contributed more to competition or to coordination?
  - Competition
  - Coordination
- 14) Explain your reasoning for the last answer.
- 15) What do you think would enhance competition?
- 16) What do you think would enhance coordination?
- 17) Did you feel you needed more information to make the decisions? If yes, how would it be useful?
- 18) Did you learn something by playing the game? What?
- 19) Would you play the game again? Why?
- 20) Did you peek at your neighbor's data or decisions? (no points will be deducted for sincerity!)
  - a. Yes, every round
  - b. Yes, a few times
  - c. No, we weren't allowed
- 21) If you did peek, what information did you look for?
- 22) Are the excel sheets easy to handle/understand? What could be further developed?
- 23) What would you change to improve the game? What would this achieve?