

LUNA (SIMULATING THE DEMAND FOR LONG-DISTANCE TRAVEL USING A NON-OD-MATRIX BASED APPROACH) - GUIDEBOOK

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1 INTRODUCTION

The aim of this Guidebook is to explain the use of the published version of the System Dynamics model LUNA (Simulating the demand for Long-distance travel Using a Non-OD-matrix based <u>Approach</u>) which was developed in the framework of the project ORIGAMI. Details about the rationale and the mathematical details can be found in Deliverable 3.1 of ORIGAMI (Lemmerer and Pfaffenbichler, 2012). LUNA results for the ORIGAMI 2050 scenario can be found in Deliverable 7.1 (Bielefeldt et al., 2013). Deliverable 3.1 and 7.1 are or will be made available from the ORIGAMI webpage (http://www.origami-project.eu/deliverables/).



2 INSTALLATION OF LUNA

2.1 SOFTWARE REQUIREMENTS

The model LUNA was written using the System Dynamics software Vensim(r) (<u>www.vensim.com</u>). The model was converted into the file format "vpm" which stands for Vensim Packaged Model. This type of models can be run with the software "Vensim Model Reader" which can be downloaded from the Vensim(r) homepage for free (<u>http://vensim.com/vensim-model-reader/</u>). In order to be able to run LUNA the user has to install the "Vensim Model Reader". The explanations and screenshots in the following sections are based on version 6.0a-1 of the "Vensim Model Reader".

Base year input and scenario definition data are stored in Microsoft Excel(r).

2.2 LUNA FILES

To install LUNA the user has to unpack all files from the file "LUNA_V30.zip" into one directory. The name and location of the directory can be selected freely. Nevertheless the internal order of the unpacked files and directory has to be kept as it is.

The file "LUNA_V30.vpm" is the core model. The directory "data" contains eight xls-files. One of this files ("origami_data.xls") contains the base year input data. The other seven files provide scenario definition data. The details concerning scenario definition are explained in more detail below. The directory "guidebook" contains this Guidebook.



3 RUN LUNA

3.1 VENSIM(R) MODEL

3.1.1 Main user interface

The first step is to open the file "LUNA_V30.vpm" using the Vensim(r) Model Reader software. For the sake of readability complex Vensim(r) models can be organised in different views containing sub-models. Figure 3-1 shows "Navigation" view of LUNA which is the main user interface. Different coloured push buttons navigate the user to different sub-systems of the model. Yellow indicates socio-demographic and economic sub-models, blue indicates transport related sub-models and green the calculation of output indicators. Pushing e.g. the button "Population >" leads the user to the population cohort-model (Figure 3-2).



Figure 3-1 View user interface LUNA

3.1.2 Analysing the model structure

The push buttons in the lower left corner allow the user to navigate to the next view, the previous view or back to the main navigation view. Elements written in red colour indicate base year input data which are read in from the data file "origami_data.xls". Elements written in blue colour indicate time series scenario definition data which are read in from the file "origami_scenario.xls". Elements written in green colour indicate constants which are defined directly in Vensim(r). Elements written in black



colour are model internal variables. The tools in the upper left corner can be used to analyse the model structure and the model output¹ (Figure 3-3).



Figure 3-2 View of the population cohort-model

¹ A comprehensive description of the Vensim® Model Reader can be found at <u>http://www.vensim.com/documentation/index.html</u>.





Figure 3-3 Tools to analyse model structure and output

The most important tools to investigate and analyse the LUNA model structure are summarised in Table 3-1. Figure 3-4 shows the causes tree for the variable population by age cohort. The tools in the upper left corner allow the user to print, copy to the clip board or save the result. Figure 3-5 shows the uses tree for the variable population by age cohort. Figure 3-6 shows the equations underlying the variable population by age cohort. As the user is able to investigate all relationships of the model in a qualitative and quantitative way LUNA qualifies as a white box model.

Symbol	Name	Explanation
A B Causes Tree	Causes tree	Shows which variables are influencing a selected variable. The depth of the causes tree is two levels backwards.
	Uses tree	Shows which variables are influenced by a selected variable. The depth of the causes tree is two levels forward.
Jocumen	Document	Shows the equation behind a selected variable.

Table 3-1 Summar	y tools to investi	gate and analyse	the model structure





Figure 3-4 Causes tree population by age cohort k





Figure 3-5 Uses tree variable population by age cohort k



😑 🗗 🖀 📋 📴 Document 🗖	x
Population k[g,k0004,r]= INTEG (
live births[g,r]-deaths k[g,k0004,r]-ageing k[g,k0004,r]+net migration k[g	
,k0004,r],	
"Population gender k T=0"[g,k0004,r])	
Population $k[g,k0584,r] = INTEG$ (
ageing k[g,prev cohort0584,r]-deaths k[g,k0584,r]-ageing k[g,k0584,r]+net migration k	
[g,k0584,r],	
"Population gender k T=0"[g,k0584,r])	
Population $k[g,k85plus,r] = INTEG$ (
ageing k[g,k8084,r]-deaths k[g,k85plus,r]+net migration k[g,k85plus,r],	
"Population gender k T=0"[g,k85plus,r])	
Units: Dmnl	



3.1.3 Analysing the model output

The model output and the value of every element, variable or constant can be shown the Graph or Table tool (Table 3-2). Figure 3-7 shows the graph of the variable share of trips by mode. Figure 3-8 shows the table of the variable share of trips by mode. Again the tools in the upper left corner allow the user to print, copy to the clip board or save the results.

Symbol	Name	Explanation
Graph	Graph	Shows the value of a selected variable in each iteration in form of a diagram.
Table	Table	Shows the value of a selected variable in each iteration in form of a table.

Table 3-2 Summary	tools to investig	ate and analyse	the model output
-------------------	-------------------	-----------------	------------------





Figure 3-7 Graph modal share trips

Time (Year)	0	1	2	3	4	5
"share trips by mode[mode]" Runs:	baseline					
share trips by mode						
[car]	0.552489	0.549178	0.549696	0.550345	0.549875	0.549231
[coach]	0.083029	0.083229	0.0827898	0.0823176	0.0820689	0.0818521
[rail]	0.0964784	0.0968765	0.0966396	0.0963369	0.0962857	0.096259
[air]	0.25056	0.253151	0.253368	0.253522	0.254302	0.255187
[maritime]	0.0174439	0.0175655	0.0175068	0.0174788	0.0174688	0.0174708
•						

Figure 3-8 Table modal share trips

The Control Panel (Figure 3-9) can be used to change the start and end time of simulation (Figure 3-10) and load/unload data from previously calculated scenarios (Figure 3-11).

🔊 Ver	isim:LU	INA_V3	0.mdl Var:	share trips by mode[mode]							
Ele E	idit ⊻ie	w Lay	out Model	Options Windows H	jelp							\frown
New Model	Open Model	Save	Print	Сору	Sim	Simulation results file name baseline	Browse	Simulate lynthesi	n Gama	Reality Checks	Build Output	Control Jubscript
A Causes Tree					Basic va	ariables and indicators		Netwo	ork usage pa	ssenger-	km	

Figure 3-9 Control Panel and Subscript Control



Control Panel	l
Variable Time Axis Scaling Datasets Graphs	þ
Time Base Time Reset to Full Range	l
	l
Start <> Special <> End <>	l
Time 0 Time 40	h
	l
	l

Figure 3-10 Defining the start and end time of a simulation

Control Panel	
Variable Time Axis Scaling Datasets	Graphs
Available - Info	Loaded - Info
test	baseline
	<u>>></u>
	<<
Delete	Load From
Keep on top	

Figure 3-11 Loading/unloading of datasets

The Subscript Control (Figure 3-9) allows to define a selection from the range of available subscripts, e.g. to view only the values for the countries Belgium, Lithuania, Luxembourg and Romania from the list of the EU27 countries plus Switzerland and Norway (Figure 3-12).



Subscript Control	
age group 3/3 d 5/5 g 2/2 hh ty mode 5/5 para 3/3 purpose 1/	pe 10/10 [income 1/3 [k 18/18 kr 18/18] 2
Subranges (edit)	Selected Elements
	Belgium
None	Lithuania
	Luxembourg
J	Romania
Available Elements	
Belgium	
Bulgaria	>>
Czech Republic	
Denmark	<<
Germany	
Estonia	
Graad	
Spain	
France	
Italu	
Coprus	
Latvia	
Lithuania	
Luxembourg	
Hungary	
Malta	
Netherlands	
Austria	
Poland	
Bomania	
Slovenia	
Slovakia	
Finland	
Sweden	
United Kingdom	
Norway	
Switzerland	Liear Selected Simple
Keep on top Edit New Skip	undefined Close

Figure 3-12 Subscript Control – countries

3.1.4 Run a simulation

Pushing the "Sim Setup" button (Figure 3-13) opens the data files "origami_data.xls" and "origami_scenario.xls" and allows the user to define a run name. Pushing the "Simulate" button (Figure 3-14) starts a simulation.

Vensim:LUNA_V30.mdl Var.share	trips by mode[mode]			
Eile Edit View Layout Model Opt	ions <u>W</u> indows <u>H</u> elp	\frown		
New Open Model Model Save Print	Copy Setup	Simulation results file name baseline	Browse Simulate jotheSir Game	Reality Checks Windows Windows Ranel
A B Causes Tree	Basic v	ariables and indicators	Network usage pa	issenger-km

Figure 3-13 Set up a simulation





Figure 3-14 Run a simulation

3.2 **DEFINE SCENARIOS**

To create the baseline has to simply push the "Simulate" button. In order to define other different scenarios the user has to change from the Vensim(r) model to the Microsoft Excel file "origami_scenario.xls". The view "ScenarioOverview" contains push buttons for the selection of predefined scenarios for the different sub-systems of LUNA (Figure 3-15). If the button is pushed then the user can select from a list of different scenarios (Figure 3-16). If a scenario is selected then the corresponding date are copied from the set of scenario definition files². When the selection of sub-scenarios is finished then user has to change back to the Vensim(r) model, define a name for the scenario and push the "Start a Simulation" button. The definition of the loaded scenarios is shown in form of a bar chart in Vensim(r) (Figure 3-17). The coding of the different sub-scenarios is shown in Table 3-3.

1	Α	В	С	D	E	F	G	Н	1	J	
1		Casia damana	a har and a second				Terroret				-
2		Socio-demogra	ipny and ecol	nomy			Transport				ł
4		Topic	Scenario		Nr.		Topic	Scenario		Nr.	t
5		1.0									Ť
6		Fertility	Base	Load scenario	1		Propulsion Technology	Base	Load scenario	1	
7					ji (
8		Life expectancy	Base	Load scenario	1		Transport policy	Base	Load scenario	1	
9					4						
10		Migration	Base	Load scenario	1						
11					8 <u>.</u>						
12		Employment	Base		1						
13					1						
14		GDP	Base	Load scenario	1						
15											

Figure 3-15 User interface sub-system scenarios for LUNA

² "origami_scenarios_fertility.xls", "origami_scenarios_gdp.xls", "origami_scenarios_life_expectance.xls", "origami_scenarios_migration.xls", "origami_scenarios_technology.xls" and "origami_scenarios_transport.xls"



			Jx							
	Α	В	С	D	E	F	G	Н		J
1										
2		Socio-demogra	phy and econo	my			Transport			
3										
4		Topic	Scenario		Nr.		Topic	Scenario		Nr.
5										
6		Fertility	Base	Load scenario	1		Propulsion Technology	Base	Load scenario	1
7										
8		Life expectancy	Base	Load scenario	1		Transport policy	Base	Load scenario	1
9						Fertility rat	tes	X		
10		Migration	Base	Load scenario	1	Base				
11						Low	O	<		
12		Employment	Base		1	nign				
13										
14		GDP	Base	Load scenario	1					
15										

Figure 3-16 E	Drop down	menu sub-	system fertility
---------------	-----------	-----------	------------------

Table 3-3 Scenario coding

Sub-model	Scenario	Number
Fertility	Base	1
-	Low	2
	High	3
Life expectancy	Base	1
	Low	2
	High	3
Migration	Base	1
	Center	2
Employment	Base	1
GDP	Base	1
	Concentrate	2
	Disperse	3
	UniHigh	4
	UniLow	5
Propulsion Technology	Base	1
	Normative	2
	LowEmission	3
Transport Policy	Base	1
	Normative	2
	RegHighInfra	3
	RegLowInfra	4
	LibLowInfra	5
	LibHighInfra	6





Figure 3-17 Display of the loaded scenario definitions



4 **REFERENCES**

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