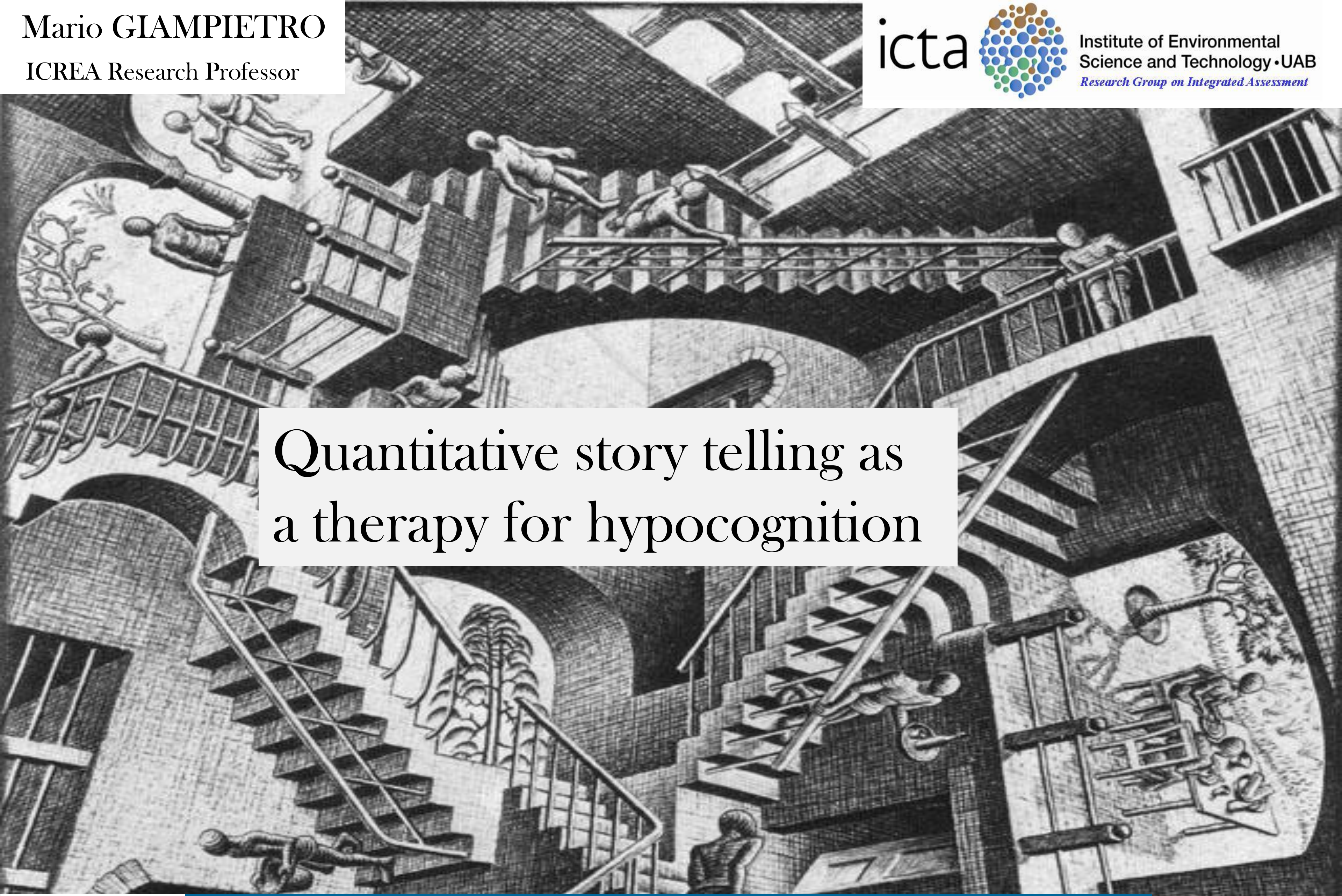
Mario GIAMPIETRO
ICREA Research Professor

icta Institute of Environmental Science and Technology • UAB
Research Group on Integrated Assessment

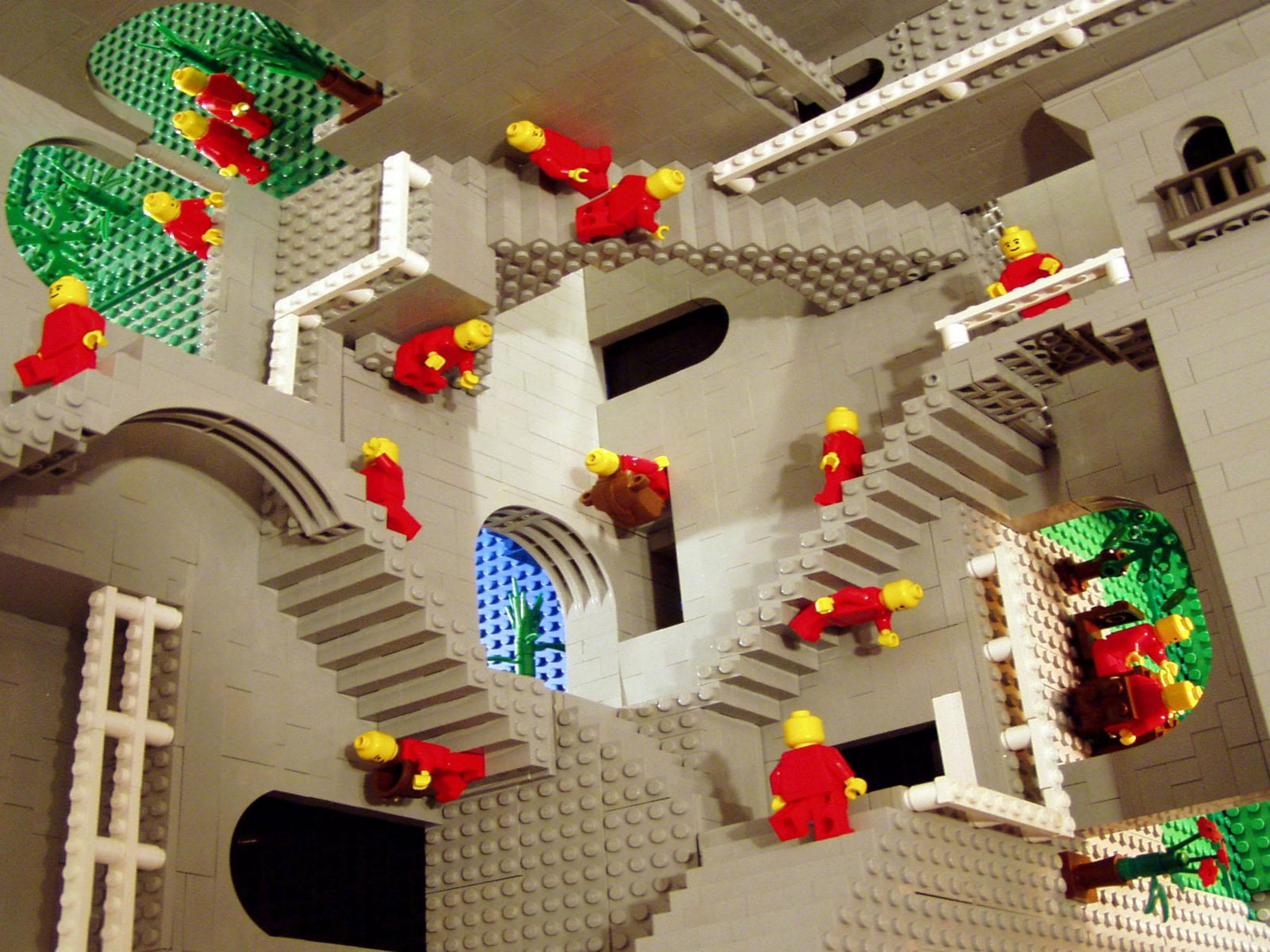


Quantitative story telling as a therapy for hypocognition

European Commission

Significant Digits
Responsible use of quantitative information
JRC - Econometrics and Applied Statistics Unit - IPSC

June 9th and 10th
FONDATION UNIVERSITAIRE
Rue d'Egmont, 11 BRUSSELS



1. Measuring requires knowing the external referent: “happy counting” in sustainability science

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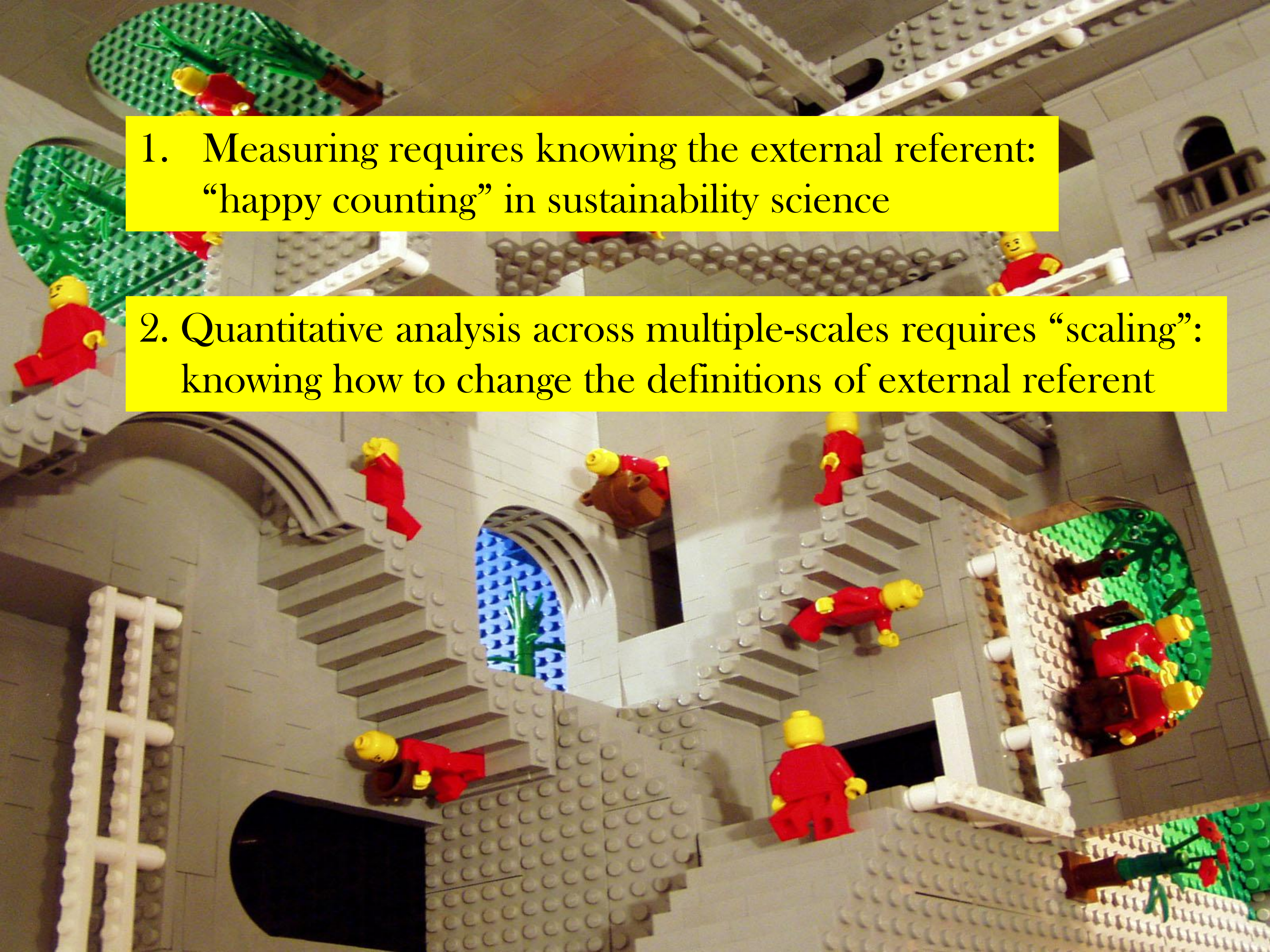
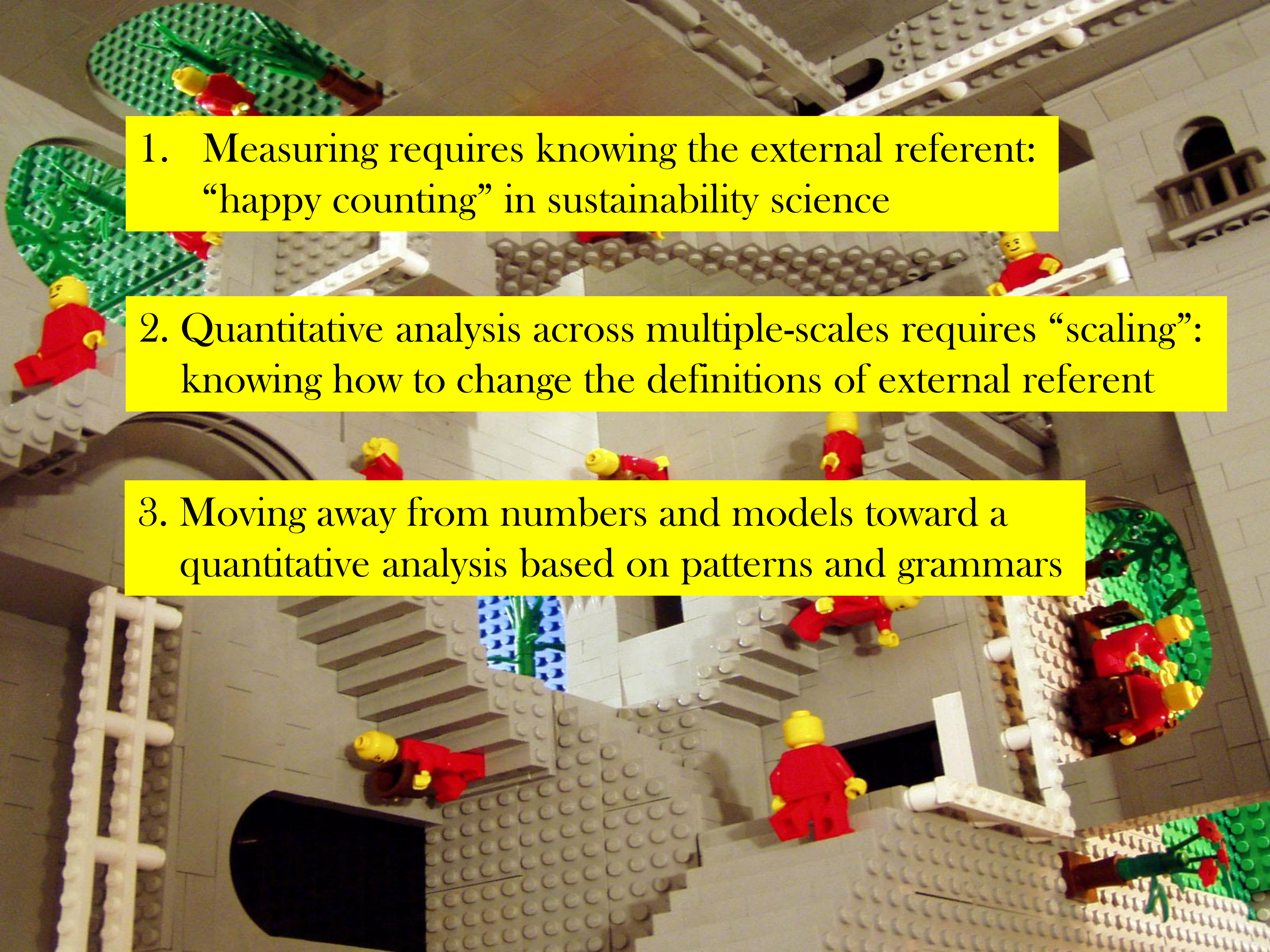
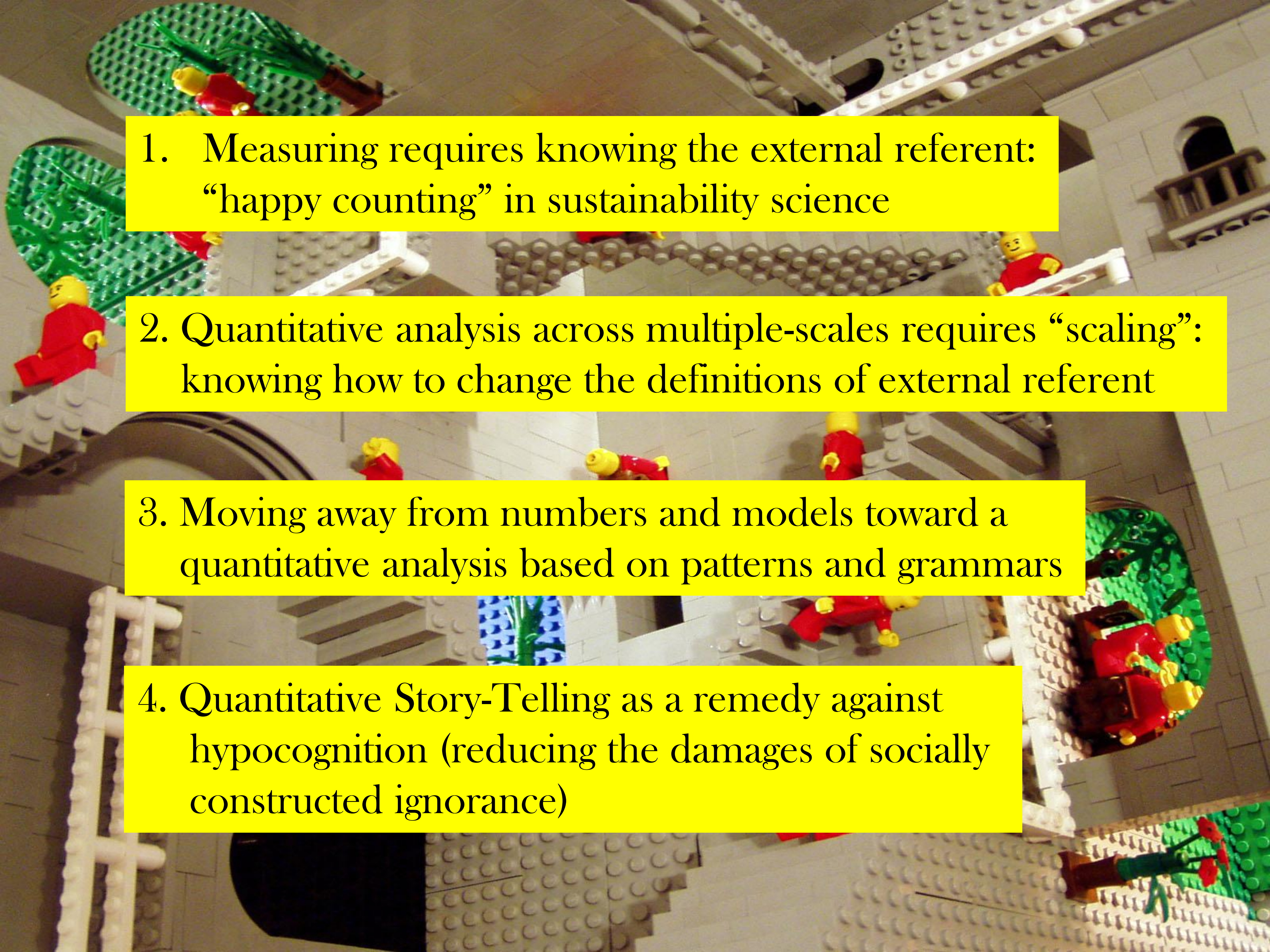
2. Quantitative analysis across multiple-scales requires "scaling": knowing how to change the definitions of external referent





1. Measuring requires knowing the external referent: "happy counting" in sustainability science
2. Quantitative analysis across multiple-scales requires "scaling": knowing how to change the definitions of external referent
3. Moving away from numbers and models toward a quantitative analysis based on patterns and grammars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2. Quantitative analysis across multiple-scales requires "scaling": knowing how to change the definitions of external referent
3. Moving away from numbers and models toward a quantitative analysis based on patterns and grammars
4. Quantitative Story-Telling as a remedy against hypocognition (reducing the damages of socially constructed ignorance)

1. Measuring requires knowing the external referent: “happy counting” in sustainability science

You cannot handle numbers if you are not able first to give a proper meaning to them

١٦٥ +

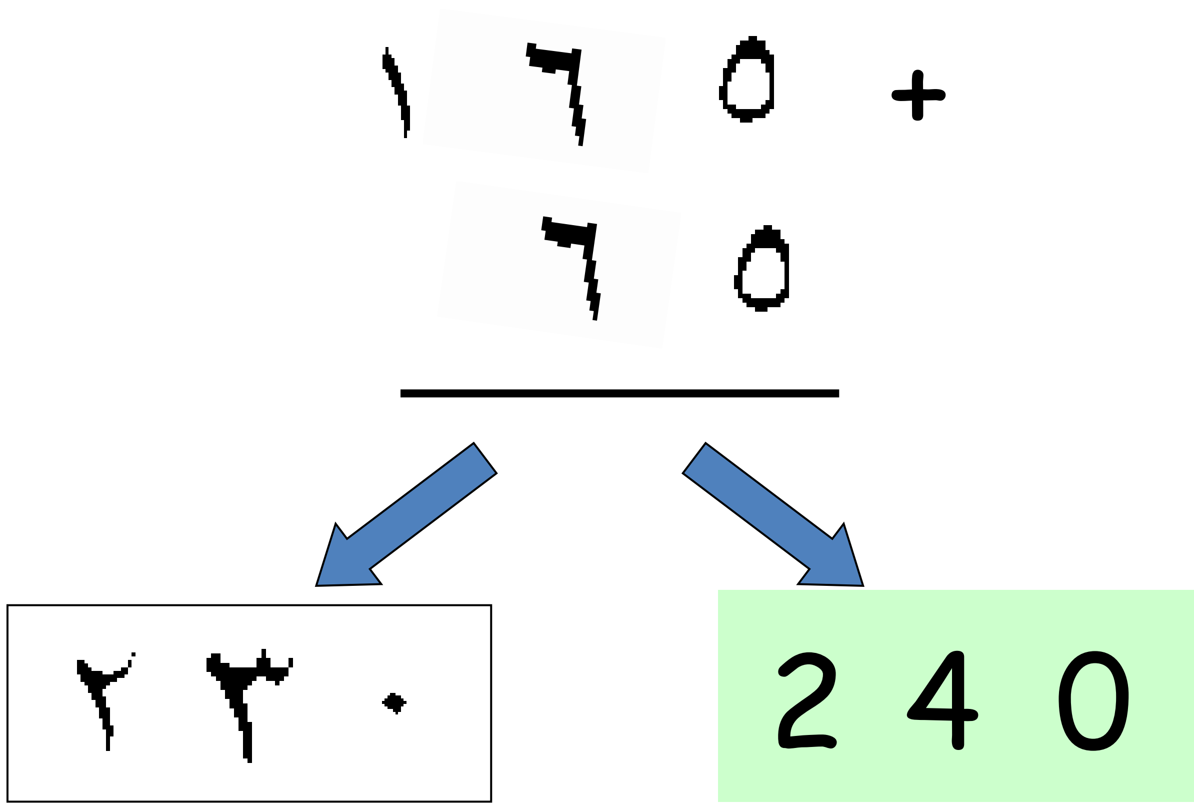
٦٥

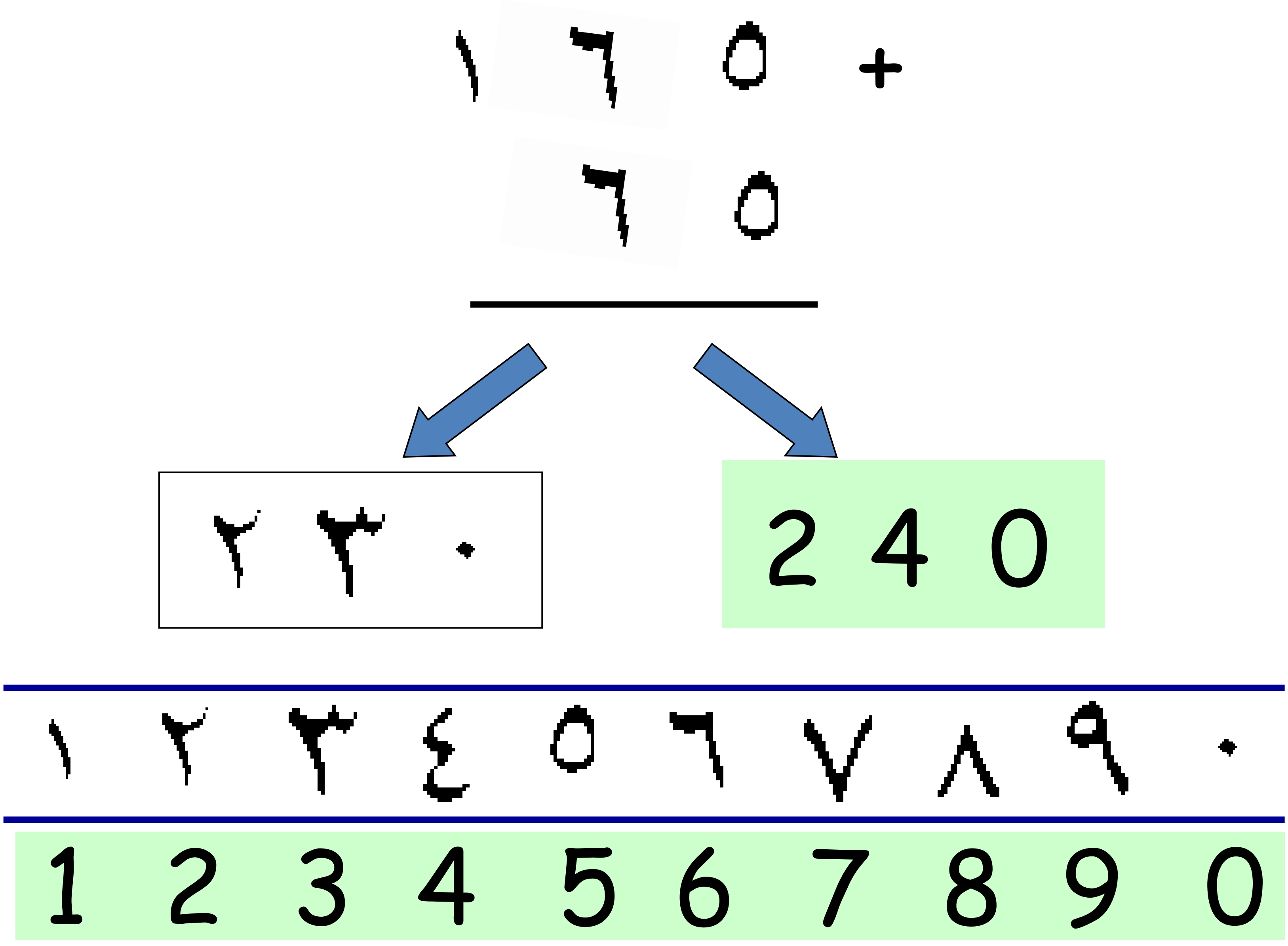
____

١٦٥ +

٦٥

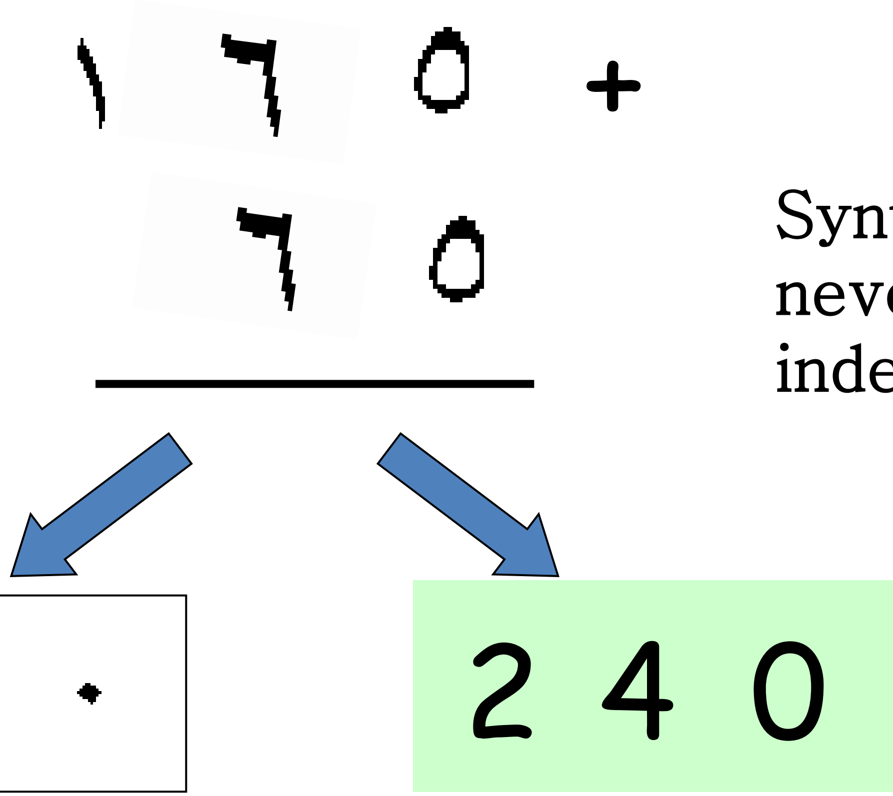
240


١٦٥ +
٦٥
٢٣٠
240



١٦٥ +
٦٥
٢٣٠
240
١ ٢ ٣ ٤ ٥ ٦ ٧ ٨ ٩ ٠
1 2 3 4 5 6 7 8 9 0

Fragility of formal entailment



Syntax is never context independent

١	٢	٣	٤	٥	٦	٧	٨	٩	٠
1	2	3	4	5	6	7	8	9	0

"The proposition [1 + 1 = 2] is occasionally useful"
A.N. Whitehead and B. Russel - in Principia Mathematica

You cannot handle numbers if you are not able first to specify the relation between variable ←→ inferential system

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Recording the changes occurring to the population of a city after a wedding of two "single*s*"

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Recording the changes occurring to the population of a city after a wedding of two "single*s*"

Using the variable "number of households"

$$1 + 1 = 1$$

You cannot handle numbers if you are not able first to specify the relation between data ←→ measurement scheme

It is not sure that it is always possible to perform the sum $A + B = C$

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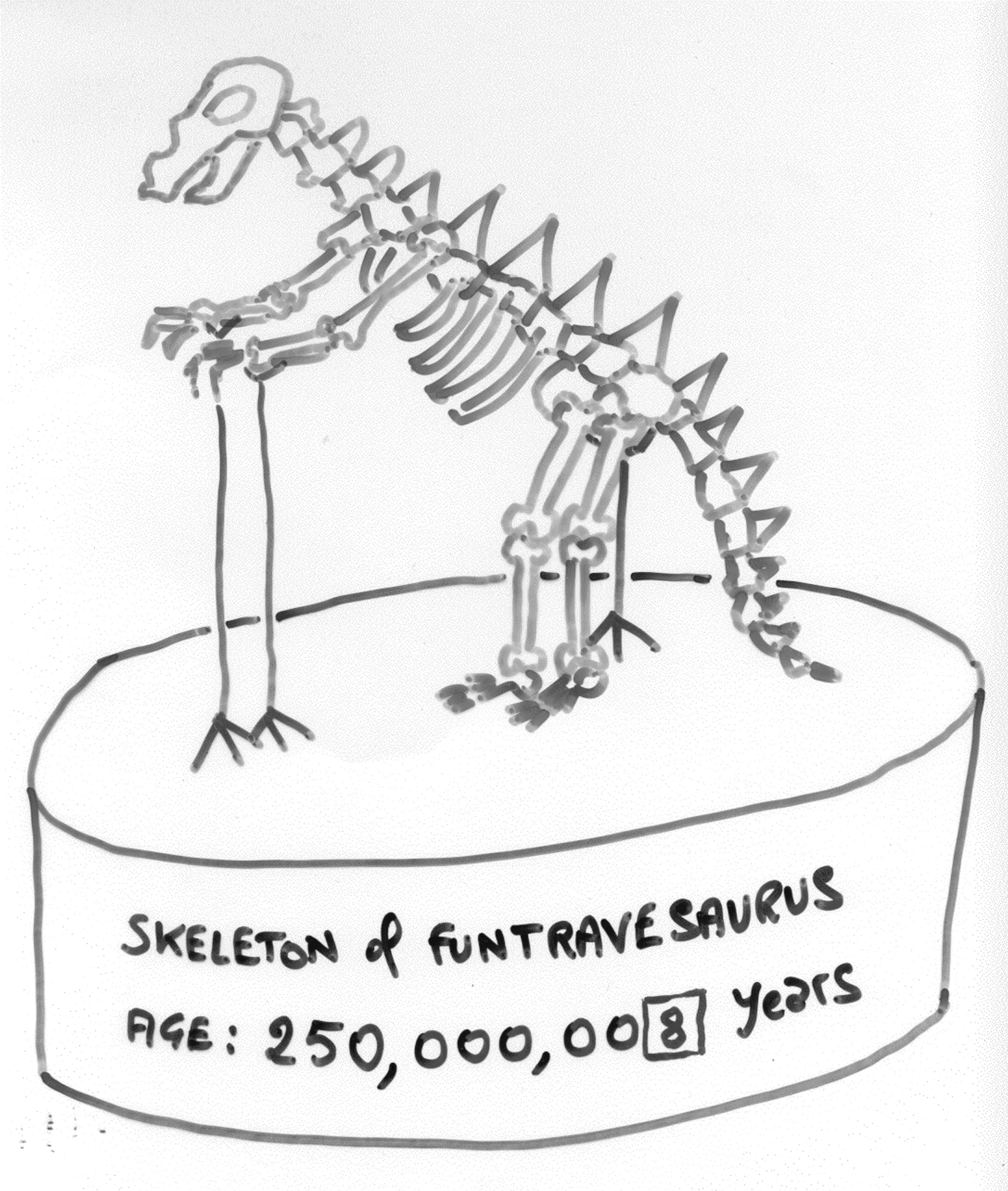


It is not sure that it is always possible to perform the sum A + B = C

Examples of MISLEADING INDICATORS (1)

"The excessive food consumption of the rich"

The standard narrative used to introduce the issue of world injustice in relation to food supply

PNAS Vol. 96, Issue 11, 5908-5914, May 25, 1999 :

World food and agriculture: Outlook for the medium and longer term

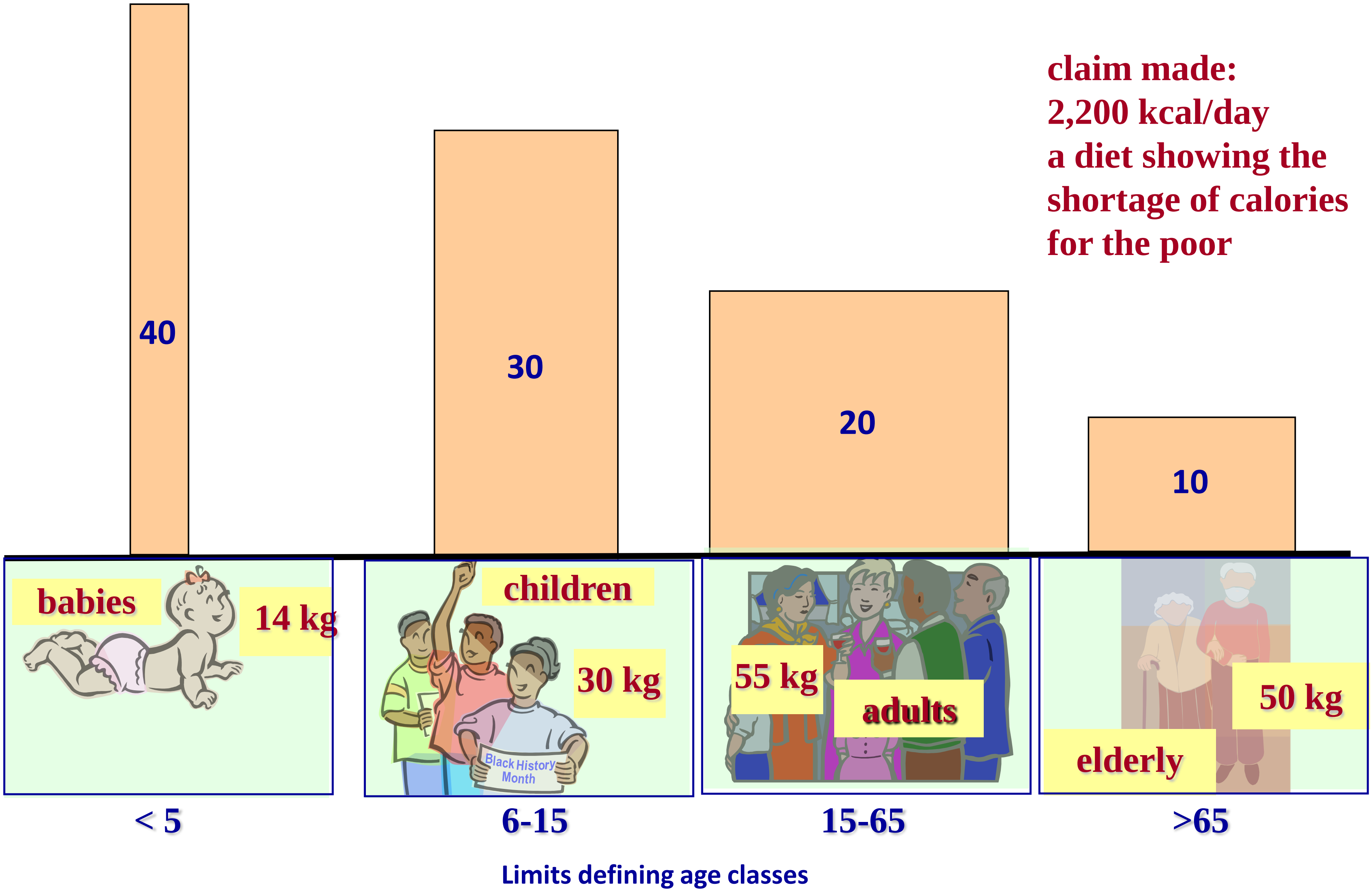
Nikos Alexandratos
Head Global Perspective Studies Unit, Food and Agriculture Organization

*** the part of world population living in countries where per person food supplies are still very low - under 2,200 kcal/day**

*** the very high levels of food availability generally found in the statistics of many high-income countries, often over 3,500 kcal/person/day**

100 people = (40 x 15) + (30 x 30) + (20 x 55) + (10 x 50) = 3,100 kg

claim made:
2,200 kcal/day
a diet showing the shortage of calories for the poor



100 people = (40 x 15) + (30 x 30) + (20 x 55) + (10 x 50) = 3,100 kg

Average weight of 1 person = 31 kg 2,200 kcal/day = 71 kcal/kg/day

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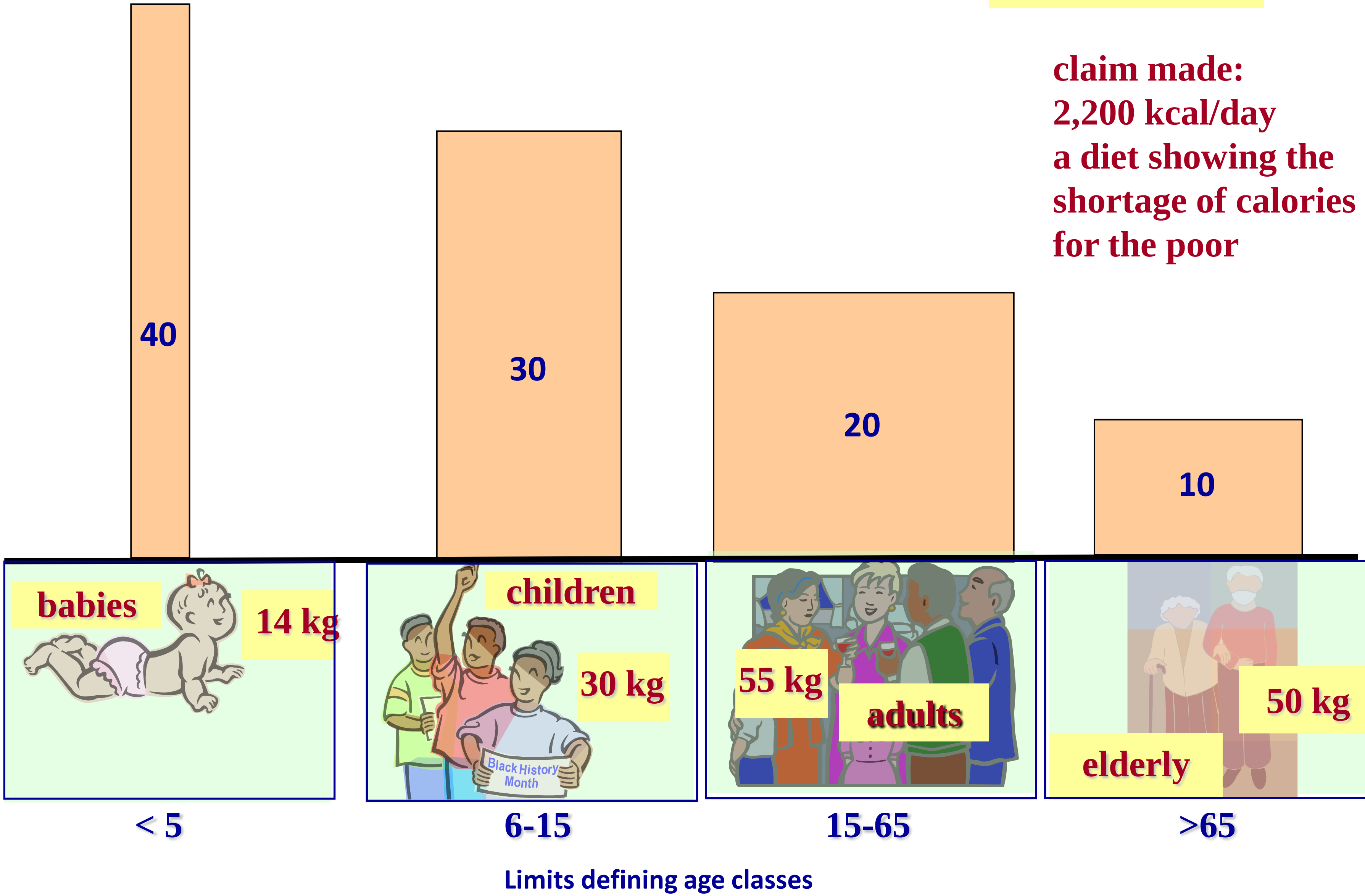
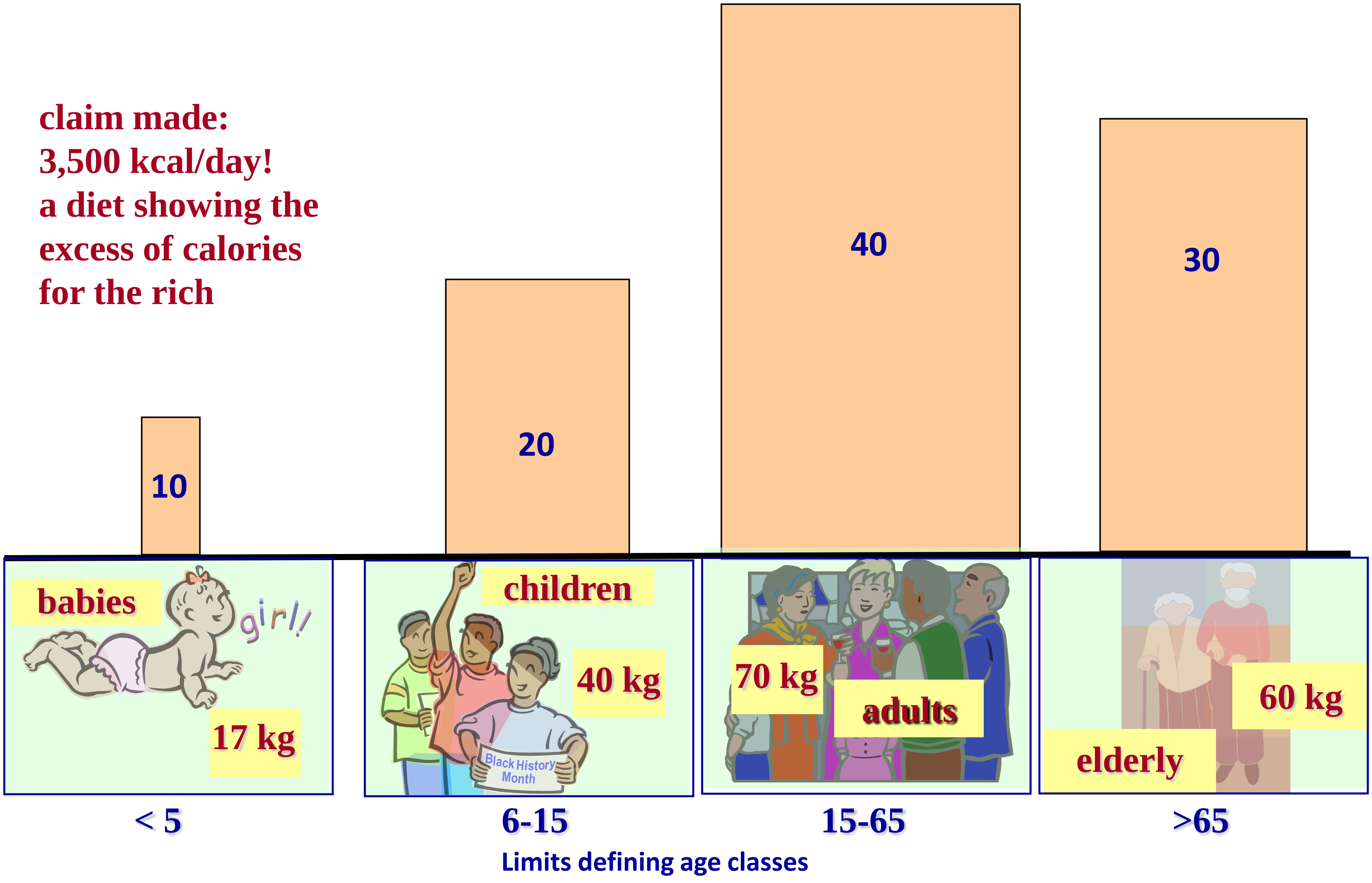


100 people = (10 x 17) + (20 x 40) + (40 x 70) + (30 x 60) = 5,570 kg

claim made:
3,500 kcal/day!
a diet showing the excess of calories for the rich



100 people = (10 x 17) + (20 x 40) + (40 x 70) + (30 x 60) = 5,570 kg

Average weight of 1 person = 55.7 kg   3,500 kcal/day = 62 kcal/kg/day

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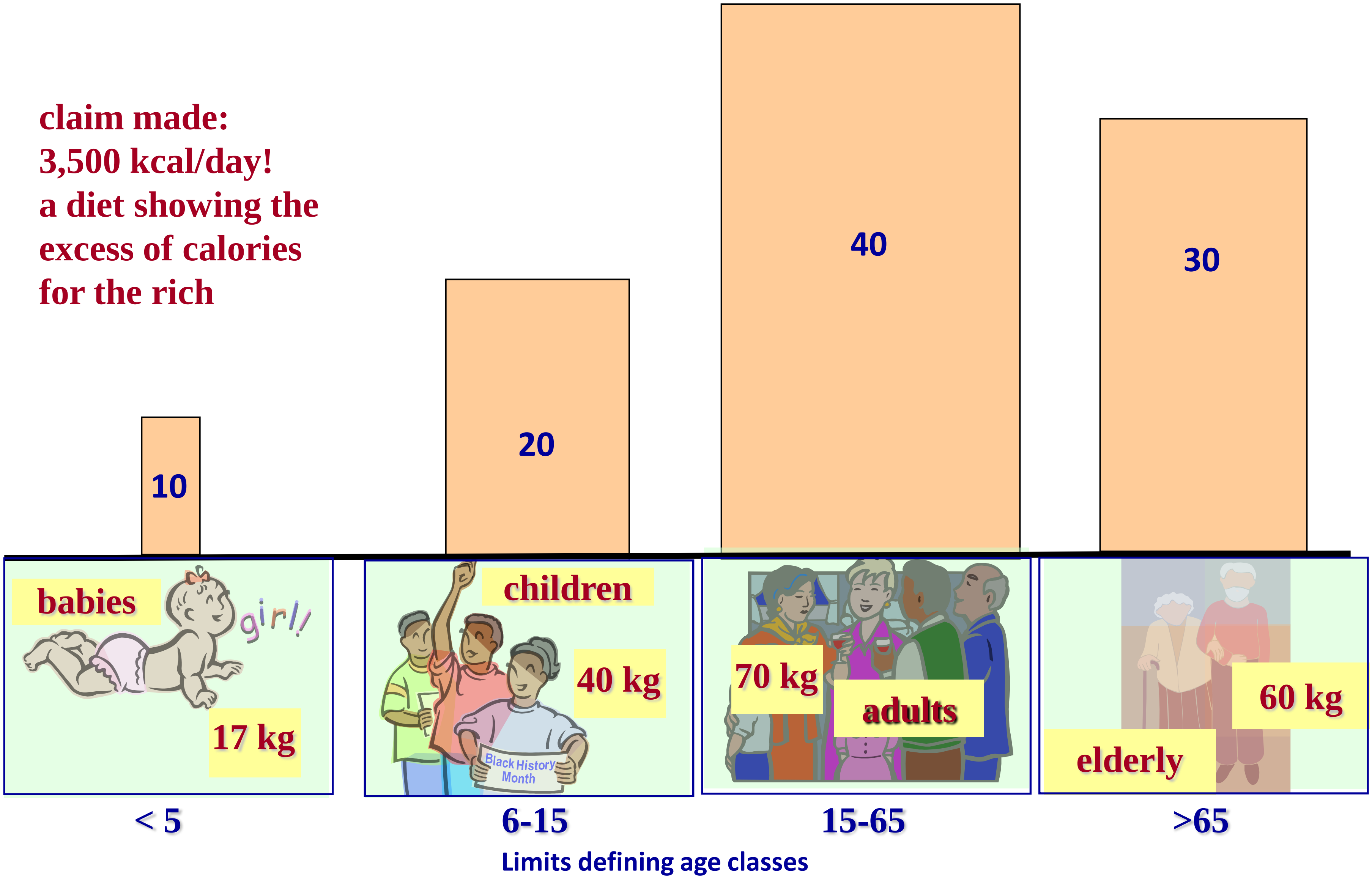

In developed countries an "average person" weights 50 kg . . .

In developing countries an "average person" weights 30 kg . . .

3,500 kcal/day!
excess of the rich

2,200 kcal/day!
shortage of the poor

70 kcal/kg/day < 73 kcal/kg/day

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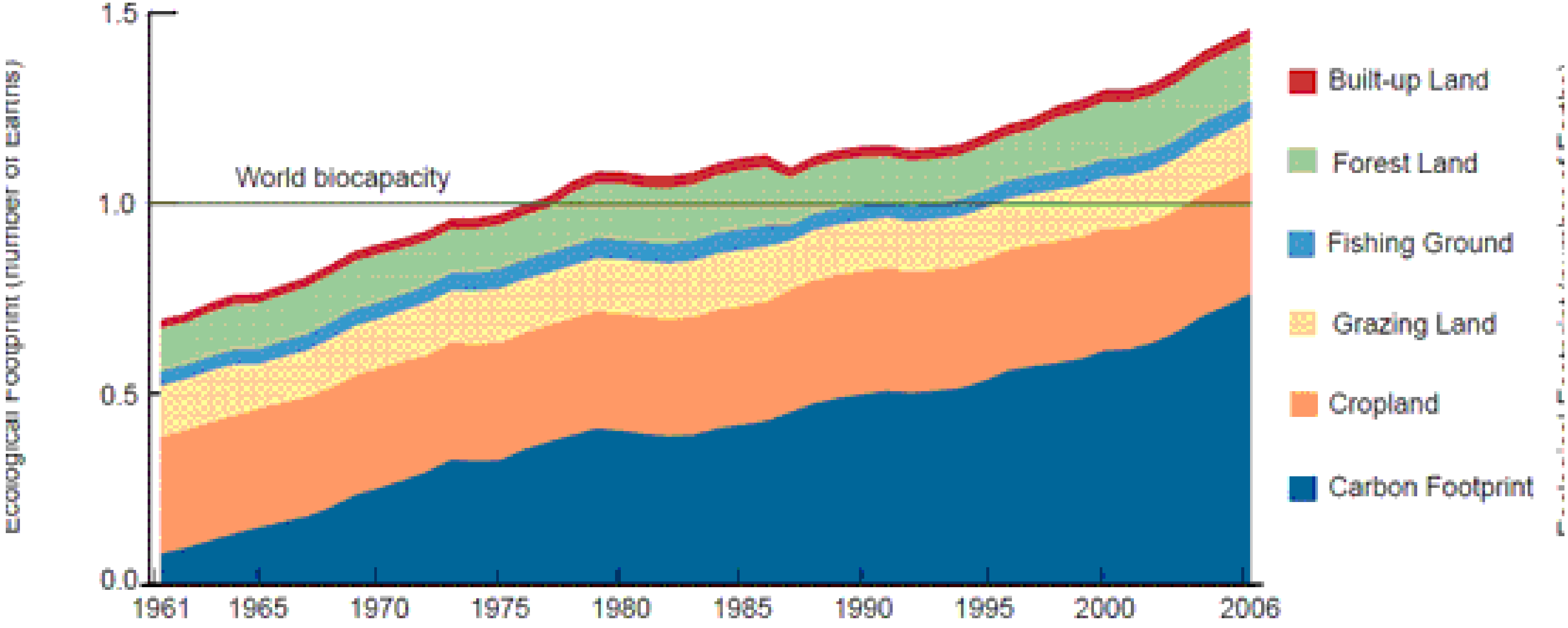
THE "EXPERTS" COULD DO BETTER!

Examples of MISLEADING INDICATOR based on SLOPPY PROTOCOLS (2)

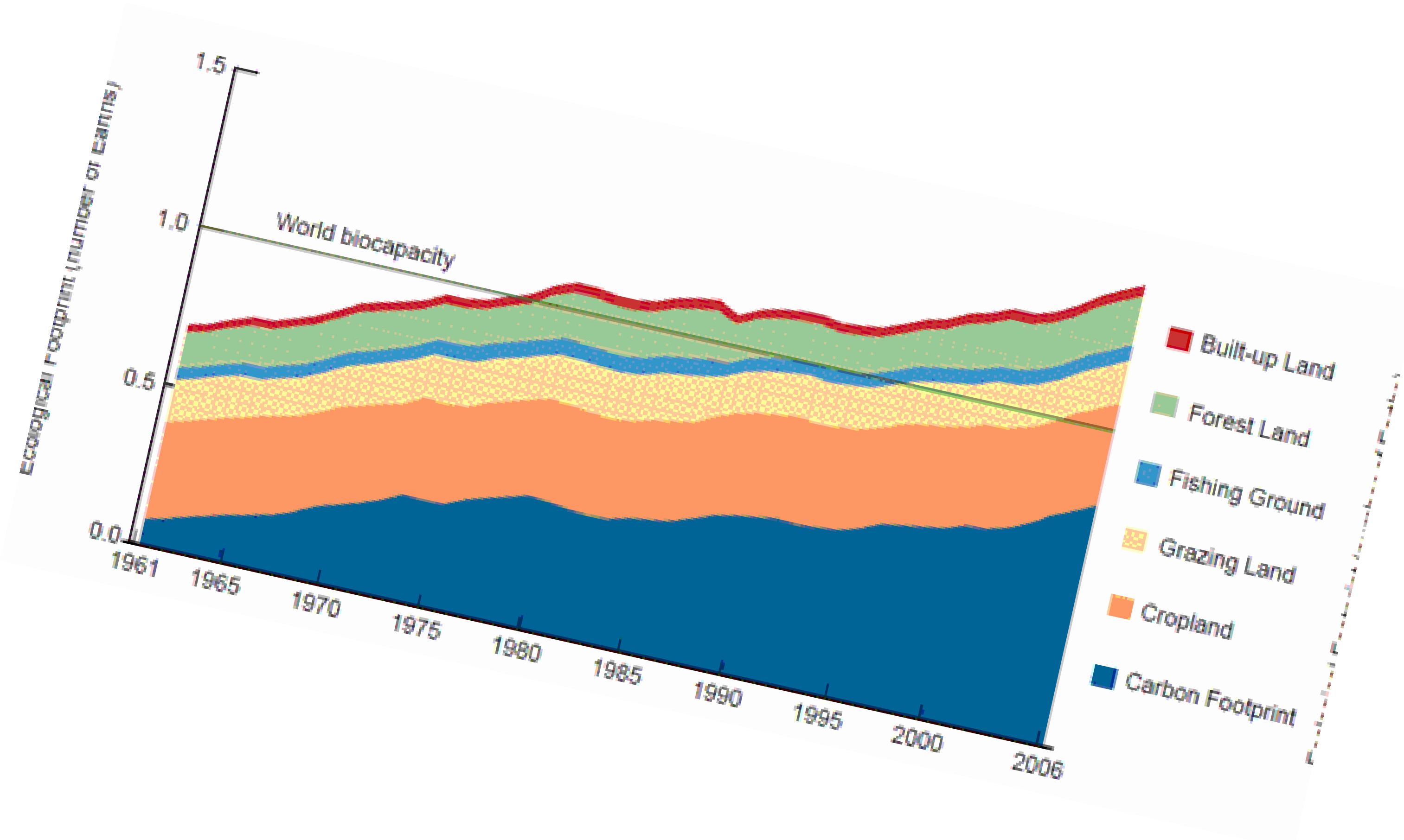
“The Ecological Footprint”

The change of world footprint in time (1961-2006)



Giampietro M. and Saltelli A. 2014. Footprints to nowhere
Ecological Indicators 46: 610-621

The change of world footprint in time (1961-2006)



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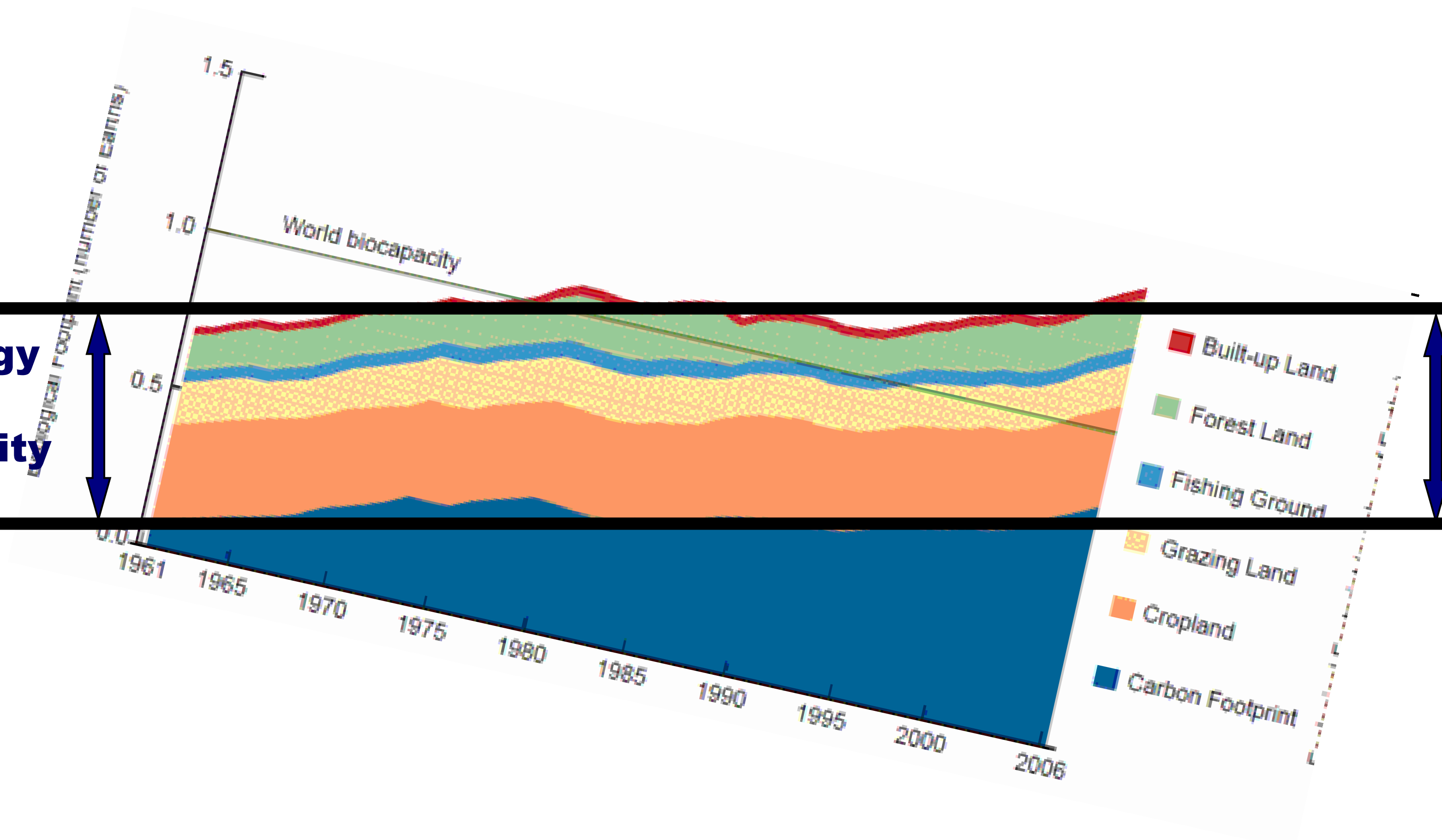
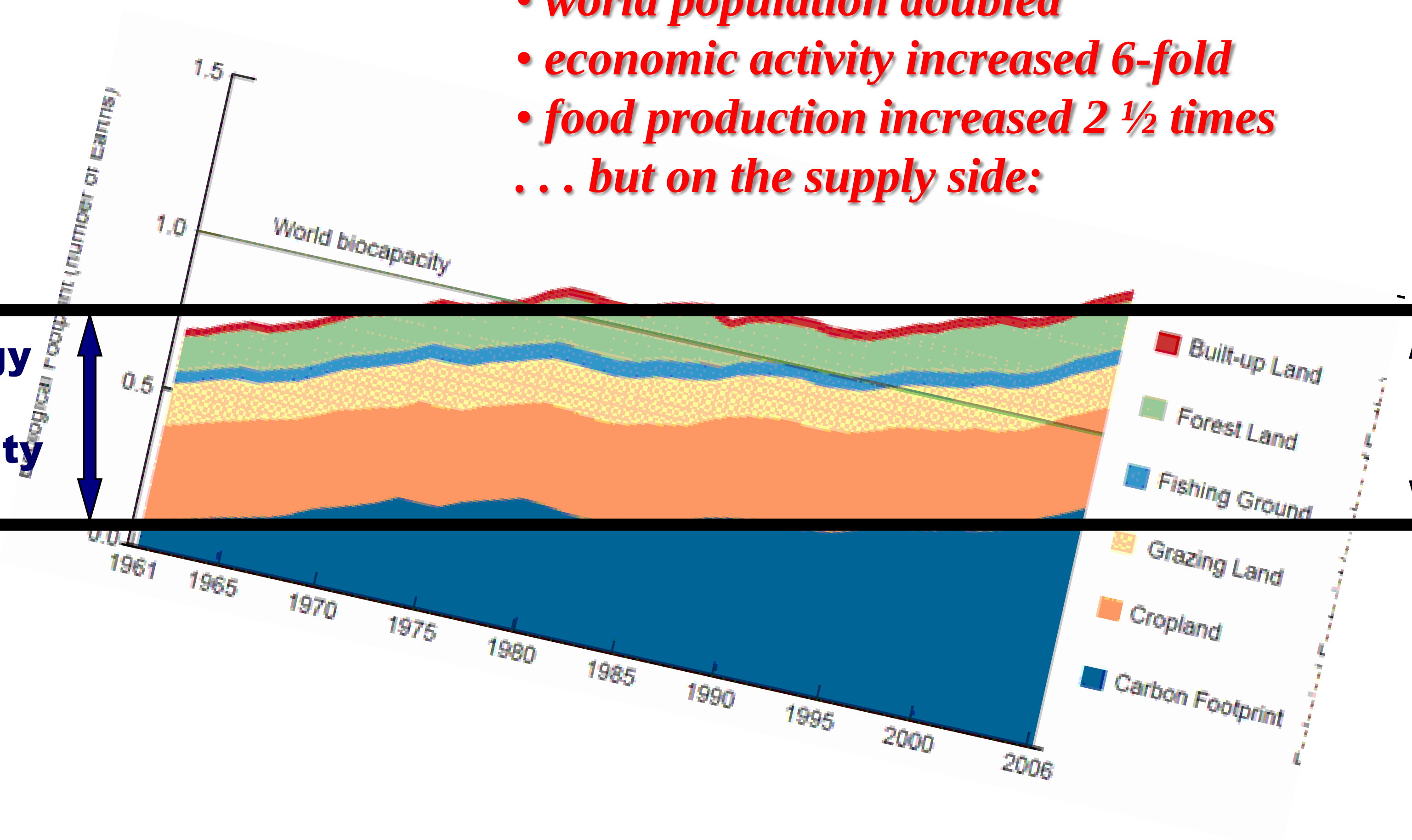


non-energy related biocapacity demand

The change of world footprint in time (1961-2006)

In this period:
- ***world population doubled***
- ***economic activity increased 6-fold***
- ***food production increased 2 ½ times***

. . . but on the supply side:



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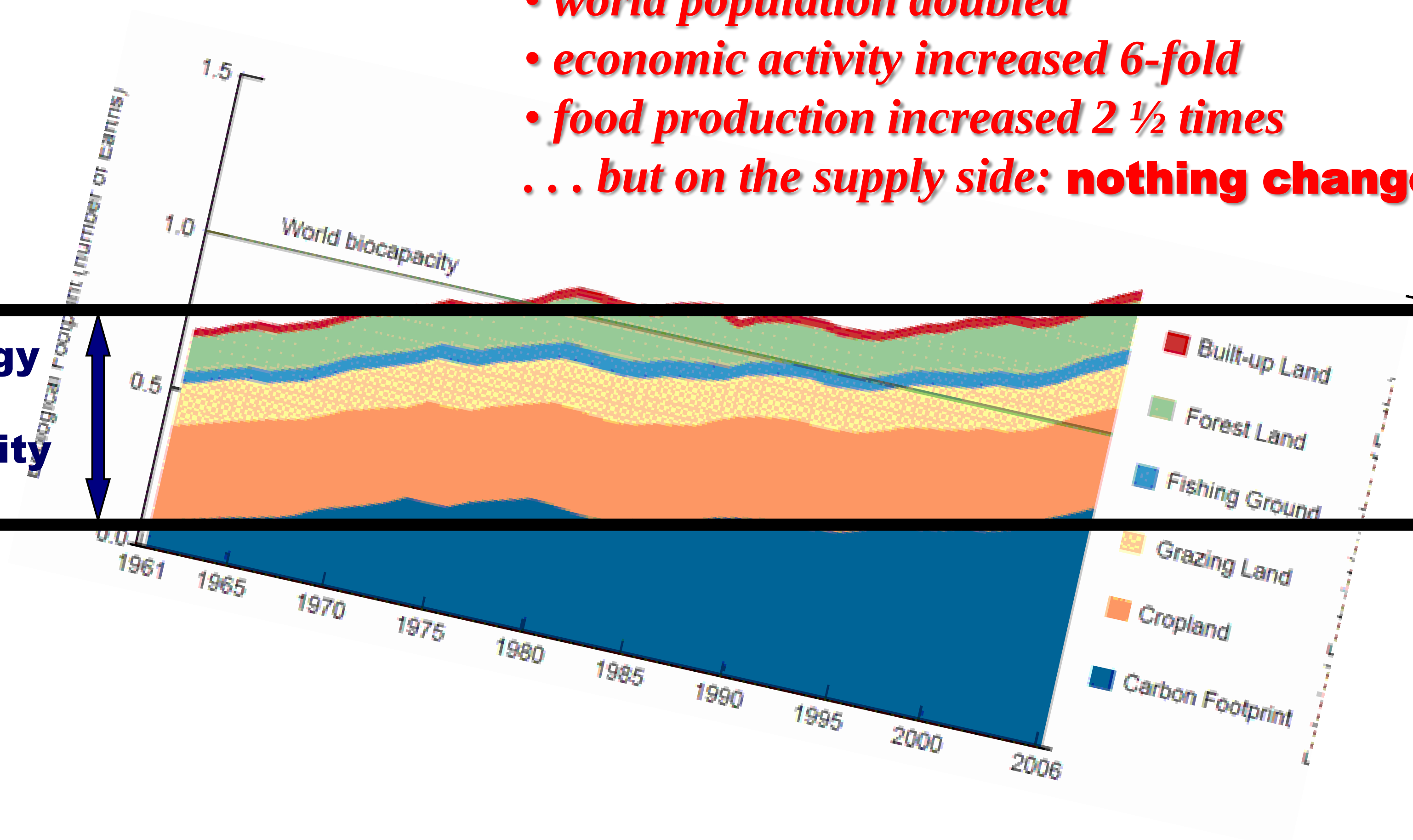

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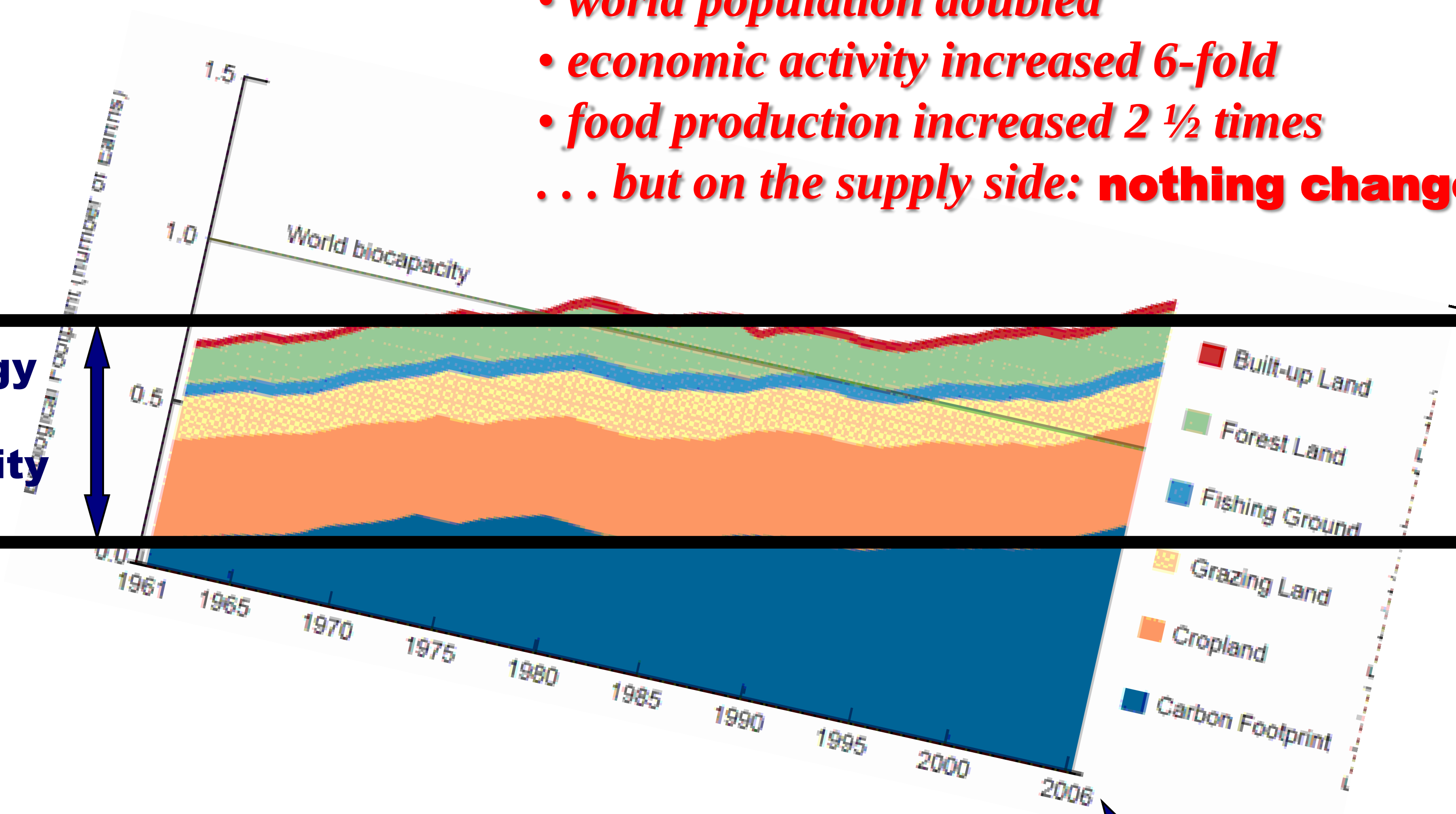

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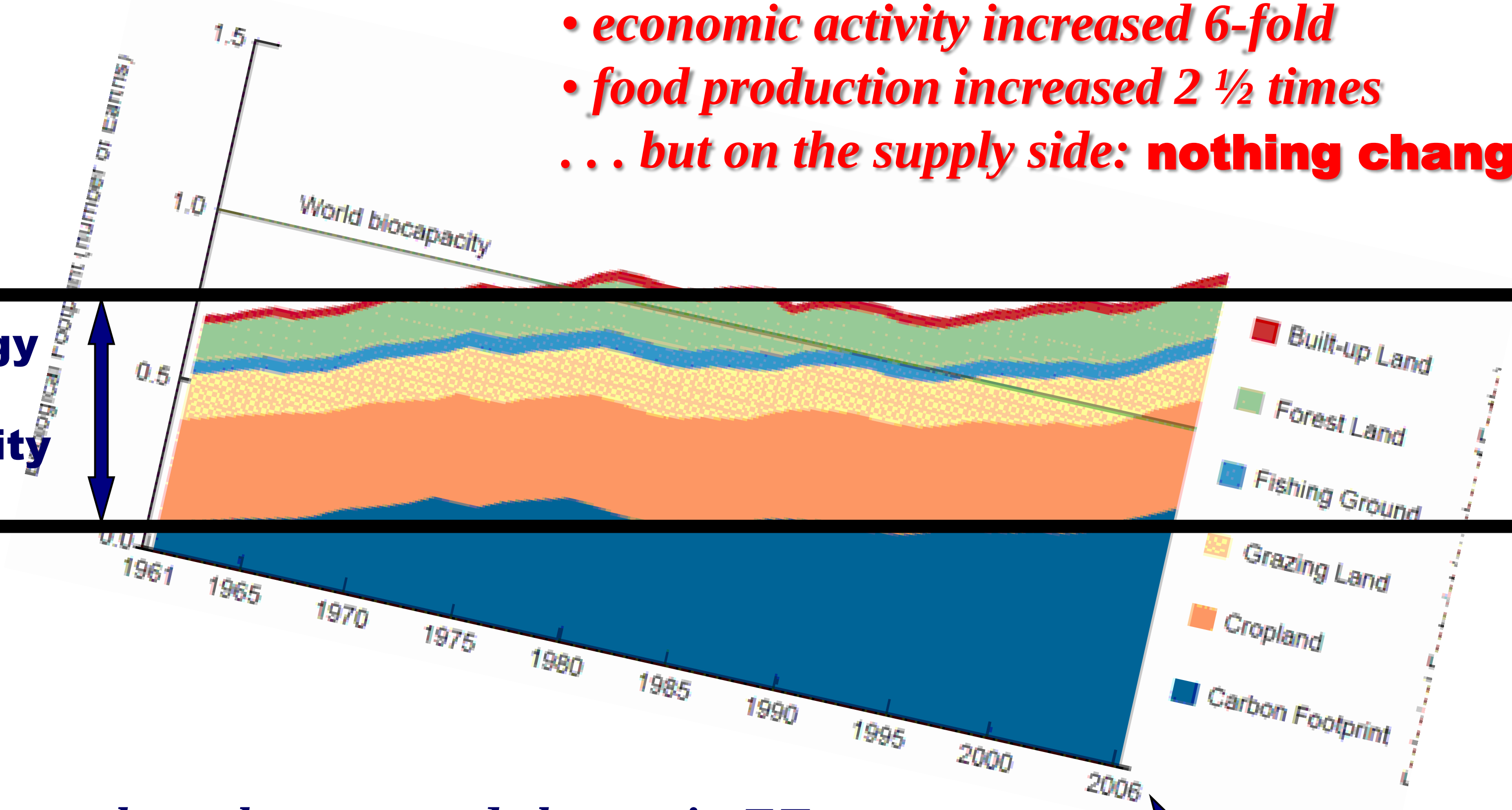

energy related biocapacity demand

the only measured change in EF is generated by a very creative protocol converting energy use into hectares of planet . . .

The blunders on the calculation of energy related biocapacity demand

Giampietro M. and Saltelli A. 2014. Footprints to nowhere
Ecological Indicators 46: 610-621

The blunders on the calculation of energy related biocapacity demand

1. Only the sink-side (area to catch CO_2)
   * what about the supply?
   * what about other GHG?

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3. It assumes that forests grow for ever!
   * this wrong assumption implies a dimensional problem with the chosen protocol

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The blunders on the calculation of energy related biocapacity demand

catch CO2)

supply

rever

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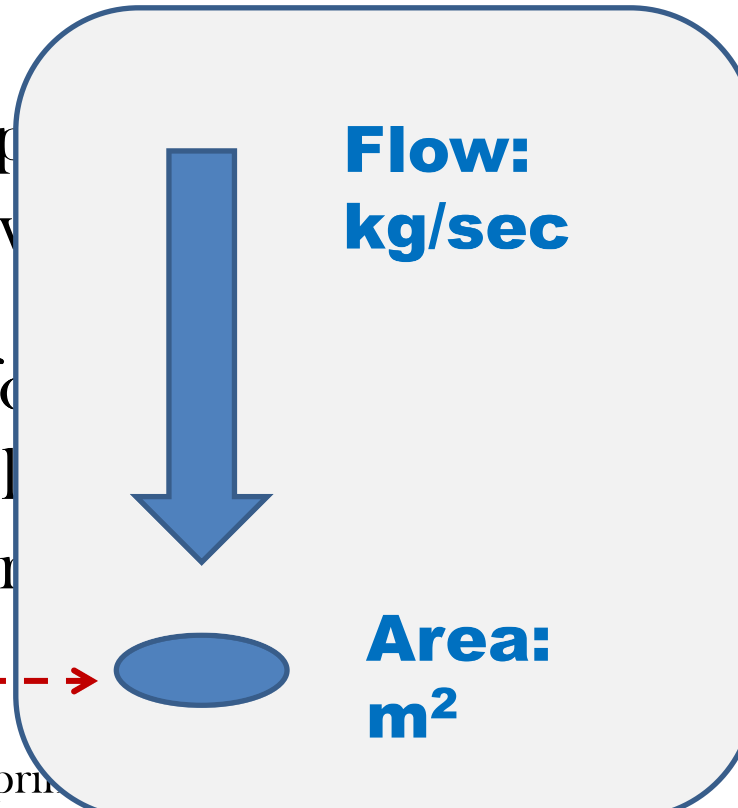

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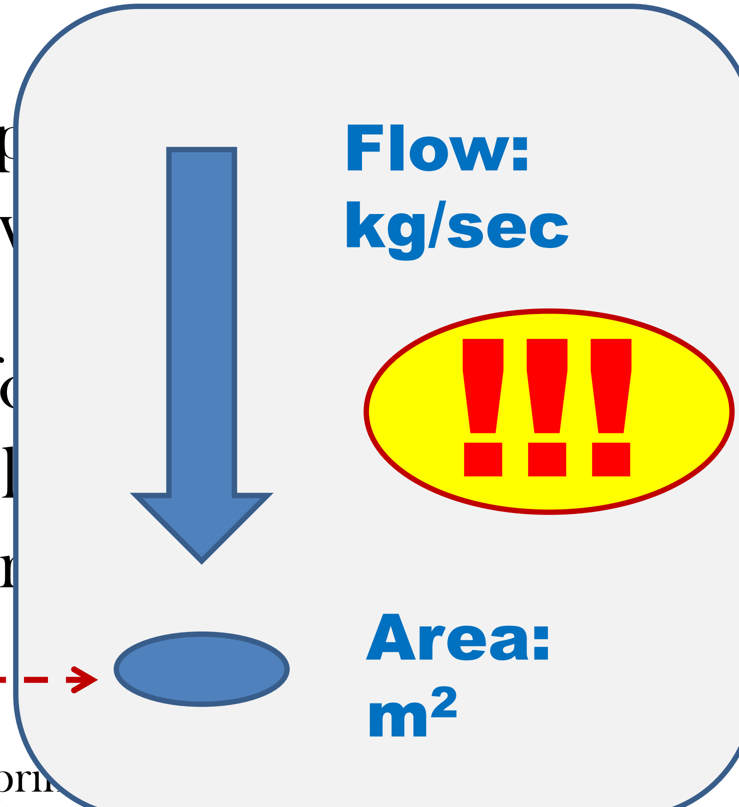

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HOW IS IT POSSIBLE THAT WE USE THESE INDICATORS?

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The validation of models is based on “perceptions” and not on a quality check of the modeling relation

- Consumption of the rich vs consumption of the poor
- Ecological footprint

Rosen theory of modeling relation

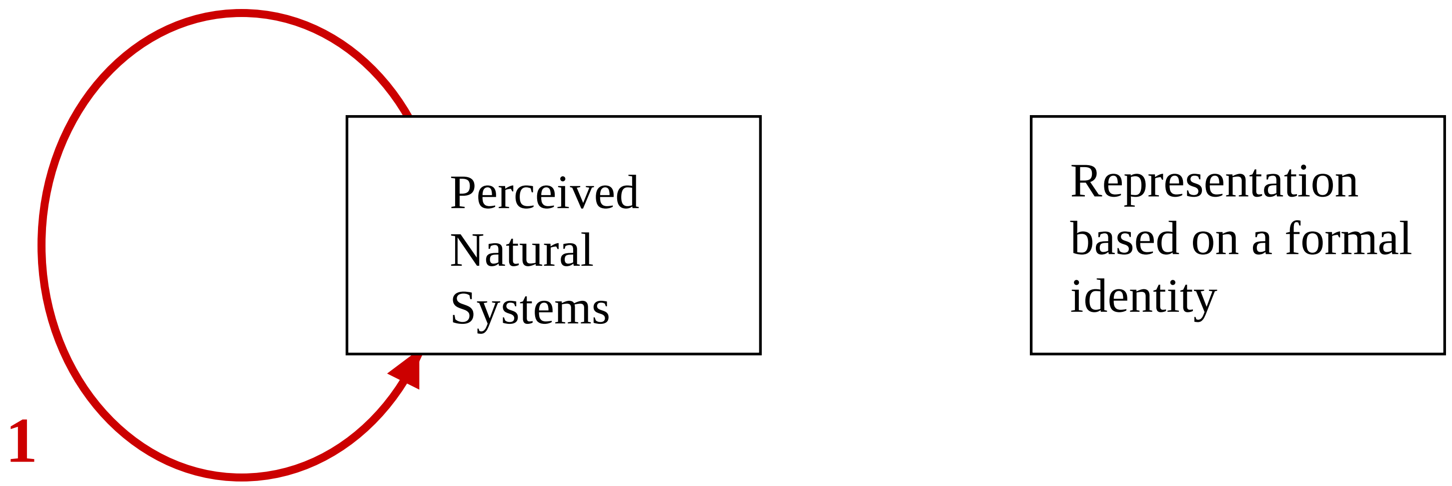
Perceived Natural Systems

Representation based on a formal identity

Rosen theory of modeling relation

NARRATIVE

Perceived causality in the Natural System



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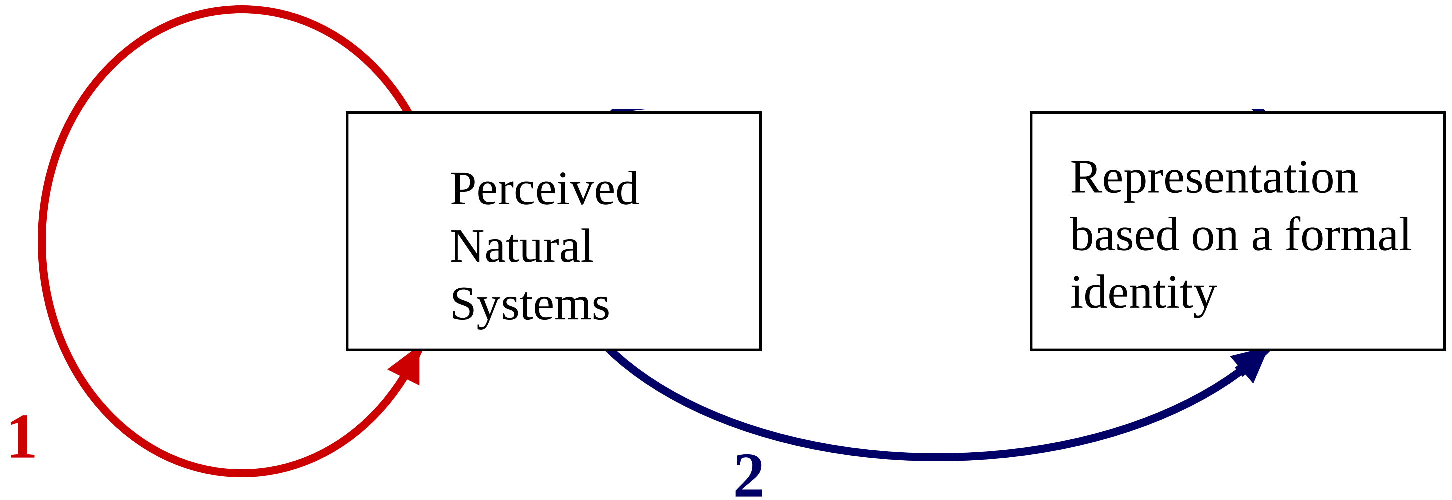

POSSIBLE ENCODINGS of RELEVANT ATTRIBUTES INTO PROXY VARIABLES

the choice of a particular encoding implies:

- selection of a finite set of measurable qualities
- selective neglecting of other attributes

Rosen theory of modeling relation

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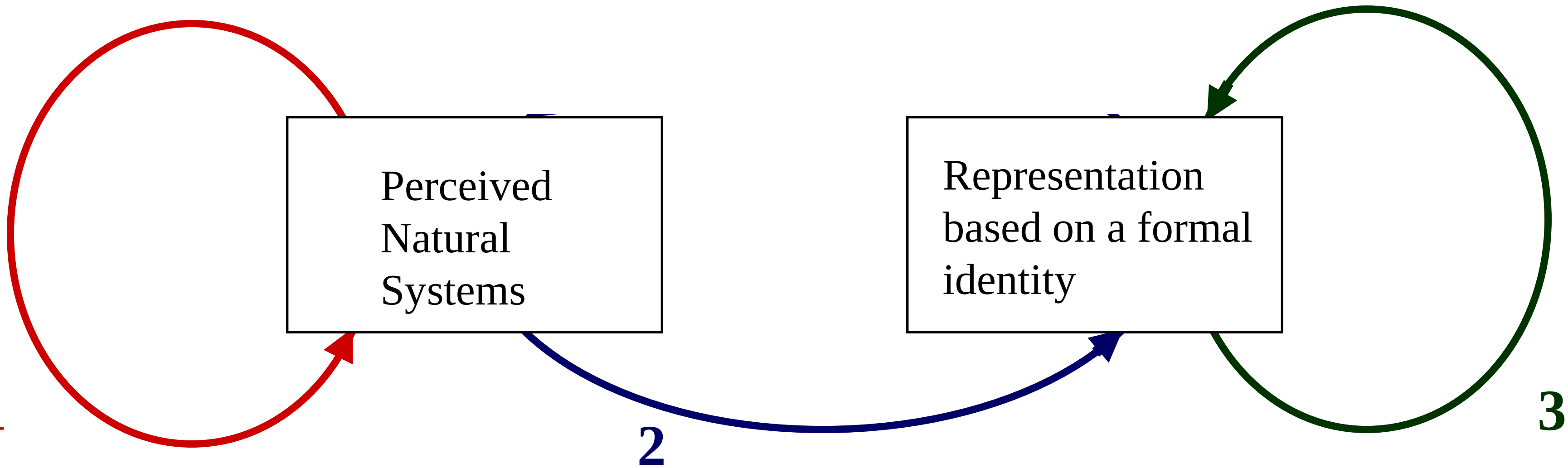
Perceived causality in the Natural System

FORMAL SYSTEM OF INFERENCE PROVIDING ANTICIPATION



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entailment rules over variables (syntactic rules)

Rosen theory of modeling relation

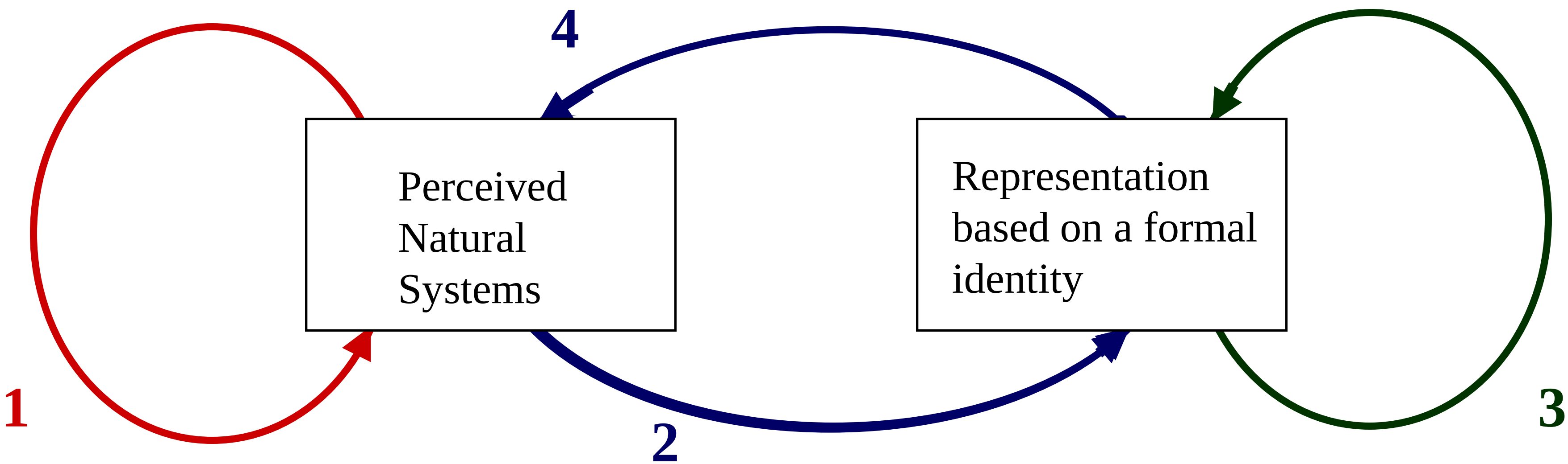
NARRATIVE

Perceived causality in the Natural System

DECODING of THE VALUES TAKEN BY PROXY VARIABLES

Developing anticipatory models

FORMAL SYSTEM OF INFERENCE PROVIDING ANTICIPATION



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IF THE "*ARROW 1*" AND THE "*ARROW 4*" ARE COMPATIBLE THEN THE MODEL IS VALIDATED AND "*ARROW 2*" AND "*ARROW 3*" ARE ASSUMED TO BE OK!

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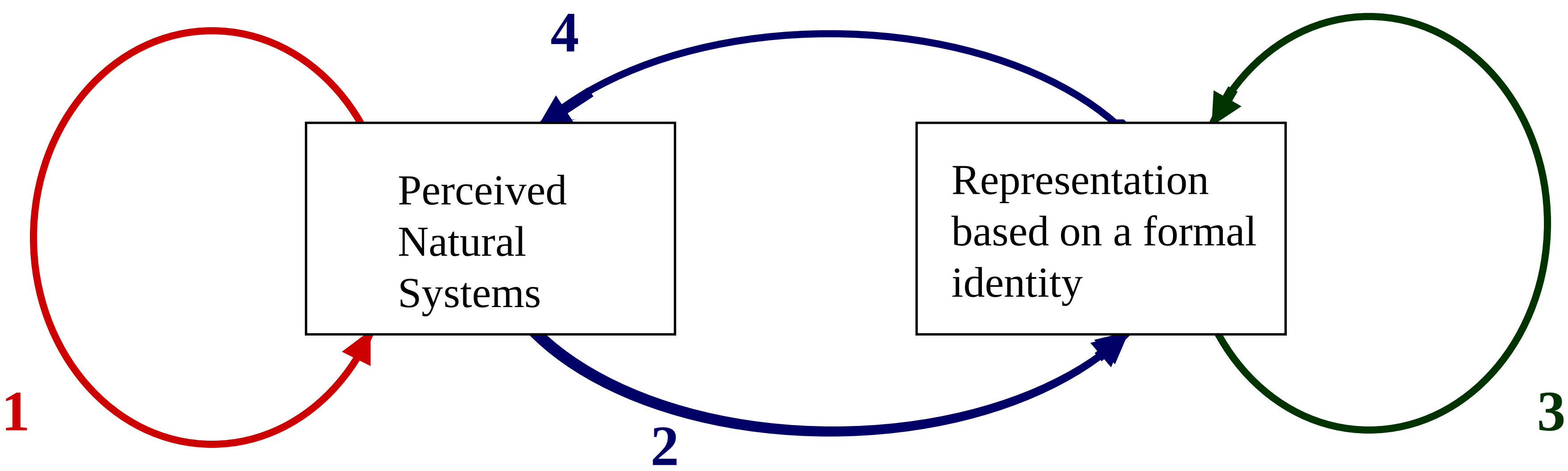

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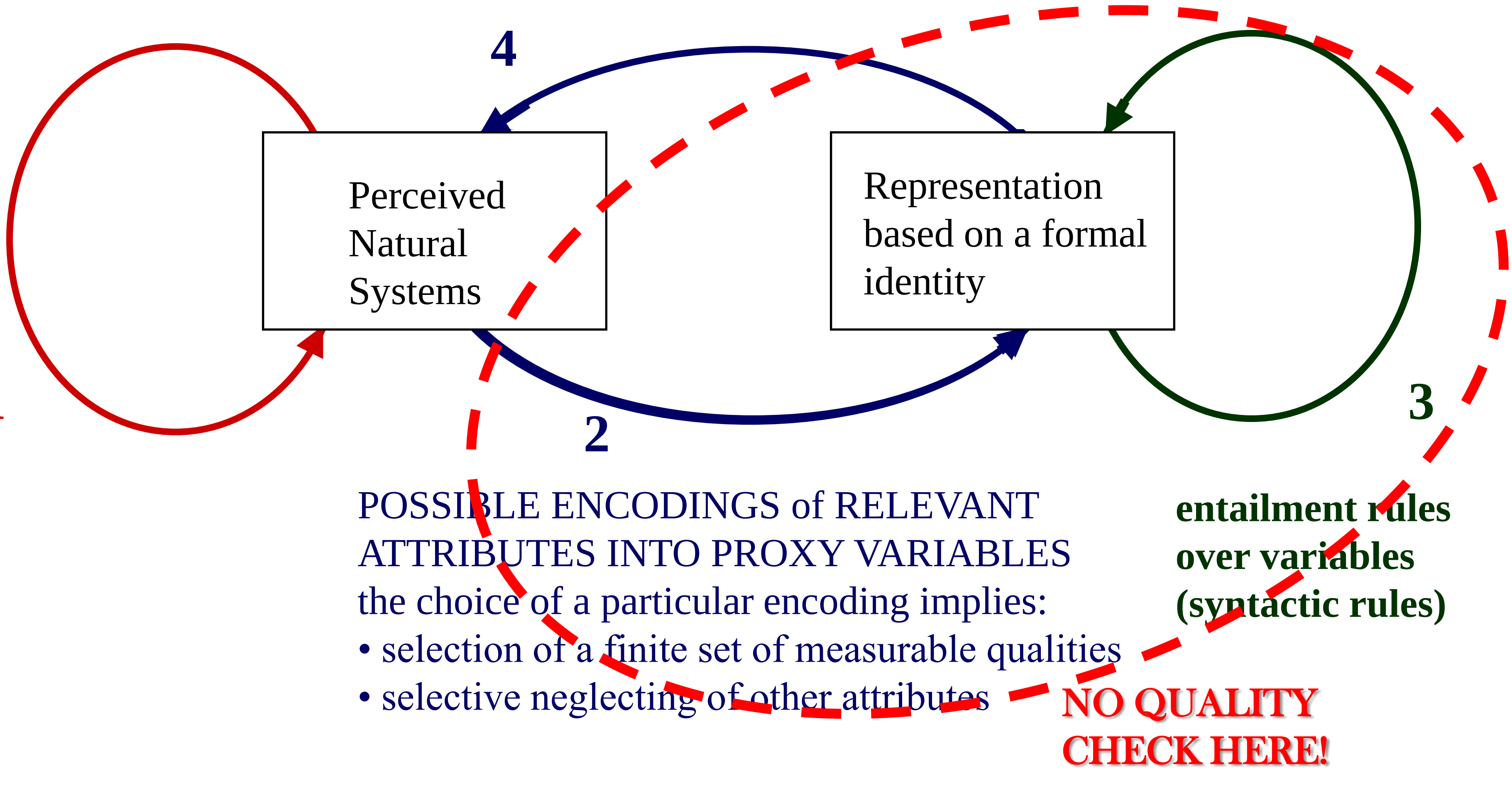
NARRATIVE

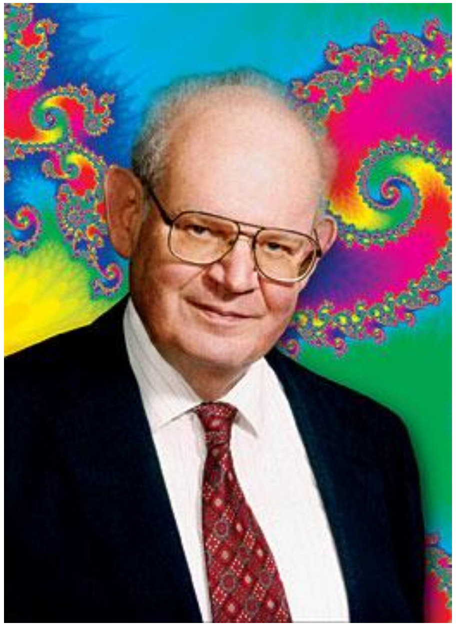
Perceived causality in the Natural System



2. Quantitative analysis across multiple-scales requires "scaling": knowing how to change the definitions of external referent

You cannot measure the length of a segment of a coastal line if you do not define first the scale of the map that you will be using

The longer the *dx* the shorter the coastal line representation



Benoit Mandelbrot

The shorter the *dx* the longer the coastal line representation

$$f_n(x)\frac{\mathrm{d}^n y}{\mathrm{d}x^n} + \cdots + f_1(x)\frac{\mathrm{d}y}{\mathrm{d}x} + f_0(x)y = h(x)$$

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Differential equation see only a single scale at the time describing events taking place in "simple time"* that is also REVERSIBLE!!!!

* a single coupling of a *dt* (time differential) and a *T* (duration)

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After 20 years

$$g_m(z)\,\frac{d^m k}{dz^m} + \dots + g_1(z)\,\frac{dk}{dz} + g_0(z)k = j\,(z)$$

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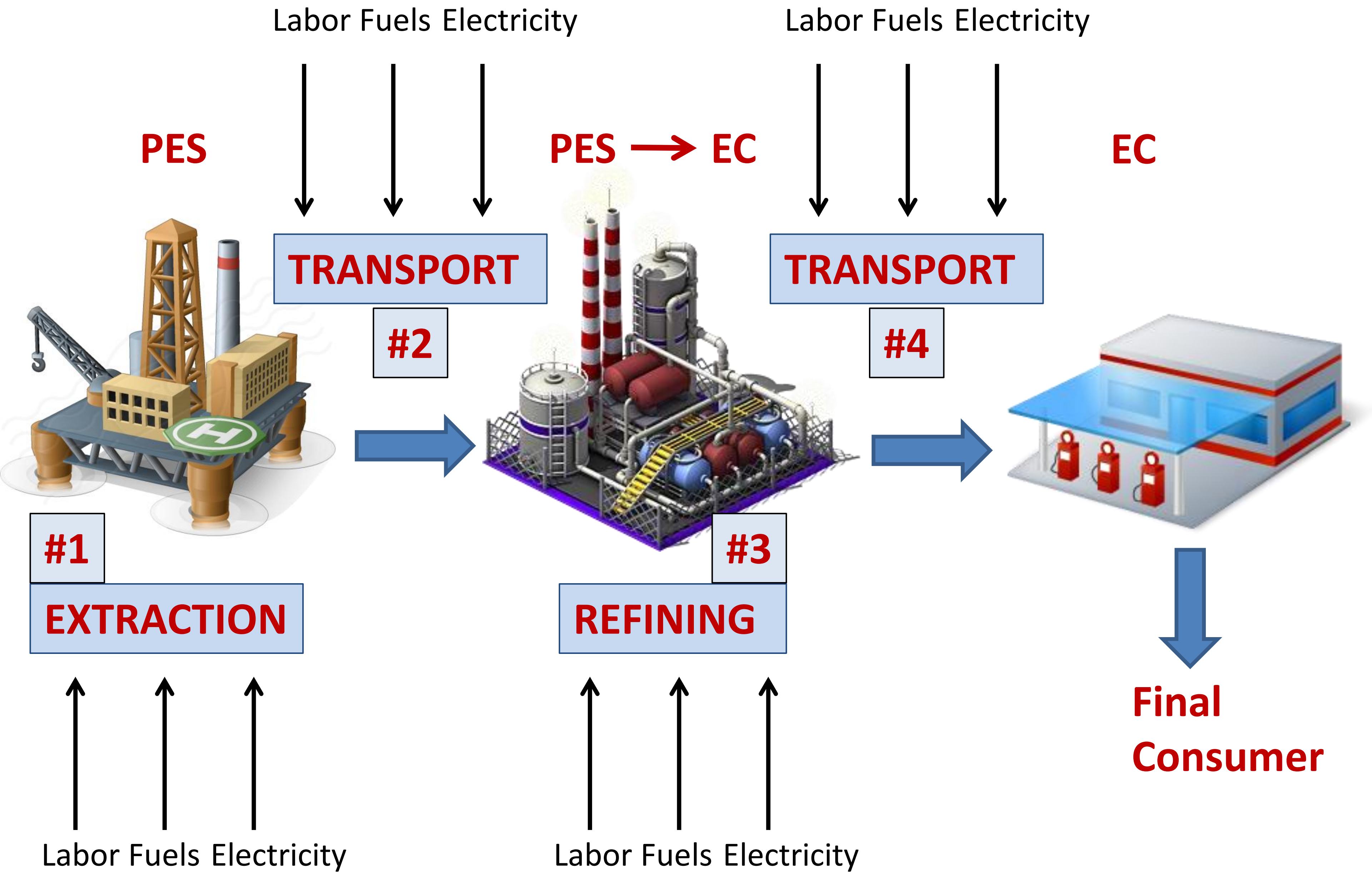
ISSUE OF SCALE (1)

When gathering quantitative information one should be aware that there is information referring to “types” (out of scale, unitary operations) and information referring to “instances” (scaled)

This distinction is totally missed in Life Cycle Assessment


Labor Fuels Electricity
Labor Fuels Electricity
PES
PES → EC
EC
TRANSPORT
#2
TRANSPORT
#4
#1
EXTRACTION
#3
REFINING
Final Consumer
Labor Fuels Electricity
Labor Fuels Electricity

Year 2010
Brazil

	INPUTS			PES throughput	FUNCTIONAL COMPARTMENTS
	Labor *Mhrs*	*GJ fuel*	*GJ electr.*	*m^3 oil/year*	
On shore Off shore	38 200	3,000 16,000	28,000 145,000	12,000,000 106,000,000 118,000,000	**EXTRACTION**
Pipeline Ships Trucks	1 20 60	1,800 9,000 18,000	600 0 0	60,000,000 29,000,000 29,000,000 **118,000,000**	**TRANSPORT TO REFINERY**
Small Medium Large	28 25 3.5	117,000 102,000 15,000	17,000 6,200 800	17,700,000 75,500,000 24,800,000 **118,000,000**	**REFINERY**
Trucks	250	70,800	0	**118,000,000**	**TRANSPORT TO END USES**

	Mhrs	GJ fuel	GJ electr.	m^3 oil	

	Mhrs	GJ fuel	GJ electr.	m^3 oil	
					EXTRACTION

	Mhrs	GJ fuel	GJ electr.	m^3 oil	
On shore	38	3,000	28,000	12,000,000	EXTRACTION
Off shore	200	16,000	145,000	106,000,000	
				118,000,000	

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					TRANSPORT TO REFINERY

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				118,000,000	
Pipeline	1	1,800	600	60,000,000	TRANSPORT TO REFINERY
Ships	20	9,000	0	29,000,000	
Trucks	60	18,000	0	29,000,000	
				118,000,000	

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				118,000,000	
Small	28	117,000	17,000	17,700,000	REFINERY
Medium	25	102,000	6,200	75,500,000	
Large	3.5	15,000	800	24,800,000	
				118,000,000	

	Mhrs	GJ fuel	GJ electr.	m^3 oil	
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				118,000,000	
Pipeline	1	1,800	600	60,000,000	TRANSPORT TO REFINERY
Ships	20	9,000	0	29,000,000	
Trucks	60	18,000	0	29,000,000	
				118,000,000	
Small	28	117,000	17,000	17,700,000	REFINERY
Medium	25	102,000	6,200	75,500,000	
Large	3.5	15,000	800	24,800,000	
				118,000,000	
					TRANSPORT TO END USES

	Mhrs	GJ fuel	GJ electr.	m^3 oil	
On shore	38	3,000	28,000	12,000,000	EXTRACTION
Off shore	200	16,000	145,000	106,000,000	
				118,000,000	
Pipeline	1	1,800	600	60,000,000	TRANSPORT TO REFINERY
Ships	20	9,000	0	29,000,000	
Trucks	60	18,000	0	29,000,000	
				118,000,000	
Small	28	117,000	17,000	17,700,000	REFINERY
Medium	25	102,000	6,200	75,500,000	
Large	3.5	15,000	800	24,800,000	
				118,000,000	
Trucks	250	70,800	0	118,000,000	TRANSPORT TO END USES

	hr/m^3	GJ fuel / m3	GJ electr. / m3	m^3 oil	
On shore	38	3,000	28,000	12,000,000	EXTRACTION
Off shore	200	16,000	145,000	106,000,000	
On shore	3.2	0.25	2.4	118,000,000	
Off shore	1.9	0.15	1.4		
Pipeline	1	1,800	600	60,000,000	TRANSPORT TO REFINERY
Ships	20	9,000	0	29,000,000	
Trucks	60	18,000	0	29,000,000	
				118,000,000	
Small	28	117,000	17,000	17,700,000	REFINERY
Medium	25	102,000	6,200	75,500,000	
Large	3.5	15,000	800	24,800,000	
				118,000,000	
Trucks	250	70,800	0	118,000,000	TRANSPORT TO END USES

	hr/m^3	GJ fuel / m3	GJ electr. / m3	m^3 oil	
On shore	38	3,000	28,000	12,000,000	EXTRACTION
Off shore	200	16,000	145,000	106,000,000	
On shore	3.2	0.25	2.4	118,000,000	
Off shore	1.9	0.15	1.4		
Pipeline	1	1,800	600	60,000,000	TRANSPORT TO REFINERY
Ships	20	9,000	0	29,000,000	
Trucks	60	18,000	0	29,000,000	
Pipeline	0.02	0.03	0.01	118,000,000	
Ships	0.7	0.3	0		
Trucks	2.1	0.6	0		
Small	28	117,000	17,000	17,700,000	REFINERY
Medium	25	102,000	6,200	75,500,000	
Large	3.5	15,000	800	24,800,000	
				118,000,000	
Trucks	250	70,800	0	118,000,000	TRANSPORT TO END USES

	hr/m^3	GJ fuel / m3	GJ electr. / m3	m^3 oil	
On shore	38	3,000	28,000	12,000,000	EXTRACTION
Off shore	200	16,000	145,000	106,000,000	
On shore	3.2	0.25	2.4	118,000,000	
Off shore	1.9	0.15	1.4		
Pipeline	1	1,800	600	60,000,000	TRANSPORT TO REFINERY
Ships	20	9,000	0	29,000,000	
Trucks	60	18,000	0	29,000,000	
Pipeline	0.02	0.03	0.01	118,000,000	
Ships	0.7	0.3	0		
Trucks	2.1	0.6	0		
Small	28	117,000	17,000	17,700,000	
Medium	25	102,000	6,200	75,500,000	REFINERY
Large	3.5	15,000	800	24,800,000	
Small	1.6	6.6	1.0	118,000,000	
Medium	0.3	1.4	0.8		
Large	0.1	0.6	0.03		
Trucks	250	70,800	0	118,000,000	TRANSPORT TO END USES

	hr/m³	GJ fuel / m3	GJ electr. / m3	m³ oil	
On shore	38	3,000	28,000	12,000,000	EXTRACTION
Off shore	200	16,000	145,000	106,000,000	
On shore	3.2	0.25	2.4	118,000,000	
Off shore	1.9	0.15	1.4		
Pipeline	1	1,800	600	60,000,000	TRANSPORT TO REFINERY
Ships	20	9,000	0	29,000,000	
Trucks	60	18,000	0	29,000,000	
Pipeline	0.02	0.03	0.01	118,000,000	
Ships	0.7	0.3	0		
Trucks	2.1	0.6	0		
Small	28	117,000	17,000	17,700,000	
Medium	25	102,000	6,200	75,500,000	REFINERY
Large	3.5	15,000	800	24,800,000	
Small	1.6	6.6	1.0	118,000,000	
Medium	0.3	1.4	0.8		
Large	0.1	0.6	0.03		
Trucks	250	70,800	0	118,000,000	TRANSPORT TO END USES
Trucks	2.1	0.6	0		

	hr/m³	GJ fuel / m3	GJ electr. / m3	m³ oil	
On shore	38	3,000	28,000	12,000,000	EXTRACTION
Off shore	200	16,000	145,000	106,000,000	
				118,000,000	
On shore	3.2	0.25	2.4		10%
Off shore	1.9	0.15	1.4		90% 118,000,000
Pipeline	1	1,800	600	60,000,000	TRANSPORT TO REFINERY
Ships	20	9,000	0	29,000,000	
Trucks	60	18,000	0	29,000,000	
				118,000,000	
Pipeline	0.02	0.03	0.01		50%
Ships	0.7	0.3	0		25% 118,000,000
Trucks	2.1	0.6	0		25%
Small	28	117,000	17,000	17,700,000	REFINERY
Medium	25	102,000	6,200	75,500,000	
Large	3.5	15,000	800	24,800,000	
				118,000,000	
Small	1.6	6.6	1.0		15%
Medium	0.3	1.4	0.8		64% 118,000,000
Large	0.1	0.6	0.03		21%
Trucks	250	70,800	0	118,000,000	TRANSPORT TO END USES
Trucks	2.1	0.6	0		100% 118,000,000

THROUGHPUT | **118,000,000 m^3**

THROUGHPUT 118,000,000 m^3

EXTRACTION

TRANSPORT #1

REFINERY

TRANSPORT #2

THROUGHPUT 118,000,000 m^3

EXTRACTION

3.2	0.25	2.4	On shore
1.9	0.15	1.4	Off shore

TRANSPORT #1

REFINERY

TRANSPORT #2

THROUGHPUT 118,000,000 m^3

EXTRACTION

3.2	0.25	2.4	On shore
1.9	0.15	1.4	Off shore

TRANSPORT #1

0.02	0.03	0.01	Pipeline
0.7	0.3	0.0	Shipping
2.1	0.6	0.0	Trucks

REFINERY

TRANSPORT #2

THROUGHPUT 118,000,000 m^3

EXTRACTION

3.2	0.25	2.4	On shore
1.9	0.15	1.4	Off shore

TRANSPORT #1

0.02	0.03	0.01	Pipeline
0.7	0.3	0.0	Shipping
2.1	0.6	0.0	Trucks

REFINERY

1.6	6.6	1.0	Small
0.3	1.4	0.8	Medium
0.1	0.6	0.03	Large

TRANSPORT #2

THROUGHPUT **118,000,000 m^3**

EXTRACTION

3.2	0.25	2.4	On shore
1.9	0.15	1.4	Off shore

TRANSPORT #1

0.02	0.03	0.01	Pipeline
0.7	0.3	0.0	Shipping
2.1	0.6	0.0	Trucks

REFINERY

1.6	6.6	1.0	Small
0.3	1.4	0.8	Medium
0.1	0.6	0.03	Large

TRANSPORT #2

0.02	0.03	0.01	Pipeline
0.7	0.3	0.0	Shipping
2.1	0.6	0.0	Trucks

THROUGHPUT 118,000,000 m^3

EXTRACTION

MIX				
0.10	3.2	0.25	2.4	On shore
0.90	1.9	0.15	1.4	Off shore

TRANSPORT #1

MIX				
0.50	0.02	0.03	0.01	Pipeline
0.25	0.7	0.3	0.0	Shipping
0.25	2.1	0.6	0.0	Trucks

REFINERY

MIX				
0.15	1.6	6.6	1.0	Small
0.64	0.3	1.4	0.8	Medium
0.21	0.1	0.6	0.03	Large

TRANSPORT #2

MIX				
0.0	0.02	0.03	0.01	Pipeline
0.0	0.7	0.3	0.0	Shipping
1.0	2.1	0.6	0.0	Trucks

THROUGHPUT 118,000,000 m^3

EXTRACTION

MIX					
0.10	3.2	0.25	2.4	On shore	238 19,000 173,000
0.90	1.9	0.15	1.4	Off shore	

TRANSPORT #1

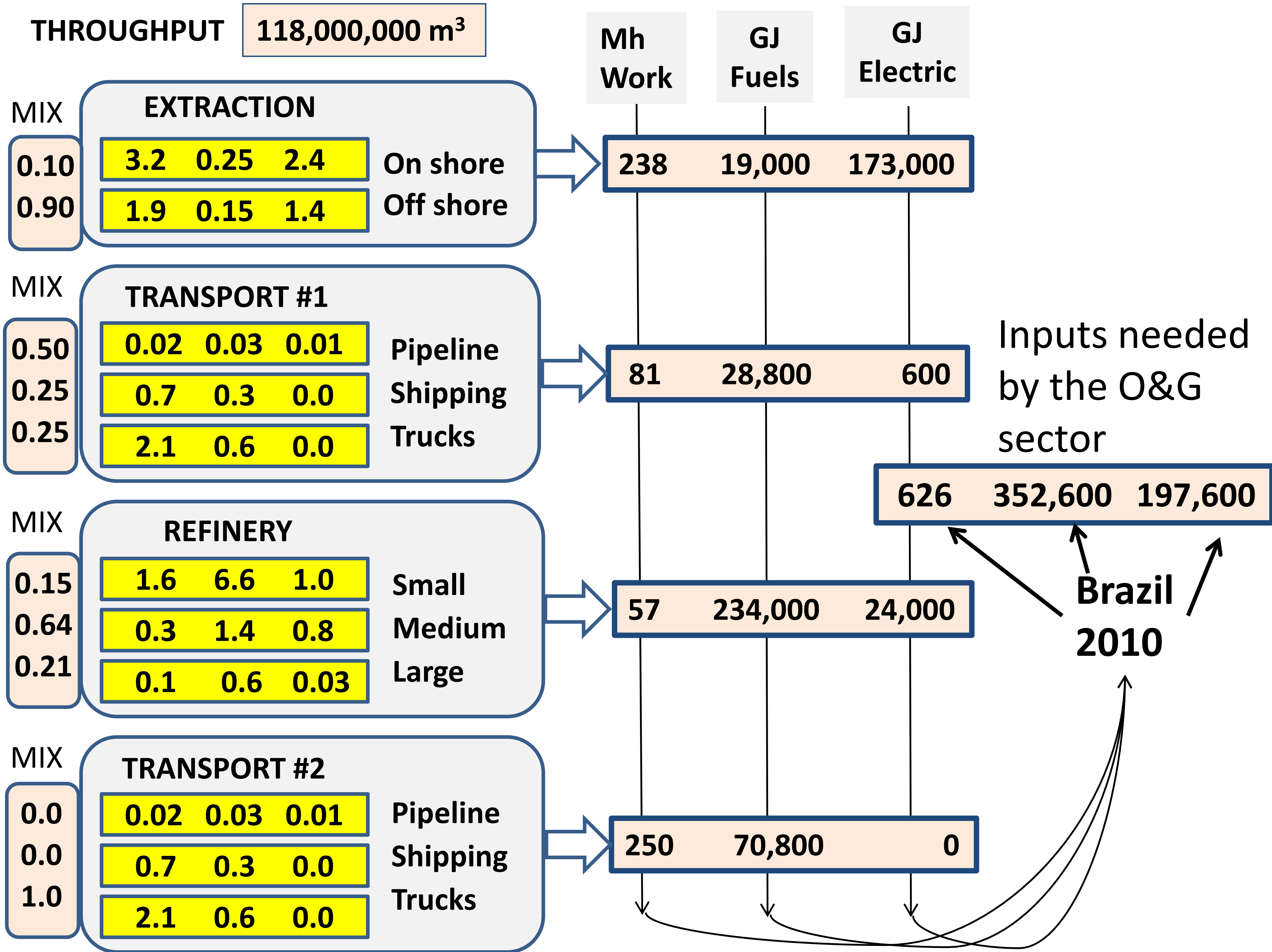
MIX					
0.50	0.02	0.03	0.01	Pipeline	81 28,800 600
0.25	0.7	0.3	0.0	Shipping	
0.25	2.1	0.6	0.0	Trucks	

REFINERY

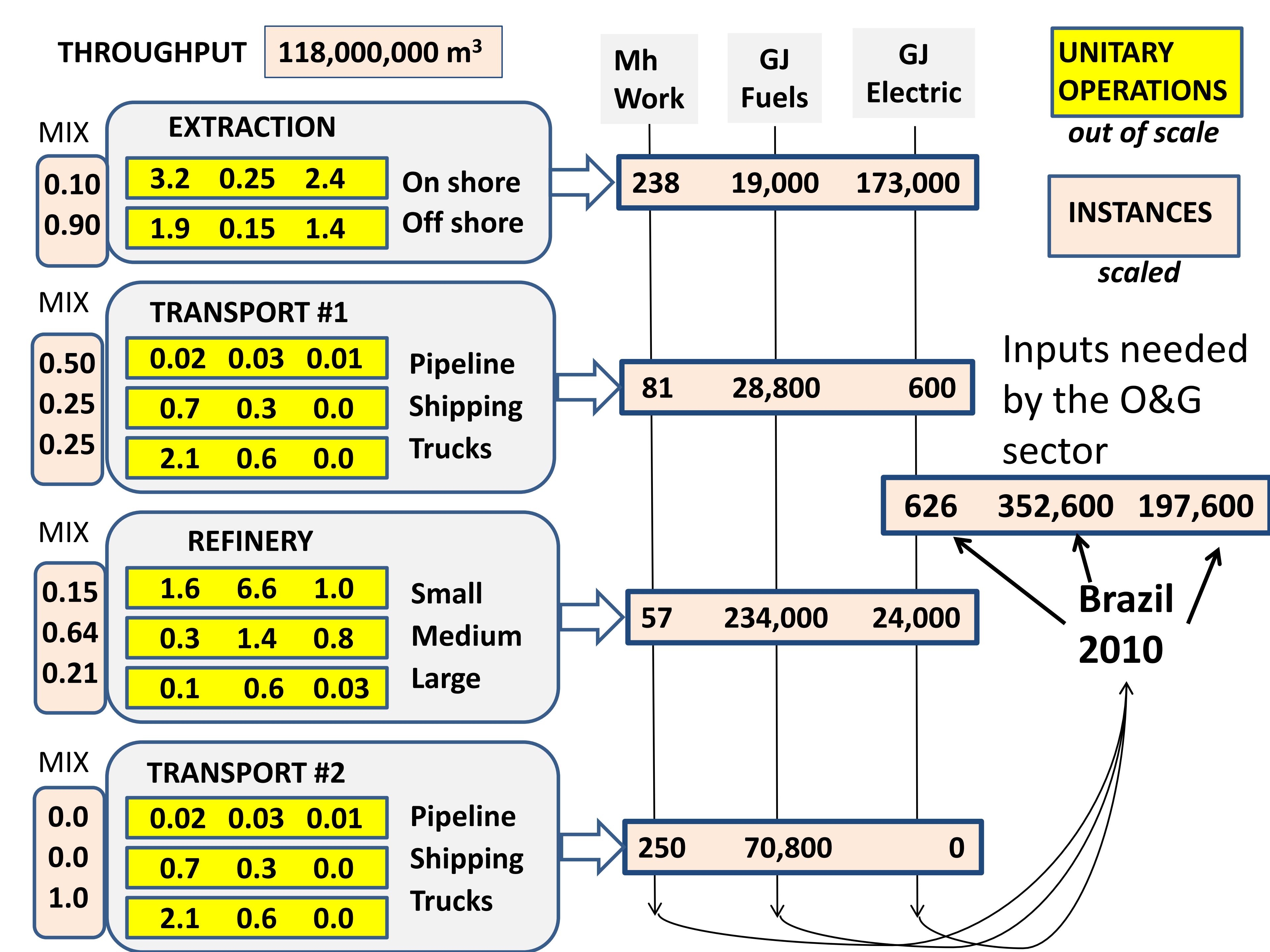
MIX					
0.15	1.6	6.6	1.0	Small	57 234,000 24,000
0.64	0.3	1.4	0.8	Medium	
0.21	0.1	0.6	0.03	Large	

TRANSPORT #2

MIX					
0.0	0.02	0.03	0.01	Pipeline	250 70,800 0
0.0	0.7	0.3	0.0	Shipping	
1.0	2.1	0.6	0.0	Trucks	



THROUGHPUT
118,000,000 m³
Mh Work
GJ Fuels
GJ Electric
MIX
0.10
0.90
EXTRACTION
3.2 0.25 2.4
1.9 0.15 1.4
On shore
Off shore
238 19,000 173,000
MIX
0.50
0.25
0.25
TRANSPORT #1
0.02 0.03 0.01
0.7 0.3 0.0
2.1 0.6 0.0
Pipeline
Shipping
Trucks
81 28,800 600
Inputs needed by the O&G sector
626 352,600 197,600
MIX
0.15
0.64
0.21
REFINERY
1.6 6.6 1.0
0.3 1.4 0.8
0.1 0.6 0.03
Small
Medium
Large
57 234,000 24,000
Brazil 2010
MIX
0.0
0.0
1.0
TRANSPORT #2
0.02 0.03 0.01
0.7 0.3 0.0
2.1 0.6 0.0
Pipeline
Shipping
Trucks
250 70,800 0


THROUGHPUT
118,000,000 m³
Mh Work
GJ Fuels
GJ Electric
UNITARY OPERATIONS
out of scale
INSTANCES
scaled
MIX
0.10
0.90
EXTRACTION
3.2 0.25 2.4
1.9 0.15 1.4
On shore
Off shore
238 19,000 173,000
MIX
0.50
0.25
0.25
TRANSPORT #1
0.02 0.03 0.01
0.7 0.3 0.0
2.1 0.6 0.0
Pipeline
Shipping
Trucks
81 28,800 600
Inputs needed by the O&G sector
626 352,600 197,600
MIX
0.15
0.64
0.21
REFINERY
1.6 6.6 1.0
0.3 1.4 0.8
0.1 0.6 0.03
Small
Medium
Large
57 234,000 24,000
Brazil 2010
MIX
0.0
0.0
1.0
TRANSPORT #2
0.02 0.03 0.01
0.7 0.3 0.0
2.1 0.6 0.0
Pipeline
Shipping
Trucks
250 70,800 0

ISSUE OF SCALE (2)

In order to assess environmental impact one has to individuate and use the right information:

(i) attributes of environmental stress have to be identified in relation to the specificity of embedding ecosystems;
(ii) the stress has to be assessed after scaling;

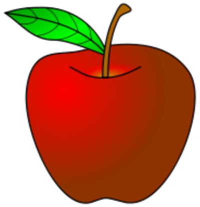
Therefore the analysis of environmental impact has to be based on georeferenced data (GIS).

Many conventional indicators of enviromental pressure are not useful because they are missing the implications of the difference between intensive variables (characteristics of types) and extensive variables (characteristics of instances . . .)

To assess environmental impact you have to define:
(i) the type of pollution;
(ii) the type of ecological funds which are polluted;
(iii) scaling this information to define the implications of the interaction under study.

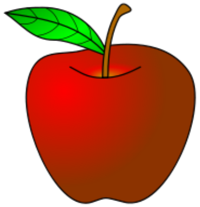
Using the measurement of the weight of an apple as an indicator to check whether the load is compatible with the truck . . .

Using the measurement of the weight of an apple as an indicator to check whether the load is compatible with the truck . . .

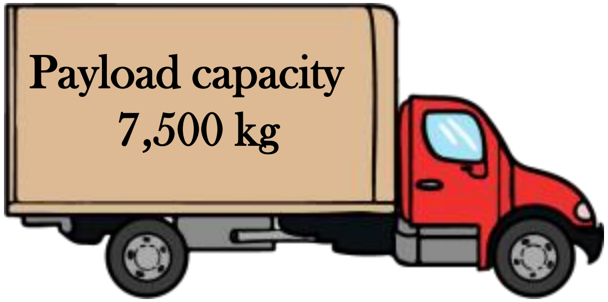


1 apple = 0.15 kg

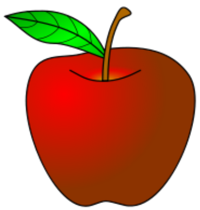
Using the measurement of the weight of an apple as an indicator to check whether the load is compatible with the truck . . .



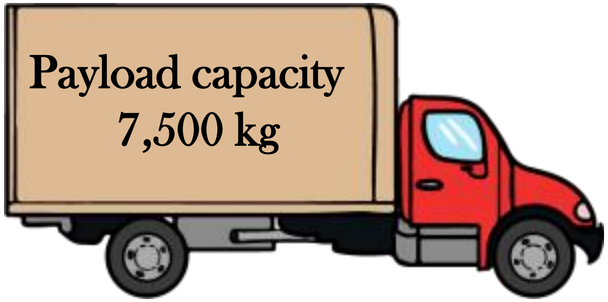
1 apple = 0.15 kg



Using the measurement of the weight of an apple as an indicator to check whether the load is compatible with the truck . . .

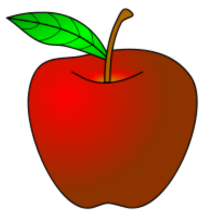


1 apple = 0.15 kg



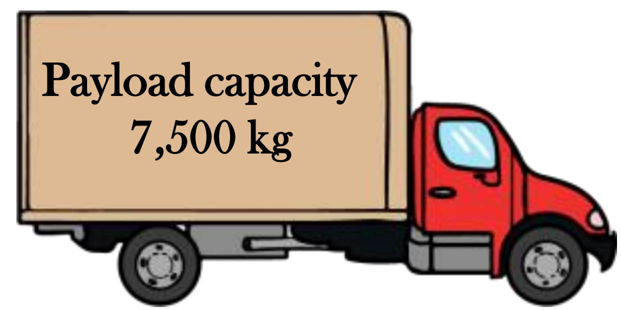
1 watermelon = 2.5 kg

Using the measurement of the weight of an apple as an indicator to check whether the load is compatible with the truck . . .



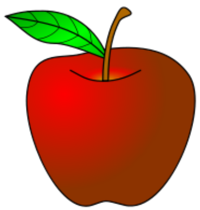
1 apple = 0.15 kg

120 apples + box = 21 kg



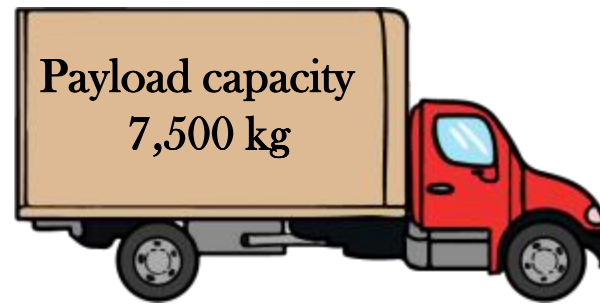
1 watermelon = 2.5 kg

Using the measurement of the weight of an apple as an indicator to check whether the load is compatible with the truck . . .



1 apple = 0.15 kg

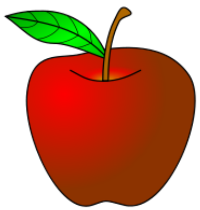
120 apples + box = 21 kg



1 watermelon = 2.5 kg

65 watermelons + box = 165 kg

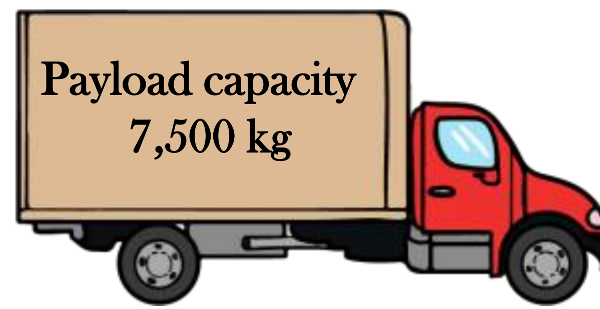
Using the measurement of the weight of an apple as an indicator to check whether the load is compatible with the truck . . .



1 apple = 0.15 kg

120 apples + box = 21 kg

360 boxes of apples

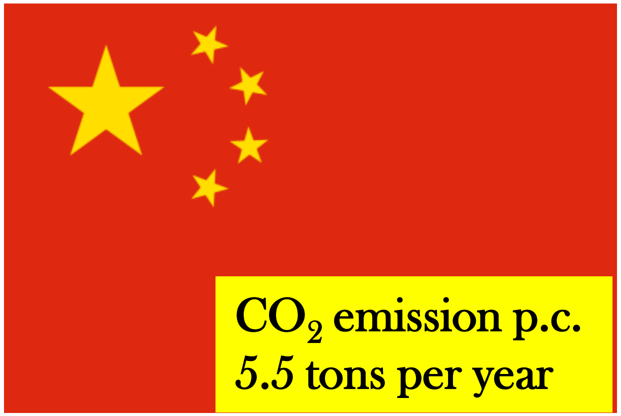


1 watermelon = 2.5 kg

65 watermelons + box = 165 kg

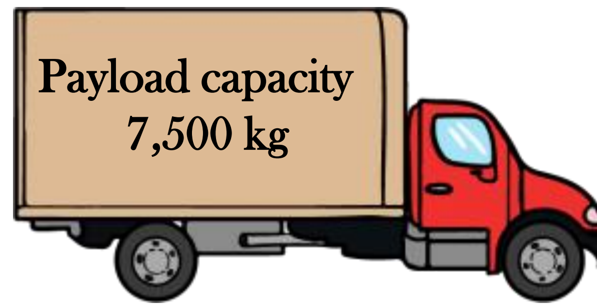
45 boxes of watermelons

Using the measurement of the weight of an apple as an indicator to check whether the load is compatible with the truck . . .



120 apples + box = 21 kg

360 boxes of apples



45 boxes of watermelons

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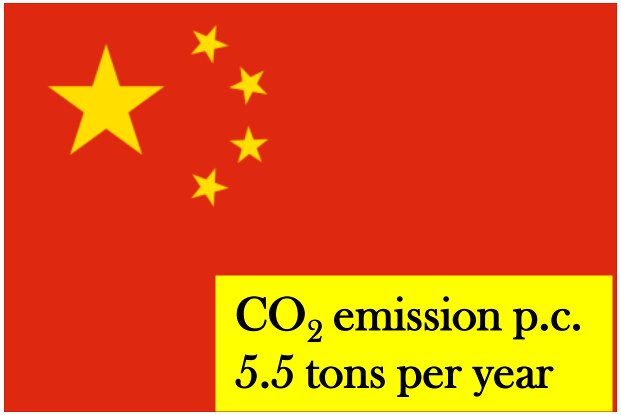
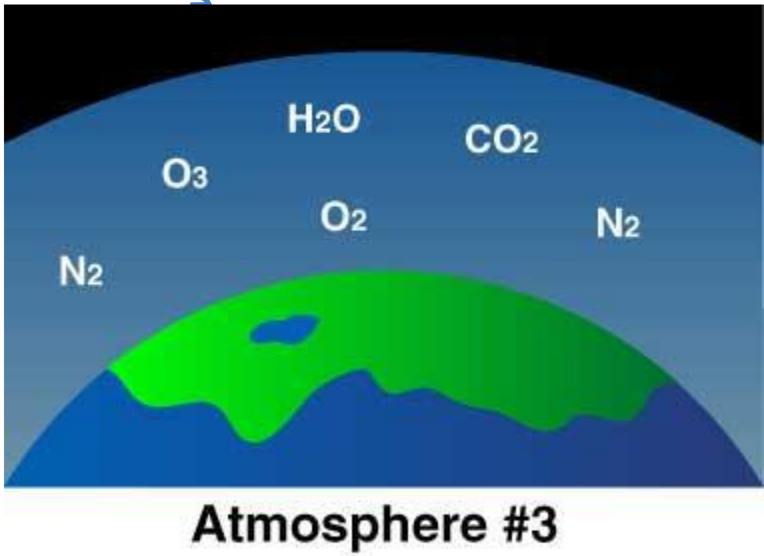


120 apples + box = 21 kg



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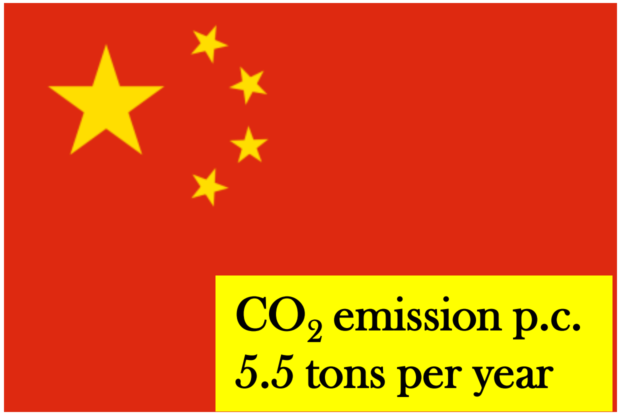
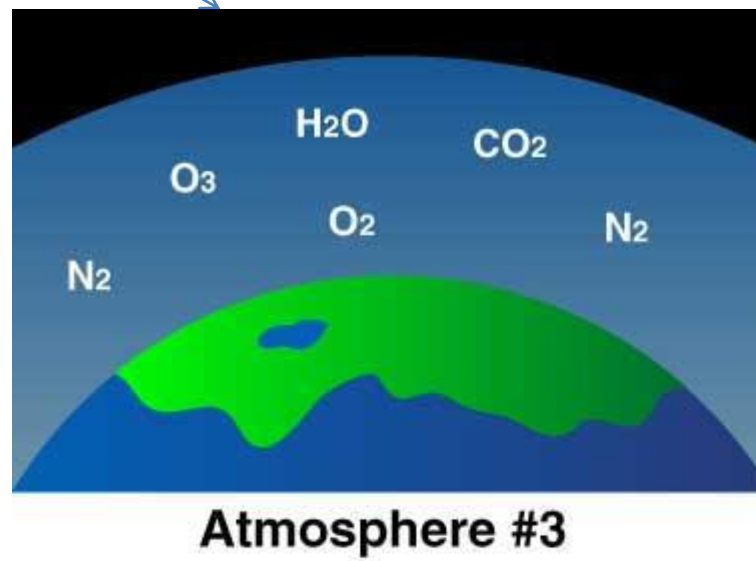
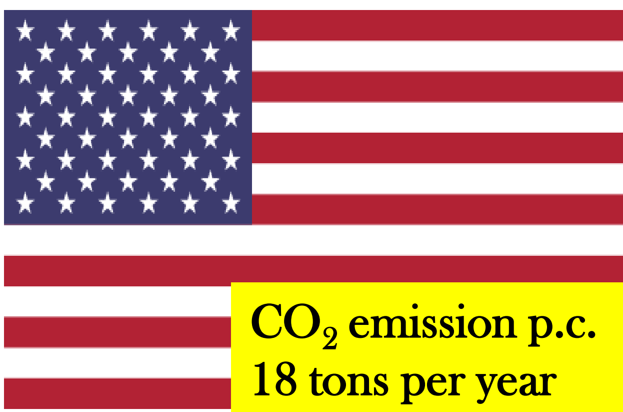
Using the measurement of the weight of an apple as an indicator to check whether the load is compatible with the truck . . .



CO_2 emission p.c.
5.5 tons per year

120 apples + box = 21 kg

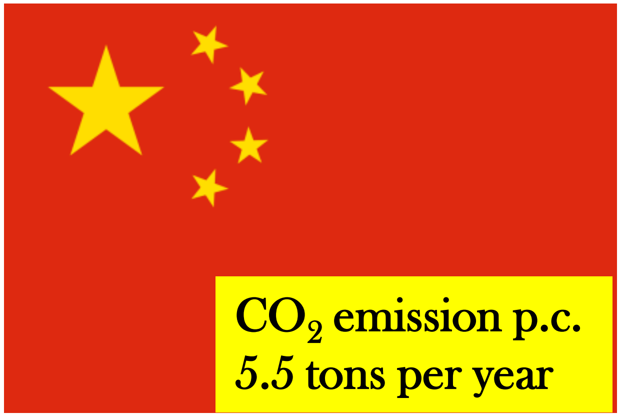




CO_2 emission p.c.
18 tons per year

65 watermelons + box = 165 kg

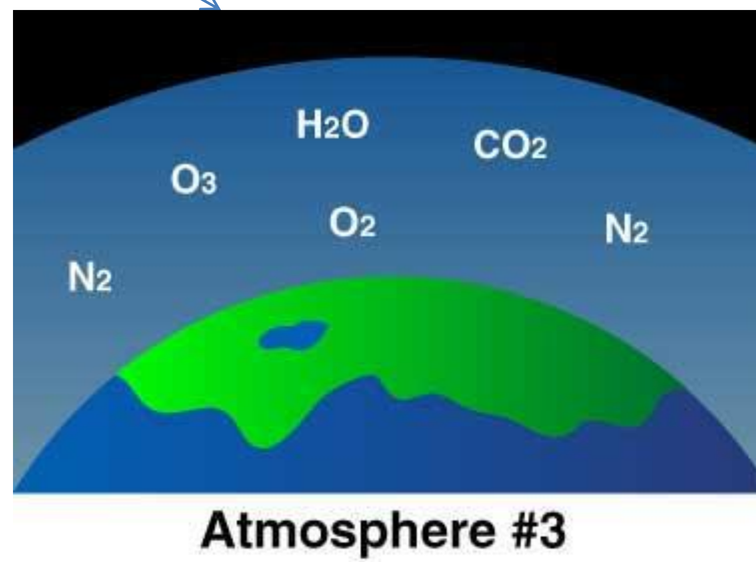
Using the measurement of the weight of an apple as an indicator to check whether the load is compatible with the truck . . .

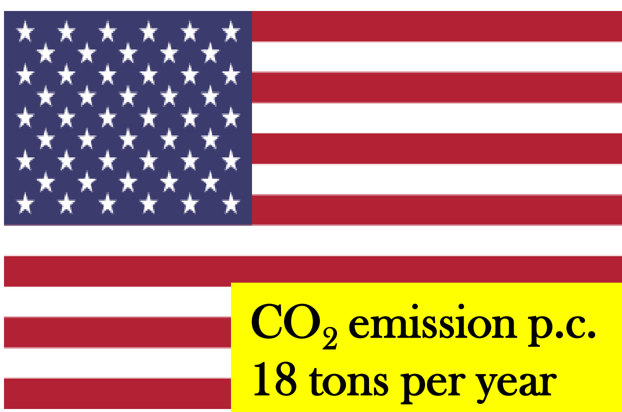


CO_2 emission p.c.
5.5 tons per year

Population
1,400 million

120 apples + box = 21 kg



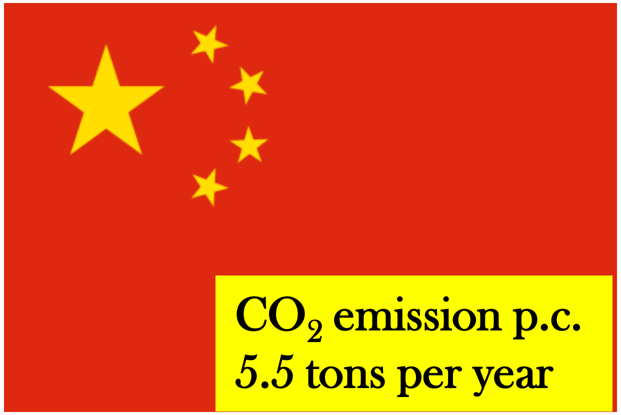


CO_2 emission p.c.
18 tons per year

Population
320 million

65 watermelons + box = 165 kg

Using the measurement of the weight of an apple as an indicator to check whether the load is compatible with the truck . . .

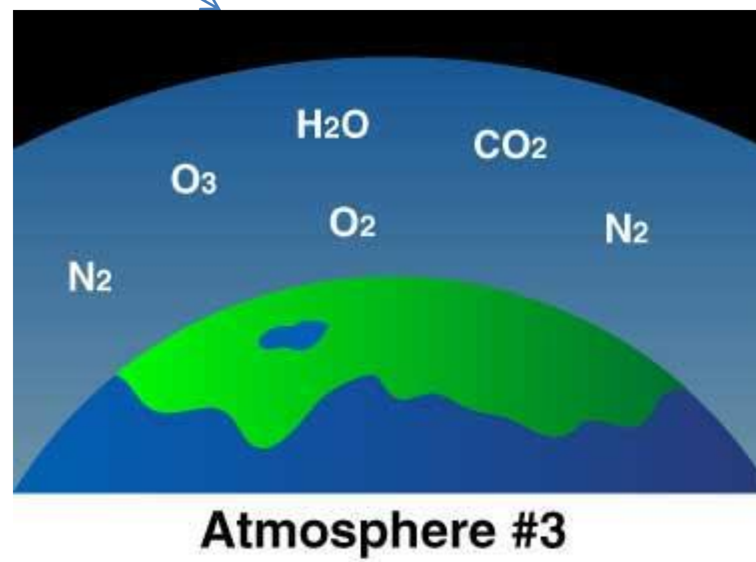


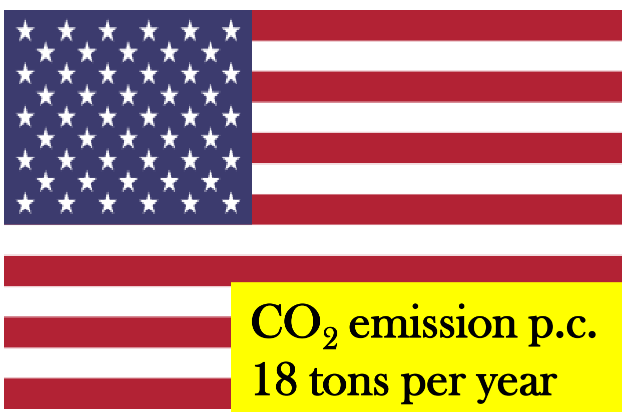
CO_2 emission p.c.
5.5 tons per year

Population
1,400 million

120 apples + box = 21 kg

load of CO_2
7.7 billion tons





CO_2 emission p.c.
18 tons per year

Population
320 million

65 watermelons + box = 165 kg

load of CO_2
5.8 billion tons

China

CO_2 emission p.c.
5.5 tons per year

USA

CO_2 emission p.c.
18 tons per year

INTENSIVE VARIABLES
they characterize in qualitative terms the society but they need scaling

China

CO_2 emission p.c.
5.5 tons per year

Qualitative characteristics of human society

USA

CO_2 emission p.c.
18 tons per year

INTENSIVE VARIABLES
they characterize in qualitative terms the society but they need scaling

China

CO_2 emission p.c.
5.5 tons per year

Population
1,400 million

Qualitative characteristics of human society

Quantitative characteristics of human society

USA

CO_2 emission p.c.
18 tons per year

Population
320 million

INTENSIVE VARIABLES
they characterize in qualitative terms the society but they need scaling

China

CO_2 emission p.c.
5.5 tons per year

Qualitative characteristics of human society

USA

CO_2 emission p.c.
18 tons per year

EXTENSIVE VARIABLES
they make it possible the scaling, after having characterized the society (how much society)

Population
1,400 million

Quantitative characteristics of human society

Population
320 million

INTENSIVE VARIABLES
they characterize in qualitative terms the society but they need scaling

EXTENSIVE VARIABLES
they make it possible the scaling, after having characterized the society (how much society)

China

CO_2 emission p.c.
5.5 tons per year

Population
1,400 million

load of CO_2
7.7 billion tons

Qualitative characteristics of human society

Quantitative characteristics of human society

Quantitative and qualitative characteristics of the pressure

USA

CO_2 emission p.c.
18 tons per year

Population
320 million

load of CO_2
5.8 billion tons

INTENSIVE VARIABLES
they characterize in qualitative terms the society but they need scaling

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CO_2 emission p.c.
5.5 tons per year

Qualitative characteristics of human society

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EXTENSIVE VARIABLES
they make it possible the scaling, after having characterized the society (how much society)

Population
1,400 million

Quantitative characteristics of human society

Population
320 million

EXTENSIVE VARIABLES
they make it possible to define the pressure (how much CO_2 has to be absorbed by atmosphere)

load of CO_2
7.7 billion tons

Quantitative and qualitative characteristics of the pressure

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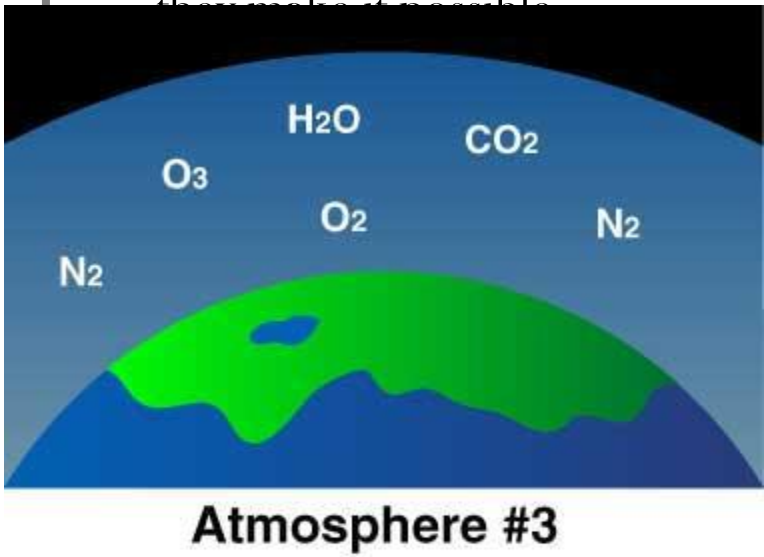

Quantitative and qualitative characteristics of the pressure

How much is too much?

How large is this flow in relation to the sink capacity of the atmosphere?

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Quantitative characteristics of human society

Population
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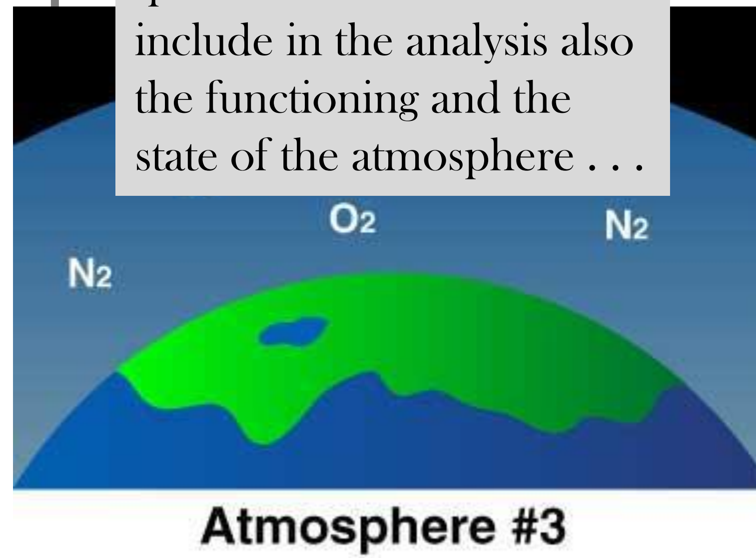
In order to answer these questions we have to include in the analysis also the functioning and the state of the atmosphere . . .



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Do 100 kg of salt generate more environmental impact than 50 kg of salt?

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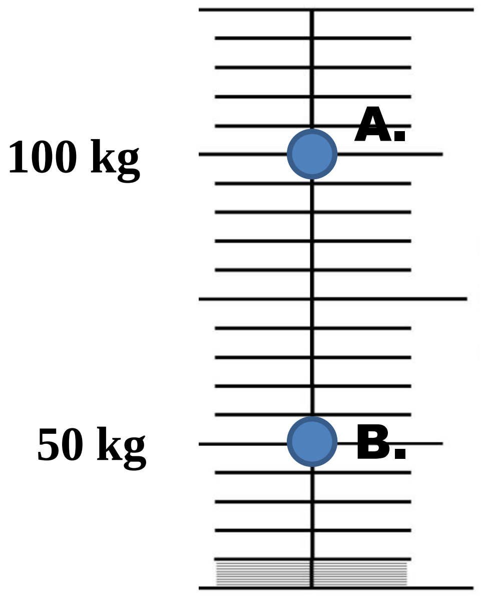
Just numbers!



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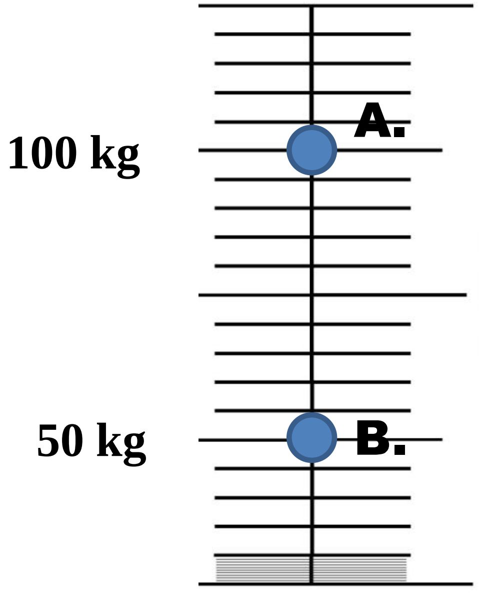

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How do we know how much is too much?

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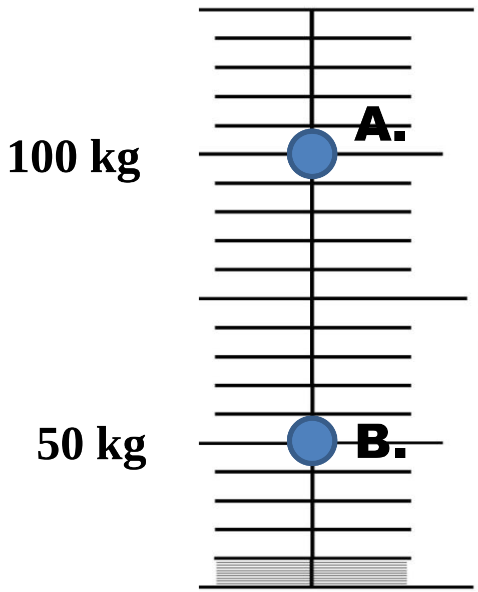
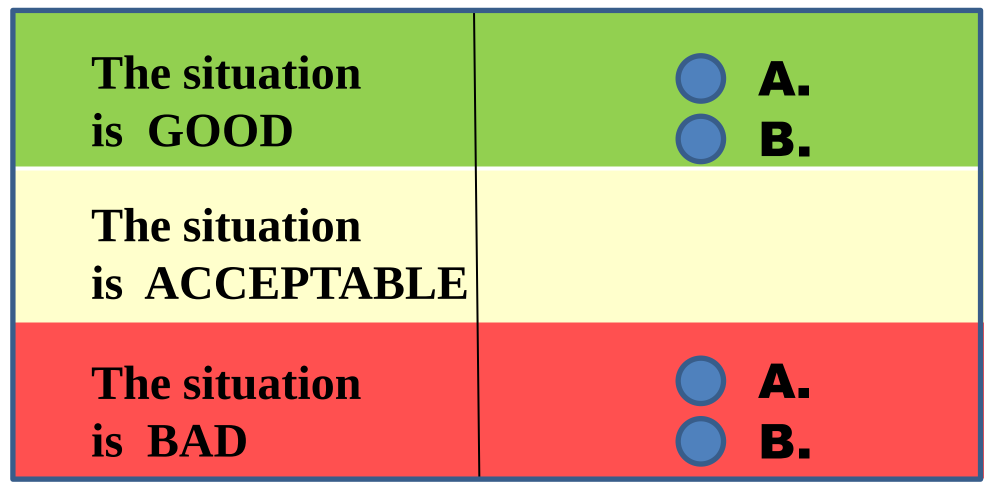


Numbers have to be assessed against benchmarks!



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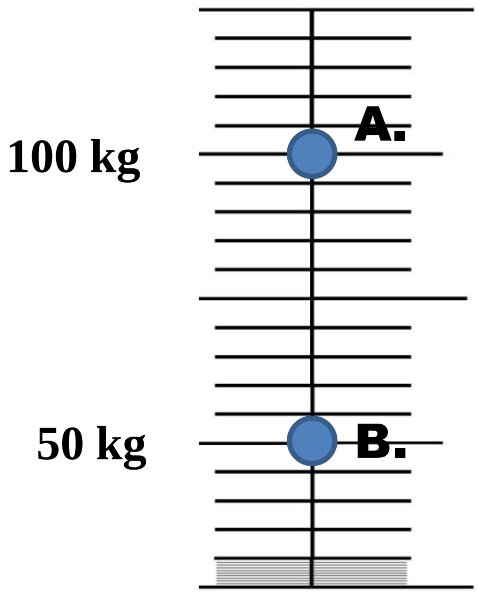

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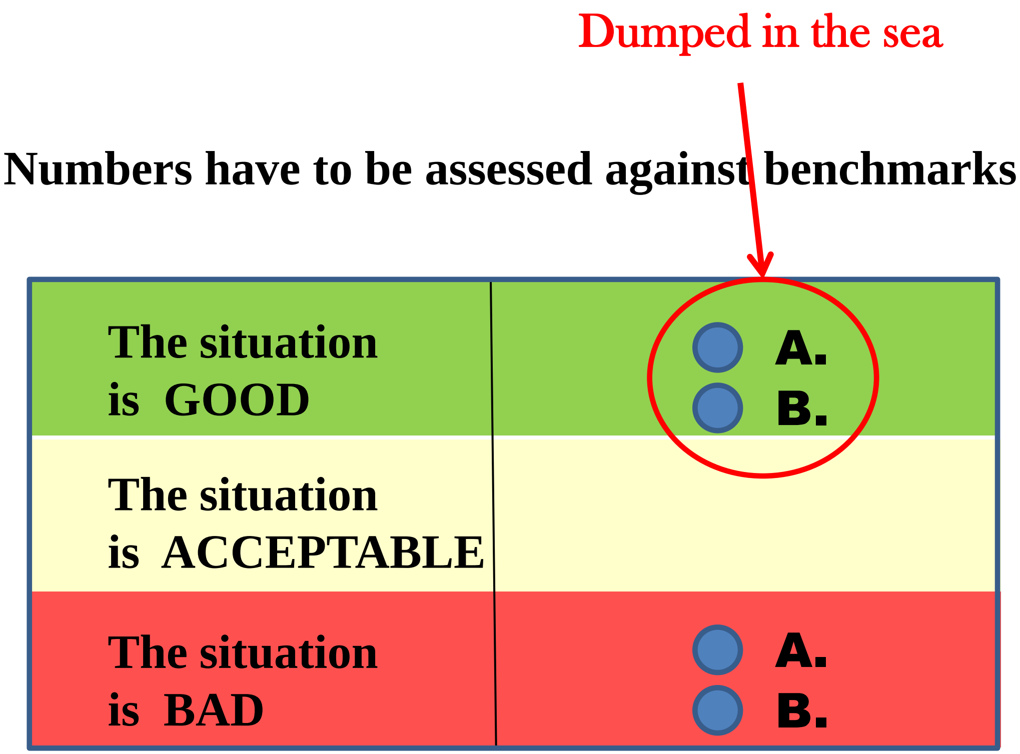

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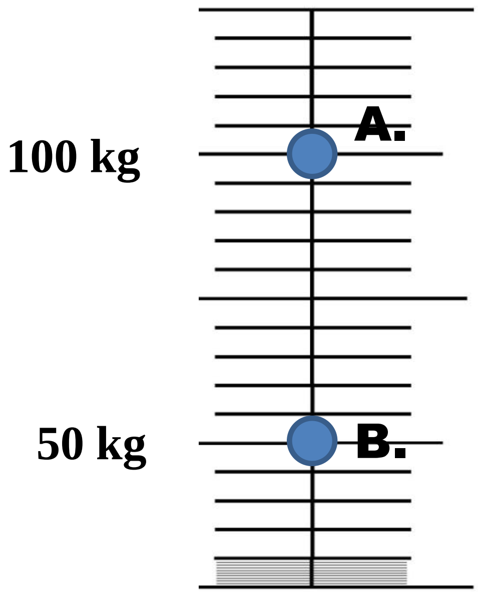

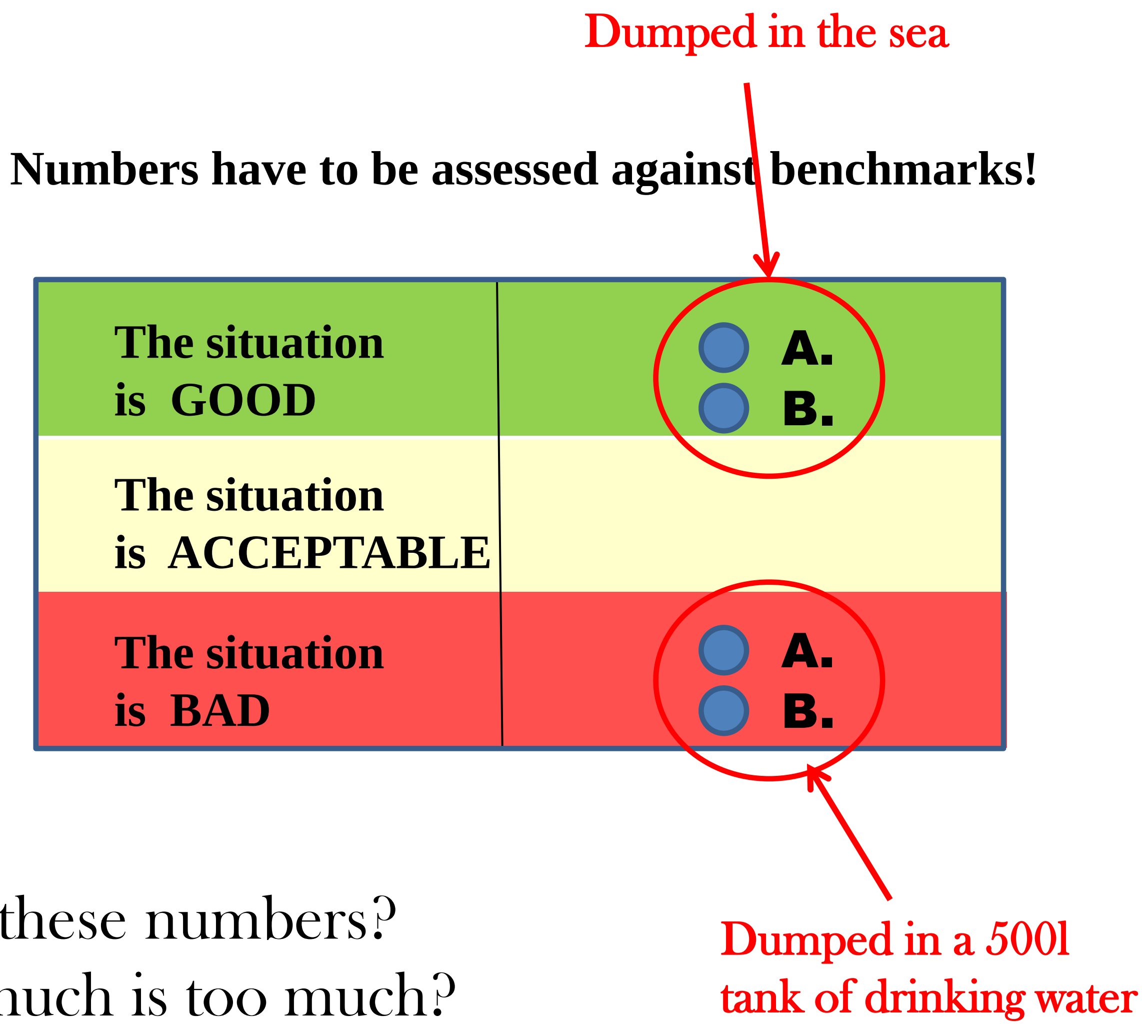

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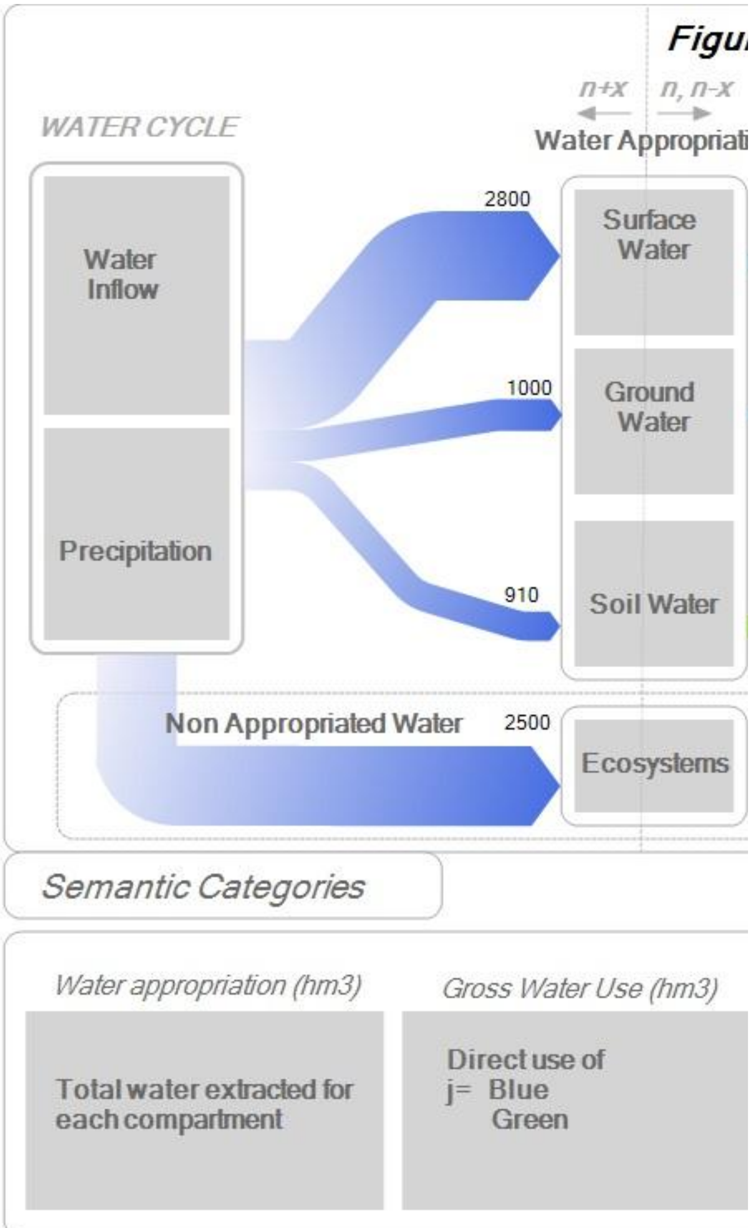
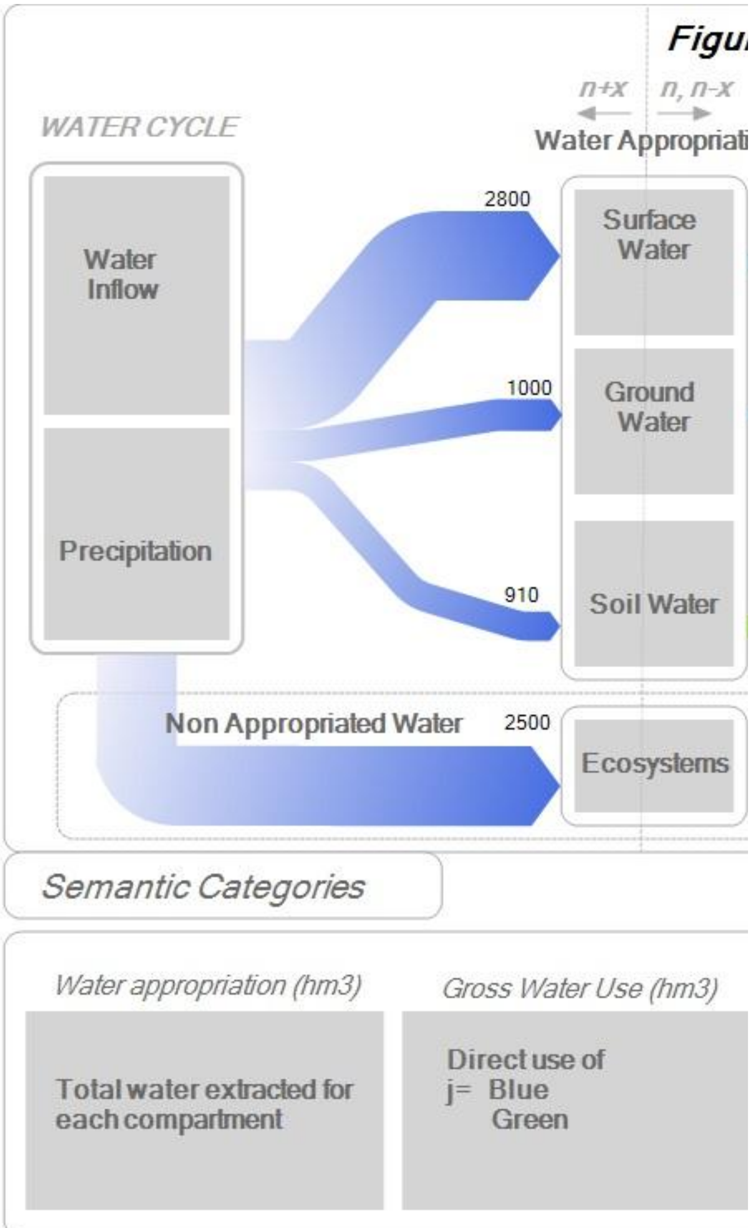
How do we know how much is too much?

4. Environment

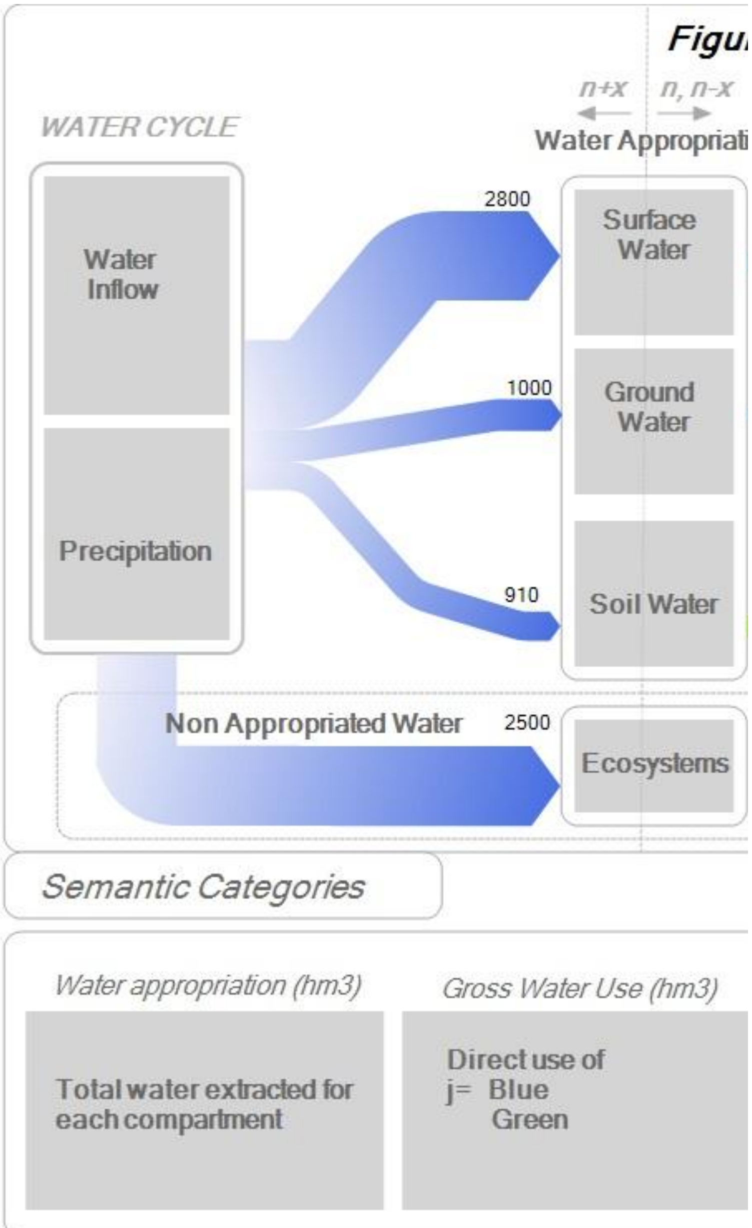


Water Accounting

4. Environment



Indicator/ Compartment	Extraction Total	EXT Blue-Surface	EXT Blue-Ground	EXT Green	USE Losses	USE Total
Whole (n)	**1,706**	**555**	**432**	**718**	**108**	**1,599**
HH (n-1)	**98**	74	24	0	14	**84**
HH-Urban (n-2)	**41**	31	10	0	0	**35**
HH-Rural (n-2)	**57**	43	14	0	0	**49**
PW (n-1)	**1,608**	481	408	718	94	**1,515**
PW-SG (n-2)	**17**	13	4	0	2	**15**
PW-TR (n-2)	**1.72**	1.30	0.42	0	0	**1**
PW-BM (n-2)	**27**	20	7	0	4	**23**
PW-EM (n-2)	**262**	255	7	0	4	**258**
PW-AG (n-2)	**1,300**	192	390	718	84	**1,218**



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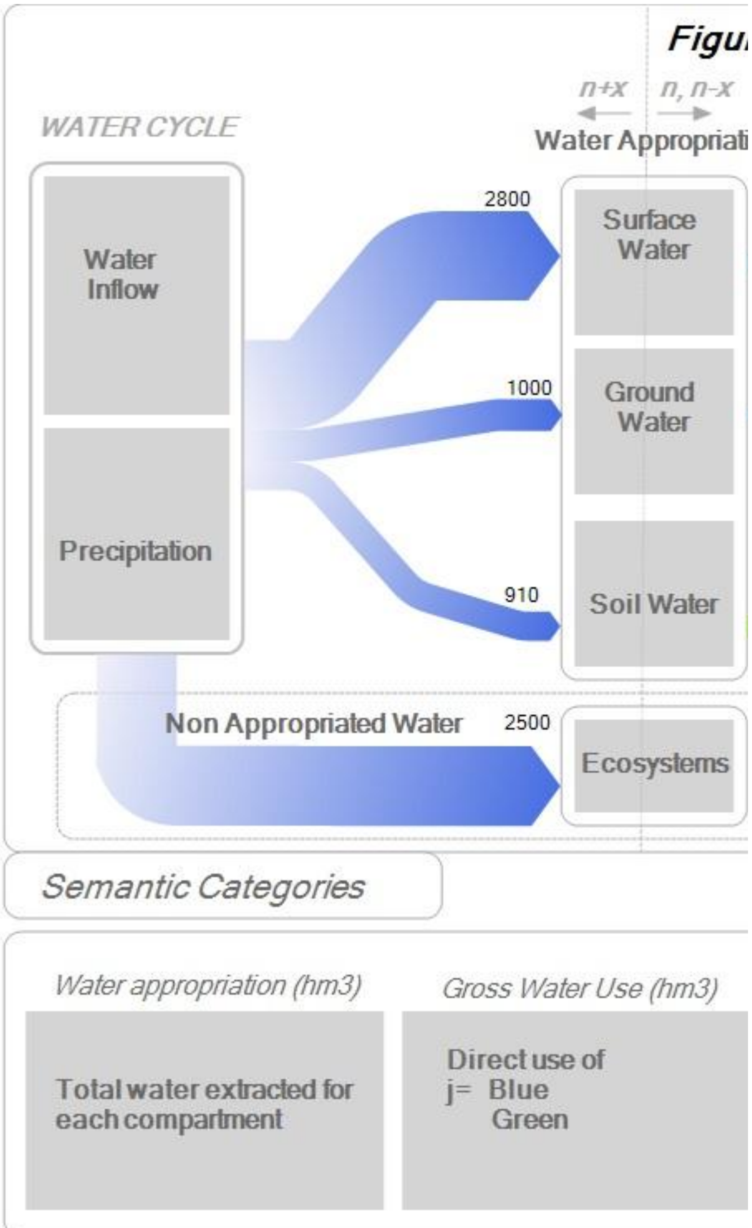
Indicator/Compartment (Supply system)	Extraction-TOTAL	Water Renewable Res ources (WRR)			Extraction as (%) WRR
		Surface Inflow	Ground Inflow	**Total**	
Territorial System Covered (n+1)	**1,492**	2,055	778	**2,834**	53
Mare Aux Vacoas-Upper (n+1)	**252**	344	130	**474**	53
Mare Aux Vacoas-Lower (n+1)	**193**	88	34	**122**	**158**
Port-Louis (n+1)	**291**	562	213	**775**	38
North (n+1)	**291**	259	98	**358**	**81**
South (n+1)	**247**	383	145	**528**	47
East (n+1)	**229**	464	176	**640**	36
Uncovered (n+1)	**214**	820	311	**1,130**	19
TOTAL (n)	**1,706**	2,875	1,089	**3,964**	**43**

Water Accounting

4. Environment



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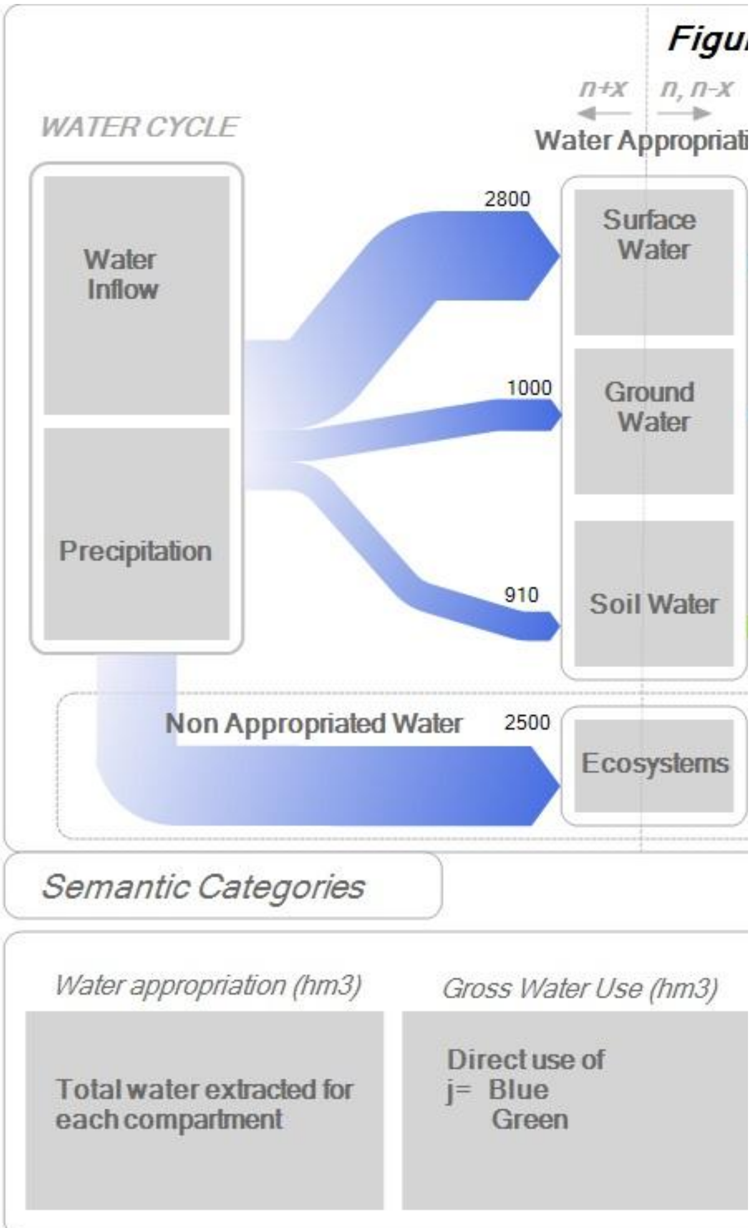

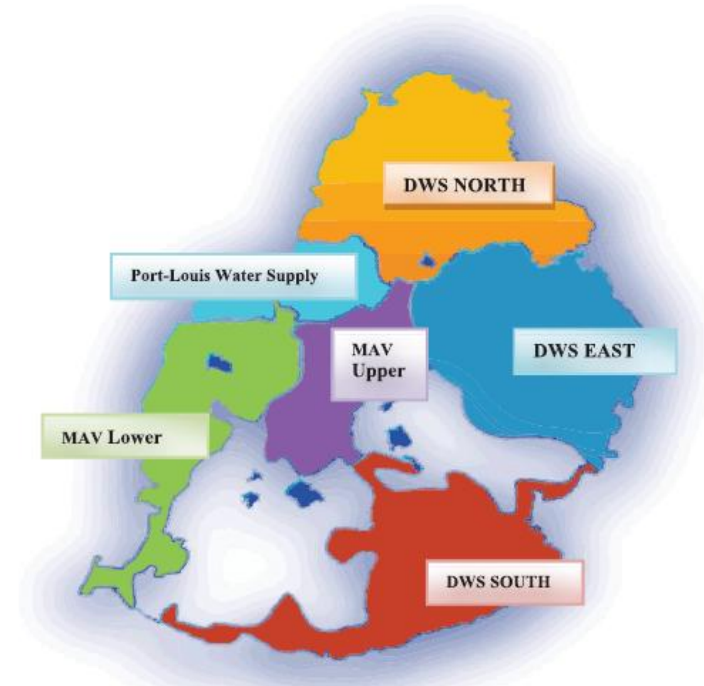

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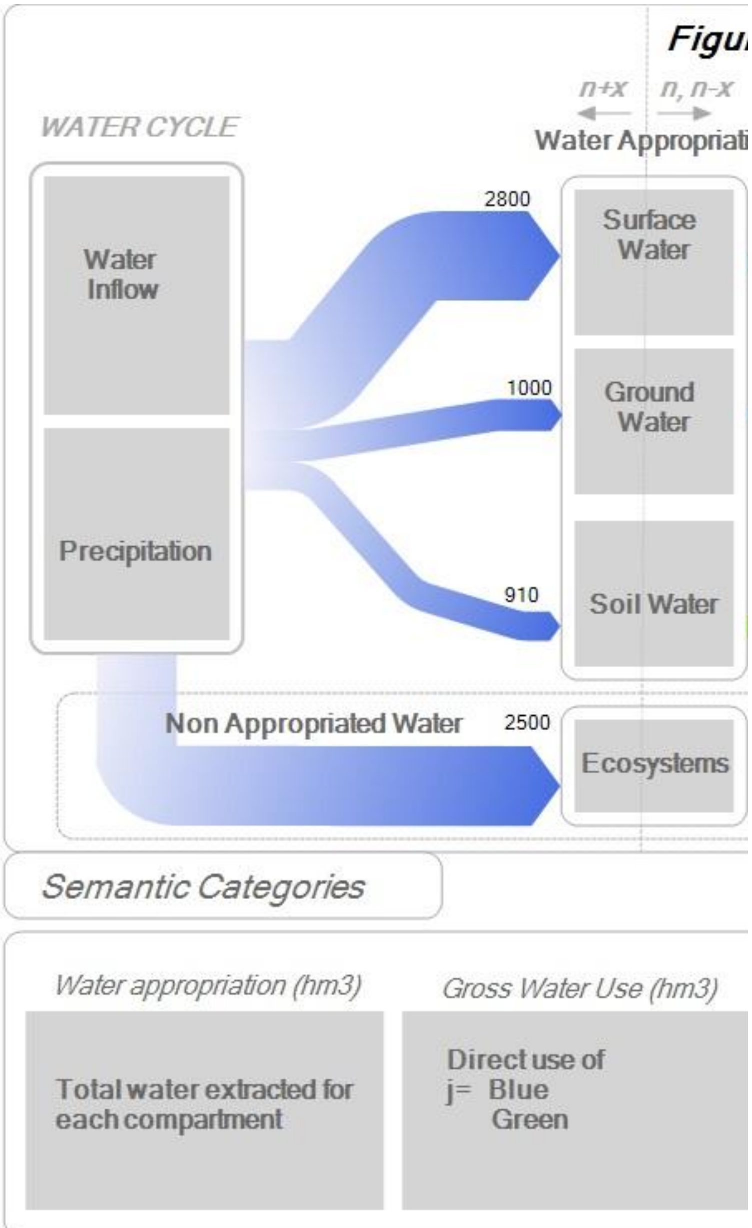

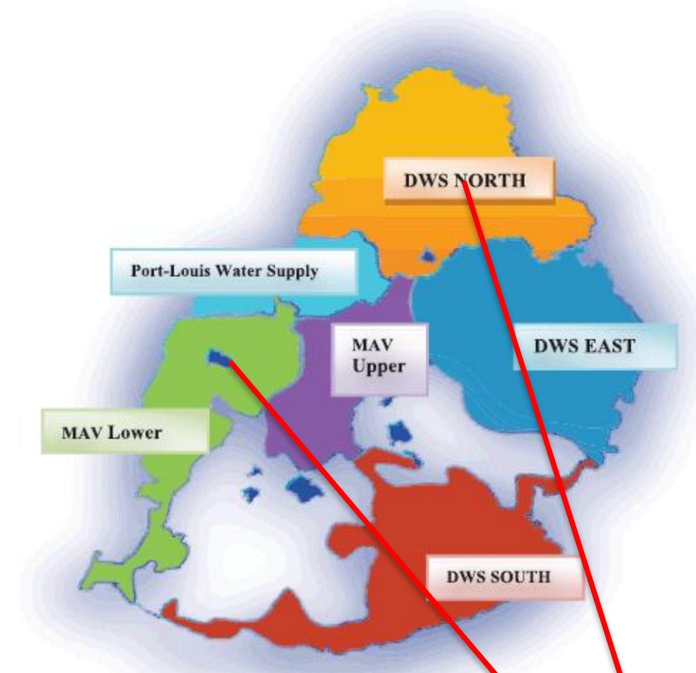

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Water Accounting

ENVIRONMENTAL IMPACT MATRIX

Taxonomy of ecological funds and categories of enviromental impact

TYPOLOGY OF FUNDS		SUPPLY STRESS INDICATOR	SINK STRESS INDICATOR
Terrestrial ecosystems	Boreal forests		
	Tropical forests		
	…..		
Aquatic (inland) ecosystems	Rivers		
	Wetlands		
	……		
Marine/Coastal systems	Gulf		
	Beach		
	….		
Soil	Alfisol		
	Oxisol		
	….		
Atmosphere	Global		
	Local		

3. Moving away from numbers and models toward a quantitative analysis based on patterns and grammars

FIGTHING HYPOCOGNITION (1)

Using the metaphor:

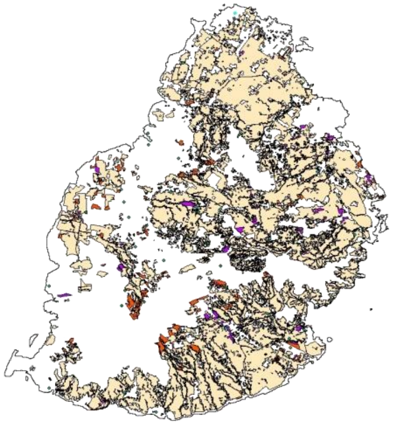
Moving away from Traditional Maps
To Geographic Information System

Old fashion map of Mauritius with information about the elevation of the points

Old fashion map of Mauritius with information about the elevation of the points

Quantitative models see only a dimension at the time . . .

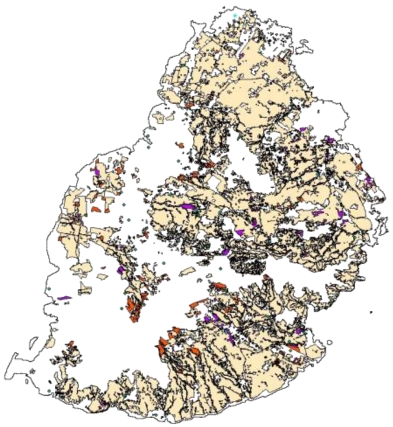
Crop mix



Current

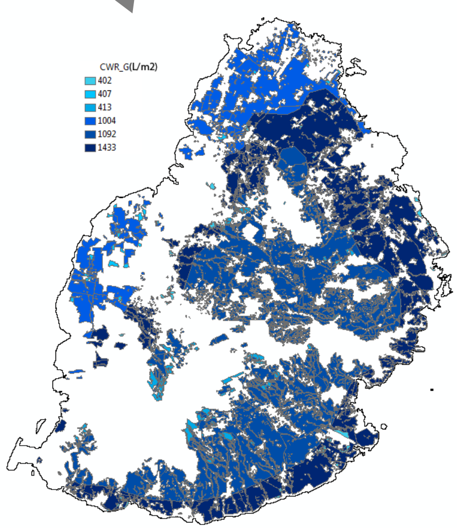
Pattern

Crop mix



Current

Pattern



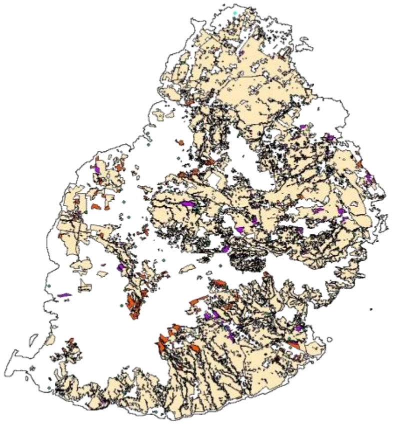
Current

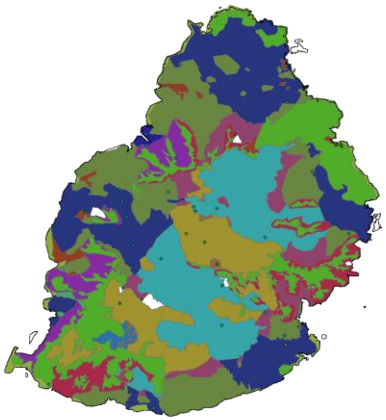
Water

use

Crop mix

Types of Soil





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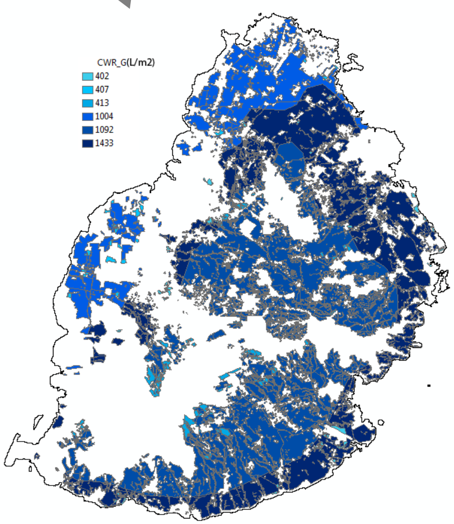

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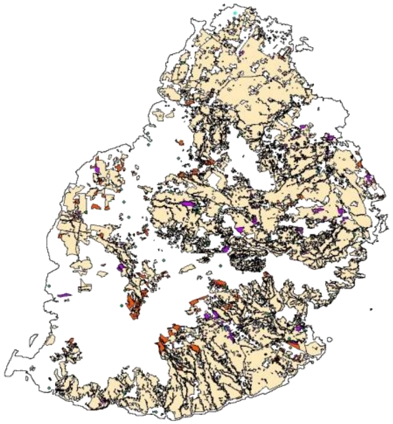

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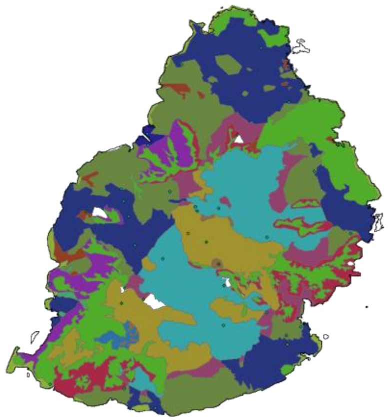
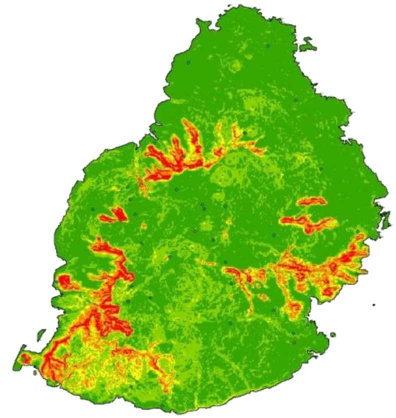
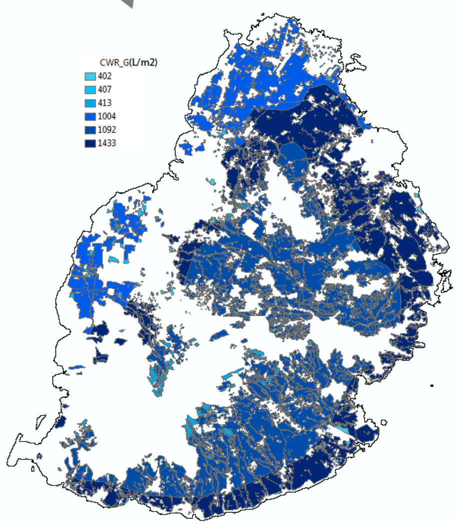


Slope

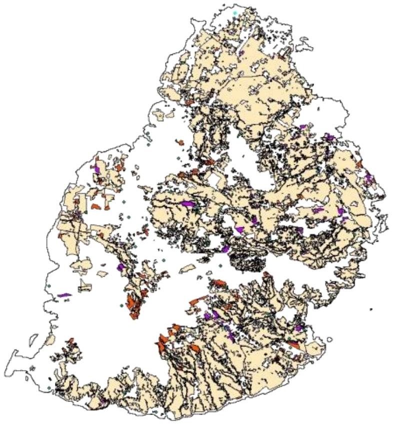


Current Pattern

Current Water use

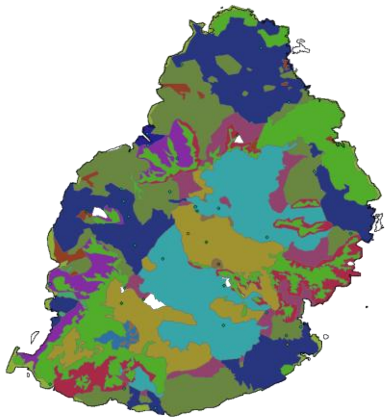


Crop mix



Current Pattern

Types of Soil



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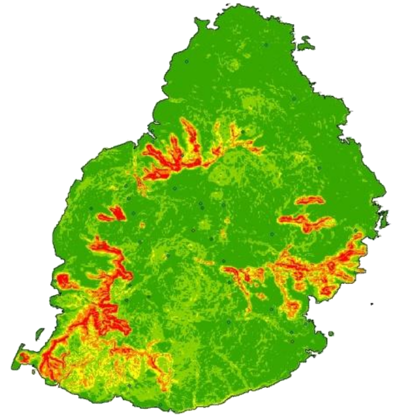
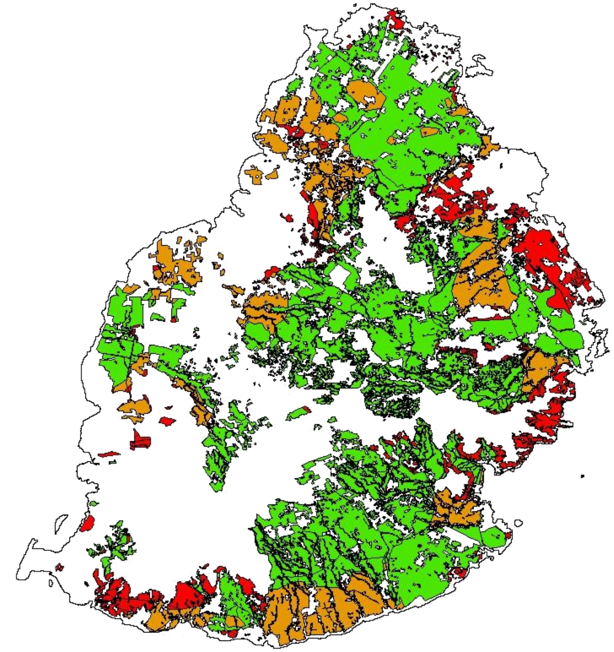
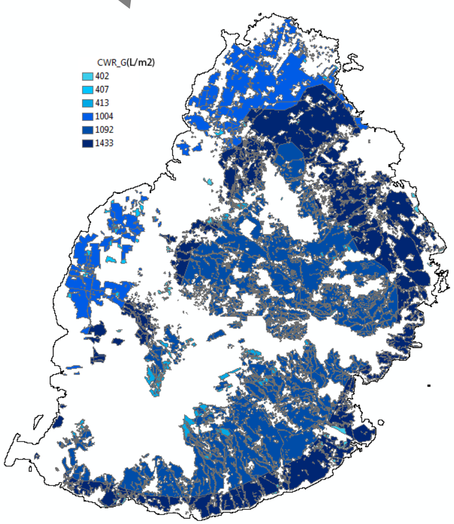
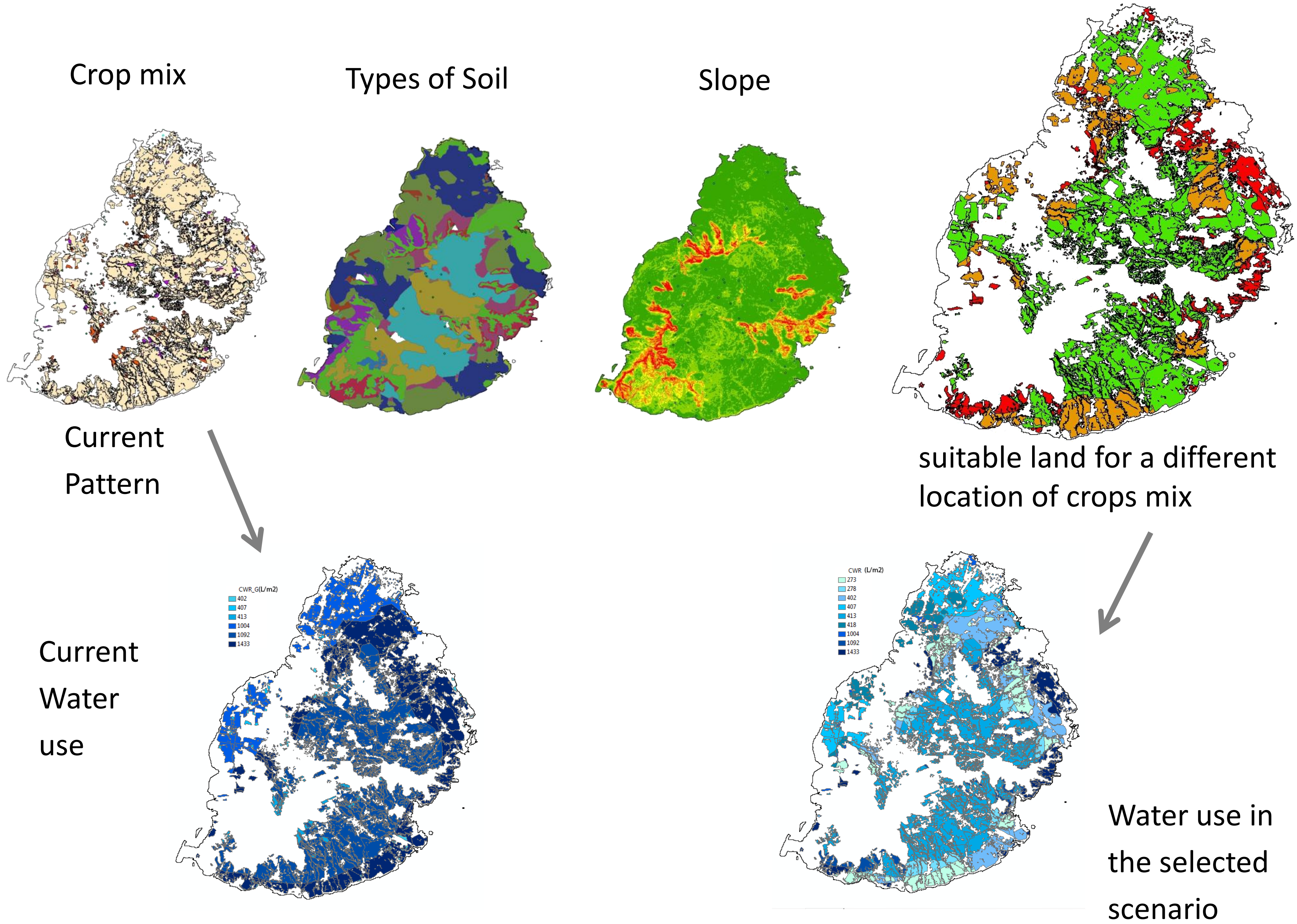




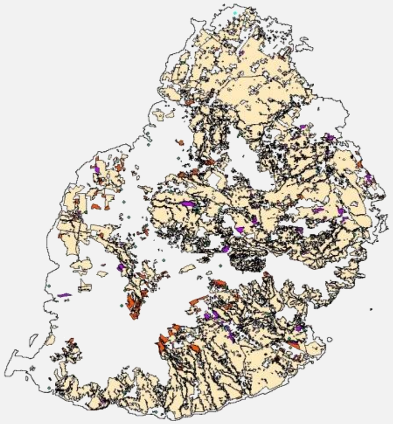
suitable land for a different location of crops mix

Current Water use



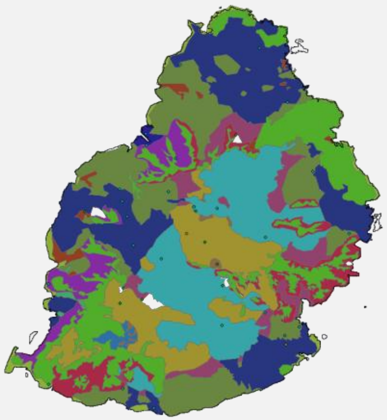

Crop mix
Types of Soil
Slope
Current
Pattern
suitable land for a different
location of crops mix
Current
Water
use
CWR_G(L/m2)
402
407
413
1004
1092
1433
CWR (L/m2)
273
278
402
407
413
418
1004
1092
1433
Water use in
the selected
scenario

Crop mix



Current Pattern

Types of Soil



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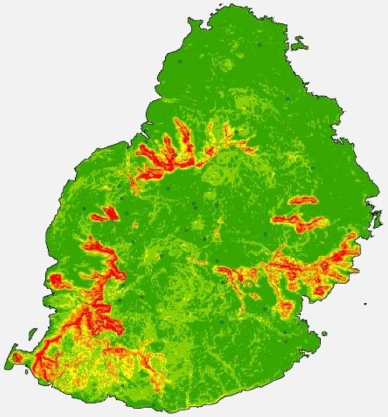
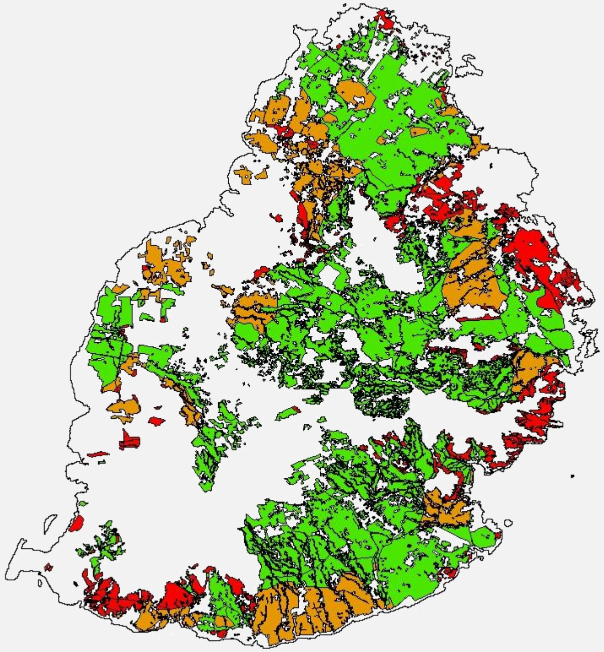
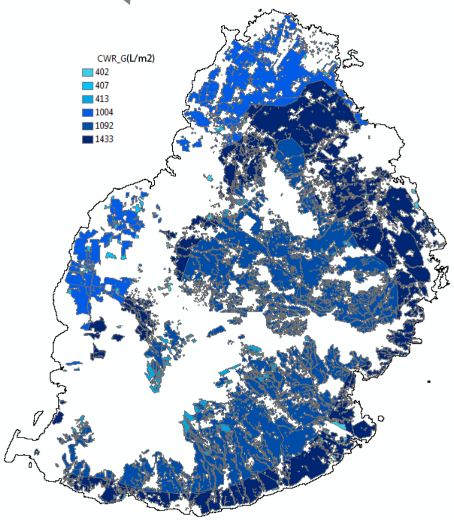


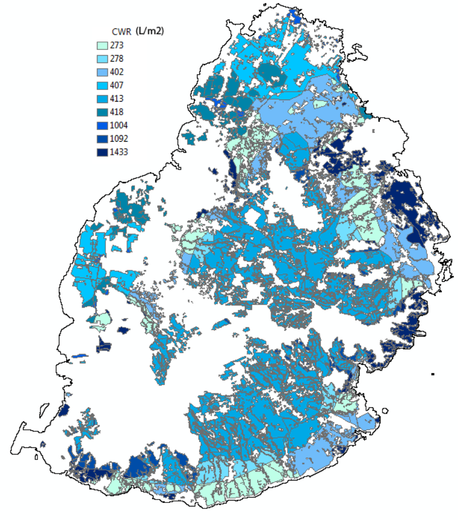


suitable land for a different location of crops mix

Food story-telling

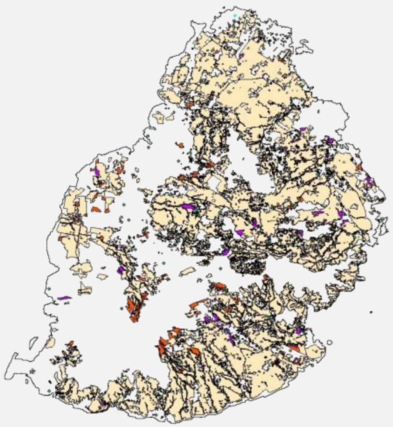
Current Water use





Water use in the selected scenario

Crop mix



Current Pattern

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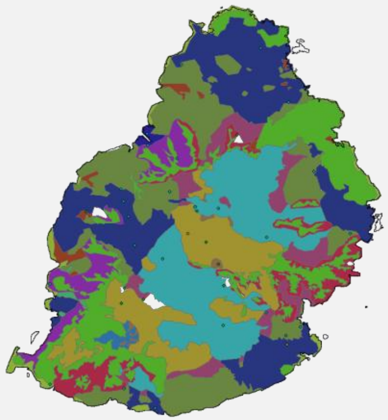

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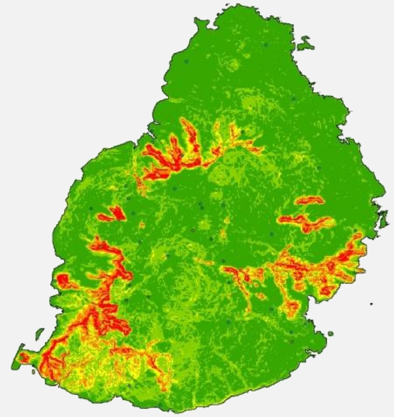
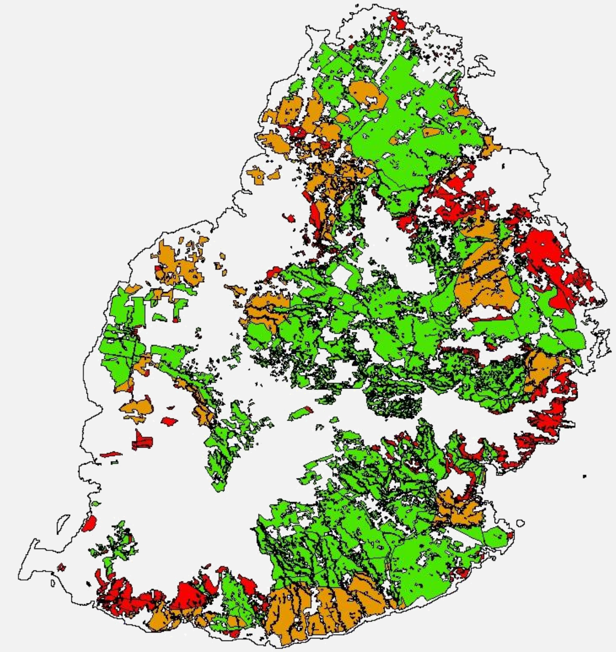
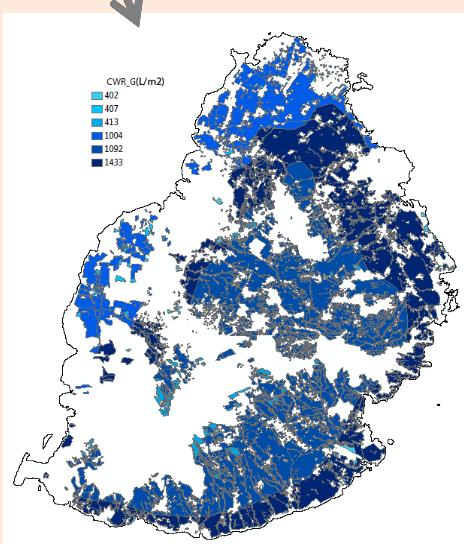


Food story-telling

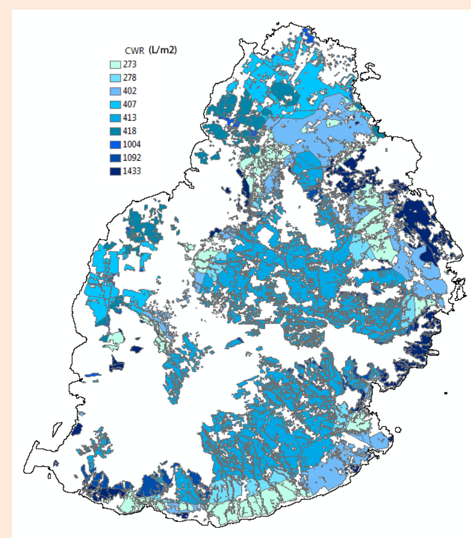


suitable land for a different location of crops mix

Current Water use



Water story-telling



Water use in the selected scenario

FIGTHING HYPOCOGNITION (2)

Moving away from assessments based on "a single set of numbers" to assessments based on "several sets of numbers" that are integrated using grammars

A GRAMMAR is a set of expected relations defined over a set of semantic categories. This implies that a GRAMMAR is a sort of meta-model that can be tailored on: (i) the specificity of the research question; and (ii) the specificity of the investigated system

3. A set of production rules – establishing causality in the chosen representation - deciding what should be considered as either a dependent or independent variable (escaping impredicativity)

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1. **A taxonomy - defining the perception of what is relevant**
the definition of semantic categories (the types of types)

3. **A set of production rules – establishing causality in the chosen representation** - deciding what should be considered as either a dependent or independent variable (escaping impredicativity)

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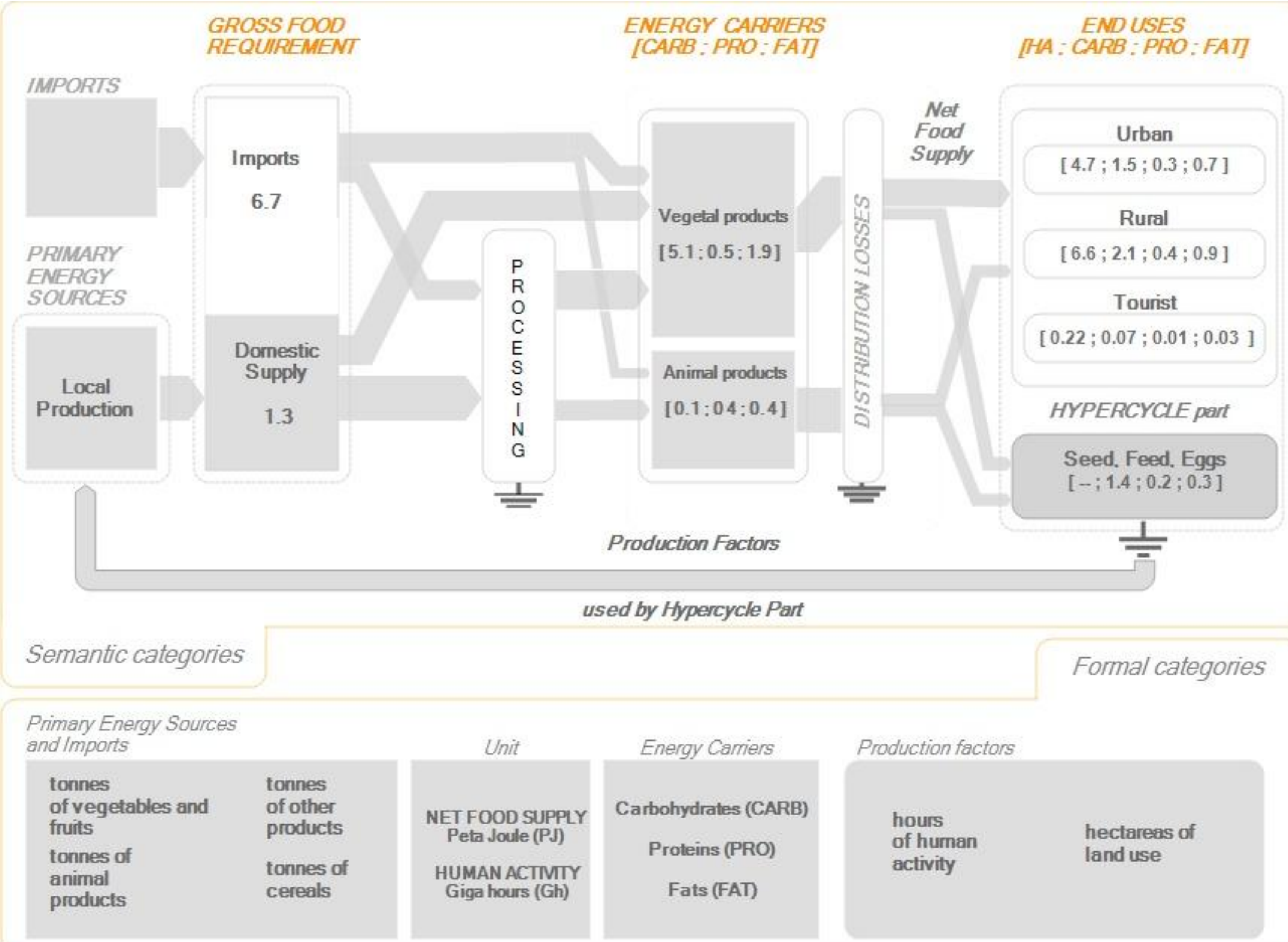
1. A taxonomy - defining the perception of what is relevant
the definition of semantic categories (the types of types)

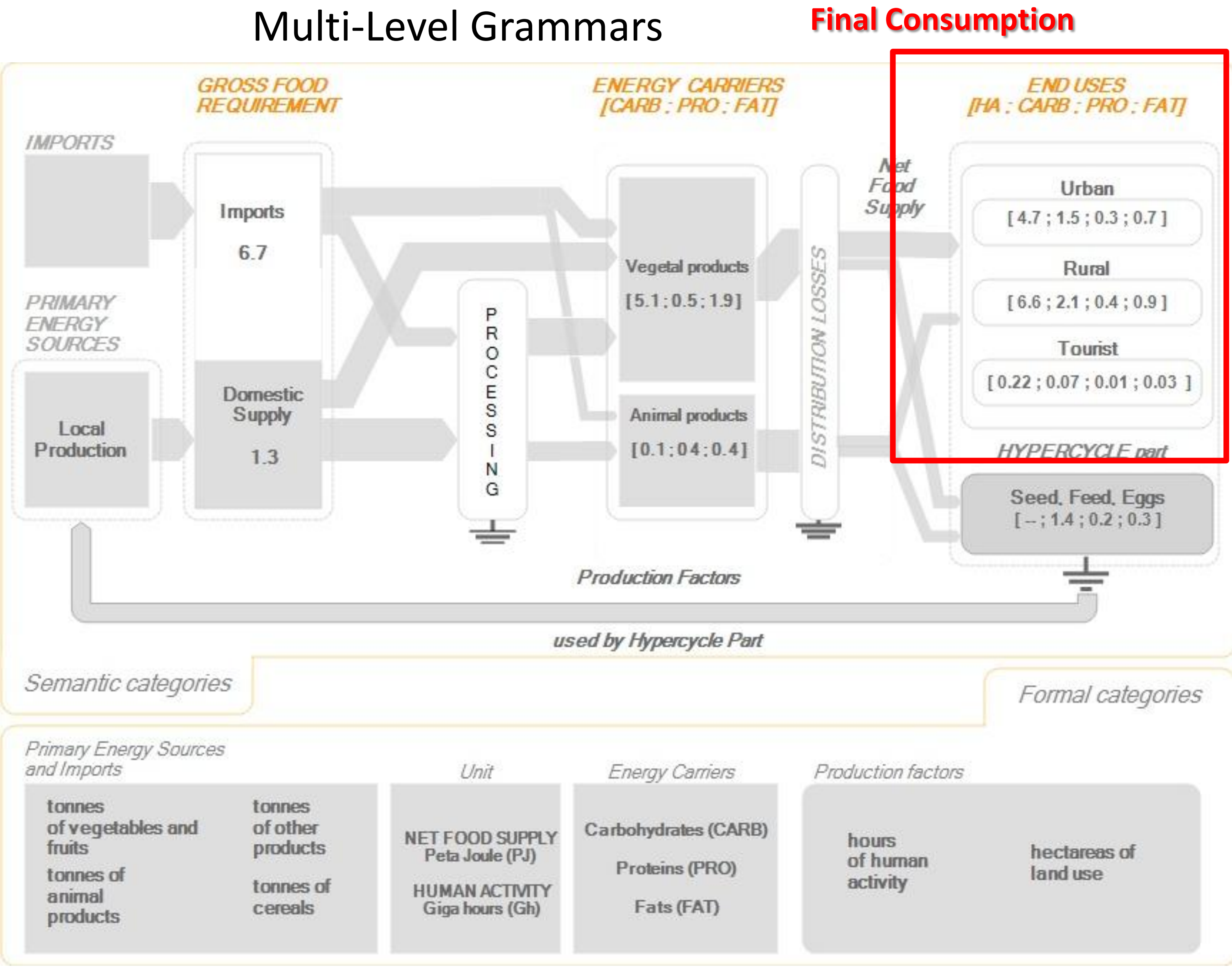
2. A lexicon (vocabulary) – choosing what is observed/represented
the definition of external referents to be assigned to the types (the formal identities used to represent the elements)

3. A set of production rules – establishing causality in the chosen representation - deciding what should be considered as either a dependent or independent variable (escaping impredicativity)

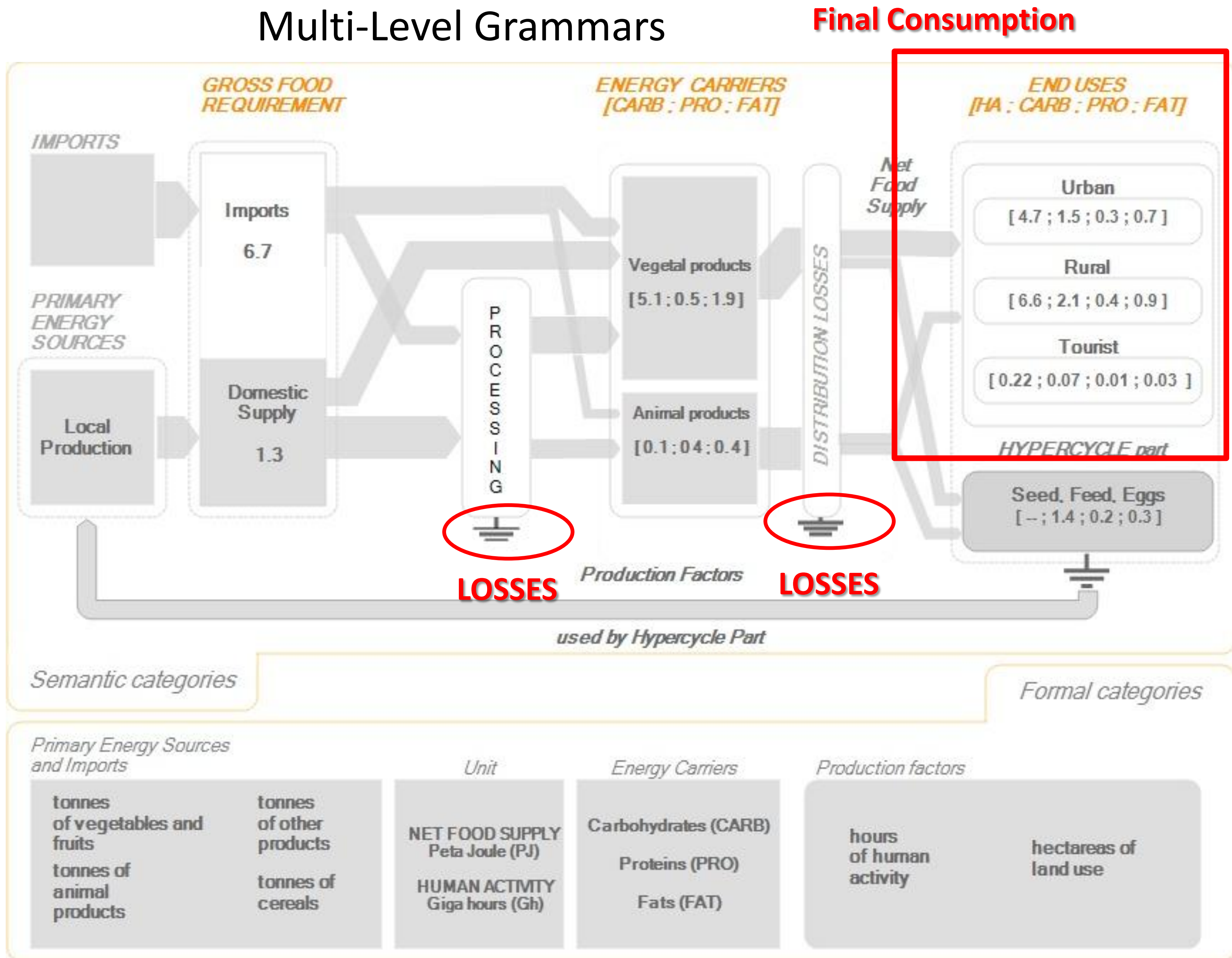
Multi-Level Grammars



Multi-Level Grammars



Multi-Level Grammars



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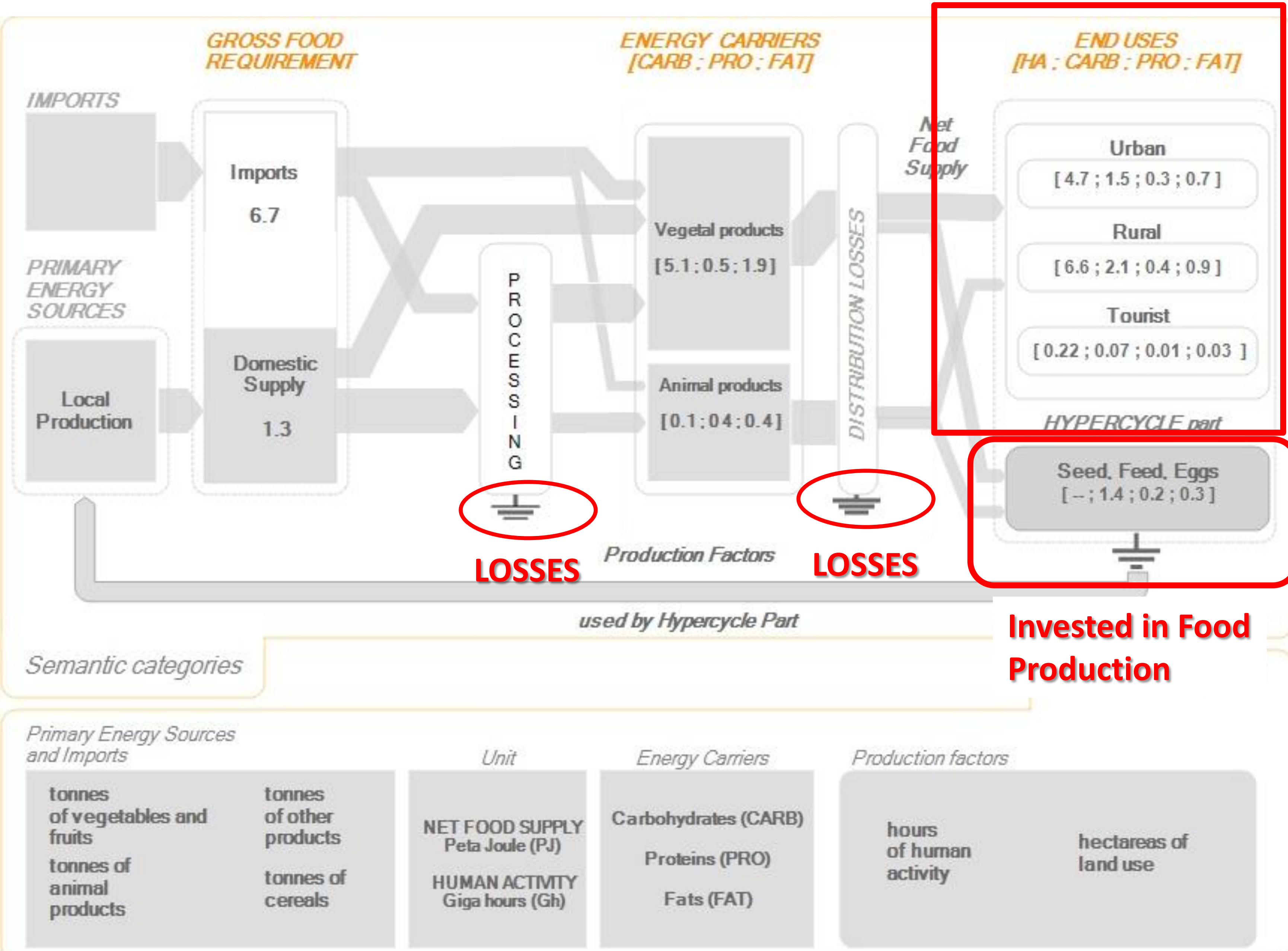

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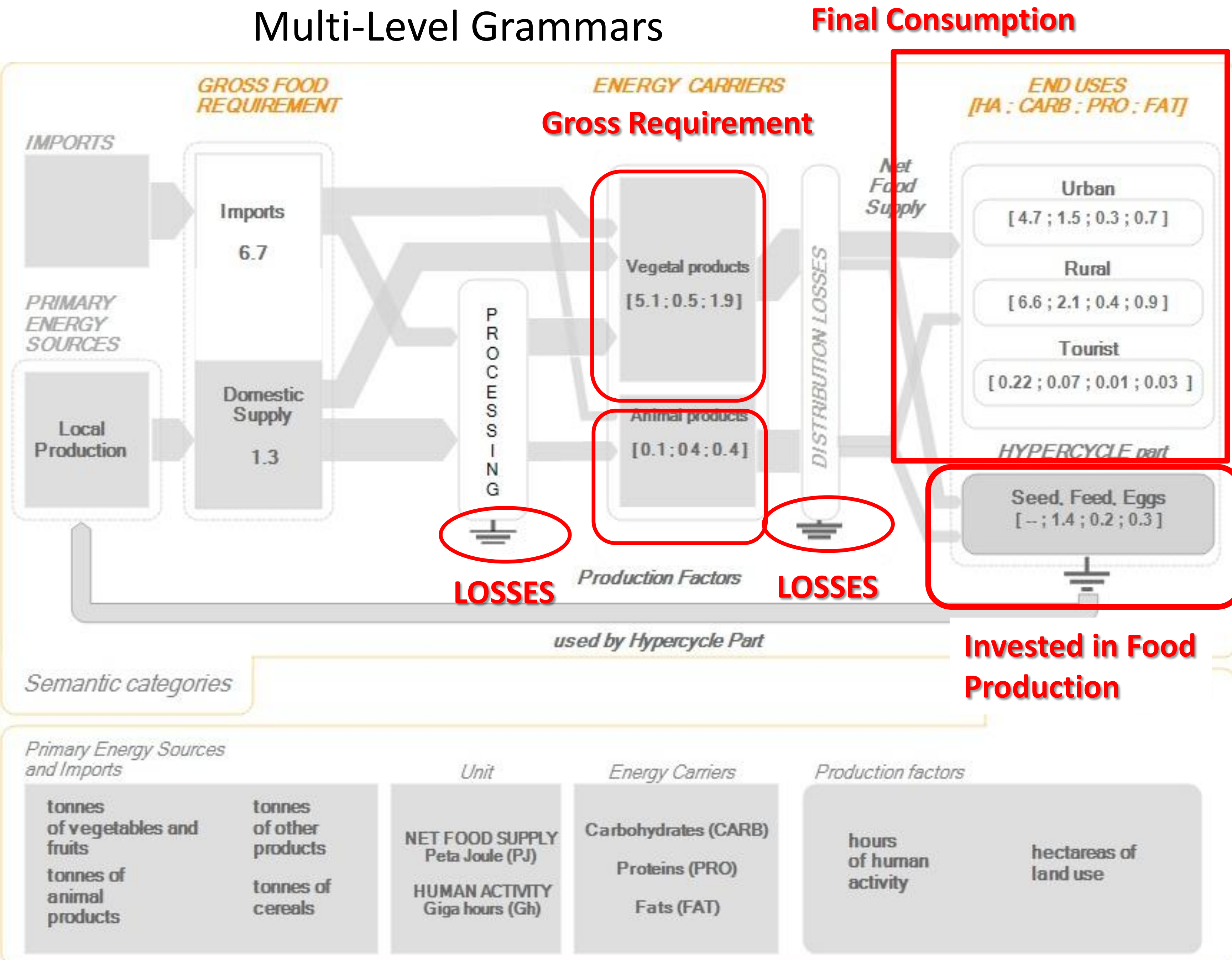

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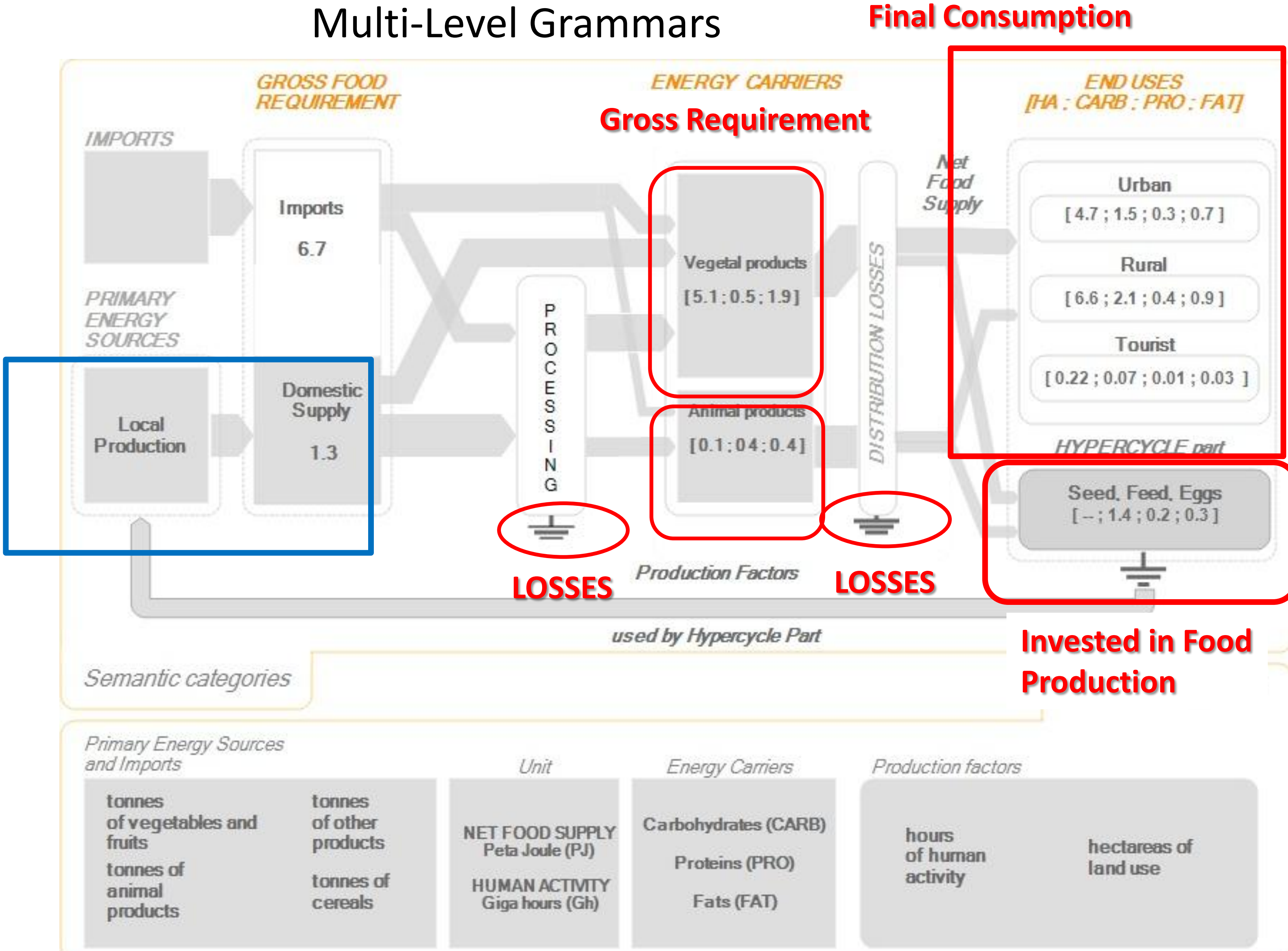

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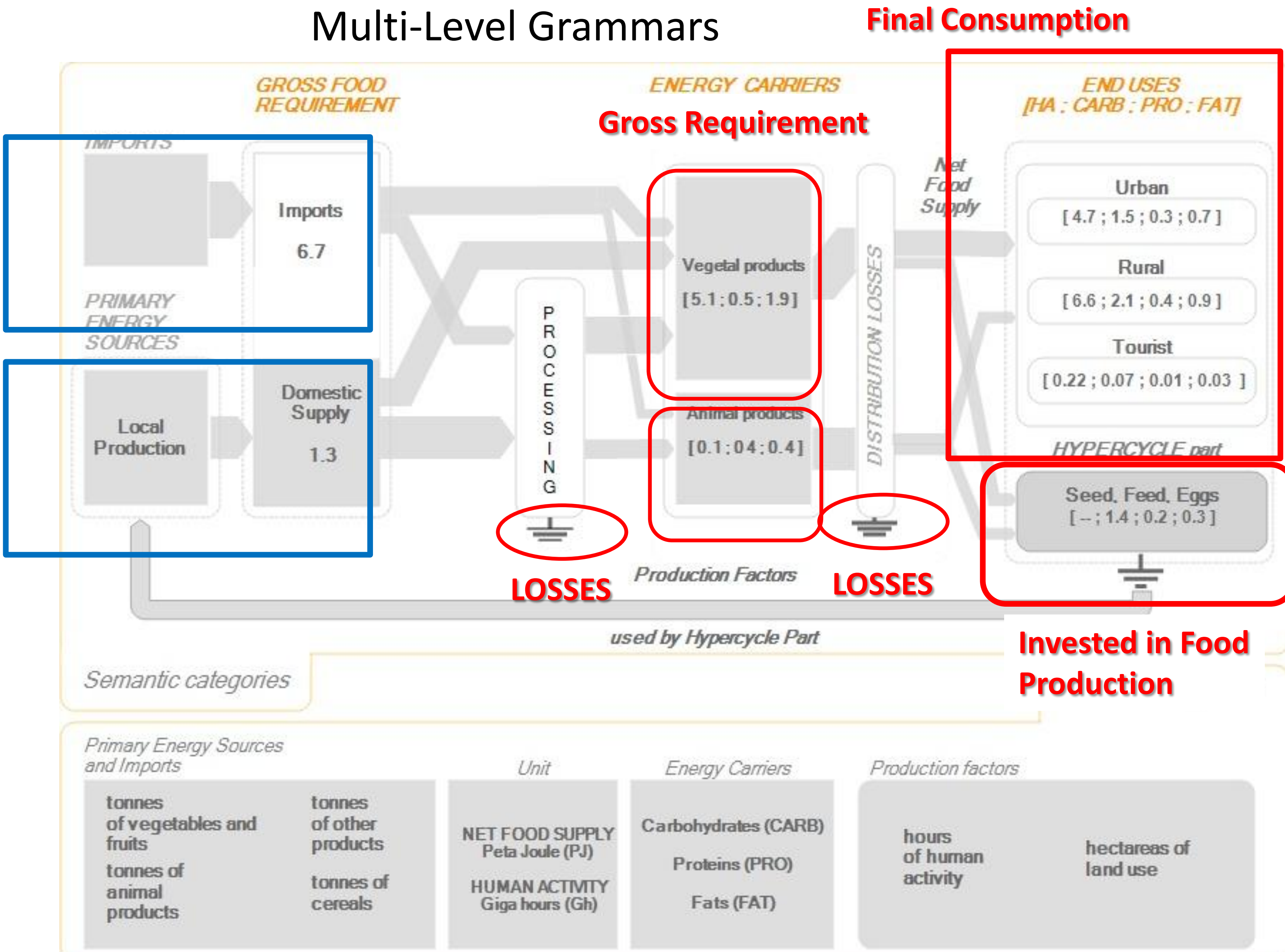

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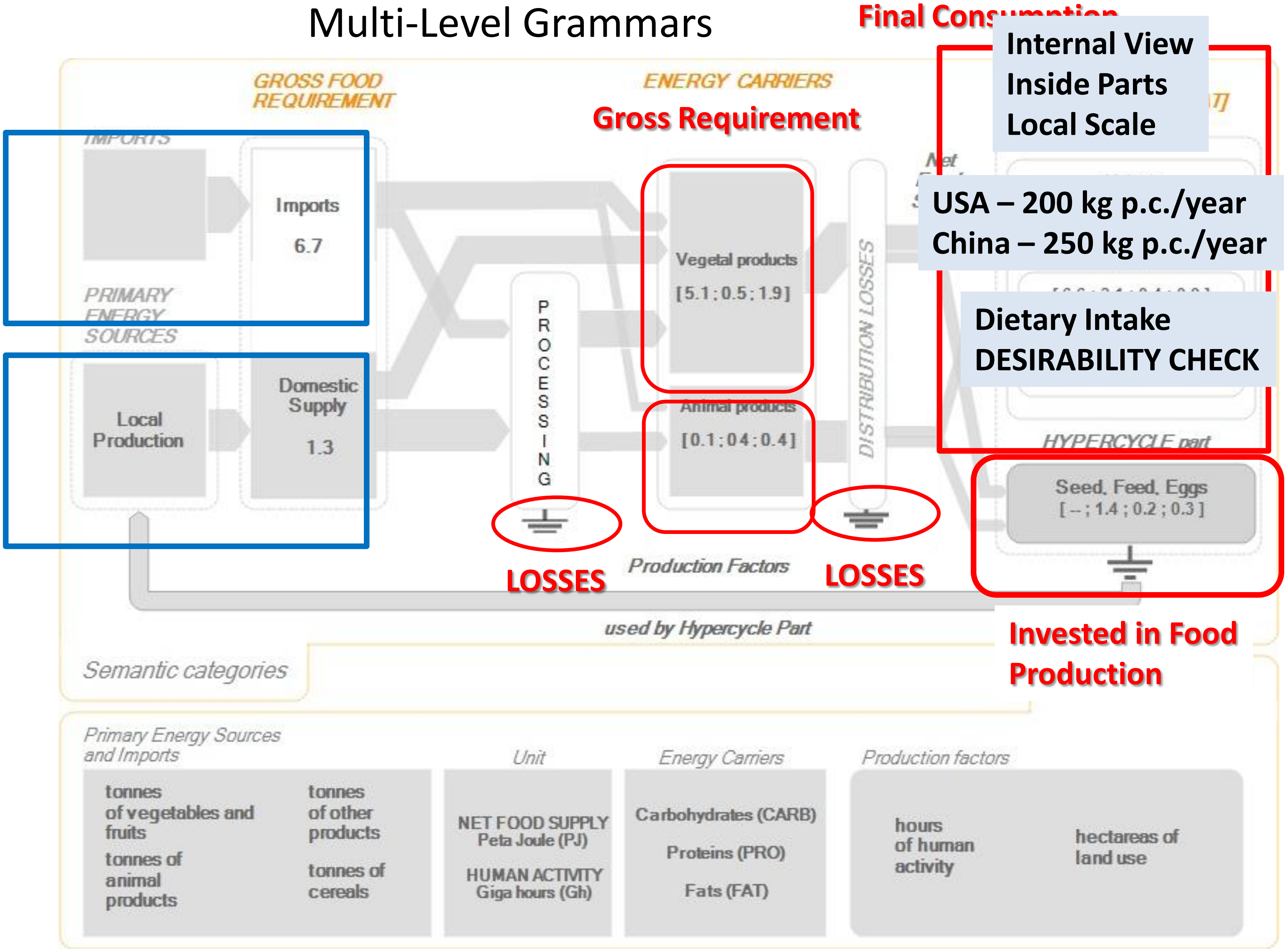

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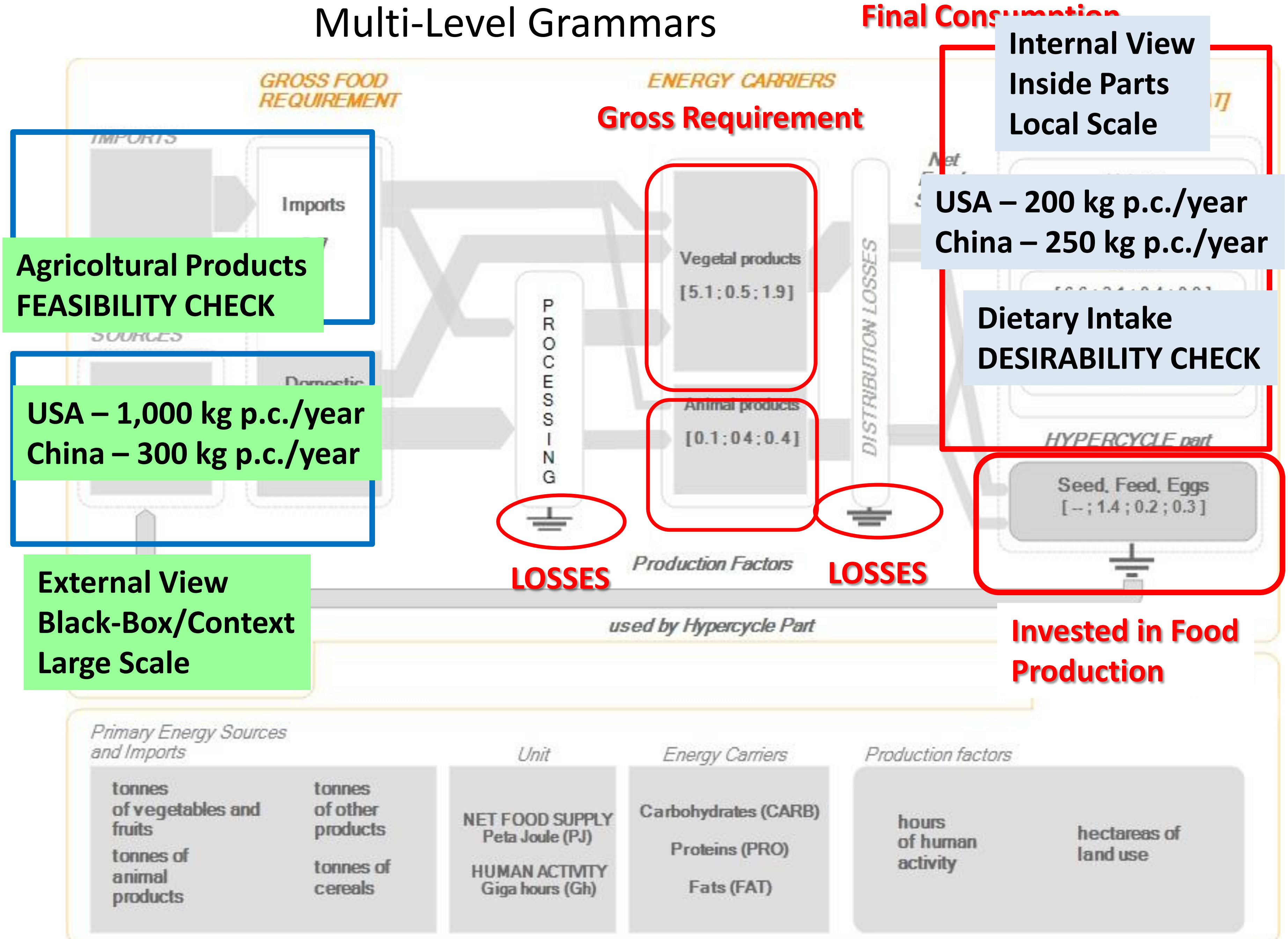

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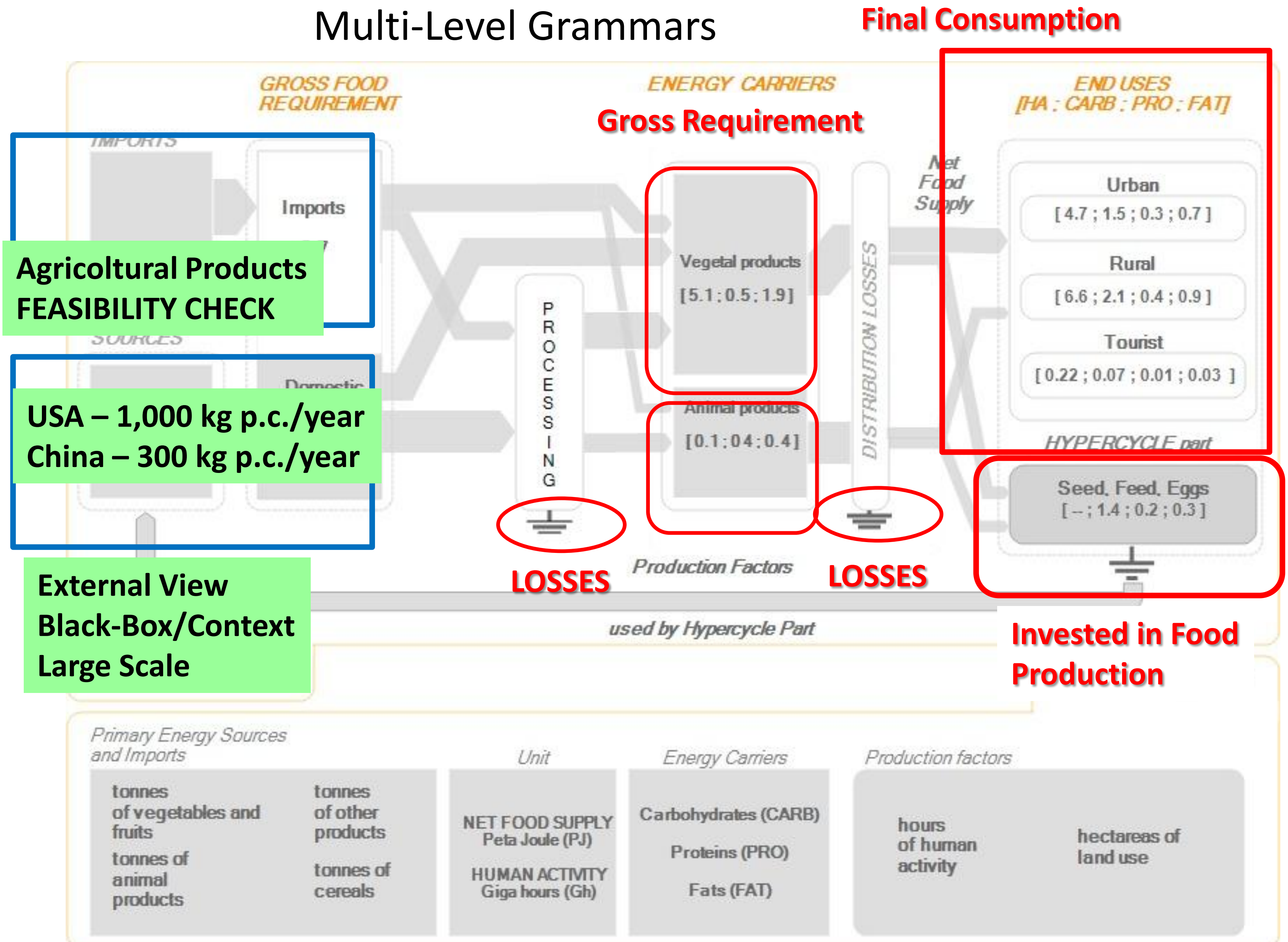

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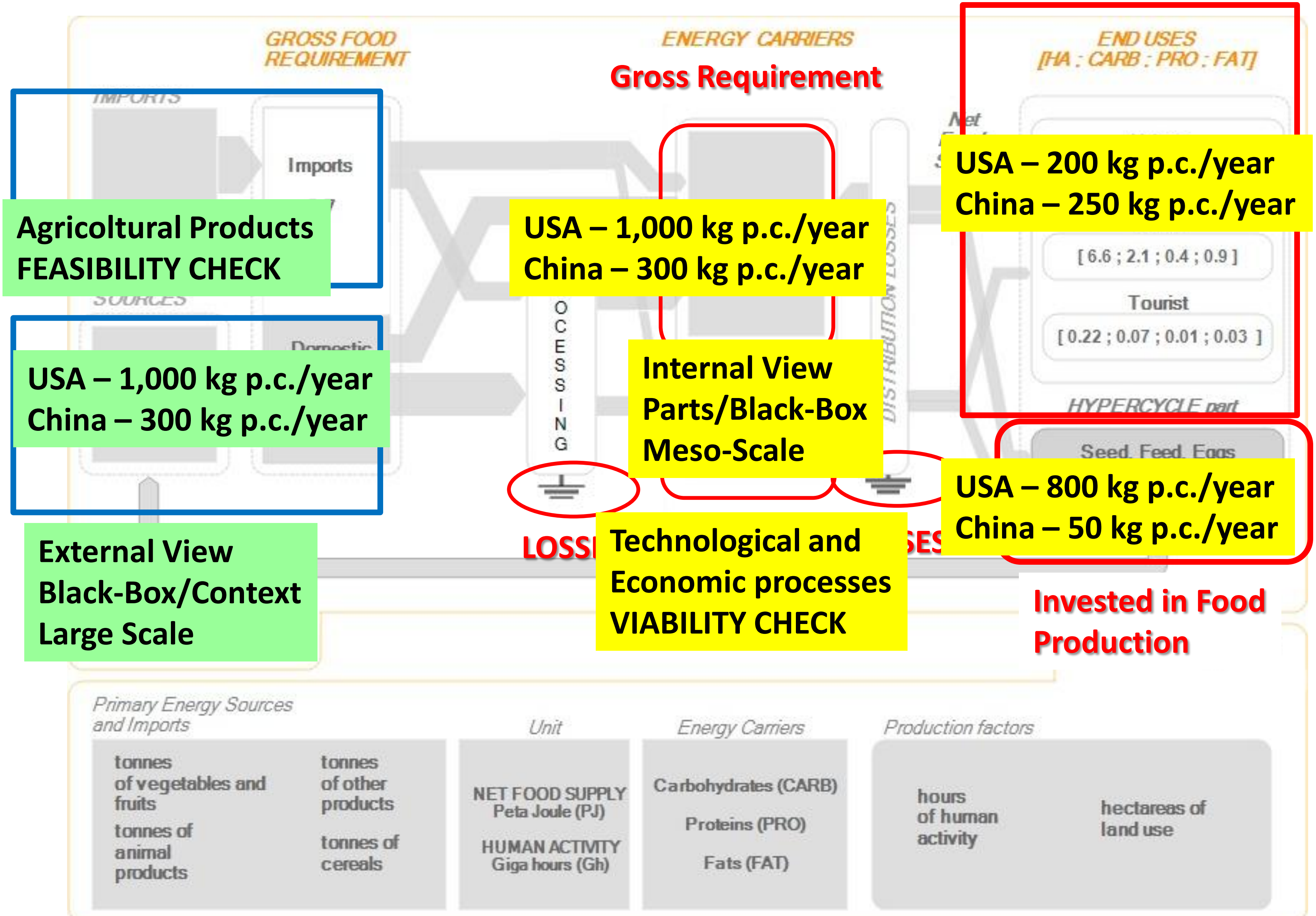
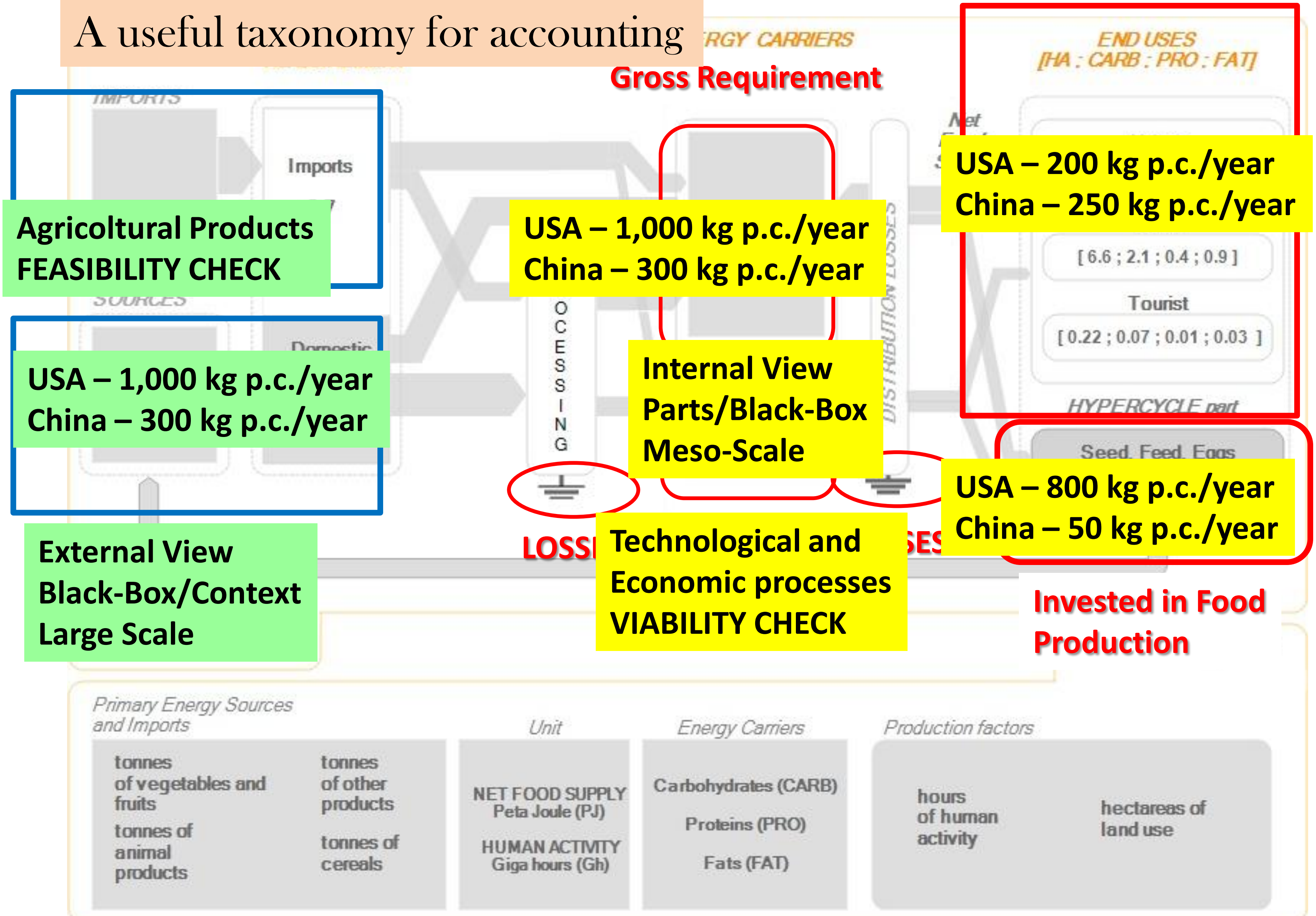


Multi-Level Grammars

A useful taxonomy for accounting



	FLOW elements			FUND elements			
	Food (PJ)	**Energy (PJ-GER)**	**Water (hm3)**	**HA (Mhr)**	**PC (GW)**	**Land (ha)**	**Money (Billion US$)**
HH	5.9	15	84	10000	4.5	28,000	
SG	***0.8 losses***	21	16	590	1.0		6
BM		16	23	250	0.5		2
AG	1.3	0	110	50	negl	20,500	0.3
EM	negl	2	260	8	negl		0.2
exp_{PW*}		0		430			5
exp_{AG}	negl		1100	33		54,000	0.3
TOT	**8**	**56**	**1700**	**11000**	**6**	**103000**	**9**
Imports	6.7	48	1300			211,500	6
Local Supply	1.3	7.2				20,500	

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0.8 losses

Diet composition

Unit: PJoules	CARB	PROT	FAT
	3.6	0.7	1.6

FLOW elements ... elements

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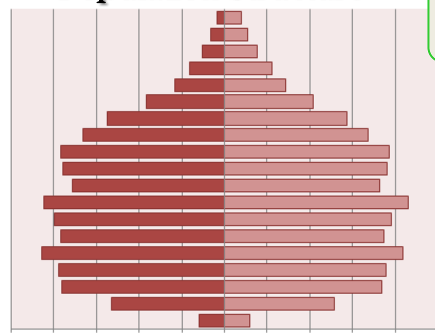
Population Structure



Dietary needs of the population

Diet Requirement

Unit: PJoule	CARB	PRO	FAT
Tourist	0.1	Negl	Negl
Rural	2.1	0.4	0.9
Urban	1.5	0.3	0.7

Diet composition

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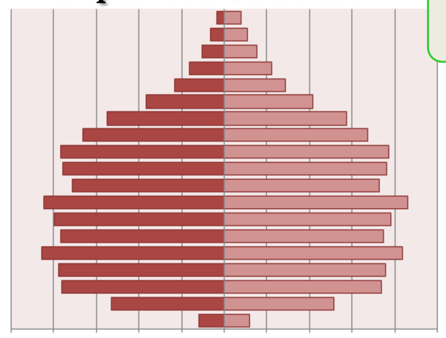

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Diet composition

Unit: PJoules	CARB	PROT	FAT
	3.6	0.7	1.6
Cereals, roots	2.7	0.3	Negl
Animals products	0.1	0.3	0.3
Veg. and fruits	0.1	Negl	Negl
Oil	Negl	Negl	1.2
Others	0.7	Negl	Negl

Primary Agricultural Products

Dietary needs of the population

FLOW elen… elements

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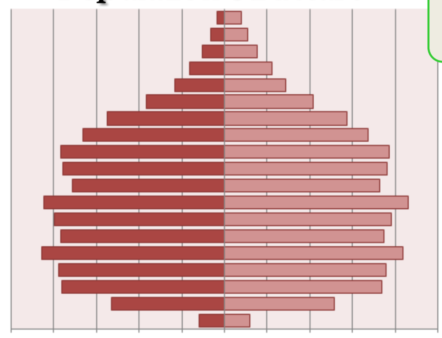
exp…		0					…5



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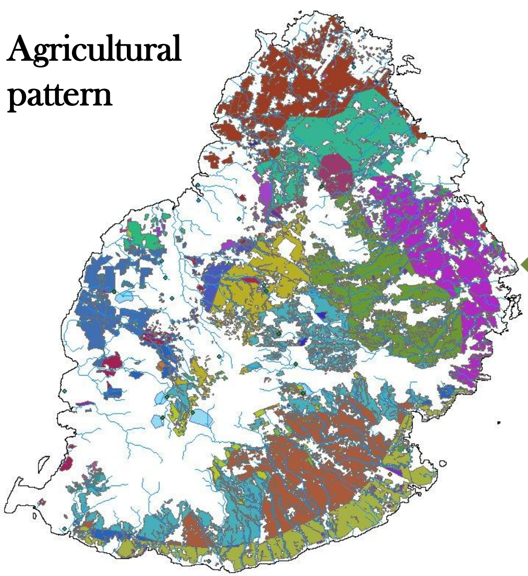
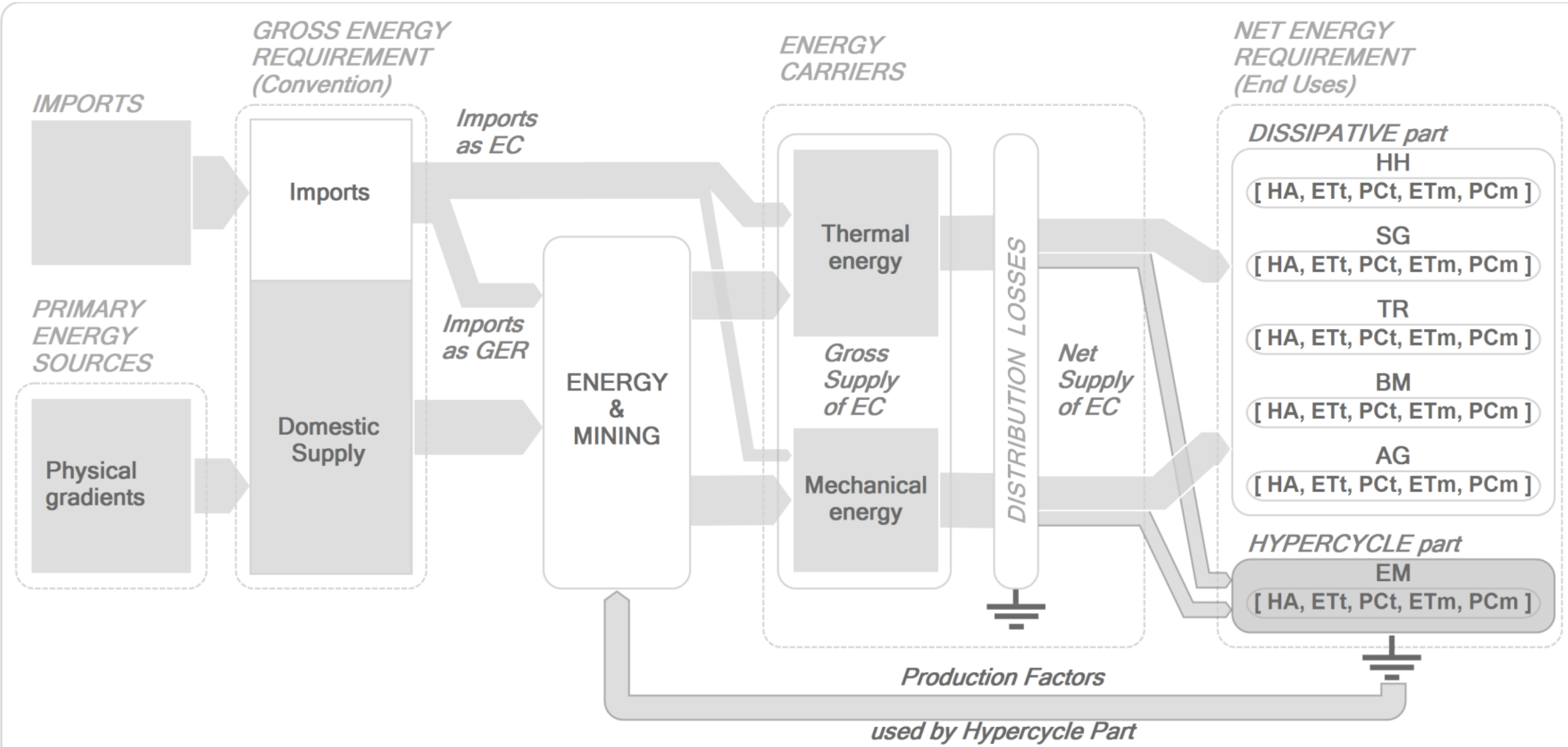
Agricultural pattern



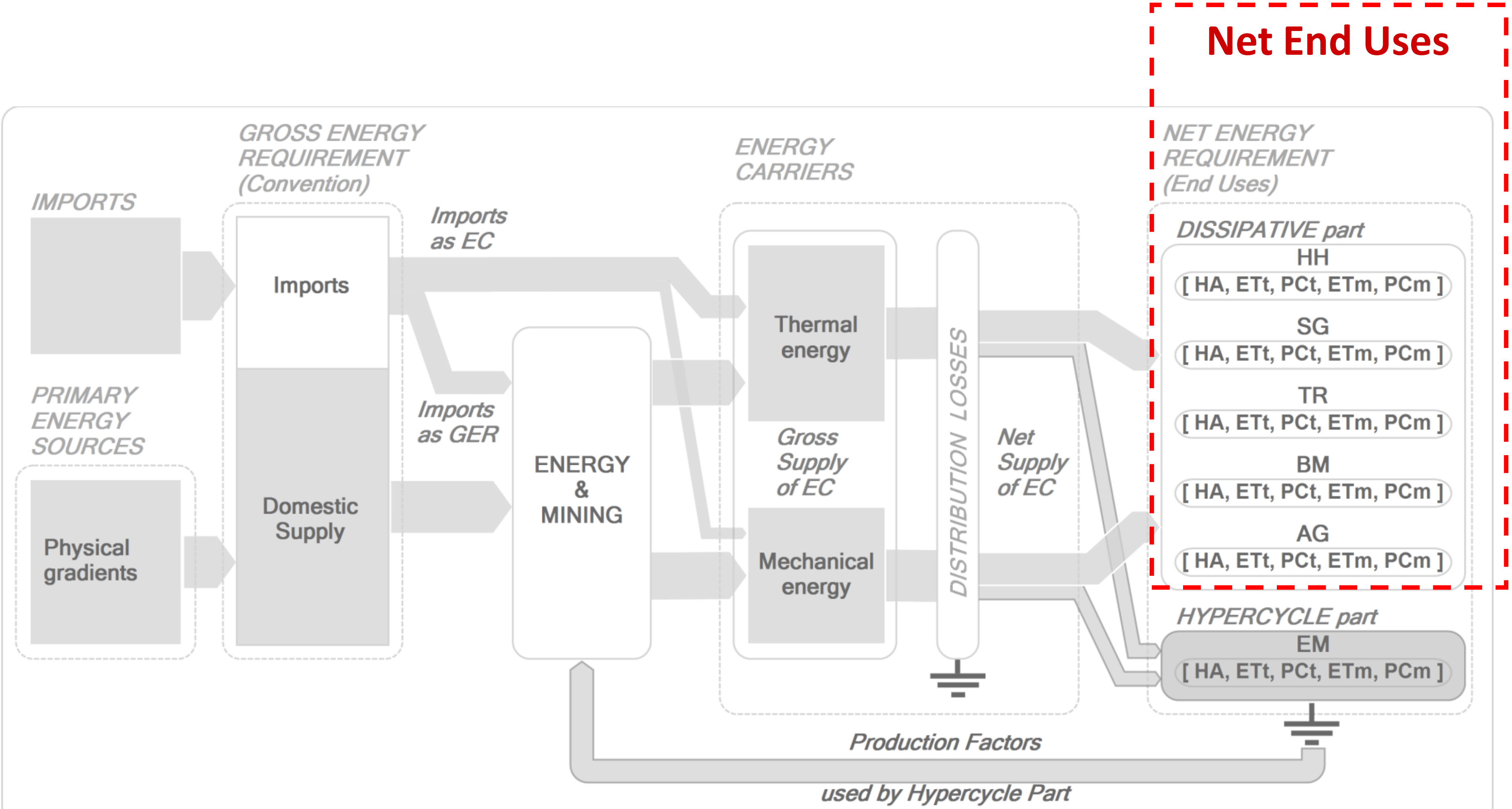
Primary Agricultural Products

Food products supply by agriculture or imports

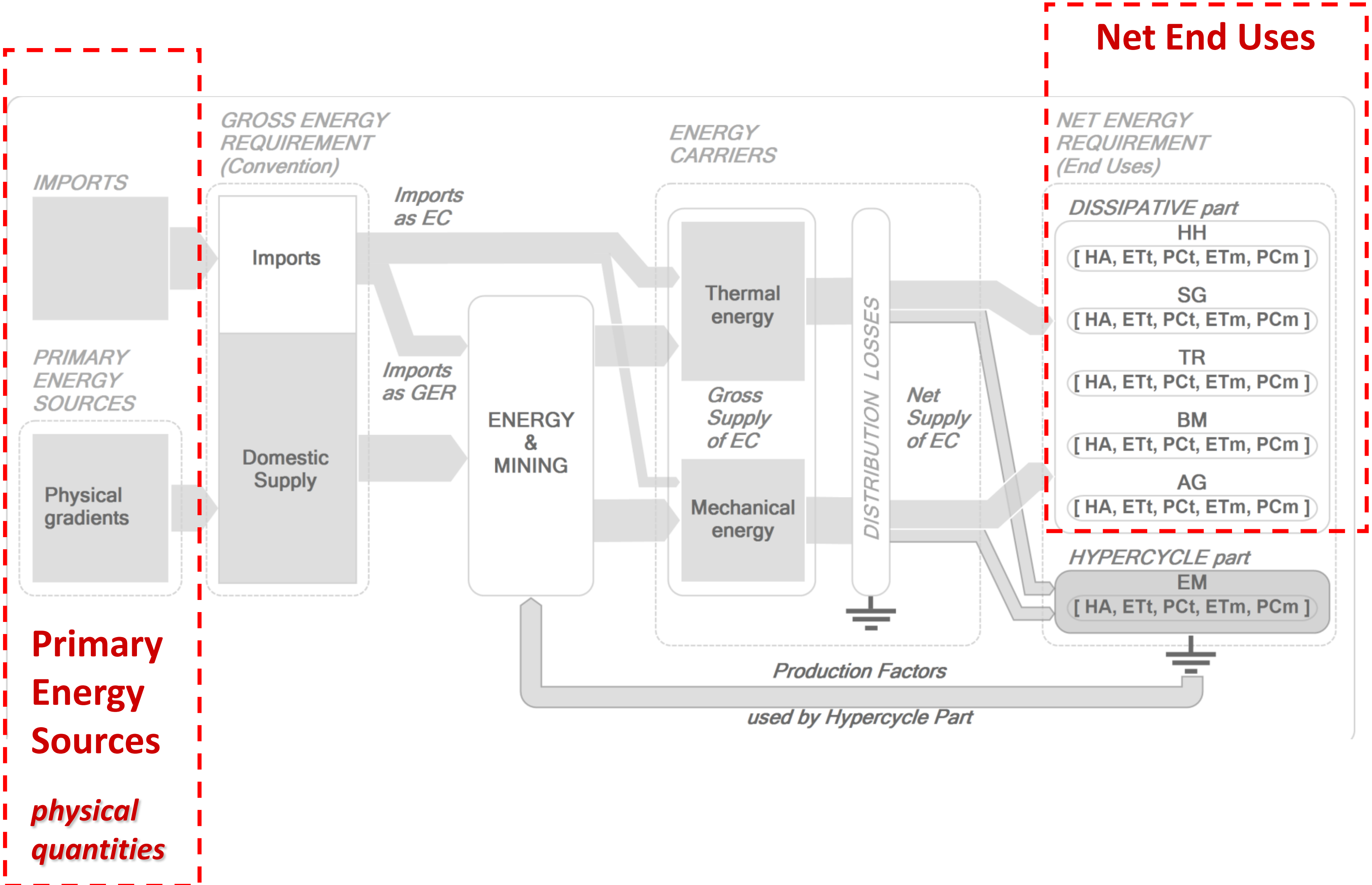
ENERGY GRAMMAR



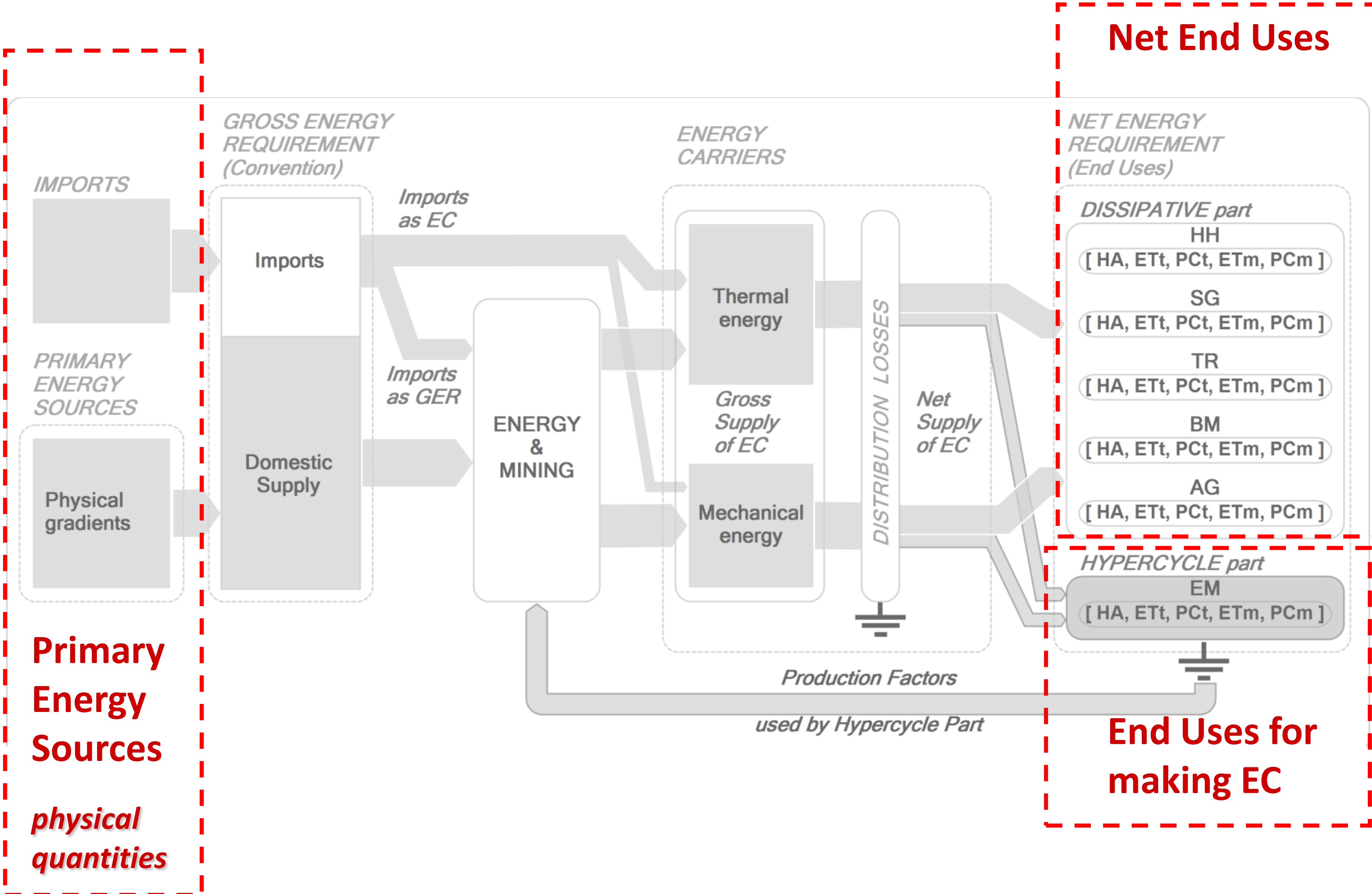
ENERGY GRAMMAR



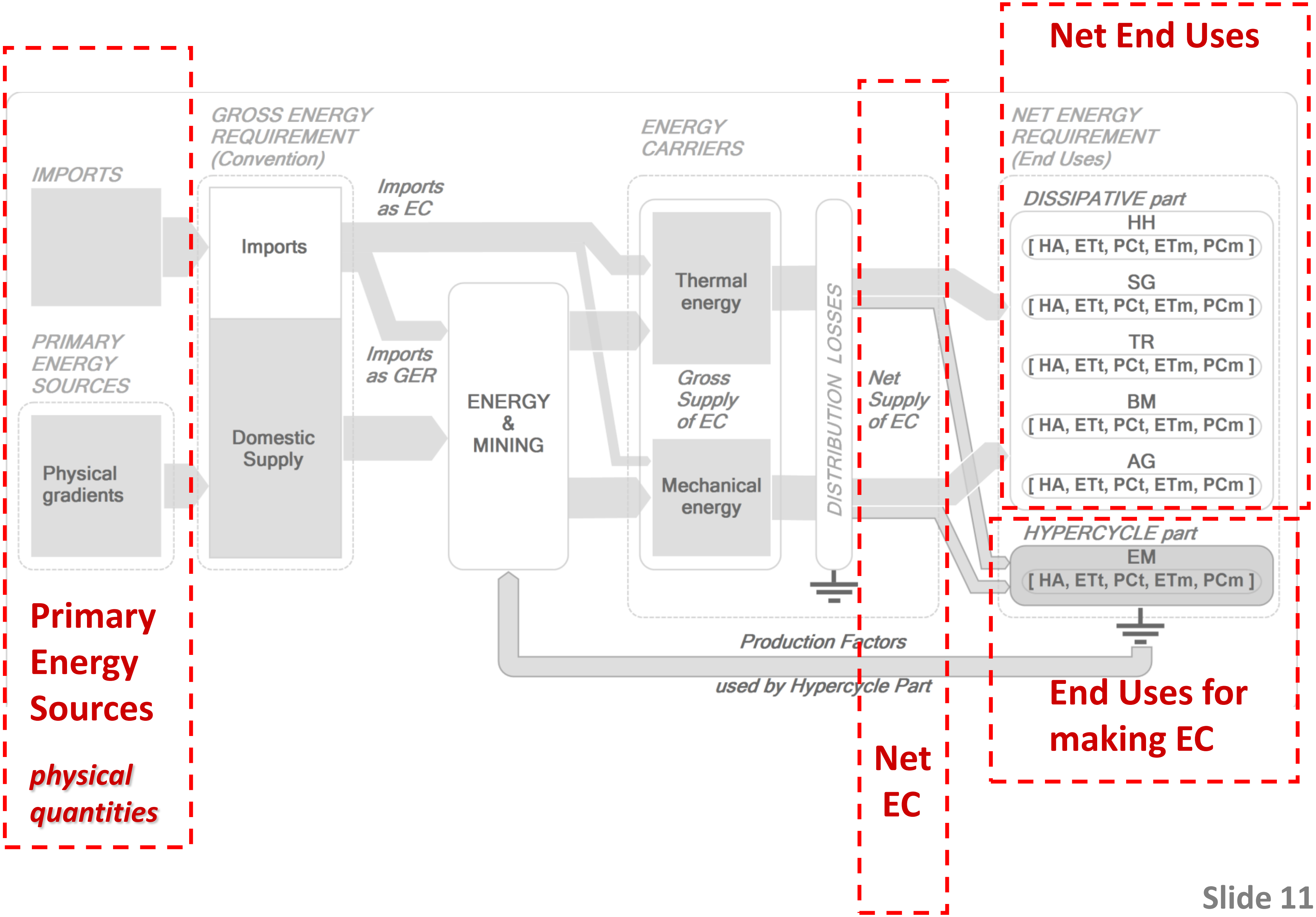
ENERGY GRAMMAR



ENERGY GRAMMAR



ENERGY GRAMMAR



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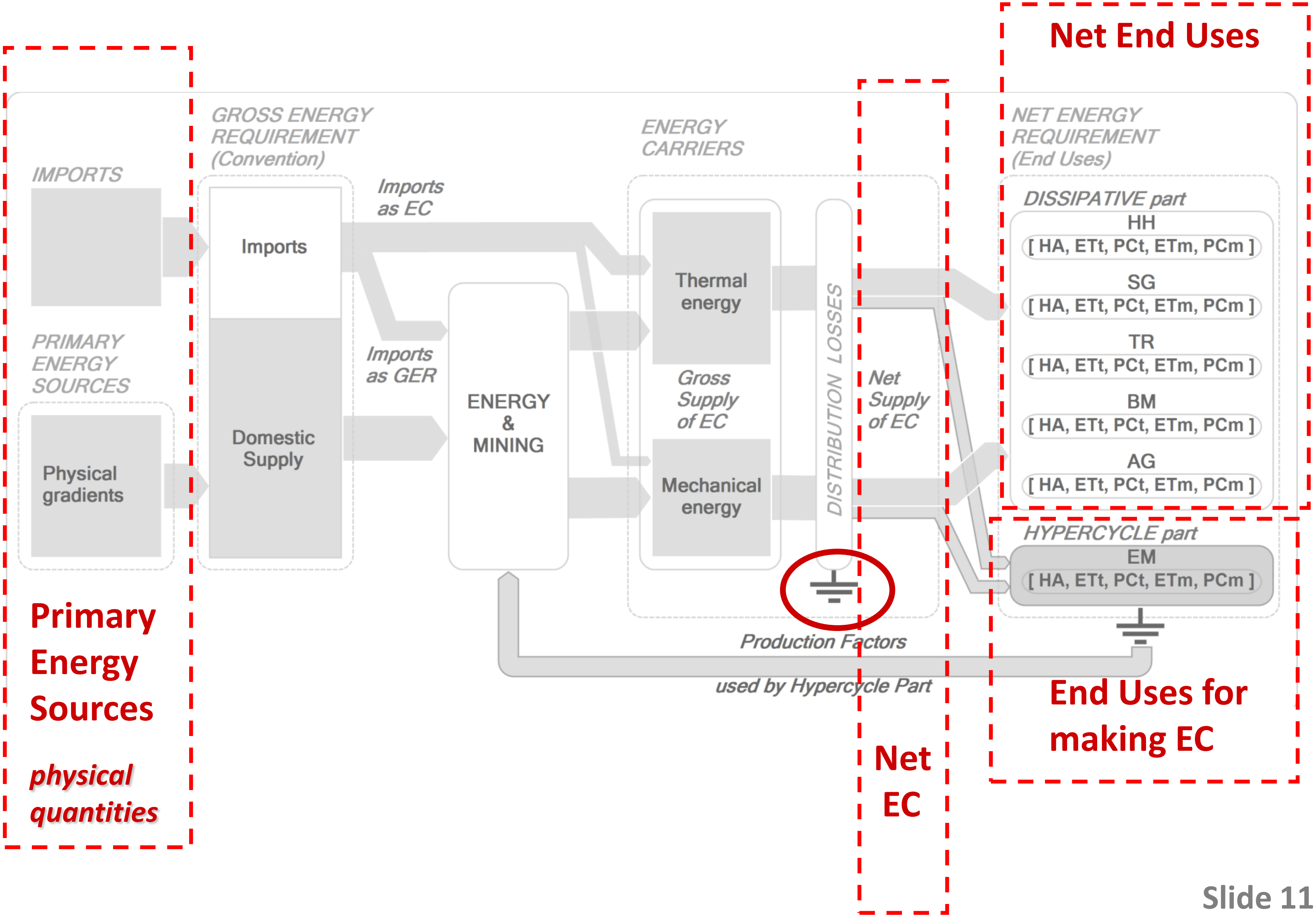
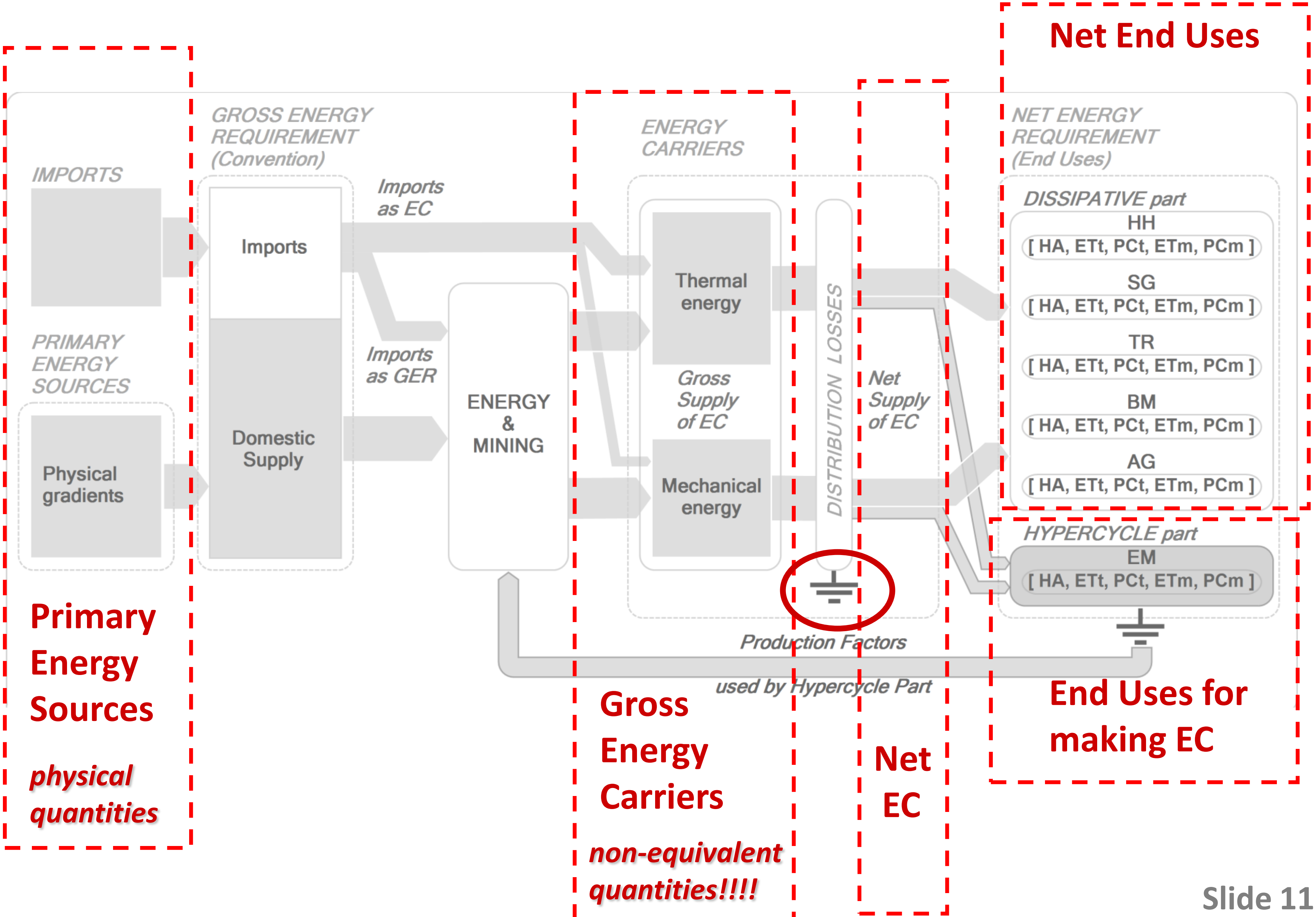


ENERGY GRAMMAR



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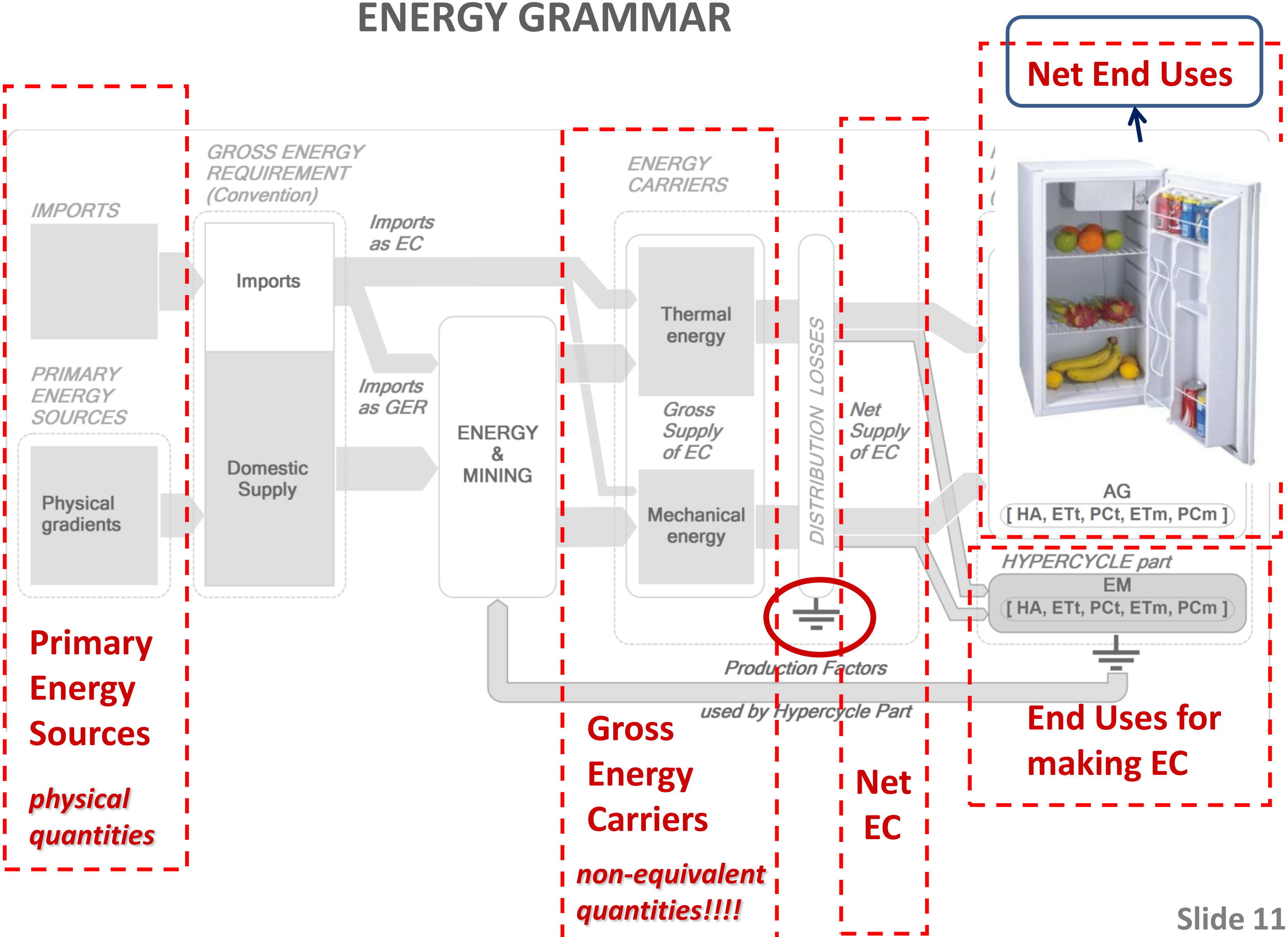

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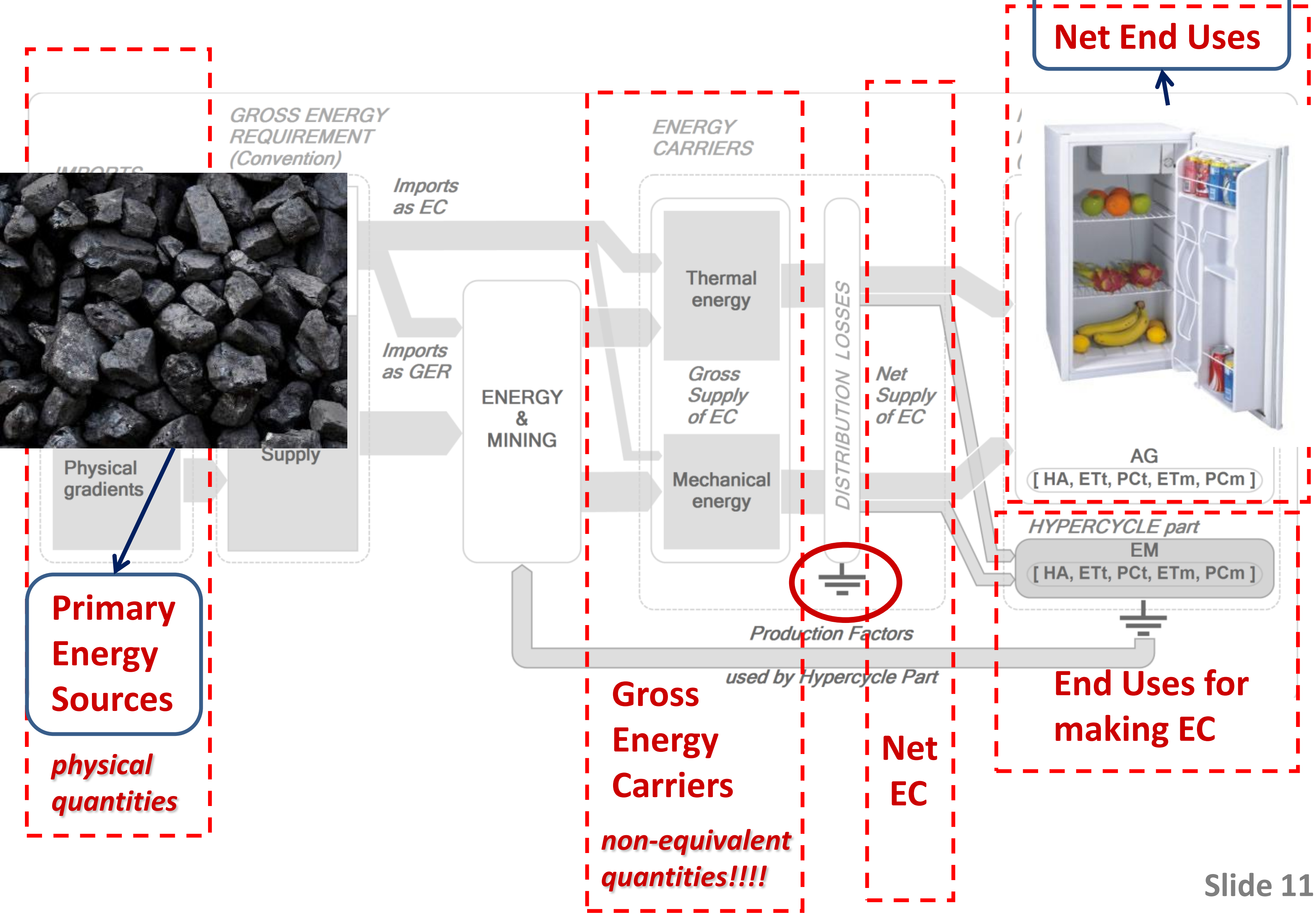

	Thermal Energy	Mechanical Energy
Primary Energy		
Secondary Energy		

Produced by processes outside human contol

Primary Energy Sources

They must be available!

They must be viable!

Energy Carriers

Produced by processes under human contol

	Thermal Energy	Mechanical Energy	
Primary Energy	Supply of a Gross Energy Requirement	Supply of a given Kinetic Energy from natural processes	Produced by processes outside human contol **Primary Energy Sources** They must be available!
Secondary Energy	Chemical energy in fuels Thermal energy in process heat	Electricity supply at the end use point	They must be viable! **Energy Carriers** Produced by processes under human contol

Fossil Energy

Ton of Oil Equivalent
42 GJ – PES Thermal

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Primary Energy	**Supply of a Gross Energy Requirement**	**Supply of a given Kinetic Energy from natural processes**
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Produced by processes outside human contol

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Fossil Energy

Ton of Oil Equivalent
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Alternatives

Wind Power
$= \frac{1}{2} A \rho U^3$
Mechanical Energy!

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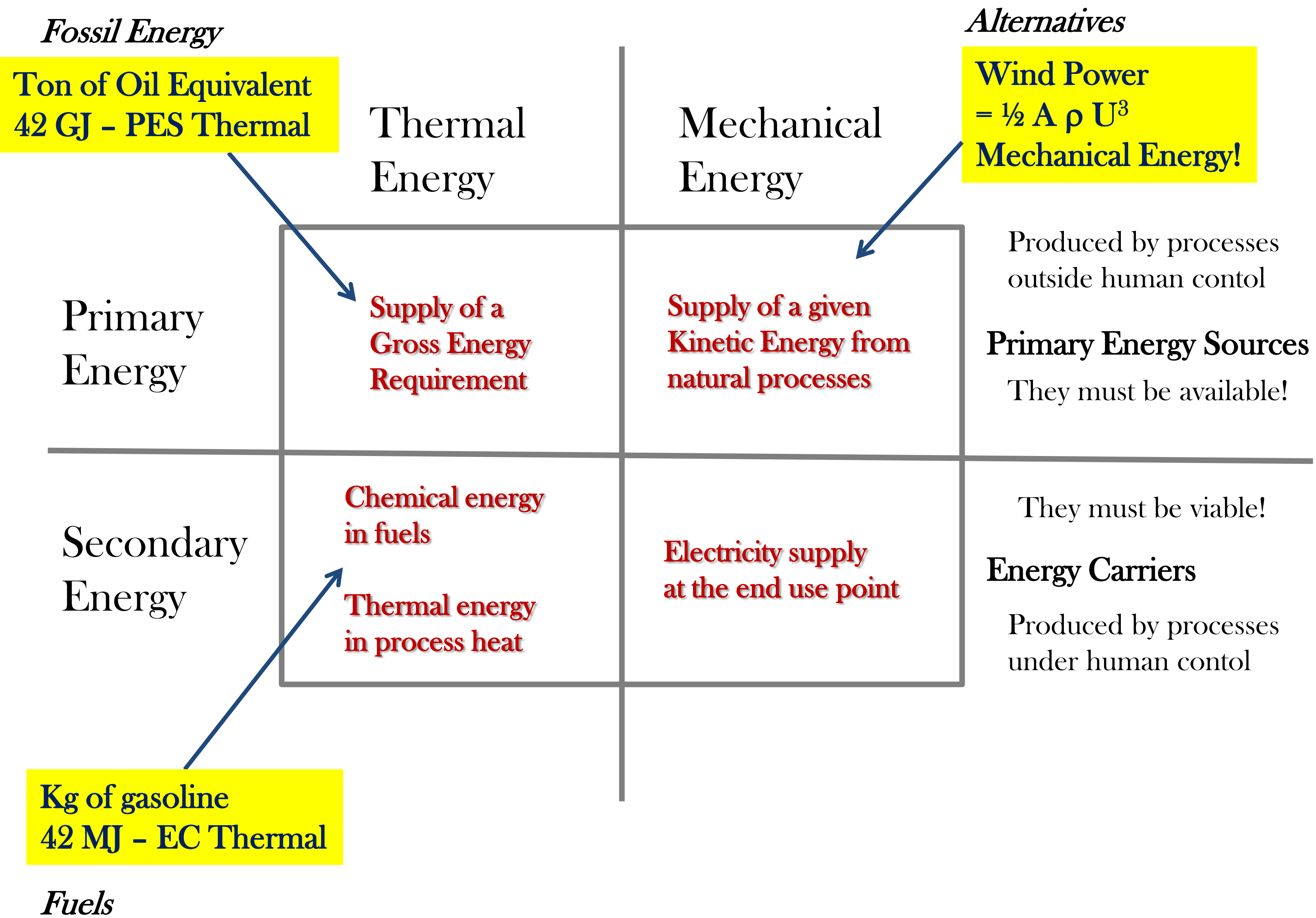
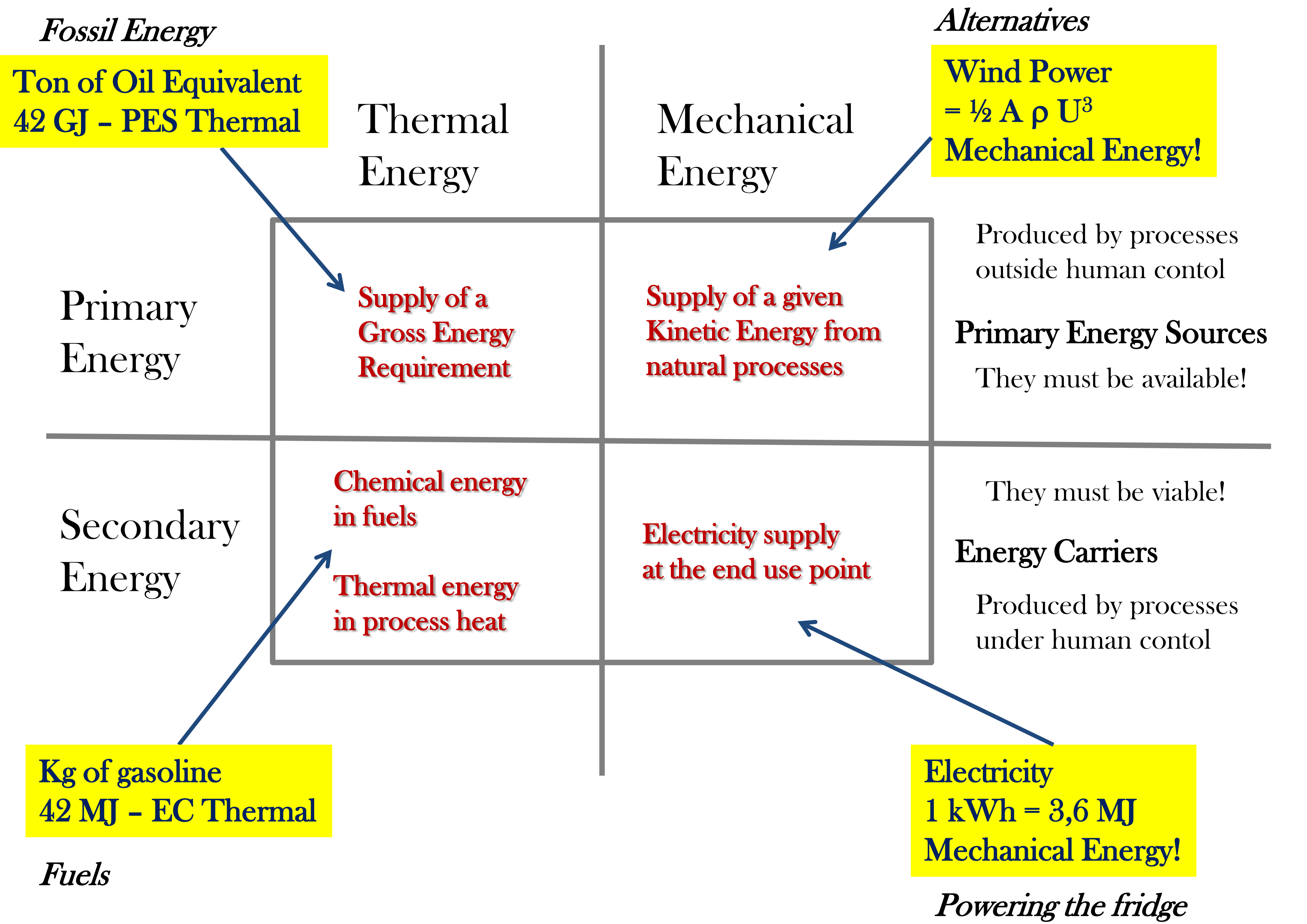

Fossil Energy
Ton of Oil Equivalent
42 GJ – PES Thermal
Thermal Energy
Mechanical Energy
Alternatives
Wind Power
= ½ A ρ U^3
Mechanical Energy!
Primary Energy
Supply of a Gross Energy Requirement
Supply of a given Kinetic Energy from natural processes
Produced by processes outside human contol
Primary Energy Sources
They must be available!
Secondary Energy
Chemical energy in fuels
Thermal energy in process heat
Electricity supply at the end use point
They must be viable!
Energy Carriers
Produced by processes under human contol
Kg of gasoline
42 MJ – EC Thermal
Fuels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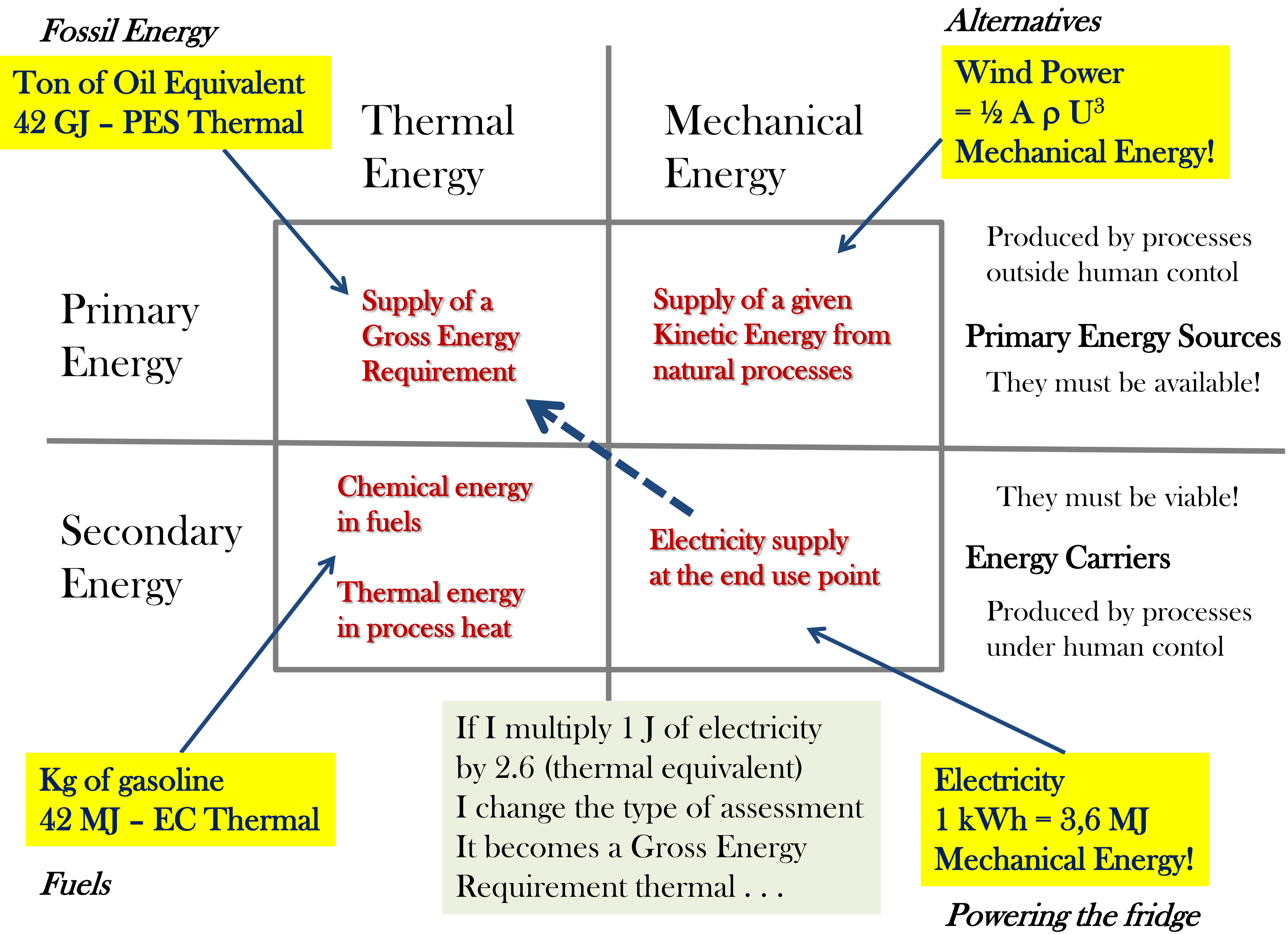
Energy Carriers
Produced by processes under human contol
Kg of gasoline
42 MJ – EC Thermal
Fuels
Electricity
1 kWh = 3,6 MJ
Mechanical Energy!
Powering the fridge


Fossil Energy
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Electricity supply at the end use point
They must be viable!
Energy Carriers
Produced by processes under human contol
Kg of gasoline
42 MJ – EC Thermal
Fuels
If I multiply 1 J of electricity by 2.6 (thermal equivalent) I change the type of assessment It becomes a Gross Energy Requirement thermal . . .
Electricity
1 kWh = 3,6 MJ
Mechanical Energy!
Powering the fridge

EXTERNAL VIEW
Primary Energy Sources

EXTERNAL VIEW
Primary Energy Sources

REQUIRED PHYSICAL GRADIENTS

EXTERNAL VIEW
Primary Energy Sources

REQUIRED PHYSICAL GRADIENTS

domestic	Sink-side	Supply-side
coal	27.4 Mton CO_2	9.3 Mtonnes
oil	0.9 Mton CO_2	0.3 Mtonnes
gas	0.9 Mton CO_2	0.4 Gm^3
nuclear	mine wastes	*imports*
hydro/wind	heat	kinetic energy
biofuels	N, P, Pesiticides	land, water, soil

Sink Capacity **Supply Capacity**

Spain 2004

EXTERNAL VIEW
Primary Energy Sources

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Sink Capacity **Supply Capacity**

LOCAL IMPACT ON THE ENVIRONMENT

Stock-flow
(non-renewable PES)

Fund-flow
(renewable PES)

Spain 2004

EXTERNAL VIEW
Primary Energy Sources

REQUIRED PHYSICAL GRADIENTS

Externalization of constraints

imports	Sink-side	Supply-side
coal	60.2 Mton CO_2	20.4 Mtonnes
oil	221.7 Mton CO_2	69 Mtonnes
gas	59.1 Mton CO_2	27 Gm^3
uranium	2.14 kton HLW	*1,244 tonnes*

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↓ **Sink Capacity** ↑ **Supply Capacity**

LOCAL IMPACT ON THE ENVIRONMENT

Stock-flow
(non-renewable PES)

Fund-flow
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Spain 2004

EXTERNAL VIEW
Primary Energy Sources

INTERNAL VIEW
Energy Carriers

REQUIRED PHYSICAL GRADIENTS

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↓ **Sink Capacity** ↑ **Supply Capacity**

Stock-flow
(non-renewable PES)

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LOCAL IMPACT ON THE ENVIRONMENT

Spain 2004

EXTERNAL VIEW
Primary Energy Sources

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hydro/wind	heat	kinetic energy
biofuels	N, P, Pesiticides	land, water, soil

Sink Capacity **Supply Capacity**

Stock-flow
(non-renewable PES)

Fund-flow
(renewable PES)

LOCAL IMPACT ON THE ENVIRONMENT

INTERNAL VIEW
Energy Carriers

Data are in PJ/year

Energy Systems PES → EC

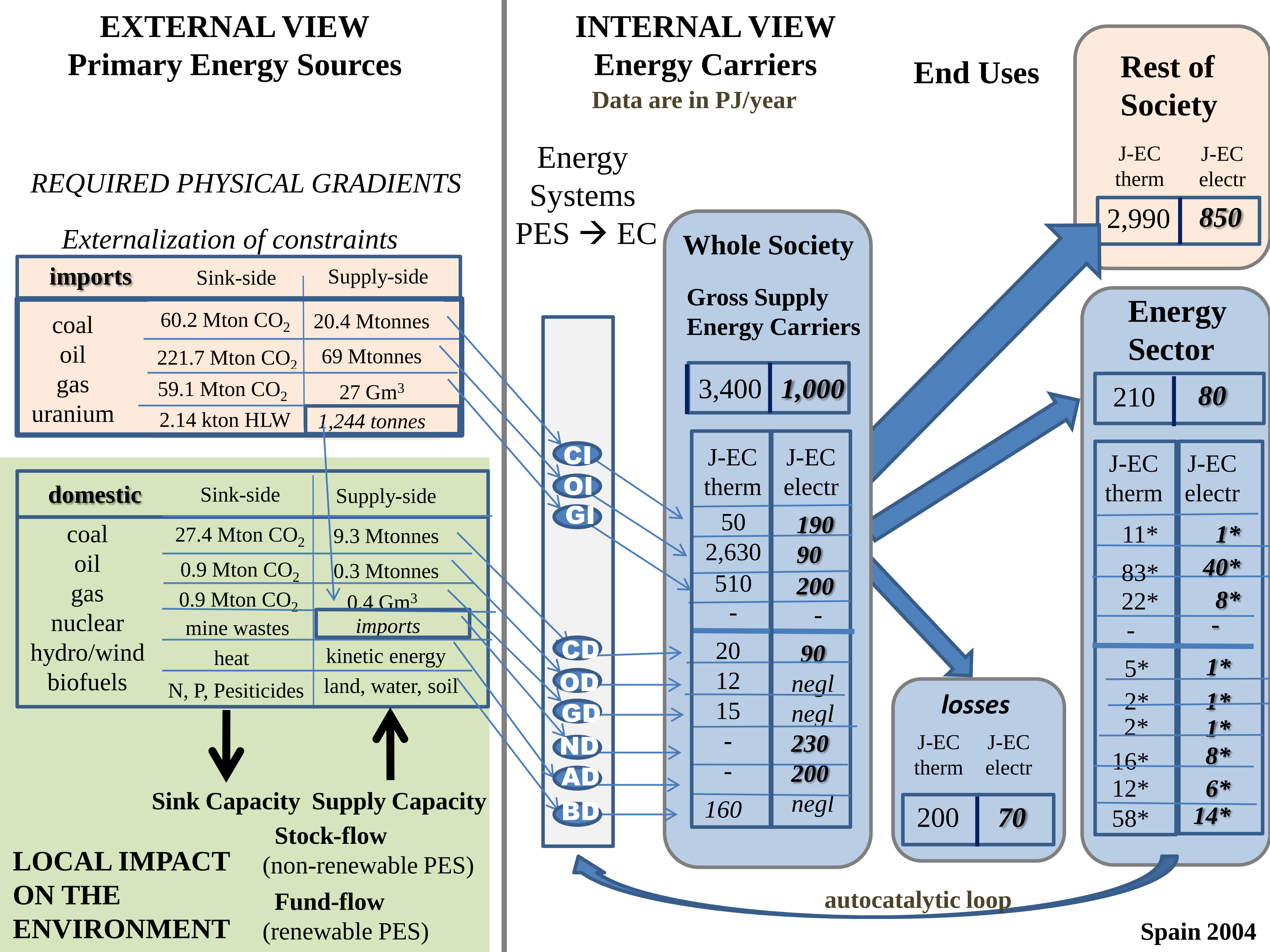
Whole Society

Gross Supply Energy Carriers

3,400	***1,000***

Carrier	J-EC therm	J-EC electr
CI	50	***190***
OI	2,630	***90***
GI	510	***200***
	-	-
CD	20	***90***
OD	12	*negl*
GD	15	*negl*
ND	-	***230***
AD	-	***200***
BD	*160*	*negl*

Spain 2004


EXTERNAL VIEW
Primary Energy Sources
REQUIRED PHYSICAL GRADIENTS
Externalization of constraints
imports
Sink-side
Supply-side
coal
oil
gas
uranium
60.2 Mton CO_2
221.7 Mton CO_2
59.1 Mton CO_2
2.14 kton HLW
20.4 Mtonnes
69 Mtonnes
27 Gm^3
1,244 tonnes
domestic
Sink-side
Supply-side
coal
oil
gas
nuclear
hydro/wind
biofuels
27.4 Mton CO_2
0.9 Mton CO_2
0.9 Mton CO_2
mine wastes
heat
N, P, Pesiticides
9.3 Mtonnes
0.3 Mtonnes
0.4 Gm^3
imports
kinetic energy
land, water, soil
Sink Capacity
Supply Capacity
Stock-flow
(non-renewable PES)
Fund-flow
(renewable PES)
LOCAL IMPACT ON THE ENVIRONMENT
INTERNAL VIEW
Energy Carriers
Data are in PJ/year
End Uses
Energy Systems
PES → EC
CI
OI
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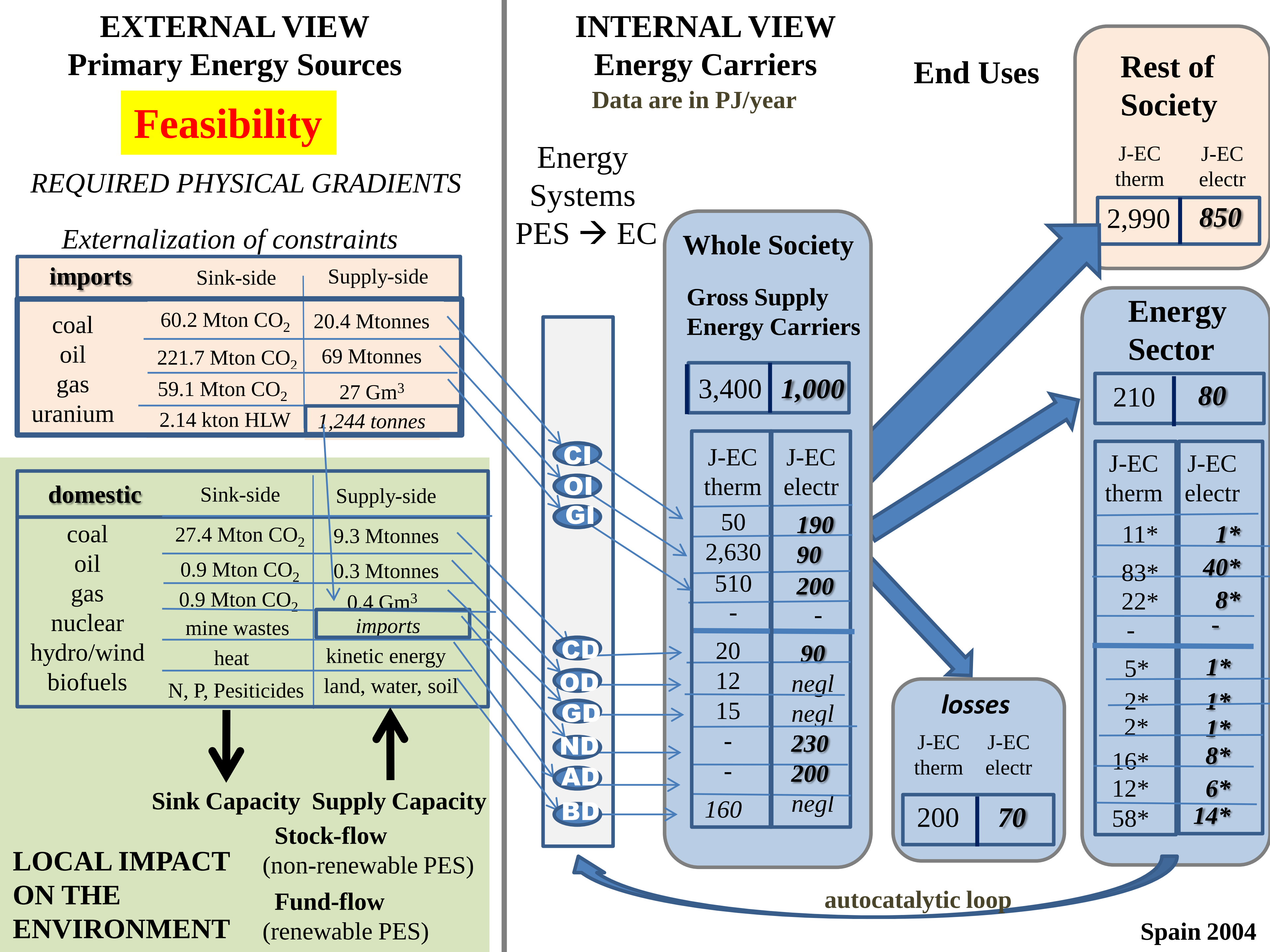
Whole Society
Gross Supply Energy Carriers
3,400
1,000
J-EC therm
J-EC electr
50
190
2,630
90
510
200
-
-
20
90
12
negl
15
negl
-
230
-
200
160
negl
Rest of Society
J-EC therm
J-EC electr
2,990
850
Energy Sector
210
80
J-EC therm
J-EC electr
11*
1*
83*
40*
22*
8*
-
-
5*
1*
2*
1*
2*
1*
16*
8*
12*
6*
58*
14*
losses
J-EC therm
J-EC electr
200
70
autocatalytic loop
Spain 2004



EXTERNAL VIEW
Primary Energy Sources
Feasibility
REQUIRED PHYSICAL GRADIENTS
Externalization of constraints
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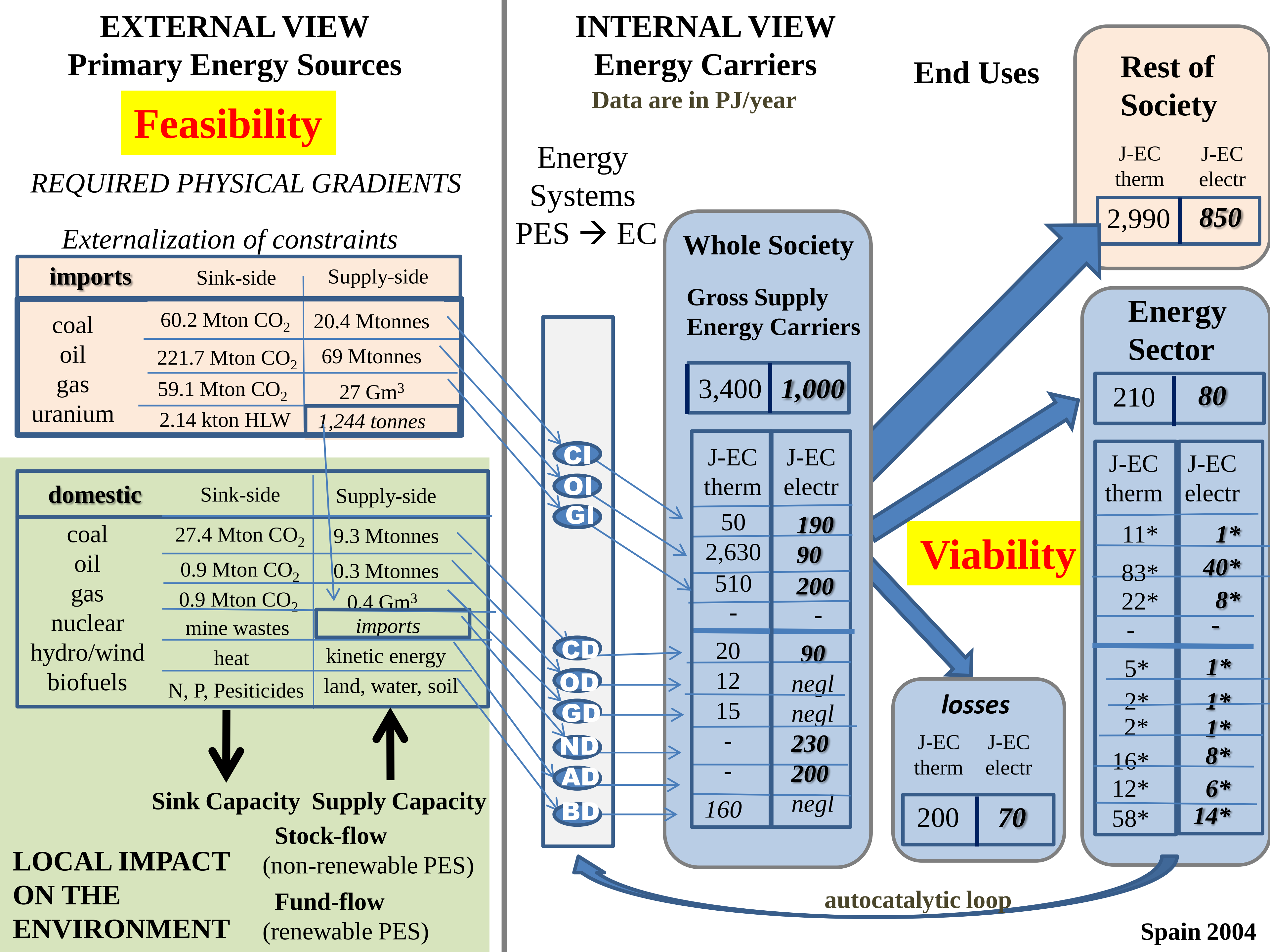
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Viability
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8*
-
1*
1*
1*
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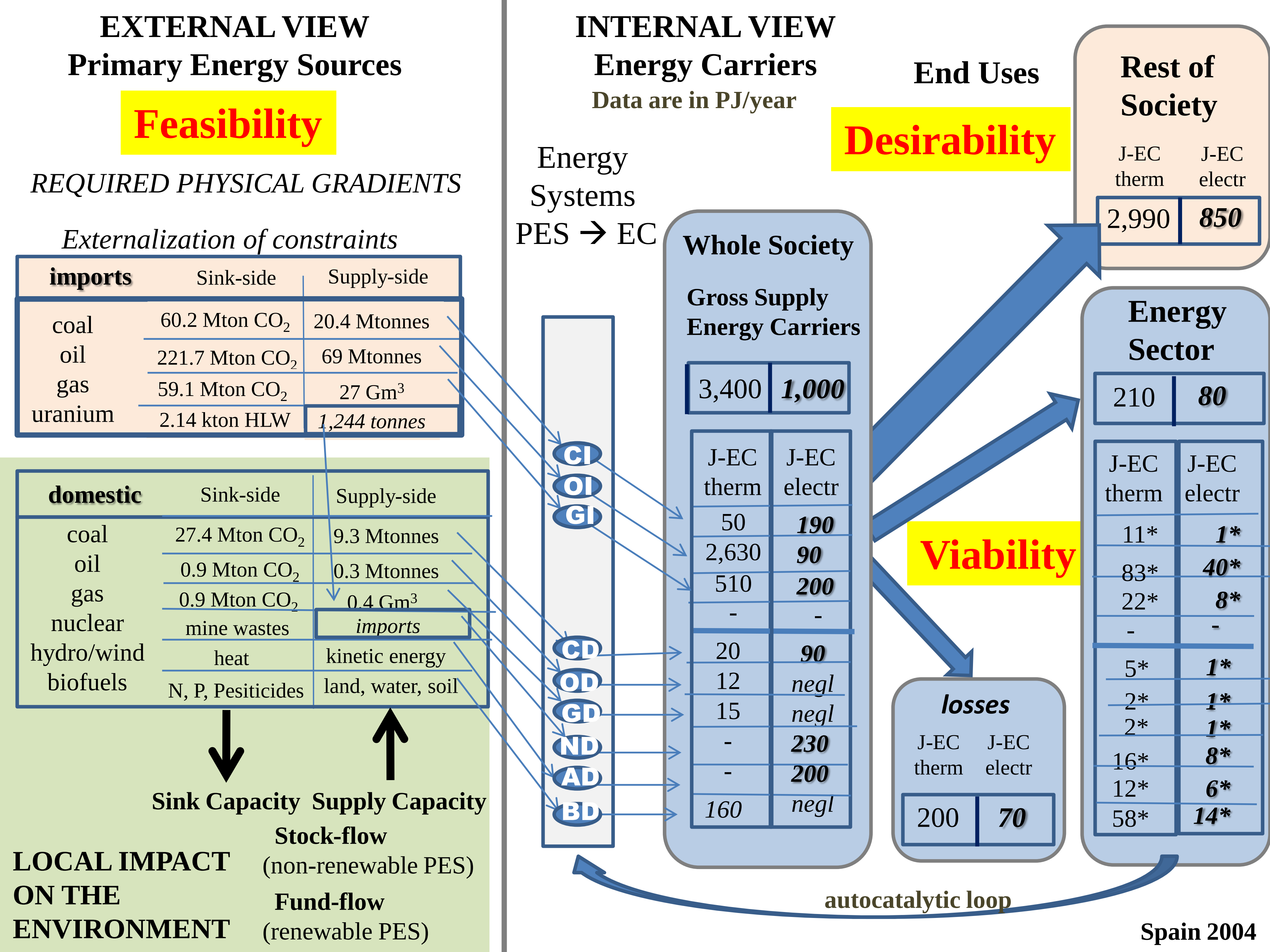
6*
14*
autocatalytic loop
Spain 2004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Fund-flow
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INTERNAL VIEW
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Data are in PJ/year
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4. Quantitative Story-Telling as a remedy against hypocognition (reducing the damages of socially constructed ignorance)

4. Quantitative Story-Telling as a remedy against hypocognition (reducing the damages of socially constructed ignorance)

Following the example of GIS

Quantitative Story-Telling
Information System

Multi-scale integrated characterization of the metabolic pattern of the Mauritius Islands

The multi-level end-uses matrix characterizing the metabolic pattern of Mauritius:

3 flows

3 funds

6 compartments consumption

2 compartments supply

Money flow is also included

EXTERNAL VIEW – assessments based on scalars

		Flow elements			Fund elements			
		Food (PJ)	Energy (PJ-GER)	Water (hm3 extraction)	HA (Mhr)	PC (GW)	Land (k ha)	Money (Billion US$)
Consumption	HH	5.9	16	100	10,000	4.5	28	n/a
	PW*	0.8	37	44	606	1.4		8,200
	AG	1.3	negl	190	39	negl	21	220
	EM	n/a	2.2	260	8	0.03	negl	180
	exp_{PW*}	n/a	n/a	3	590	n/a	n/a	59% GDP
	exp_{AG}	negl	0.4	1,100	33	0.02	54	2.5% GDP
	Whole	8	56	1,700	11,300	6.0	103	10,000 (GDP)
Supply	Imports	6.7	49	n/a	n/a	n/a	n/a	63% GDP
	Domestic Supply	1.3	7	1,700	11,300	6.0	103	n/a

Multi-scale integrated characterization of the metabolic pattern of the Mauritius Islands

The multi-level end-uses matrix characterizing the metabolic pattern of Mauritius:

3 flows

3 funds

6 compartments consumption

2 compartments supply

Money flow is also included

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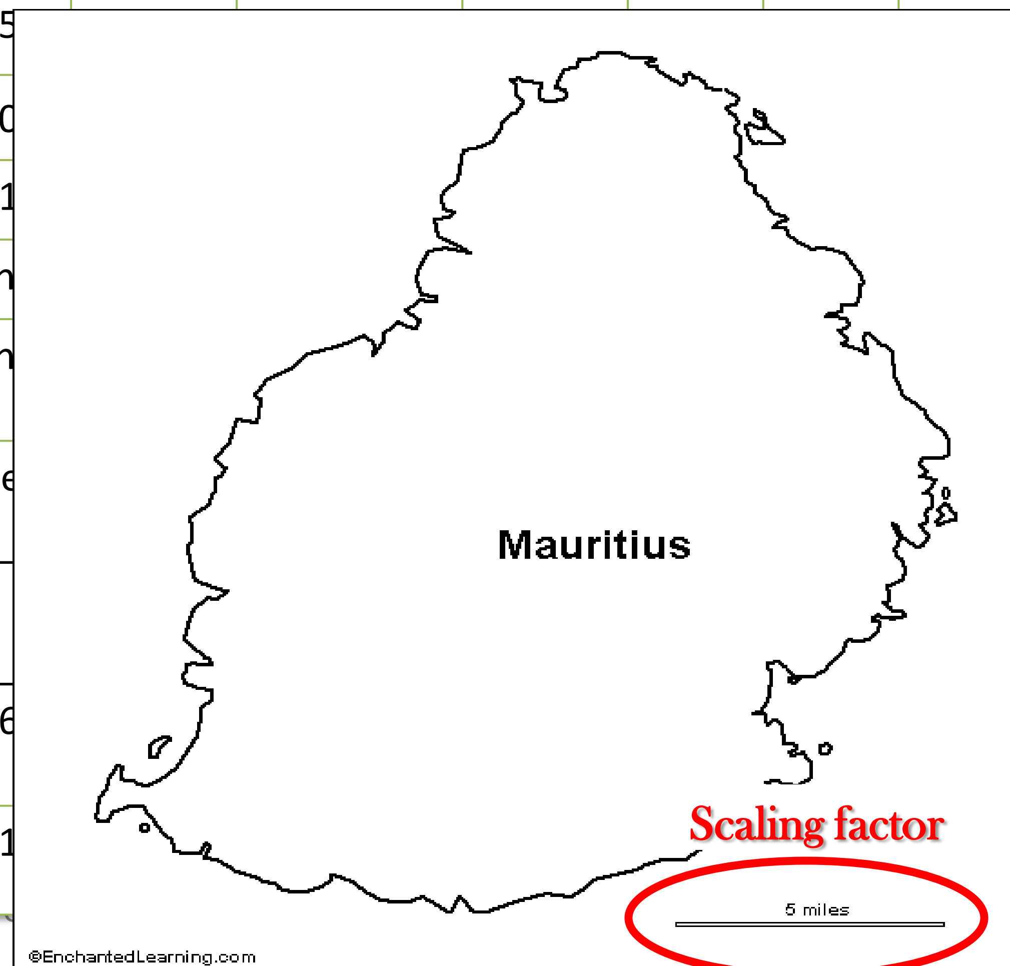
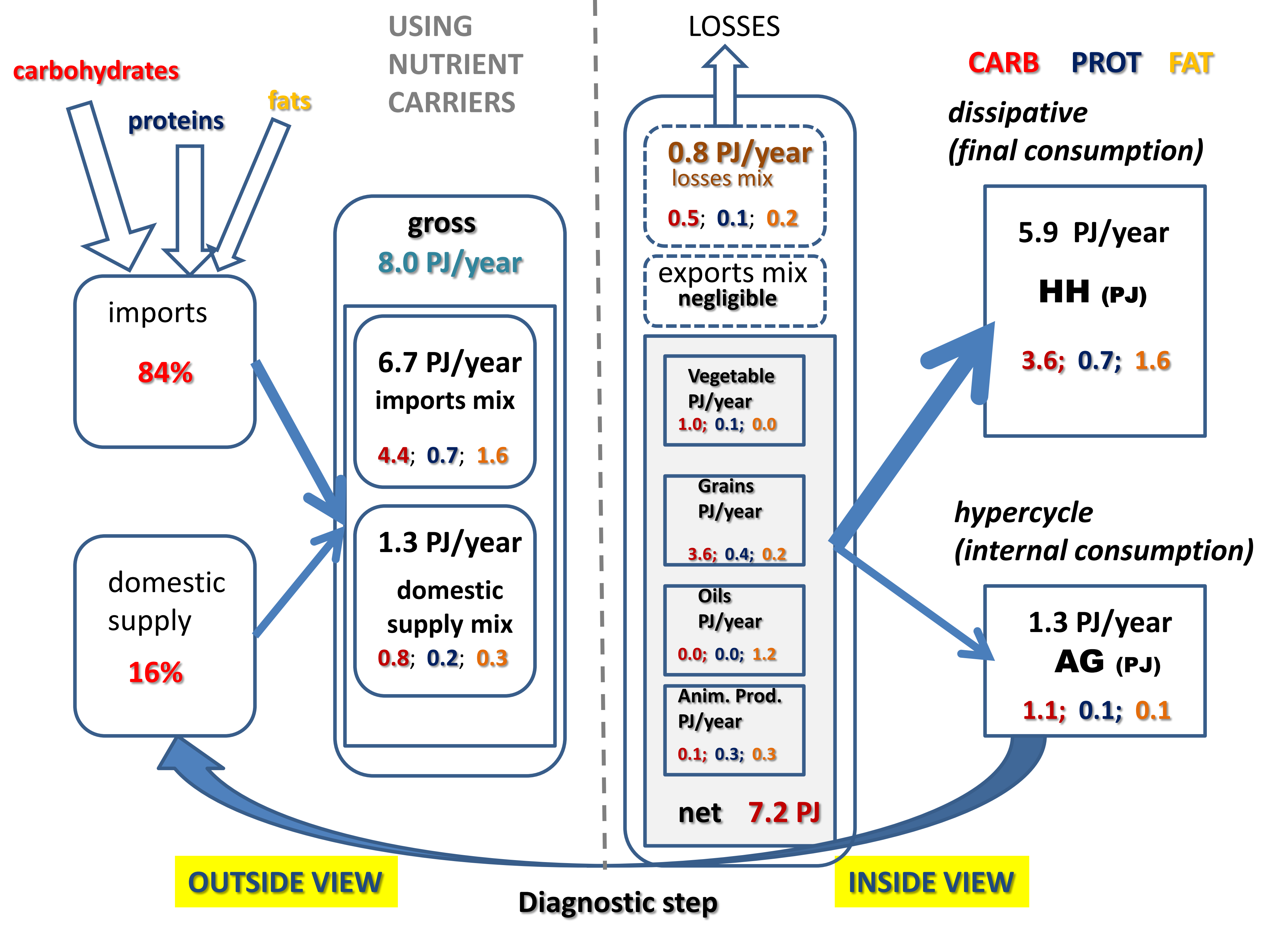
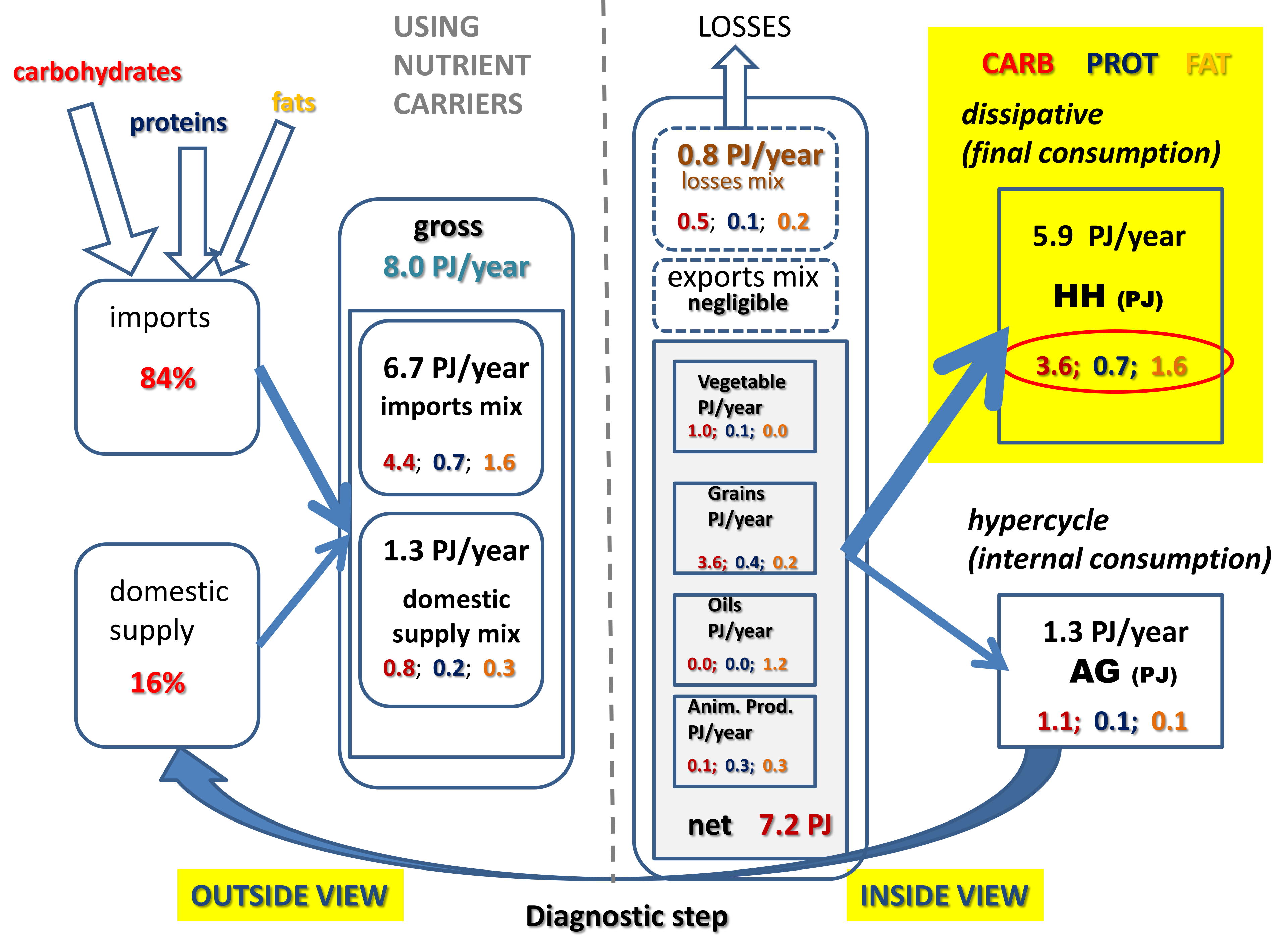
		Flow elements			Fund elements			
		Food (PJ)	Energy (PJ-GER)	Water (hm3 extraction)	HA (Mhr)	PC (GW)	Land (k ha)	Money (Billion US$)
Consumption	HH	5						/a
	PW*	0						00
	AG	1						20
	EM	n						80
	exp$_{PW*}$	n						9% DP
	exp$_{AG}$	ne						5% DP
	Whole							00 P)
Supply	Imports	6						3% DP
	Domestic Supply	1						/a



Political relevance of your "number crunching" . . .

Do we guarantee an adequate diet to the population?


USING
NUTRIENT
CARRIERS
LOSSES
carbohydrates
proteins
fats
CARB PROT FAT
dissipative
(final consumption)
imports
84%
gross
8.0 PJ/year
6.7 PJ/year
imports mix
4.4; 0.7; 1.6
1.3 PJ/year
domestic
supply mix
0.8; 0.2; 0.3
domestic
supply
16%
0.8 PJ/year
losses mix
0.5; 0.1; 0.2
exports mix
negligible
Vegetable
PJ/year
1.0; 0.1; 0.0
Grains
PJ/year
3.6; 0.4; 0.2
Oils
PJ/year
0.0; 0.0; 1.2
Anim. Prod.
PJ/year
0.1; 0.3; 0.3
net 7.2 PJ
5.9 PJ/year
HH (PJ)
3.6; 0.7; 1.6
hypercycle
(internal consumption)
1.3 PJ/year
AG (PJ)
1.1; 0.1; 0.1
OUTSIDE VIEW
INSIDE VIEW
Diagnostic step



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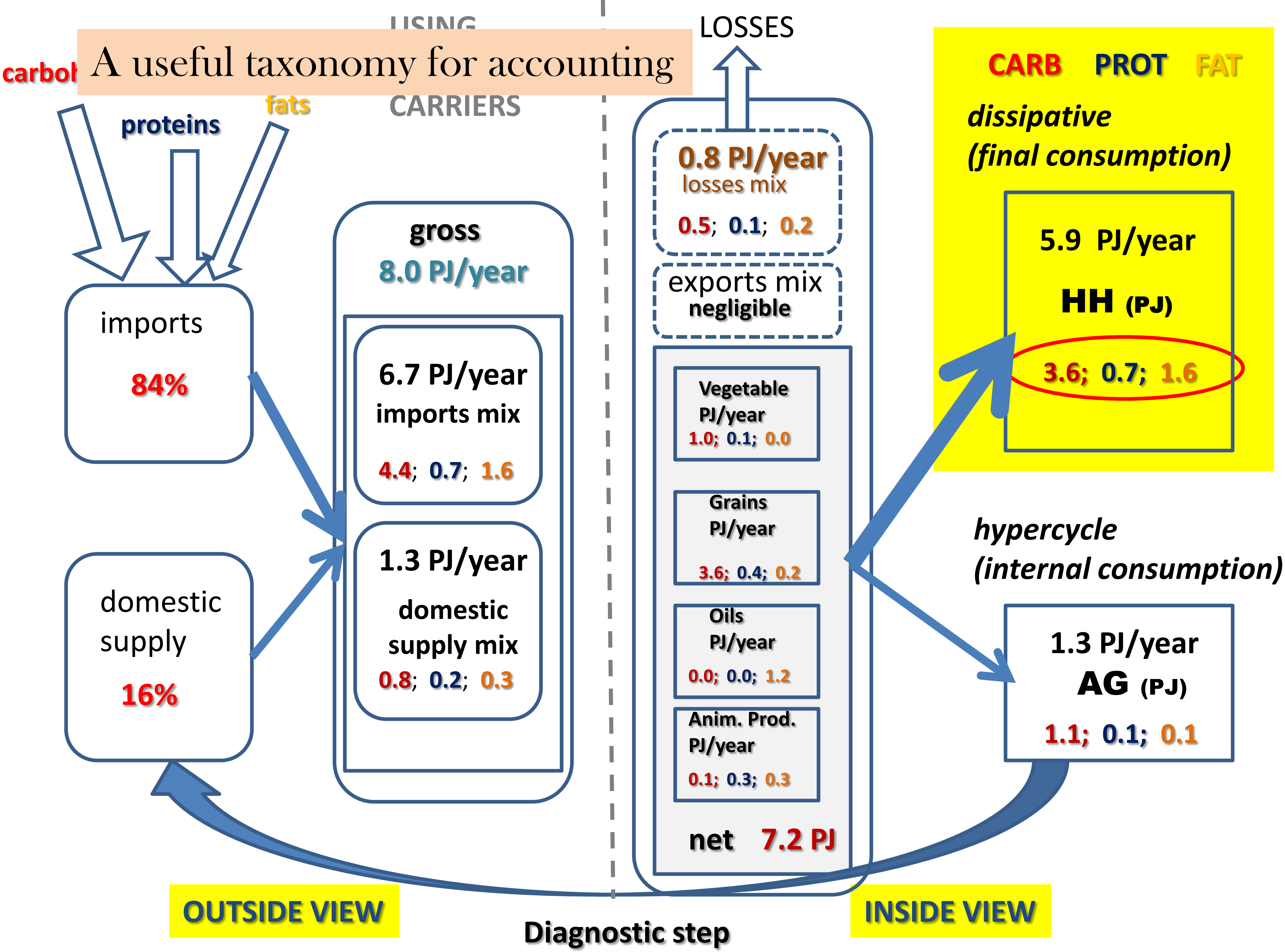
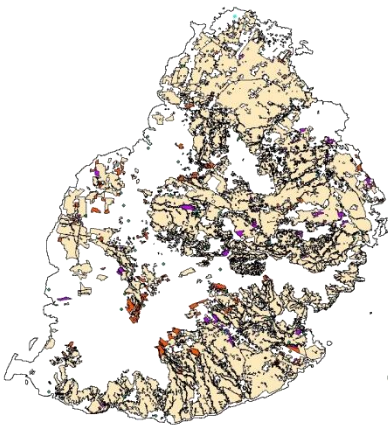
1.1; 0.1; 0.1
OUTSIDE VIEW
INSIDE VIEW
Diagnostic step

A useful taxonomy for accounting

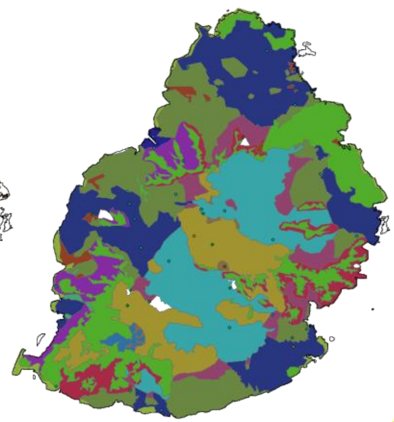


Political relevance of your "number crunching" . . .

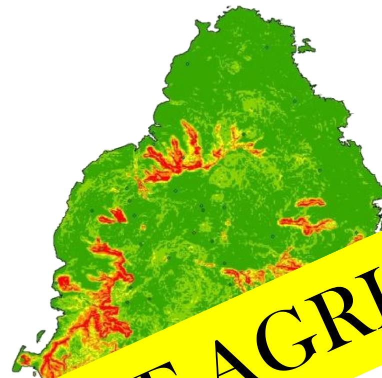
Sugar Cane

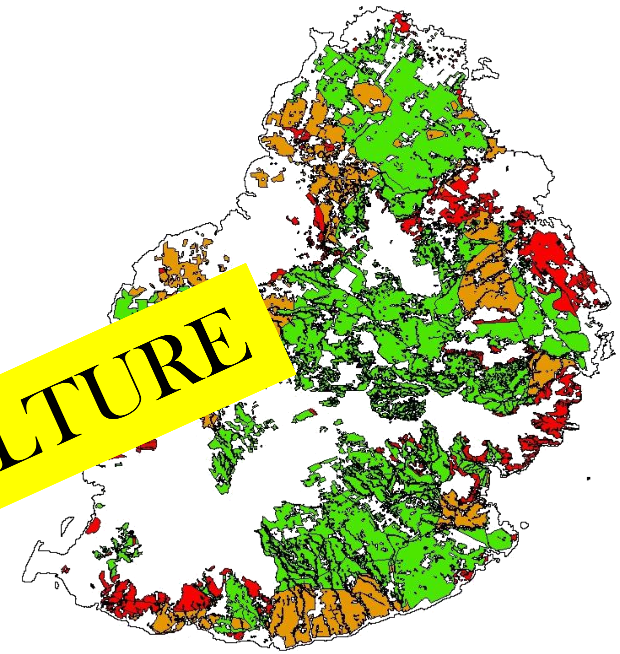


Types of Soil



Slope





Check of Previous Locations

\+

Comp

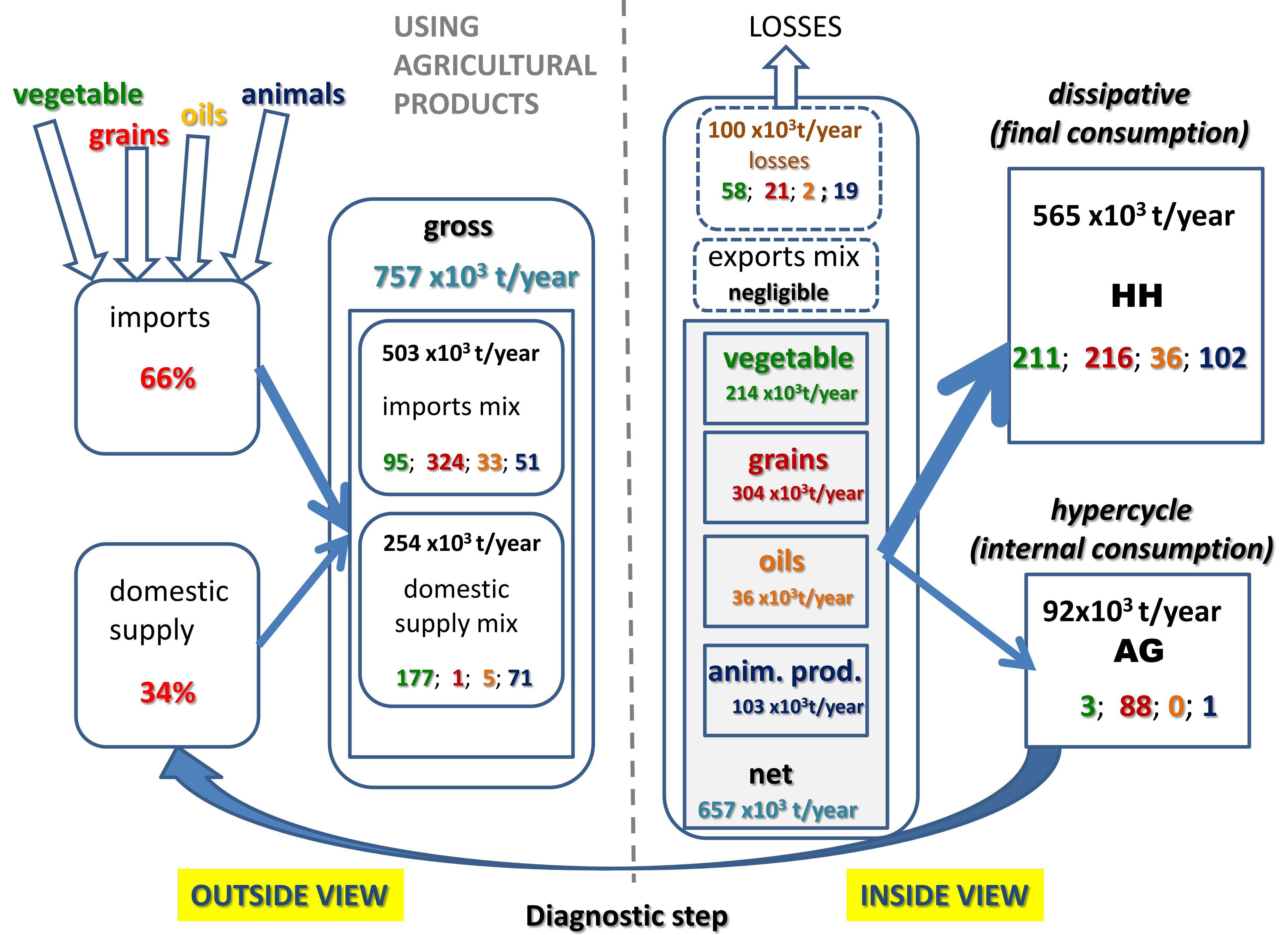
Slope compatibility

⇨ suitable land for a different location of crops mix

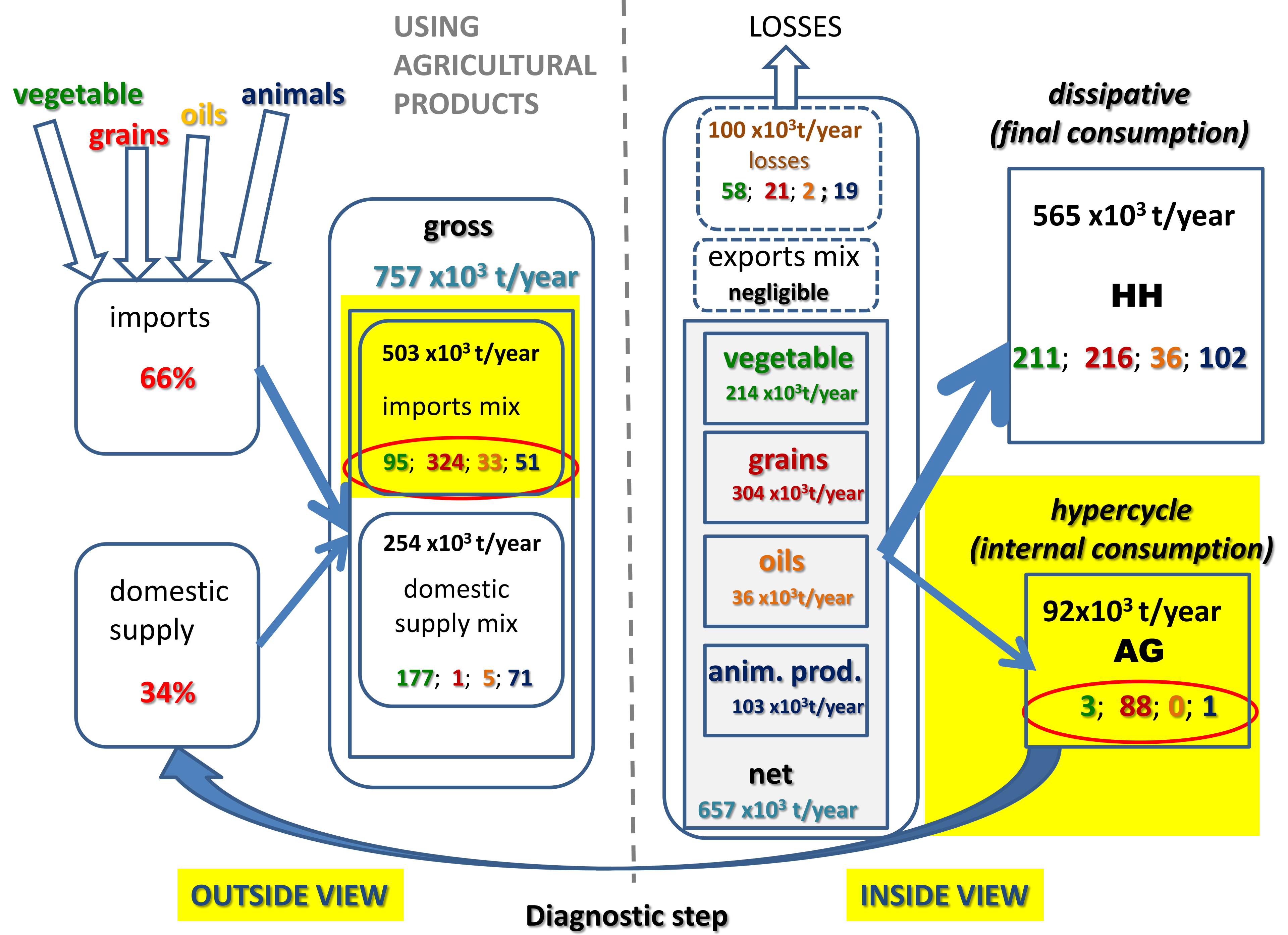
STORY ABOUT AGRICULTURE

Suitable for new crop mix	
Suitable for maize	
Only suitable for sugarcane	

Do we have an adequate amount of land for agriculture?



USING AGRICULTURAL PRODUCTS
vegetable
grains
oils
animals
imports
66%
domestic supply
34%
gross
757 x10³ t/year
503 x10³ t/year
imports mix
95; 324; 33; 51
254 x10³ t/year
domestic supply mix
177; 1; 5; 71
LOSSES
100 x10³t/year
losses
58; 21; 2 ; 19
exports mix
negligible
vegetable
214 x10³t/year
grains
304 x10³t/year
oils
36 x10³t/year
anim. prod.
103 x10³t/year
net
657 x10³ t/year
dissipative
(final consumption)
565 x10³ t/year
HH
211; 216; 36; 102
hypercycle
(internal consumption)
92x10³ t/year
AG
3; 88; 0; 1
OUTSIDE VIEW
INSIDE VIEW
Diagnostic step



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INSIDE VIEW
Diagnostic step

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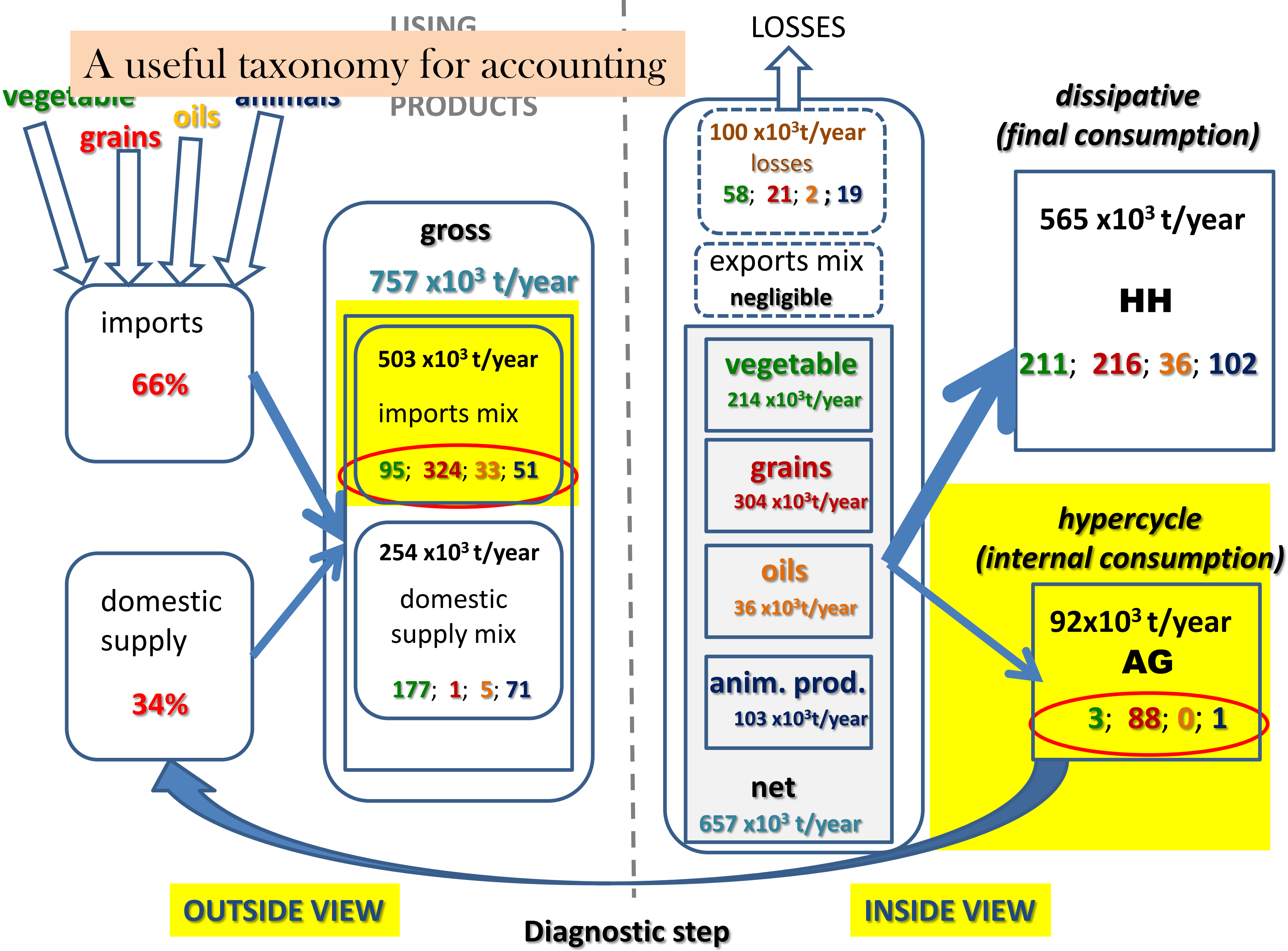

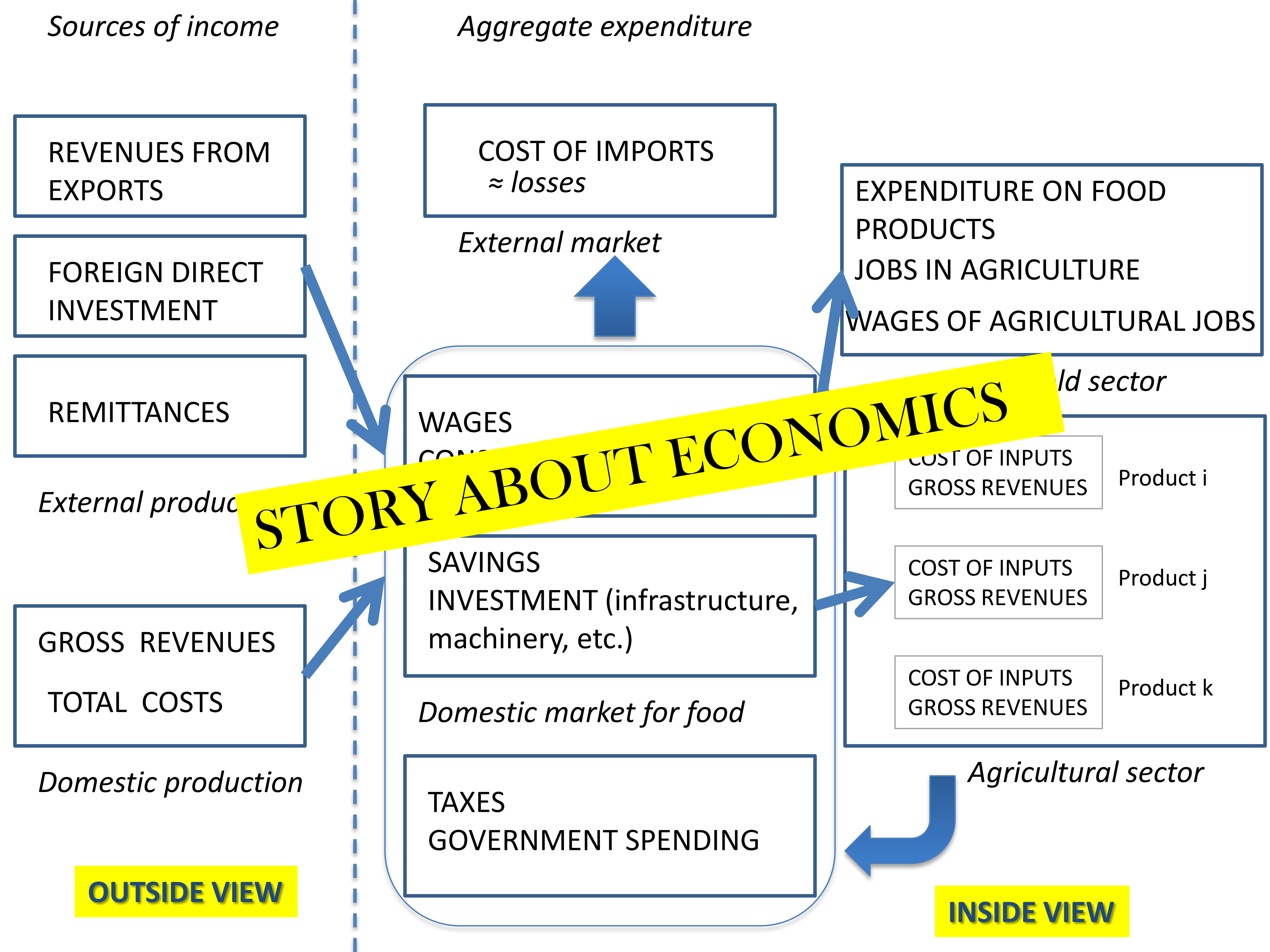

Sources of income
Aggregate expenditure
REVENUES FROM EXPORTS
FOREIGN DIRECT INVESTMENT
REMITTANCES
External produc
GROSS REVENUES
TOTAL COSTS
Domestic production
OUTSIDE VIEW
COST OF IMPORTS
≈ losses
External market
WAGES
SAVINGS
INVESTMENT (infrastructure, machinery, etc.)
Domestic market for food
TAXES
GOVERNMENT SPENDING
EXPENDITURE ON FOOD PRODUCTS
JOBS IN AGRICULTURE
WAGES OF AGRICULTURAL JOBS
ld sector
COST OF INPUTS
GROSS REVENUES
Product i
COST OF INPUTS
GROSS REVENUES
Product j
COST OF INPUTS
GROSS REVENUES
Product k
Agricultural sector
INSIDE VIEW
STORY ABOUT ECONOMICS

Caracterización del Sistema energético

Ecuador, 2012

Supply

Fuentes primarias / Importaciones		FUENTES PRIMARIAS DE ENERGIA	VECTORES ENERGETICOS	
		Termica equiv.	Termica PJ-EC	Elec PJ-EC
SUMINISTRO DOMESTICO				
Petroleo crudo	output	12 PJ-GER	-	4.7
	input	0.30 Mtn	0.26	1.6
Productos petrolíferos	output	230 PJ-GER	227	28
	input	8.4 Mtn	17	[illegible]
Gas natural	output	33 PJ [illegible]	[illegible]	[illegible]
	input	1630 [illegible]	[illegible]	[illegible]
Hydroenergía	output	112 PJ-GER	-	44
	input	7,400 hm3 de agua	negl.	11
IMPORTACIONES (EC)				
Productos petrolíferos	output	251 PJ-GER	251	negl.
	input	n/a	n/a	n/a
Electricidad	output	2.2 PJ-GER	-	0.86
	input	n/a	n/a	n/a

Total output	**508**	**92**
Total input	**24**	**24**
EROI	**21:1**	**3.8:1**

Consumptions

*Ecuador (2012)**

CONSUMPTION	FUNDS	FLOWS		METABOLIC RATES	
	HUMAN ACTIVITY (Ghr)	GSEC Thermal (PJ-EC)	GSEC Elec (PJ-EC)	EMR Thermal (MJ/hr)	EMR Elec (MJ/hr)
ECUADOR (n)	136	508	104	3.7	0.8
HH (Hogares)	[illegible]	[illegible]	23	0.7	0.2
[illegible]	[illegible]	[illegible]	23	38	3.0
[illegible]	[illegible]	105	34	41	13
(Agricultura)	3.4	6	negl.	1.7	0

Hypercycle

EM (En./Min.)	0.13	24	24	187	188

**: numbers may not add up due to rounding*

STORY ABOUT ENERGY

Extraction	Blue	Green	Total
Underground	31	0	31
Surface	15	0	15
Soil	0	26	26
TOTAL	46	26	72

-

Loses factor (Blue)
0
6
0

=

Use	Blue	Green	Total
Underground	31	0	31
Surface	9	0	9
Soil	0	26	26
TOTAL	40	26	66

External view

Internal view

STORY ABOUT WATER

Extraction	Blue	Green	Total
Underground	31	0	31
Surface	15	0	15
Soil	0	26	26
TOTAL	46	26	72

-

Loses factor (Blue)
0
6
0

=

Use	Blue	Green	Total
Underground	31	0	31
Surface	9	0	9
Soil	0	26	26
TOTAL	40	26	66

External view

Internal view

STORY ABOUT WATER

[illegible]	[illegible]	Green	WMR	EPW
[illegible]	1	0	5	N/A
PW (n-1)	39	26	2,993	31
AG (n-2)	39	26	9,129	9
Rice & Wheat (n-3)	35	23	9,064	N/A
TOTAL Whole (n)	40	26	274	30
Imports	0	0	0	0

4. Environment

Extraction	Blue	Green	Total
Underground	31	0	31
Surface	15	0	15
Soil	0	26	26
TOTAL	46	26	72

-

Loses factor (Blue)
0
6
0

=

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Surface	9	0	9
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External view

Internal view

STORY ABOUT WATER

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Imports	0	0	0	0

Domestic Use	Blue	Green
HH + PW* (n-2)	1	0
AG (n-2)	10	9
Rice & Wheat (n-3	7	6
TOTAL SA (n)	11	9
Expeditions India	28	16
Expeditions %	71%	64%

Extraction	Blue	Green	Total
Underground	31	0	31
Surface	15	0	15
Soil	0	26	26
TOTAL	46	26	72

-

Loses factor (Blue)
0
6
0

=

Use	Blue	Green	Total
Underground	31	0	31
Surface	9	0	9
Soil	0	26	26
TOTAL	40	26	66

External view

Internal view

STORY ABOUT WATER

[illegible]	[illegible]	Green	WMR	EPW
[illegible]	1	0	5	N/A
PW (n-1)	39	26	2,993	31
AG (n-2)	39	26	9,129	9
Rice & Wheat (n-3)	35	23	9,064	N/A
TOTAL Whole (n)	40	26	274	30
Imports	0	0	0	0

Domestic Use	Blue	Green
HH + PW* (n-2)	1	0
AG (n-2)	10	9
Rice & Wheat (n-3	7	6
TOTAL SA (n)	11	9
Expeditions India	28	16
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Openness= -68% (Net exporter)

4. Environment

Extraction	Blue	Green	Total
Underground	31	0	31
Surface	15	0	15
Soil	0	26	26
TOTAL	46	26	72

\-

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6
0

=

Use	Blue	Green	Total
Underground	31	0	31
Surface	9	0	9
Soil	0	26	26
TOTAL	40	26	66

STORY ABOUT WATER

External view

	Appropriation	Bi[illegible]	[illegible]
Extraction	Recharge (Km3)	[illegible]	[illegible]
	Interntl. Use Rig[illegible]	25%	100%
	Dam Reserve (km3)	11	N/A
	Blocks (no.)	N/A	138
	Extraction (km3)	15	31
	Overexp. Blocks (no.)	N/A	110
Lodging	RAMSAR in Risk	3/3	N/A
	Regions Over Salinity	N/A	6/25
	Regist. Over Nitrate	N/A	16/25
	Regist. Over Metals	N/A	10/25
	Regist. Max. BOD (mgL)	50	N/A

Internal view

[illegible]	[illegible]	Green	WMR	EPW
[illegible]	1	0	5	N/A
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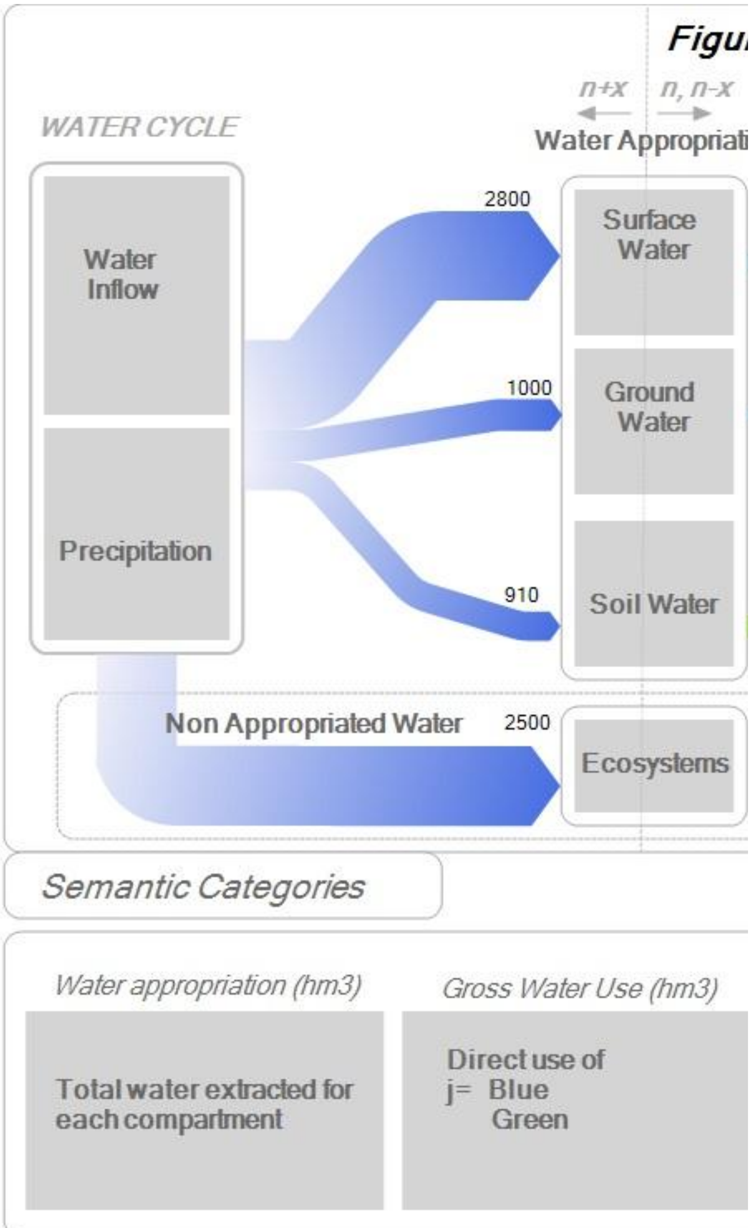
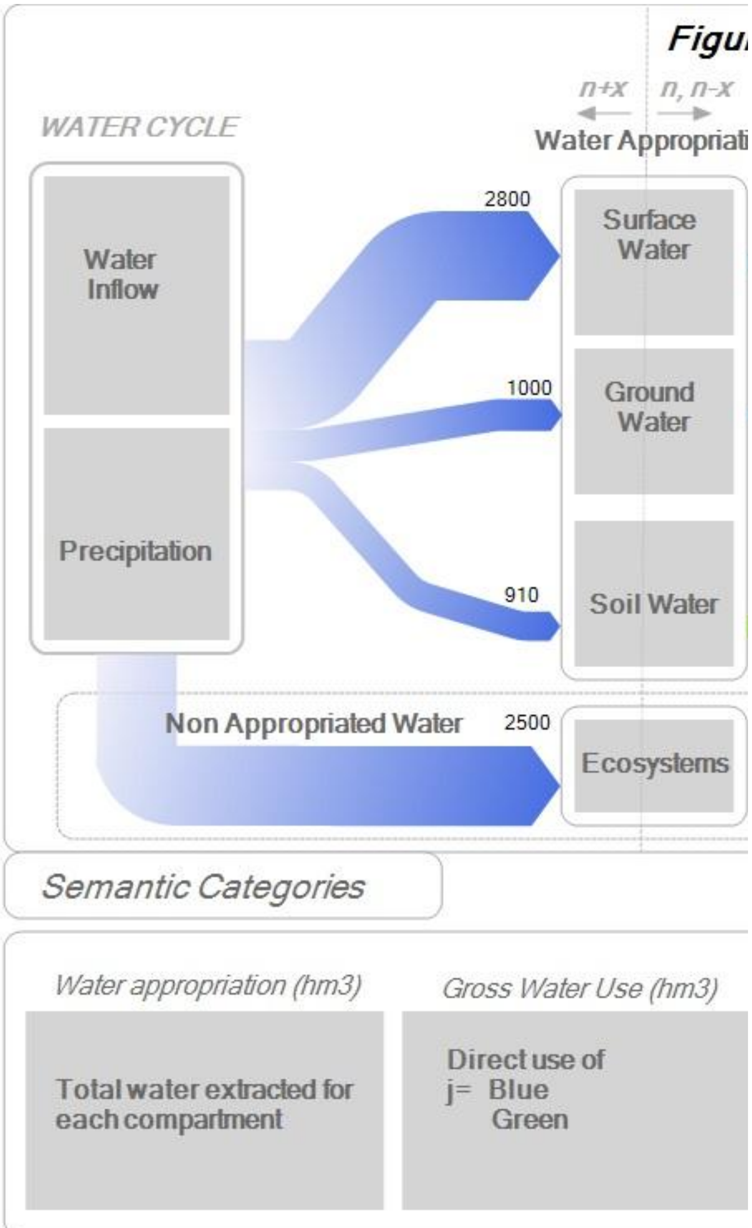


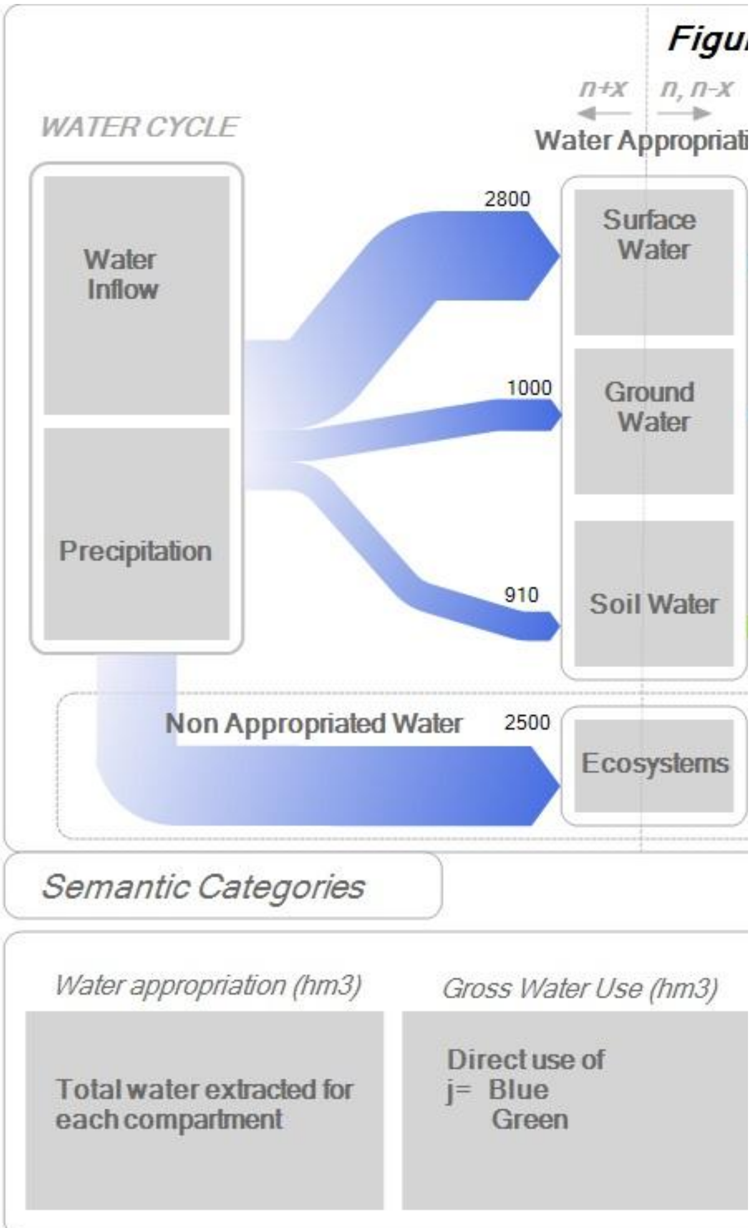
Water Accounting



Indicator/ Compartment	Extraction Total	EXT Blue-Surface	EXT Blue-Ground	EXT Green	USE Losses	USE Total
Whole (n)	**1,706**	**555**	**432**	**718**	**108**	**1,599**
HH (n-1)	**98**	74	24	0	14	**84**
HH-Urban (n-2)	**41**	31	10	0	0	**35**
HH-Rural (n-2)	**57**	43	14	0	0	**49**
PW (n-1)	**1,608**	481	408	718	94	**1,515**
PW-SG (n-2)	**17**	13	4	0	2	**15**
PW-TR (n-2)	**1.72**	1.30	0.42	0	0	**1**
PW-BM (n-2)	**27**	20	7	0	4	**23**
PW-EM (n-2)	**262**	255	7	0	4	**258**
PW-AG (n-2)	**1,300**	192	390	718	84	**1,218**

Water Accounting

4. Environment



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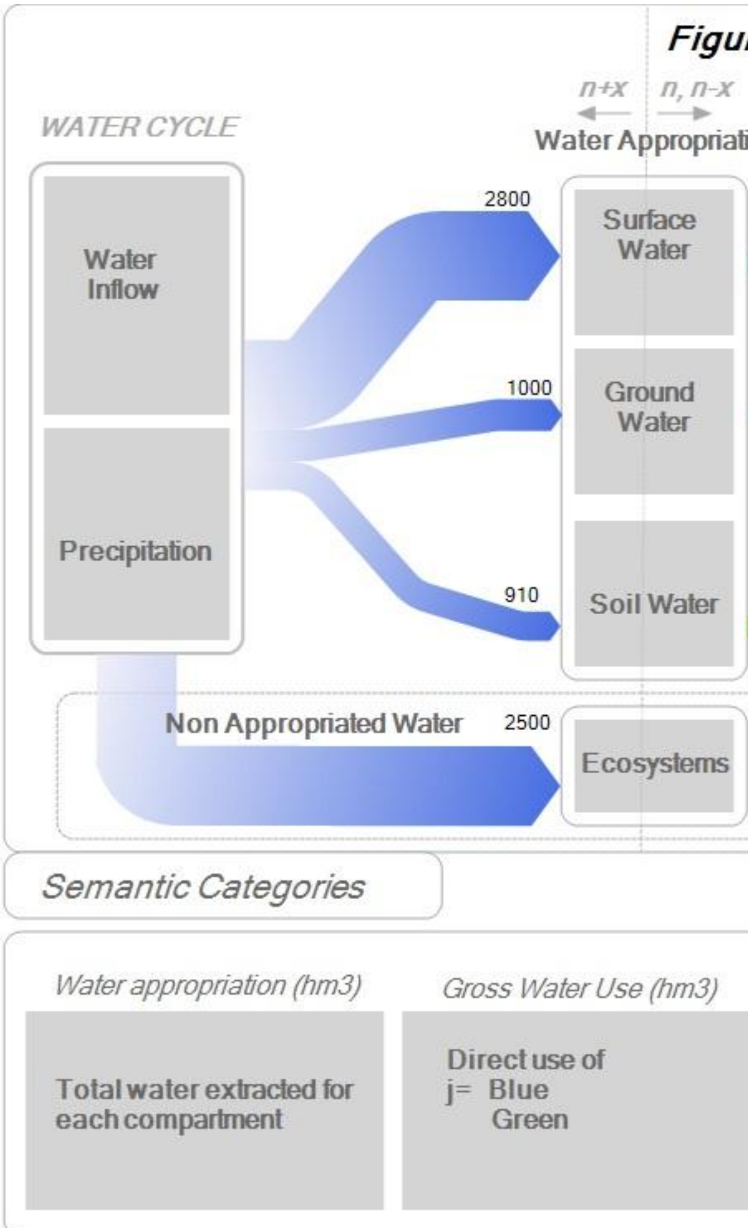
Indicator/Compartment (Supply system)	Extraction-TOTAL	Water Renewable Res ources (WRR)			Extraction as (%) WRR
		Surface Inflow	Ground Inflow	**Total**	
Territorial System Covered (n+1)	**1,492**	2,055	778	**2,834**	53
Mare Aux Vacoas-Upper (n+1)	**252**	344	130	**474**	53
Mare Aux Vacoas-Lower (n+1)	**193**	88	34	**122**	**158**
Port-Louis (n+1)	**291**	562	213	**775**	38
North (n+1)	**291**	259	98	**358**	**81**
South (n+1)	**247**	383	145	**528**	47
East (n+1)	**229**	464	176	**640**	36
Uncovered (n+1)	**214**	820	311	**1,130**	19
TOTAL (n)	**1,706**	2,875	1,089	**3,964**	43

Water Accounting

4. Environment



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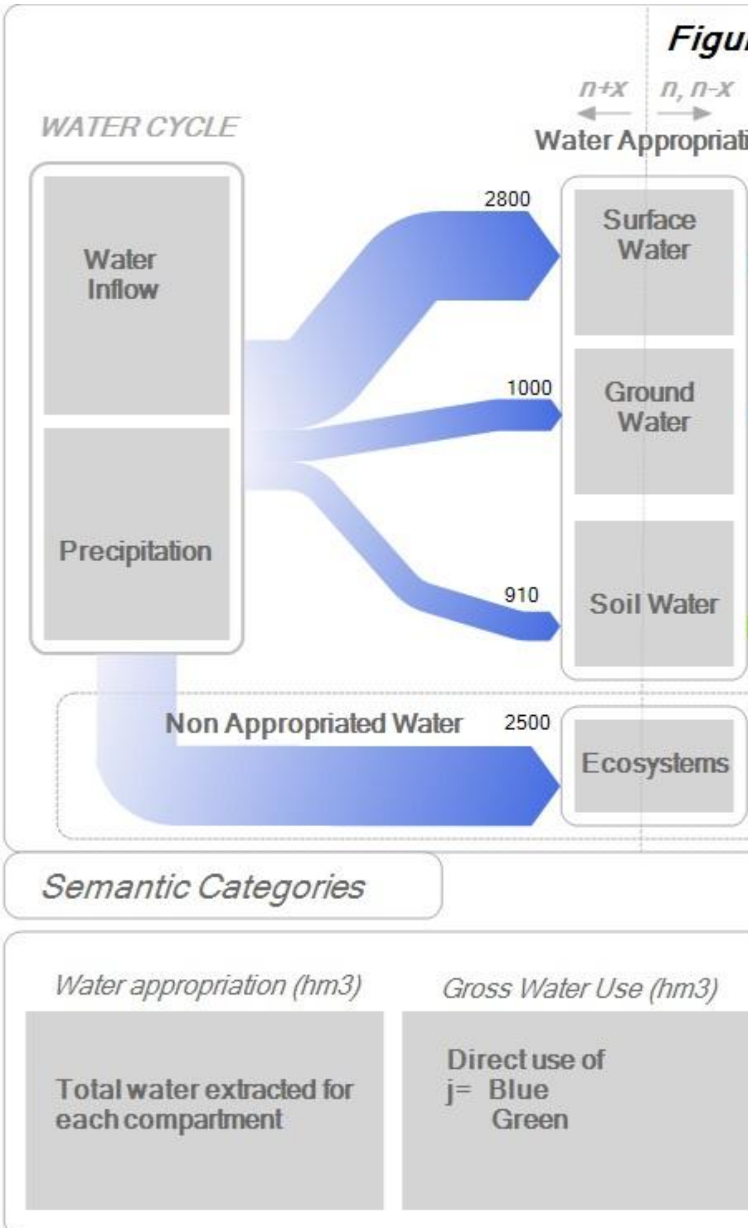

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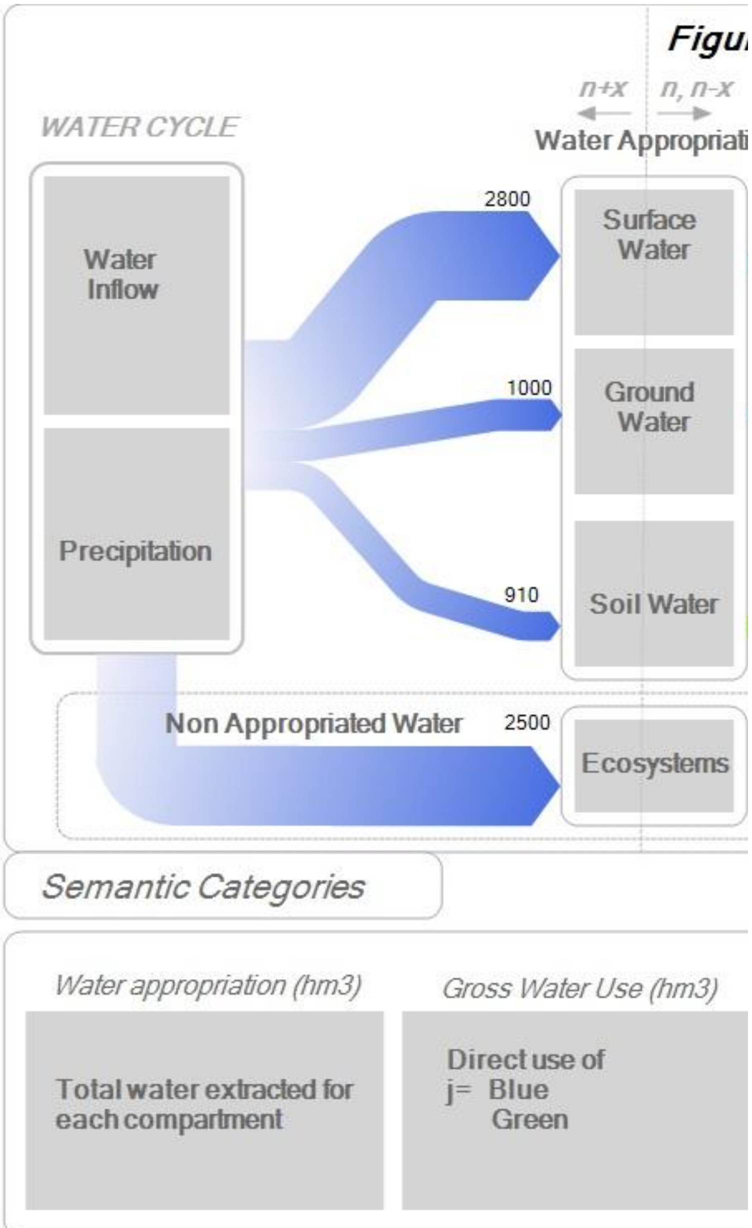

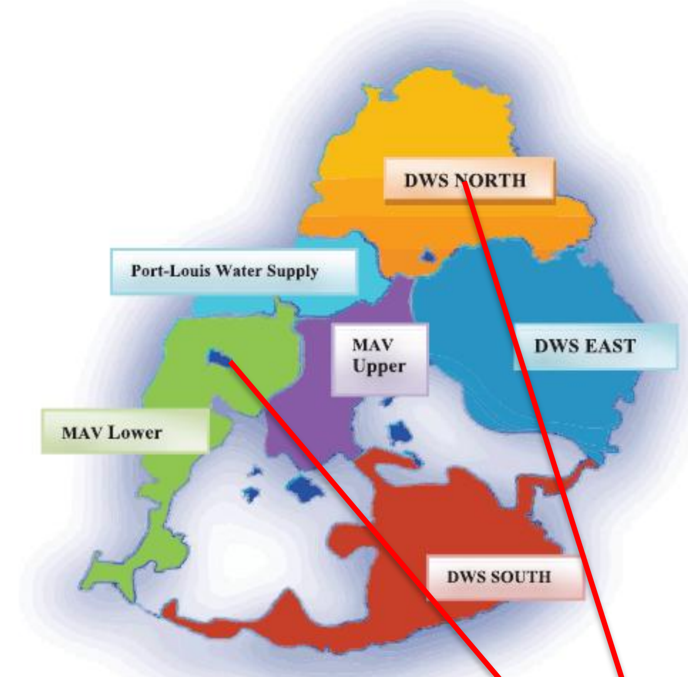

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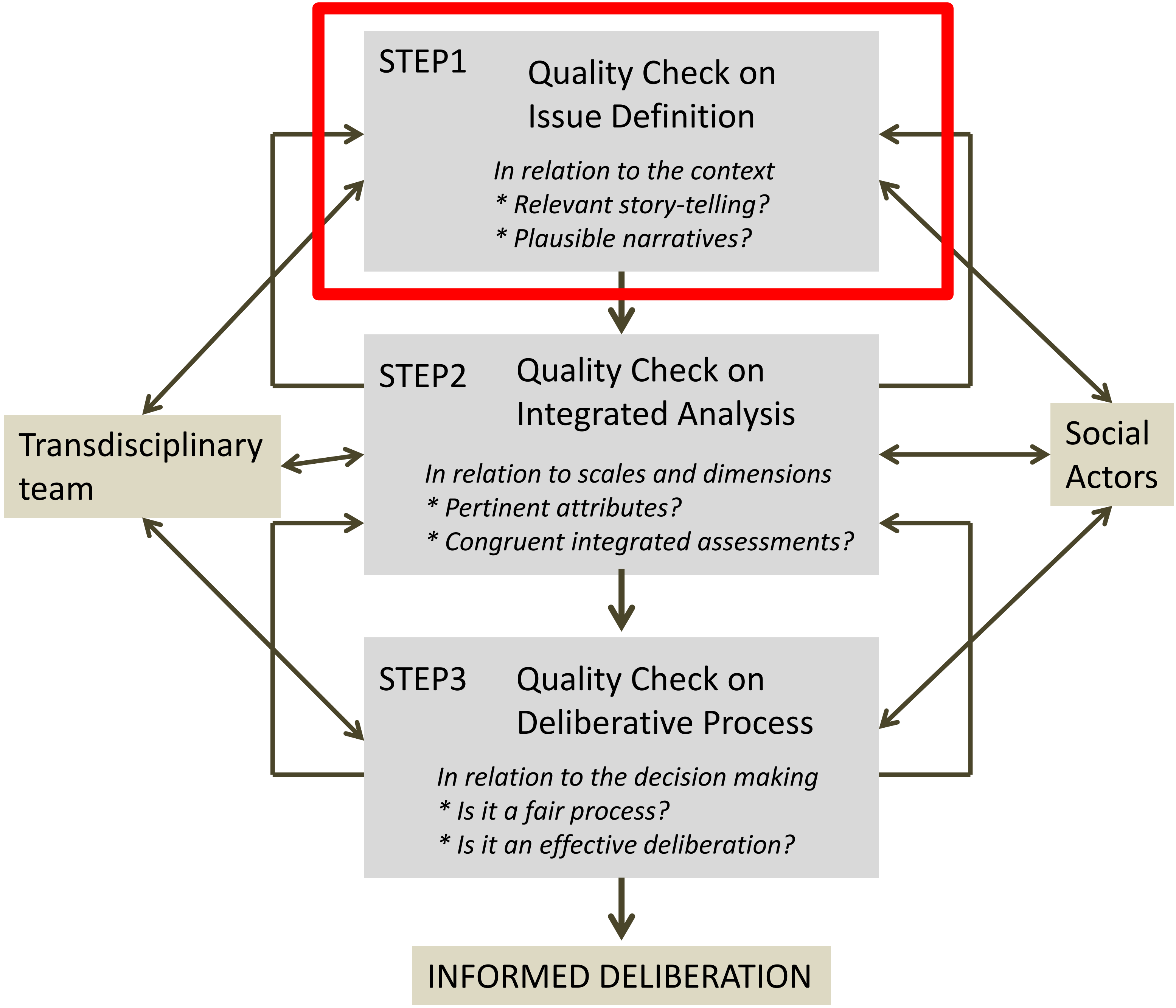
Water Accounting

FIGTHING HYPOCOGNITION (3)

A procedure of participatory integrated assessment
based on the concept of Quantitative Story Telling


STEP1
Quality Check on
Issue Definition
In relation to the context
* Relevant story-telling?
* Plausible narratives?
STEP2
Quality Check on
Integrated Analysis
In relation to scales and dimensions
* Pertinent attributes?
* Congruent integrated assessments?
STEP3
Quality Check on
Deliberative Process
In relation to the decision making
* Is it a fair process?
* Is it an effective deliberation?
Transdisciplinary team
Social Actors
INFORMED DELIBERATION

Checking the quality (usefulness) of the chosen issue definition of sustainability

International Conference on World Food Security SAGUF -Zurich, October 9 - 10, 1996

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PRESERVING local cultural heritage	NGO - Swiss Feminist

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FIGHTING local cultural heritage	**Sociologist - Prof. from India**

"Models by their nature are like blinders. In leaving out certain things, they focus our attention on other things. They provide a frame through which we see the world".

Joseph Stiglitz

Hypocognition is a term used to flag the risk of the tunnel-vision effect generated by the adoption of a given frame of analysis. Hypocognition hampers the capacity to deal with the implications of uncertainty and complexity.

George Lakoff

In quantitative analysis the use of a single dimension and scale at the time reduces the explanatory power of the representation missing feedback loops and interactions with other dimensions and scales of analysis.

when dealing with complex issues
any formalization of the chosen issue definition (problem structuring) into a finite set of data and models unavoidably generates **hypo-cognition***
= the missing of relevant known-known and relevant known-unknown plus a reduced ability to deal with unknown unknowns.

This entails that without a quality check on the choice of the story-telling, more data and larger models developed within sloppy explanations and perceptions will only increase the level of indeterminacy and uncertainty leaving untouched the level of hypo-cognition.

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SOCIALLY CONSTRUCTED IGNORANCE!

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Problem Structuring: a brutal simplification of the information space

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Other Social Actors

information space
virtually infinite

* ethical principles
* entities "we" care for
* relevant criteria/attributes
* data, models and targets

Decision Makers

information space small
but not always known

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Scientists

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1st compression

NORMATIVE SIDE
deciding the identity of the “Story-Teller”

CRITERIA OF PERFORMANCE	ATTRIBUTES	CONSIDERED ALTERNATIVES: “high tech” market	“organic” market	“household” subsistence
relevant for consumers	*final price*	✓	~	✓
	quality of milk	~	✓	~
	convenience	✓	✓	✗
relevant for the economy	*production cost*	✗	✗	✓
	job creation	✗	~	✗
	need of subsidies	✗	~	✓
relevant for the environment	*GHG emissions*	✗	✓	✓
	Nitrogen pollution	✗	✓	✓
	deforestation (feed)	✗	~	✓
relevant for the country	*food security (supply)*	✓	✓	✗
	food safety	~	✓	✗
	rural development	✗	✓	✗

DESCRIPTIVE SIDE
deciding the identity of the information space

Selecting a limited set of Alternatives, Attributes, Targets

Moving from an open information space to a finite information space

2nd compression

Consequences of the simplification/compression

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Moving from an open
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2nd compression

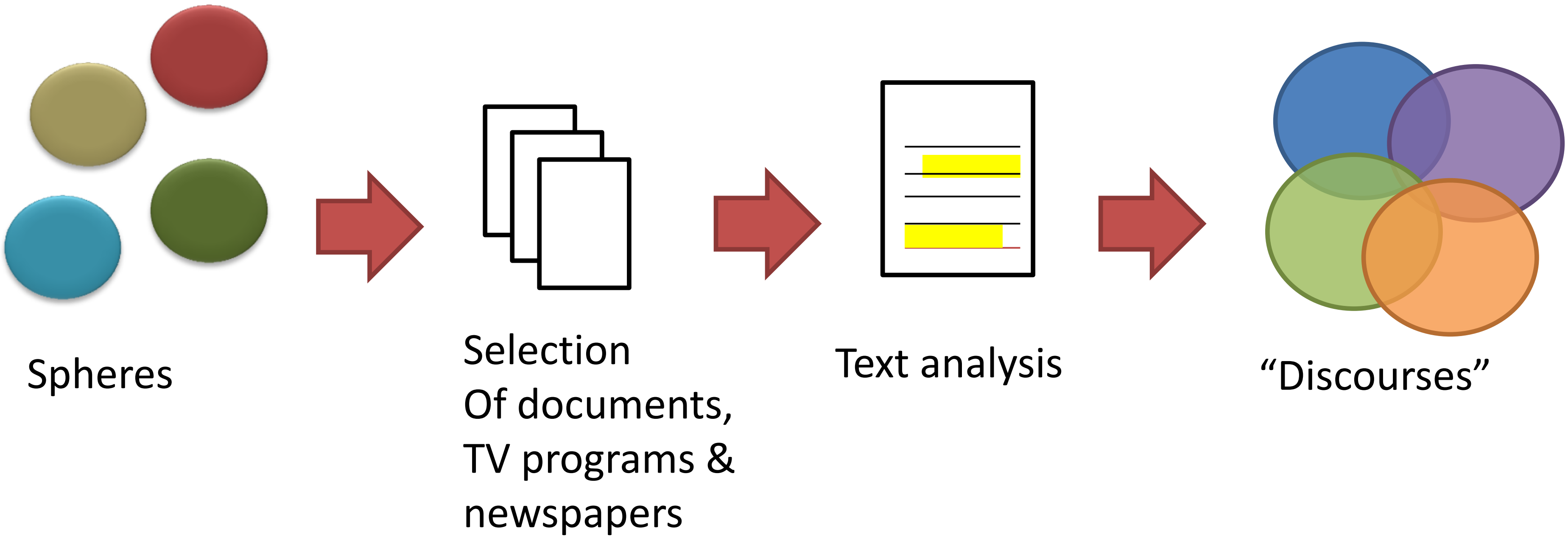
Consequences of the simplification/compression

BAD
Scenario Analysis
Policy Choice

HYPOCOGNITION

* Ignoring “known knowns”
* Missing “known unknowns”
* Poor handling of “unknown unknowns”

Insititutional & discourse analysis– Scoping and framing



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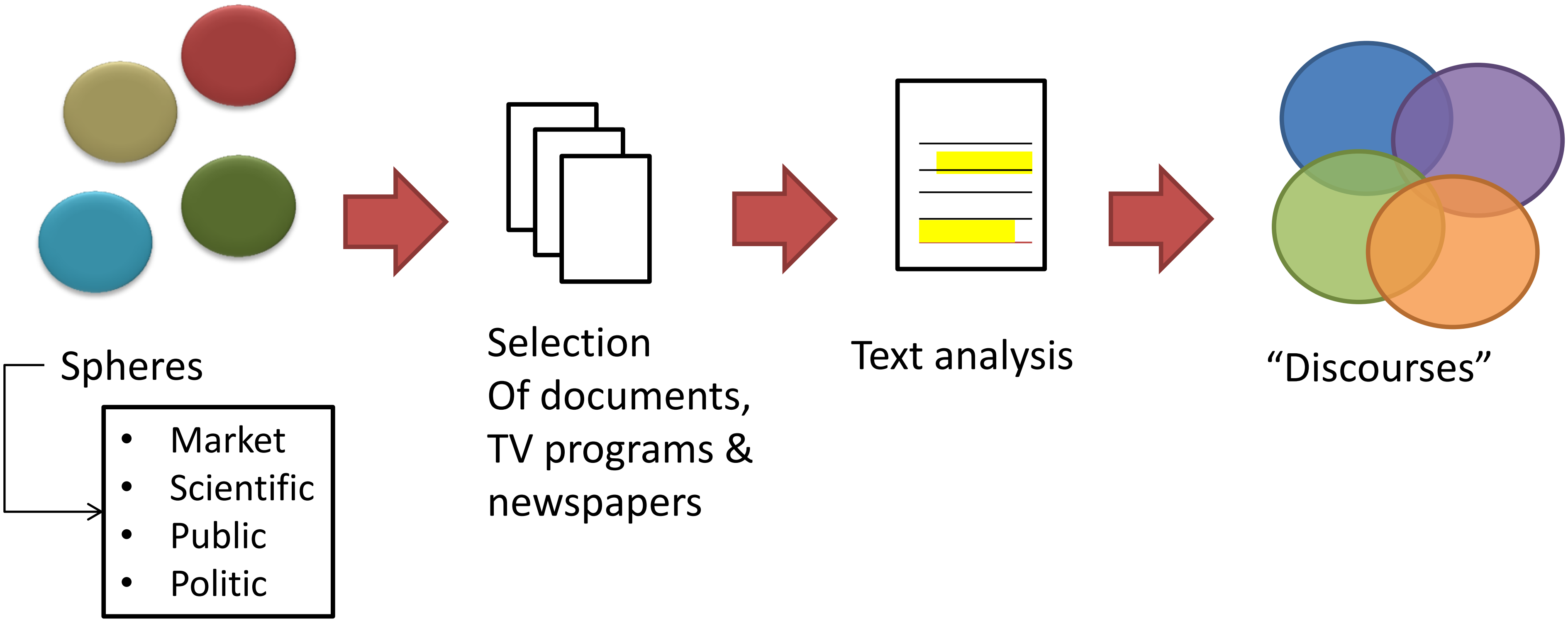
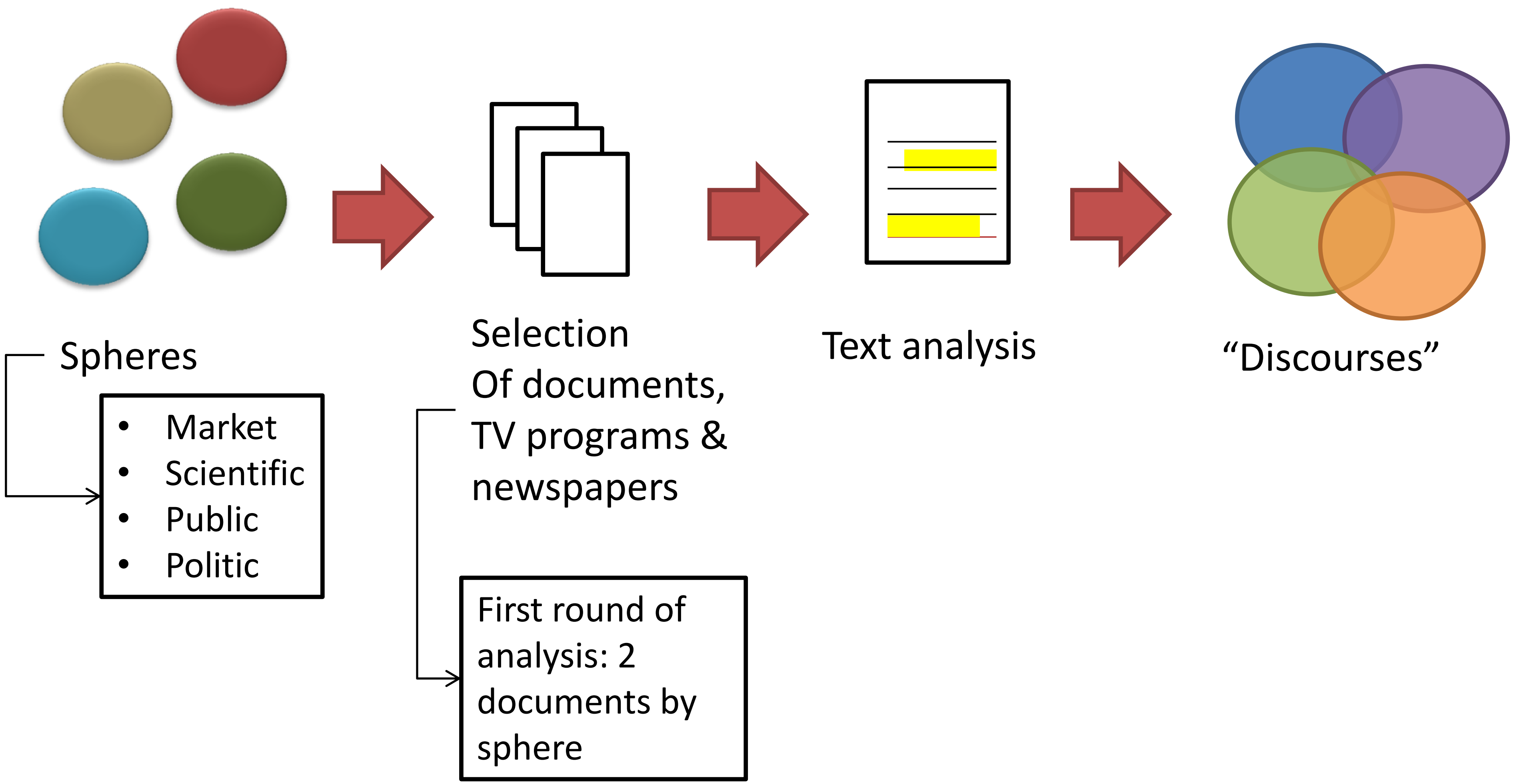


Insititutional & discourse analysis– Scoping and framing



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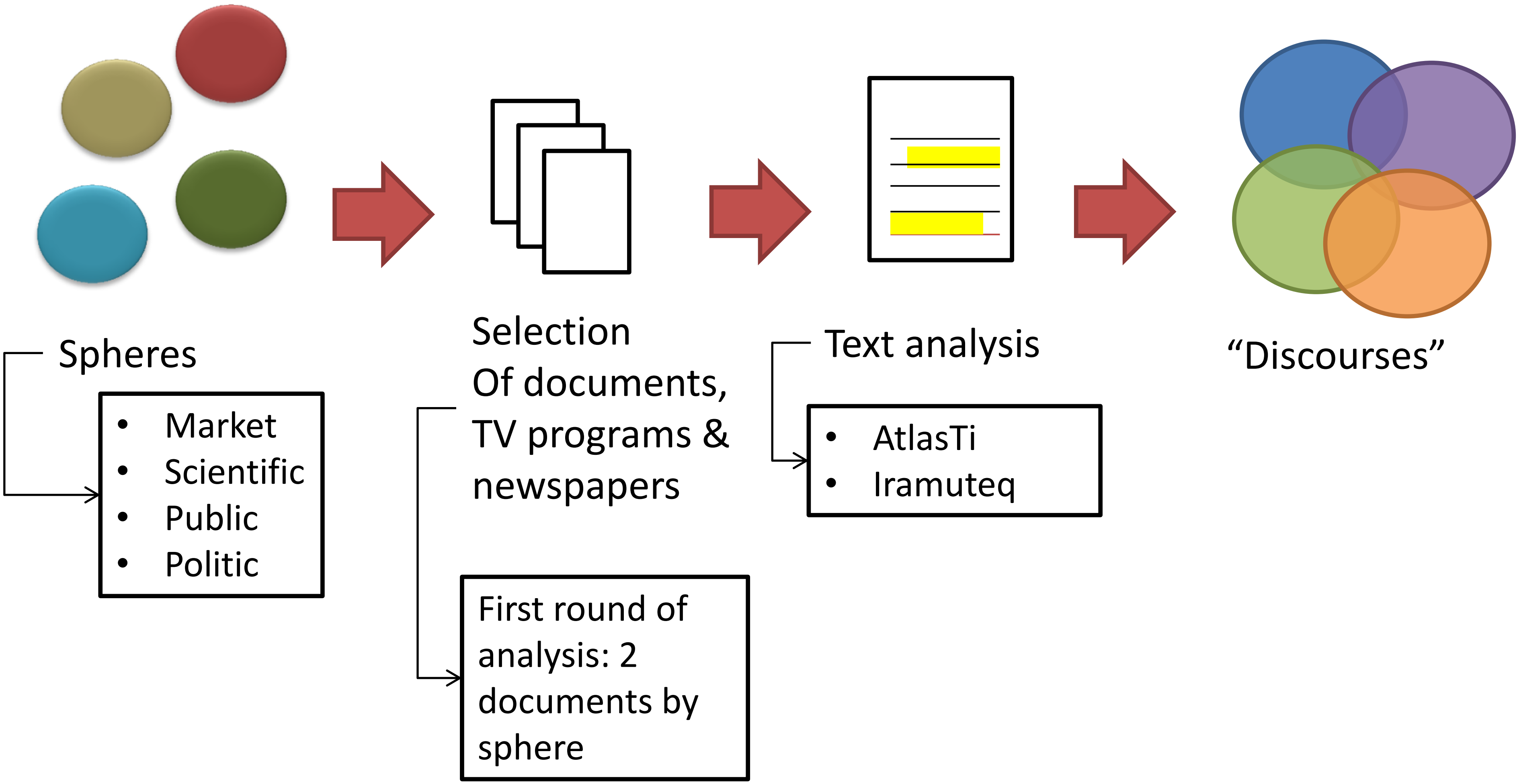

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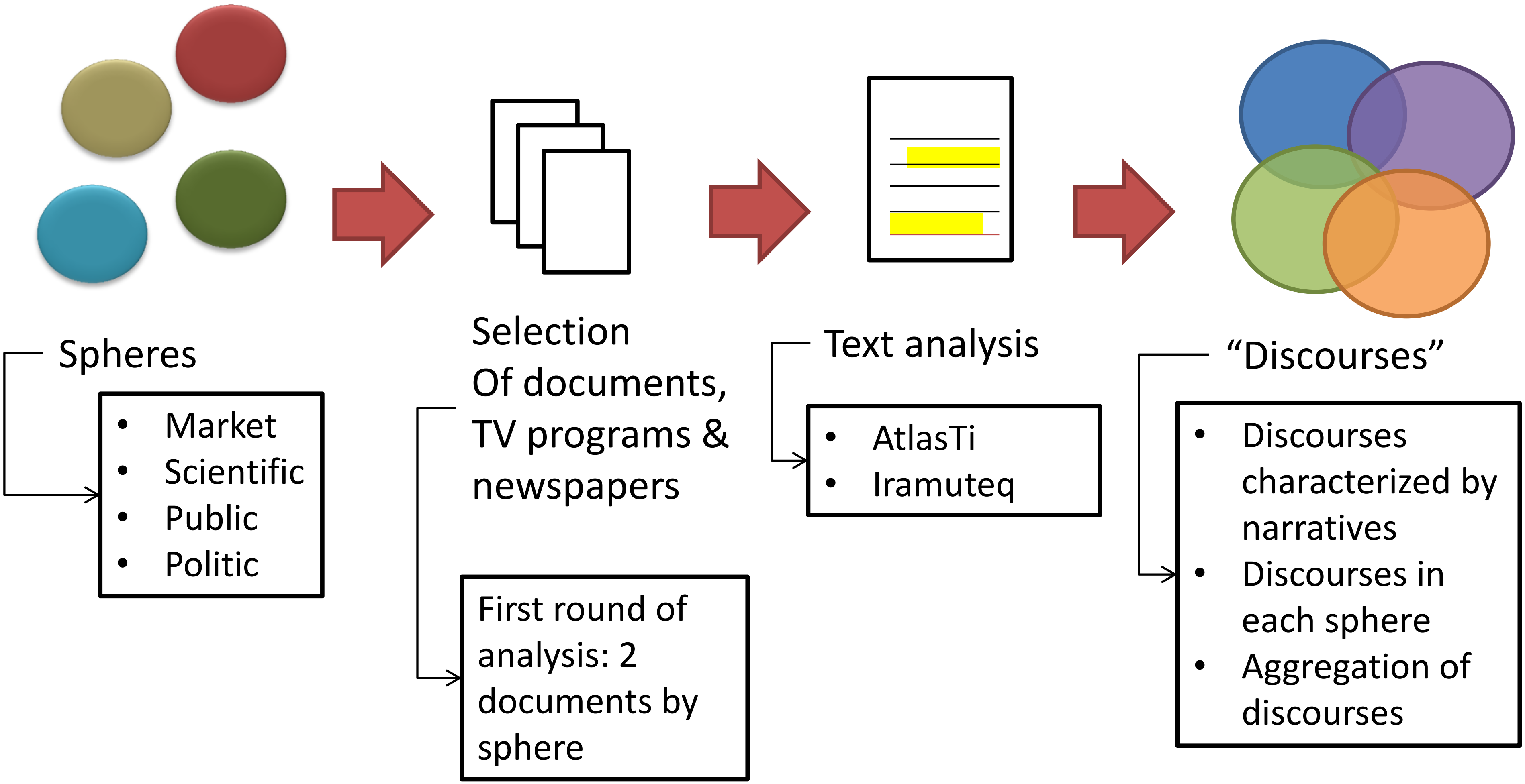

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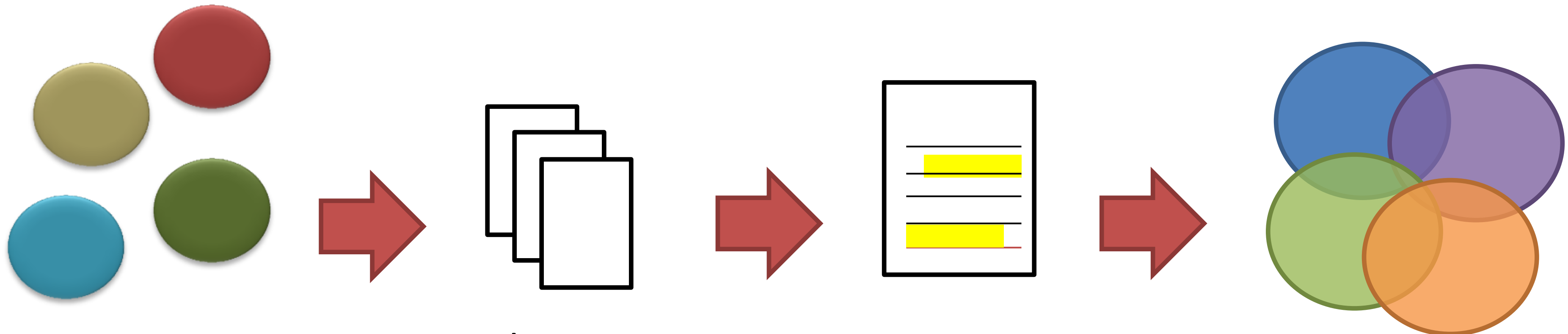

Spheres

- Market
- Scientific
- Public
- Politic

Selection Of documents, TV programs & newspapers

First round of analysis: 2 documents by sphere

Text analysis

- AtlasTi
- Iramuteq

"Discourses"

- Discourses characterized by narratives
- Discourses in each sphere
- Aggregation of discourses

Attributes & Indicators

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STORY TELLINGS ABOUT FOOD SUPPLY CHAINS

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(1) It expresses technical processes in order to produce food commodities at a given level of profit, its sustainability depends on economic viability

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Needed by economic agents (producers & consumers)

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(5) It gener… goals.
Therefo… on our
normat… adopted in the society.

Needed by everybody: sustainability requires addressing moral and political issues

How useful is a characterization of performance of FSC based on the conventional multicriteria approach?

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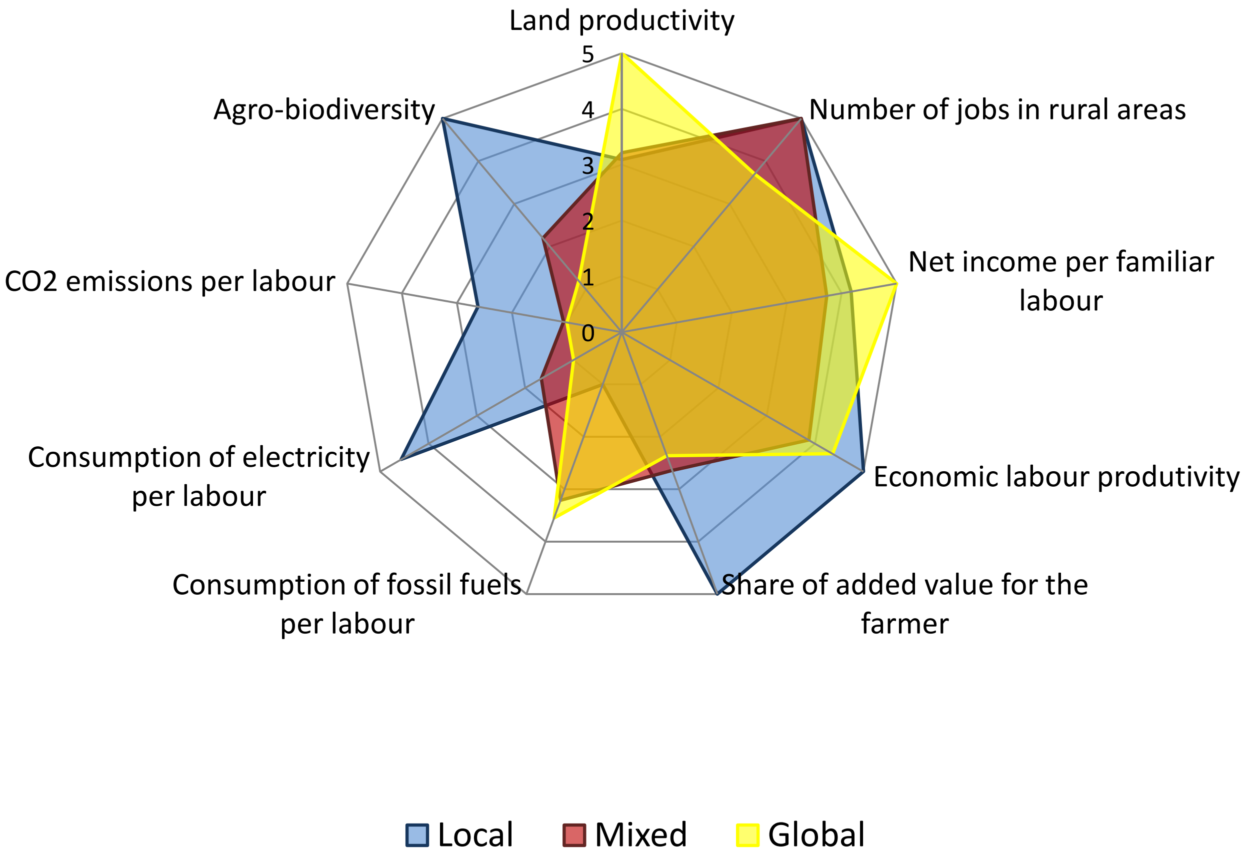
Enviromental dimension

Economic dimension



What if, rather than by dimensions, we organize the characterization based on attributes/indicators by story-telling (i.e. by typologies of social actors?)

In this way, we can still use all the indicators that we want, but organizing them in a set of different dash-boards we can better understand policy relevant issues such as:

(i) winners, losers, critical situations;

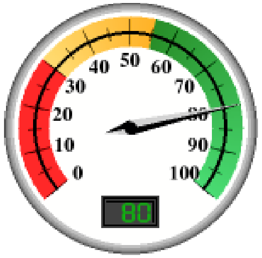
(i) trade-offs to be considered when looking for feasible, viable, and desirable compromises.

What if we organize the set of indicators over dash-boards reflecting the existence of different story-telling?

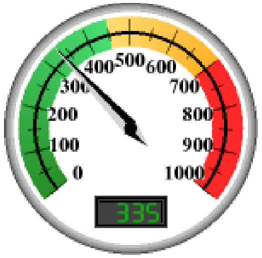
Food Chain Supply is about COMMODITIES

(investors/entrepreneurs)

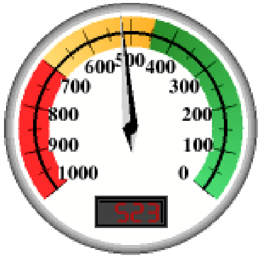
PROFIT



REGULATION



SUBSIDIES



Food Chain Supply is about **COMMODITIES**

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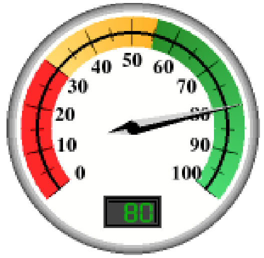

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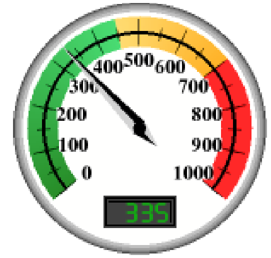

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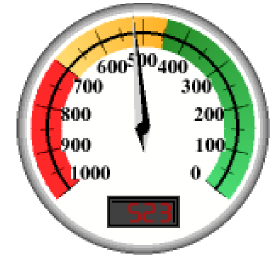
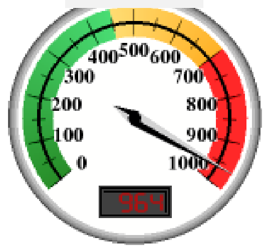


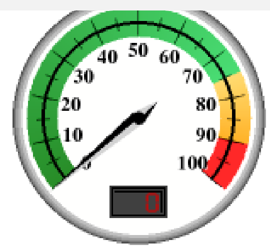
Food Chain Supply is about **LIVELIHOOD** (whose development?)

(community/local admin.)

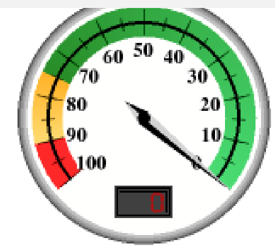
JOBS



$ FLOW TO LOCAL



SIDE EFFECTS



Food Chain Supply is about **COMMODITIES**

(investors/entrepreneurs)

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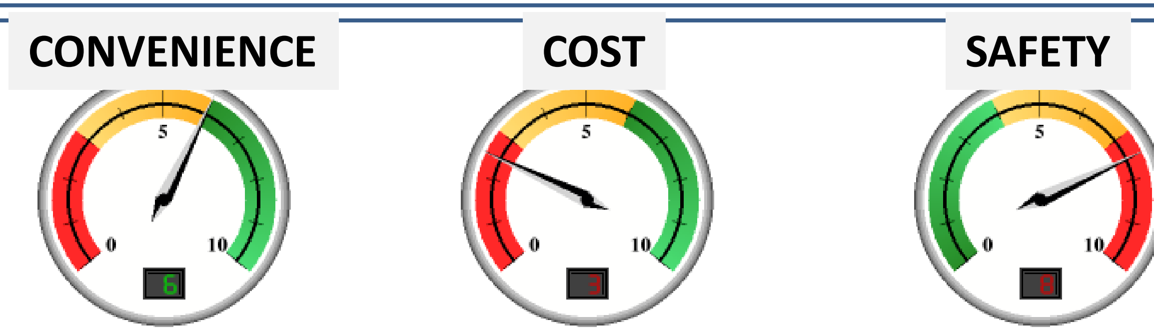
Food Chain Supply is about **FOOD SECURITY**

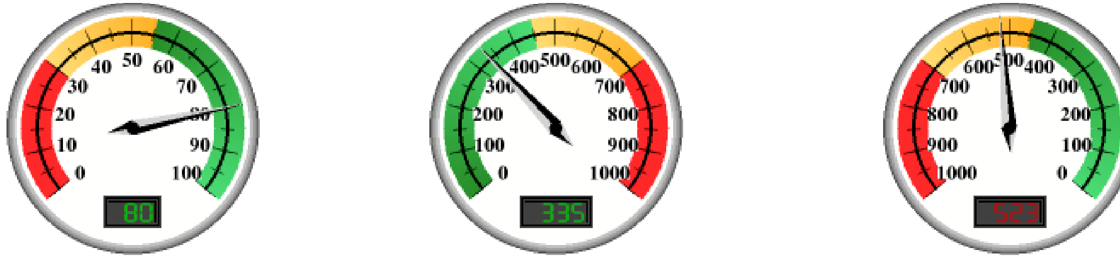
(consumers/governments)



Food Chain Supply is about **COMMODITIES**

(investors/entrepreneurs)

PROFIT | REGULATION | SUBSIDIES



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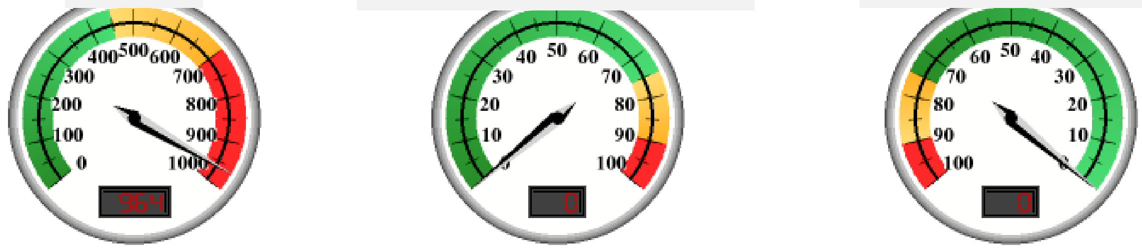
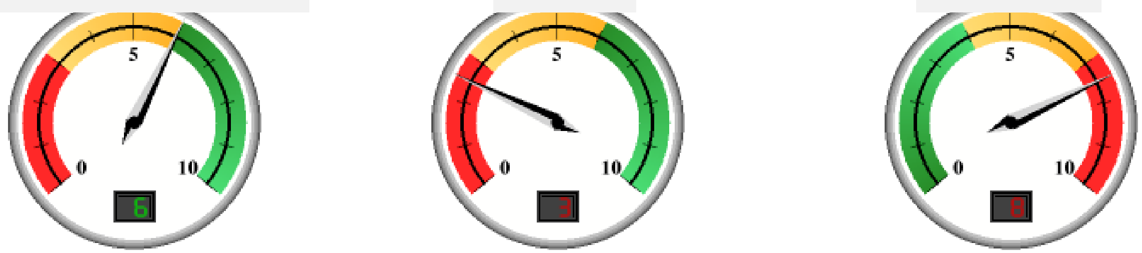
JOBS | $ FLOW TO LOCAL | SIDE EFFECTS



Food Chain Supply is about **FOOD SECURITY**

(consumers/governments)

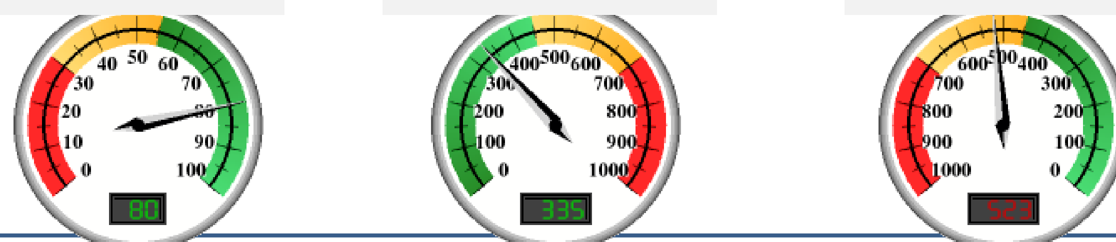
CONVENIENCE | COST | SAFETY

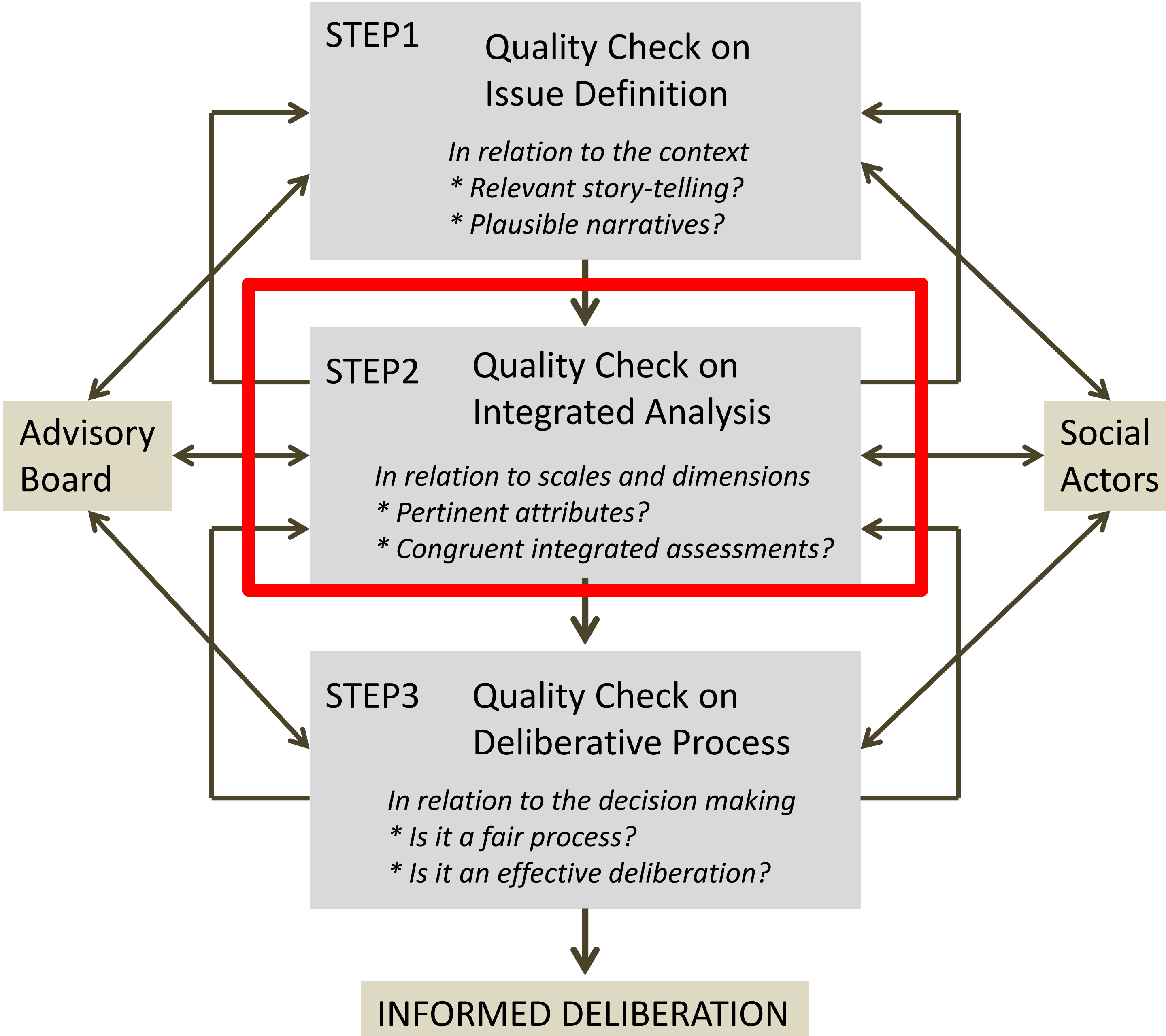


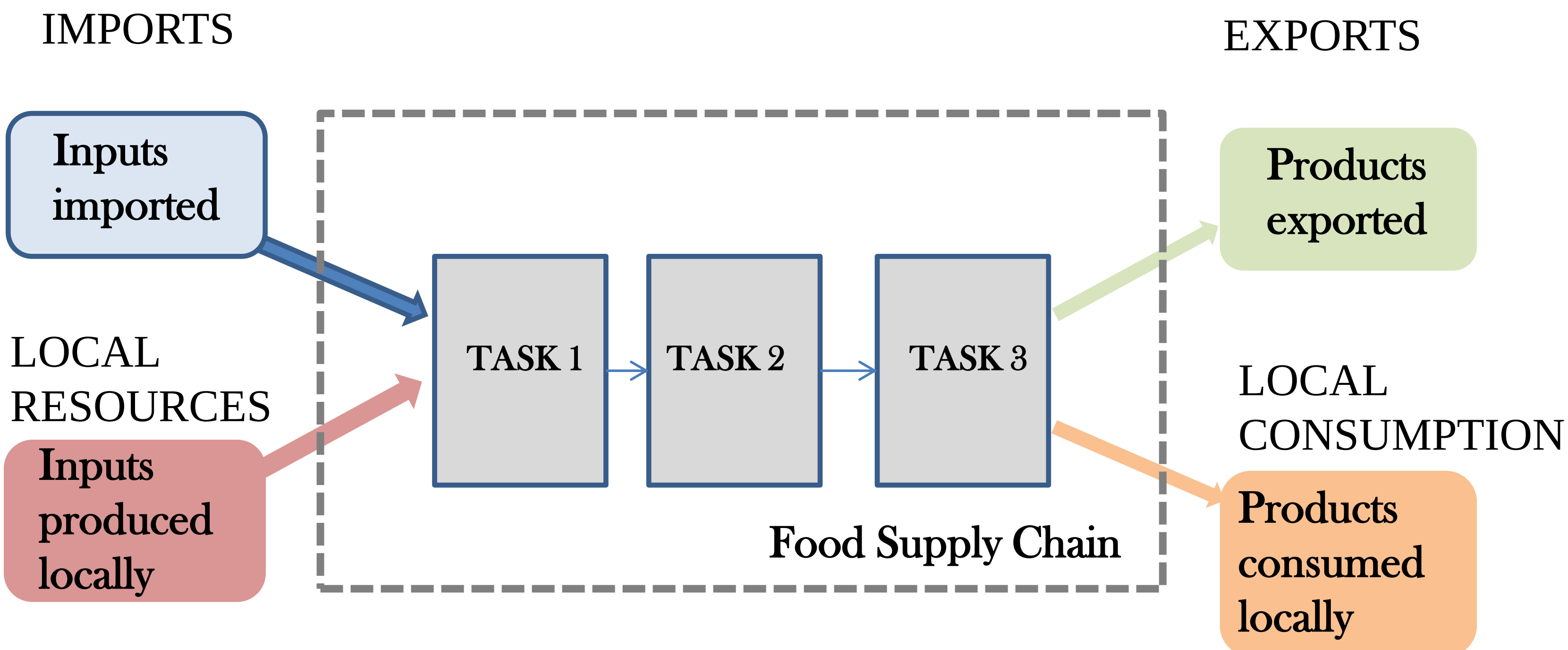
Food Chain Supply should be compatible with the **ENVIRONMENT**

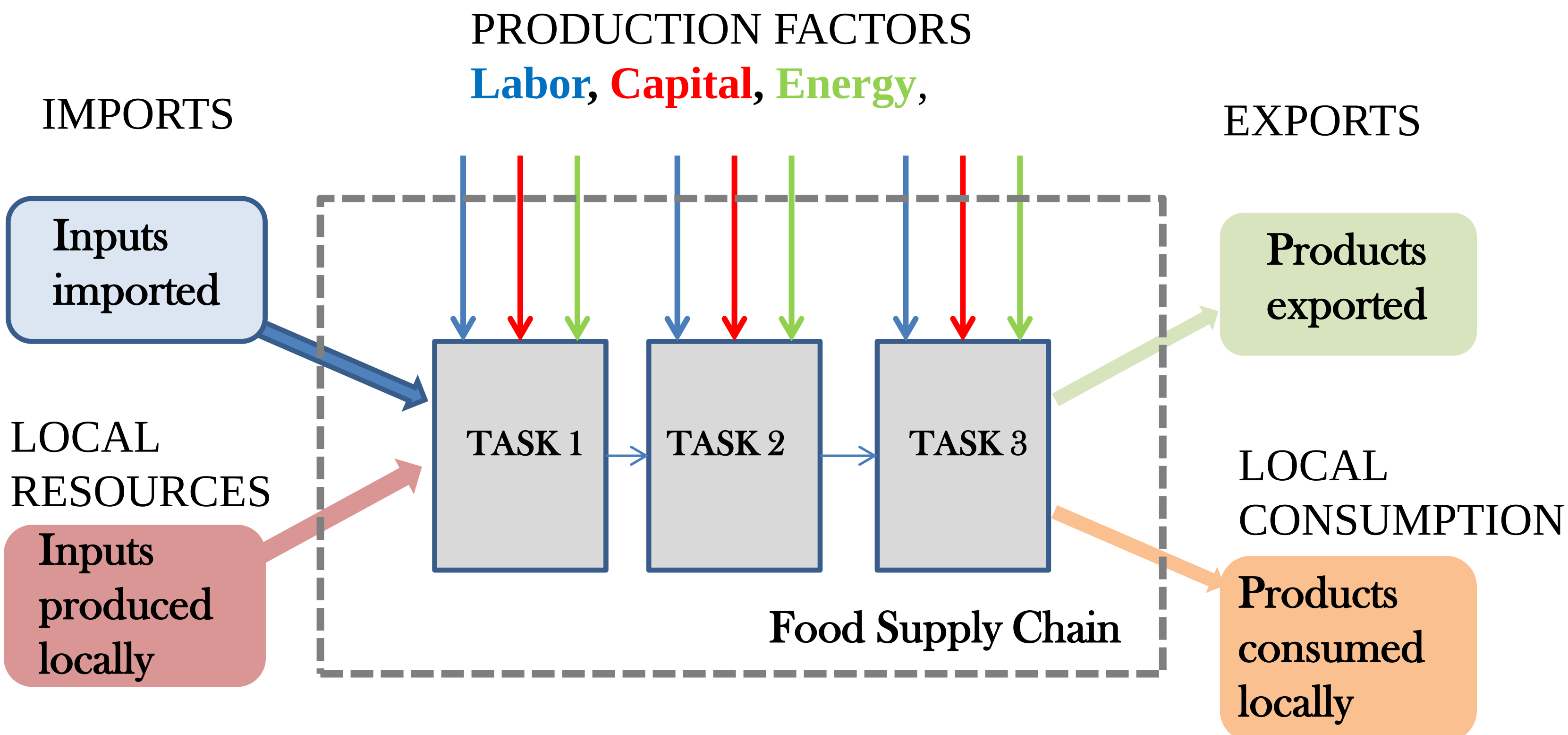
(long term view of sustain.)

ENV. IMPACT 1 | ENV. IMPACT 2 | ENV. IMPACT 3




STEP1
Quality Check on Issue Definition
In relation to the context
* Relevant story-telling?
* Plausible narratives?
STEP2
Quality Check on Integrated Analysis
In relation to scales and dimensions
* Pertinent attributes?
* Congruent integrated assessments?
STEP3
Quality Check on Deliberative Process
In relation to the decision making
* Is it a fair process?
* Is it an effective deliberation?
Advisory Board
Social Actors
INFORMED DELIBERATION


IMPORTS
Inputs imported
LOCAL RESOURCES
Inputs produced locally
TASK 1
TASK 2
TASK 3
Food Supply Chain
EXPORTS
Products exported
LOCAL CONSUMPTION
Products consumed locally



PRODUCTION FACTORS
Labor, Capital, Energy,
IMPORTS
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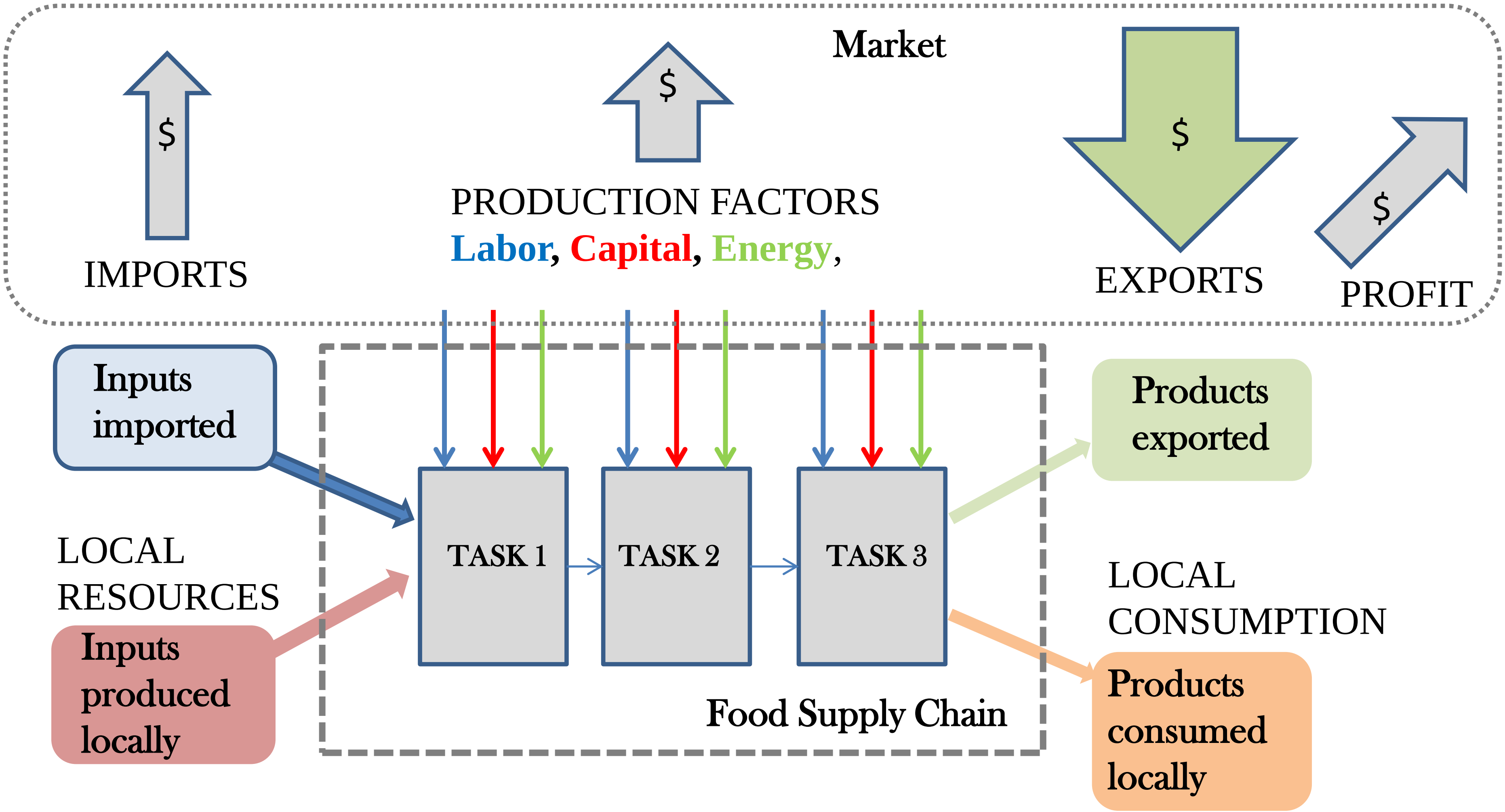

Market
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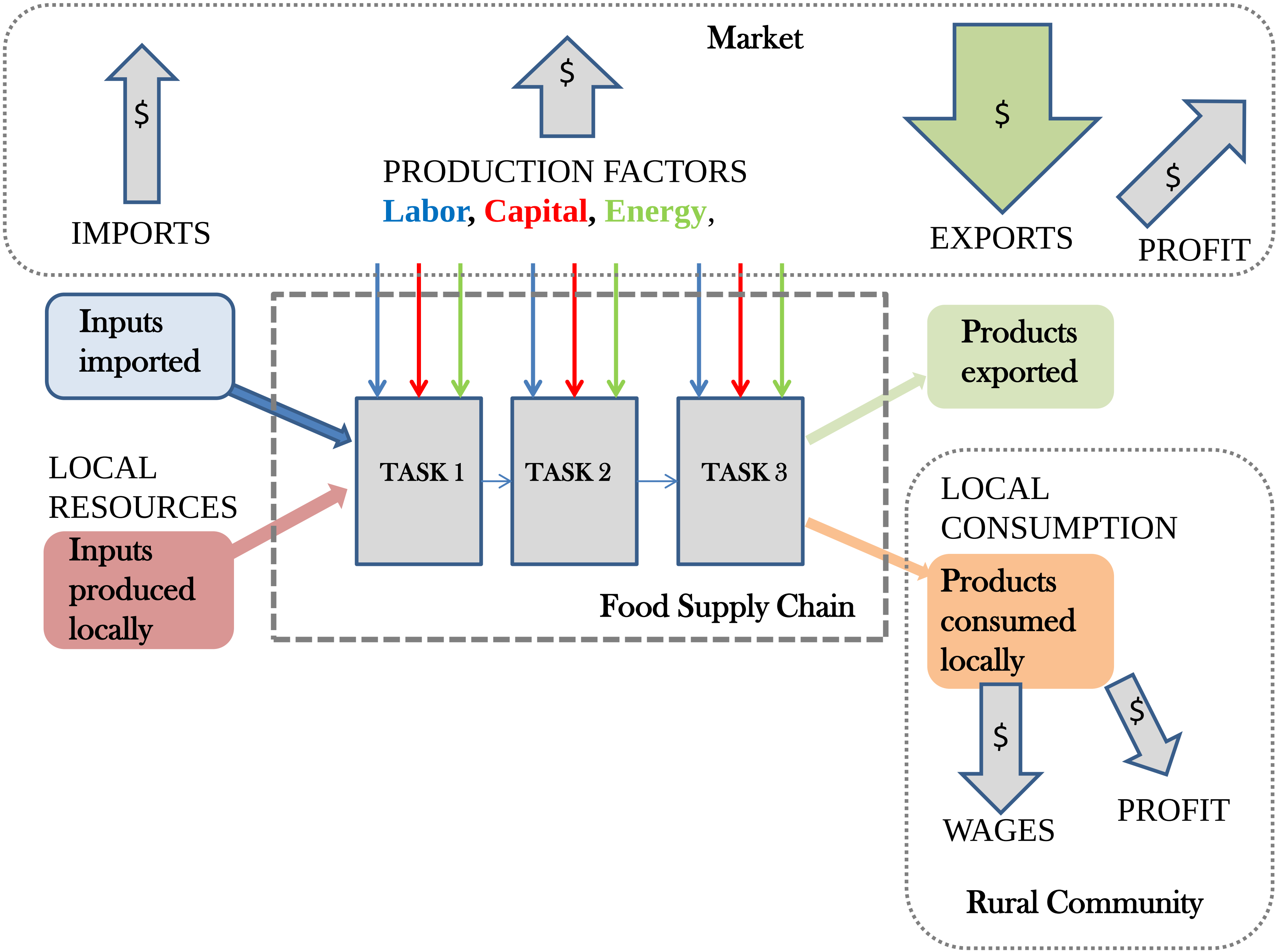

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LOCAL CONSUMPTION
Products consumed locally
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WAGES
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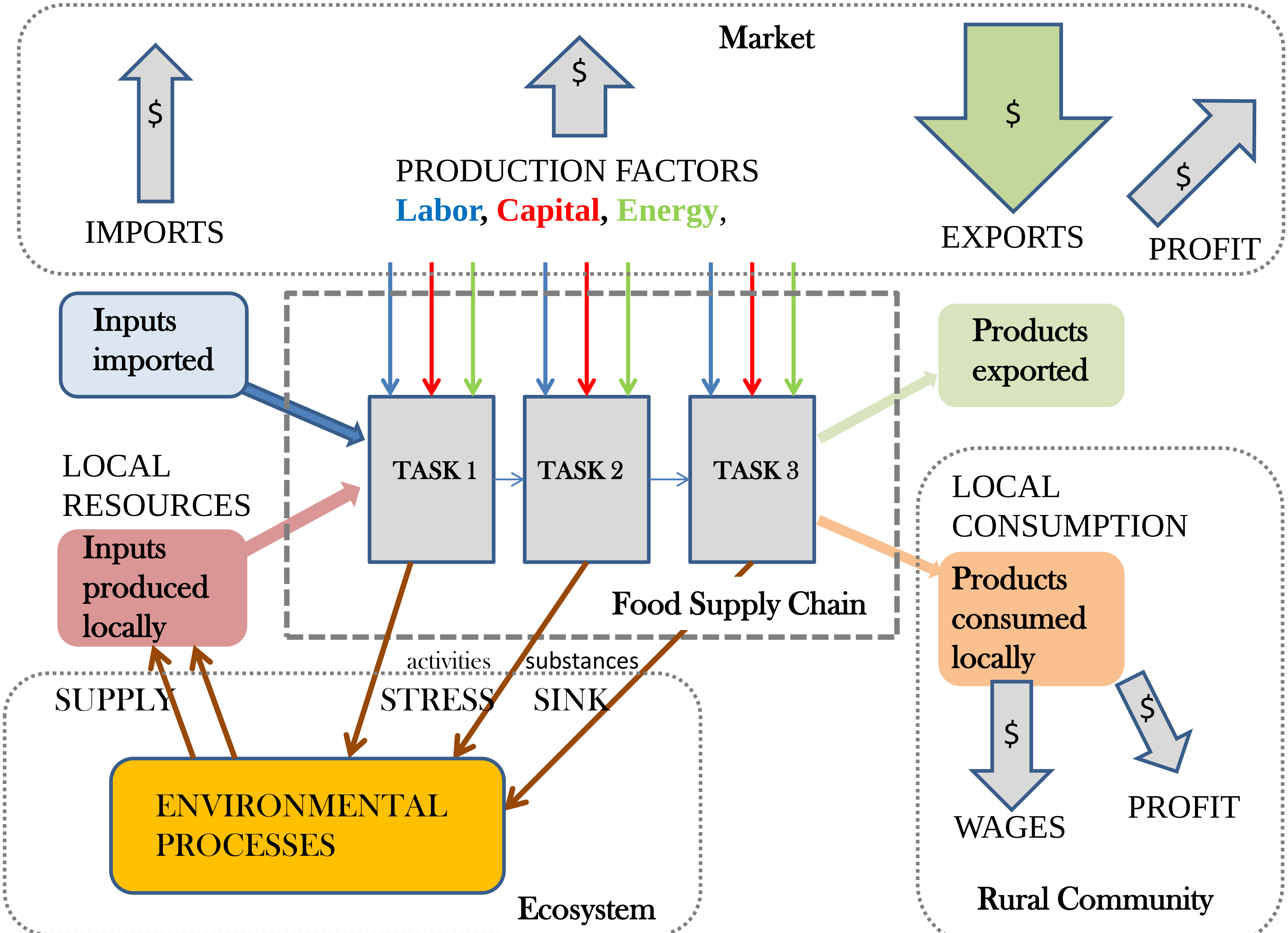
PROFIT
Rural Community



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EXPORTS
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TASK 3
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LOCAL RESOURCES
Inputs produced locally
Food Supply Chain
LOCAL CONSUMPTION
Products consumed locally
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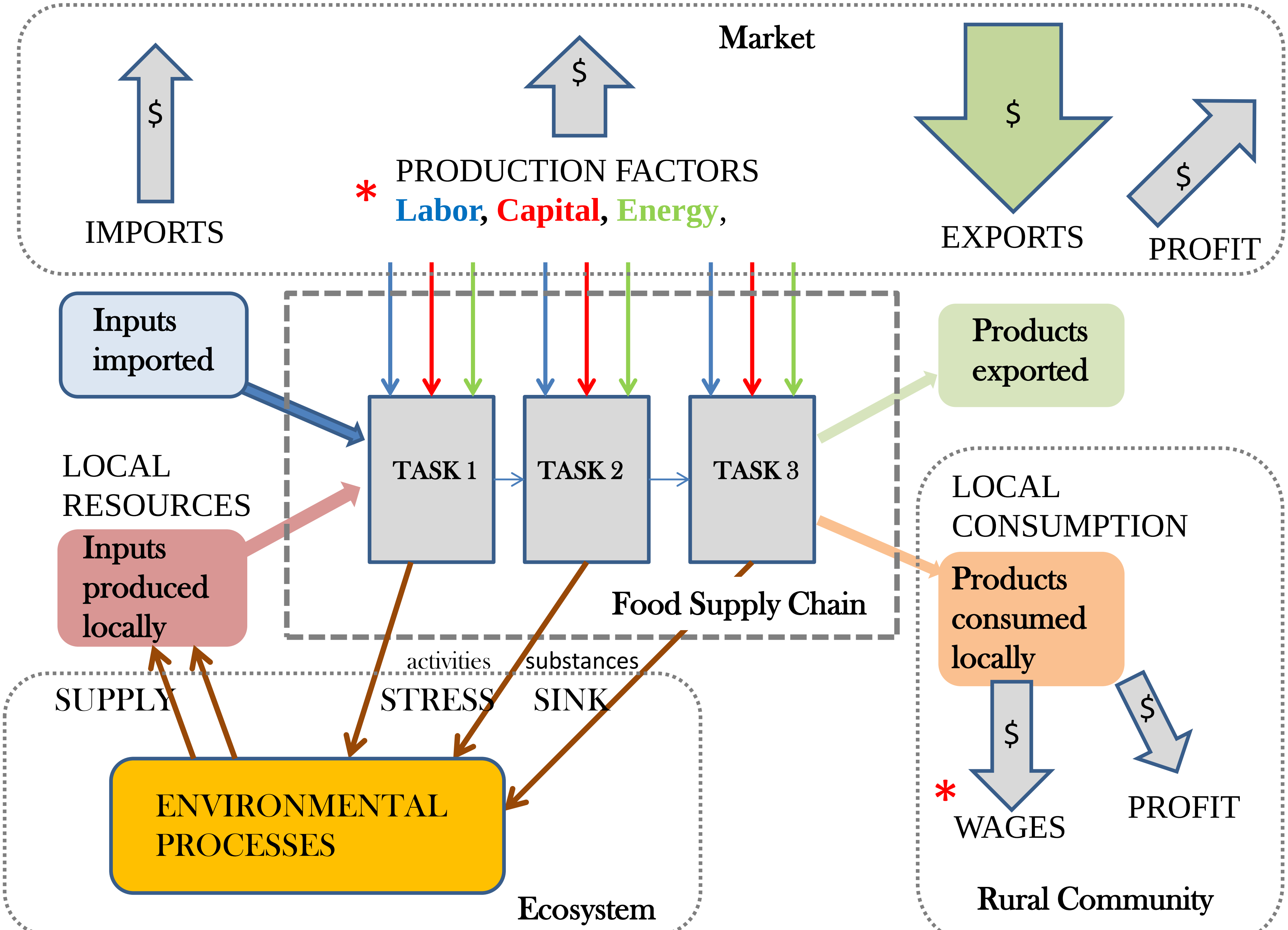
substances
SUPPLY
STRESS
SINK
$
$
WAGES
PROFIT
ENVIRONMENTAL PROCESSES
Ecosystem
Rural Community



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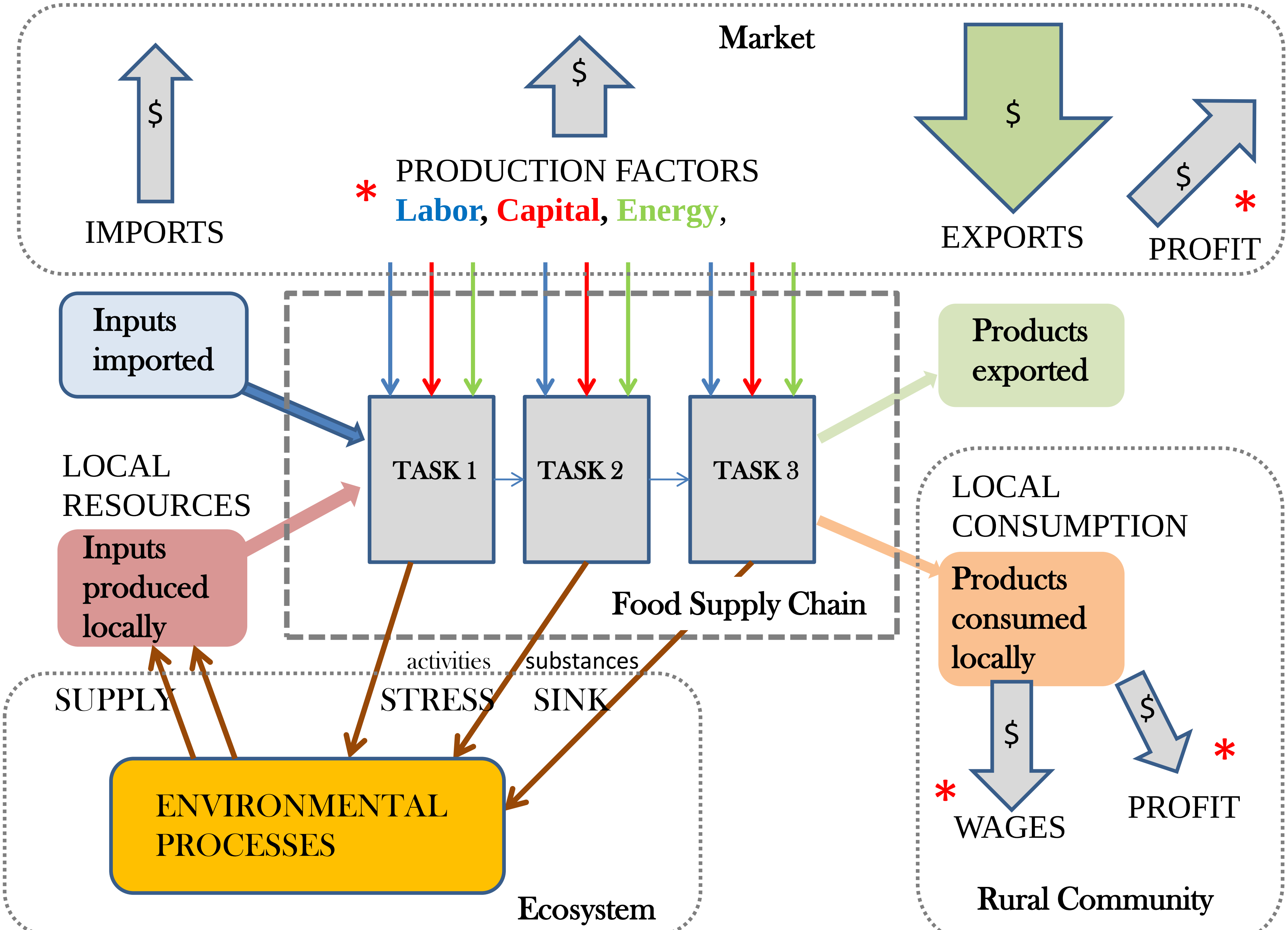
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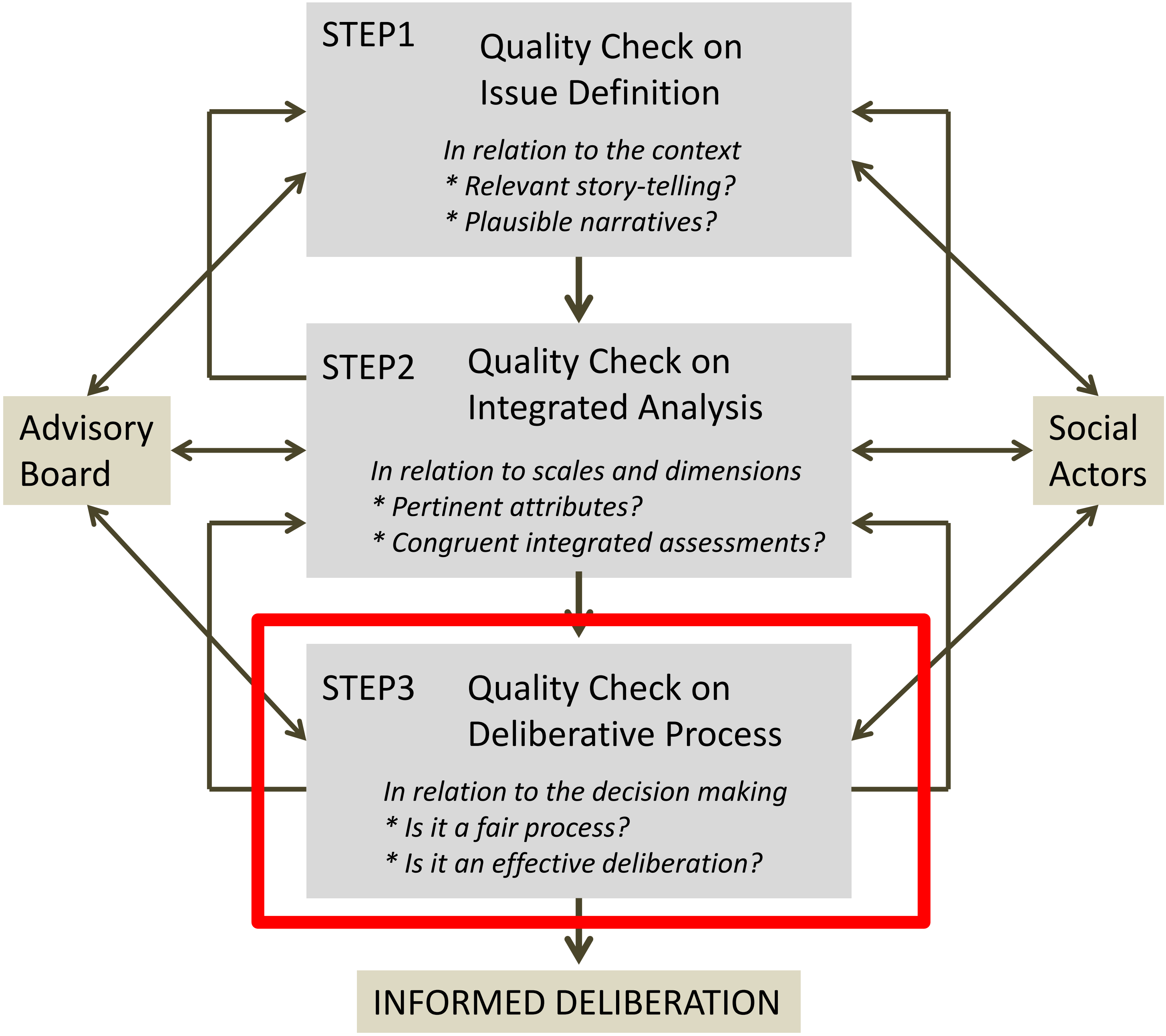
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So what?

KNOWLEDGE
adequate information made up of narratives, data and models that **can be used** to deal **successfully** with **relevant** issues

This definition of KNOWLEDGE implies the definition of a STORY-TELLER needed to provide a legitimate value judgment about "**success**" and "**relevance**"

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IGNORANCE → LACK OF KNOWLEDGE
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Prediction and Control

vs

Wisdom and Adaptability

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Prediction and Control
vs
Wisdom and Adaptability

Whose relevance matters?
How to know what will be relevant in the future?

Do we have a problem with quantitative science in the field of sustainability?

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Not necessarily. When dealing with complex systems we can still use quantitative science to gather useful insight

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Not necessarily. When dealing with complex systems we can still use quantitative science to gather useful insight

But we do have a problem with the way quantitative science is used in the field of sustainability right now

The problem is generated when quantitative science is used for dealing with complex issues with the goal of obtaining **prediction and control** – i.e. individuating the best course of action, optimal solutions, risk assessments . . .

The damages of socially constructed ignorance are generated by either:

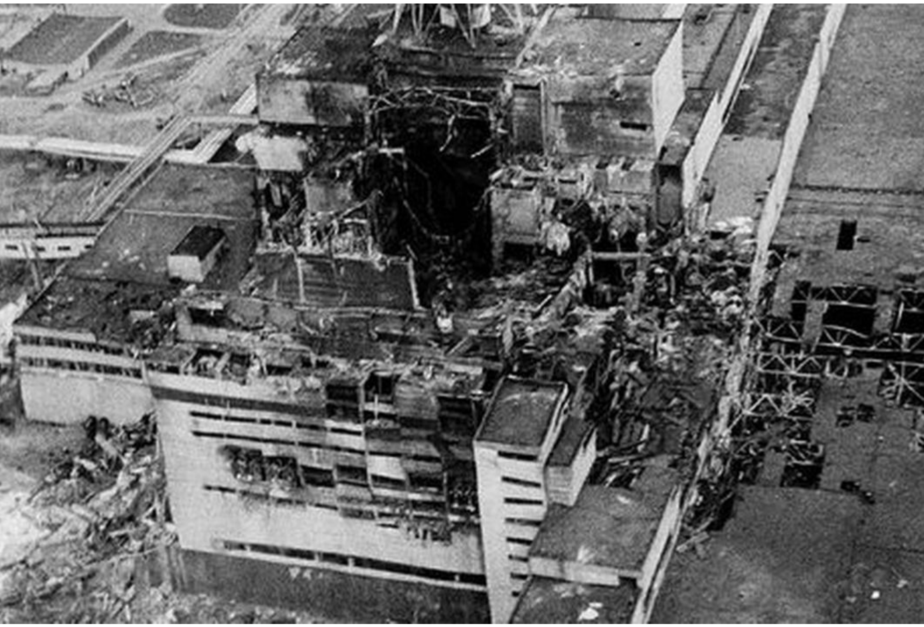
1. ENDORSEMENT OF SLOPPY QUANTITATIVE ANALYSIS (BAD MODELS or INDICATORS)

2. ENDORSEMENT OF IRRELEVANT STORY-TELLING

THEN UNCERTAINTY (IGNORANCE) DEPENDS FIRST OF ALL ON THE JUDGMENT ABOUT THE RELEVANCE OF THE SELECTED STORY-TELLING!!!!

There is uncertainty about nuclear energy?

There is uncertainty about nuclear energy?




Only if someone insists that is a relevant issue to be discussed . . .

There is uncertainty about GMOs?

There is uncertainty about GMOs?

WHAT IS RELEVANT FOR THE CONSUMERS?

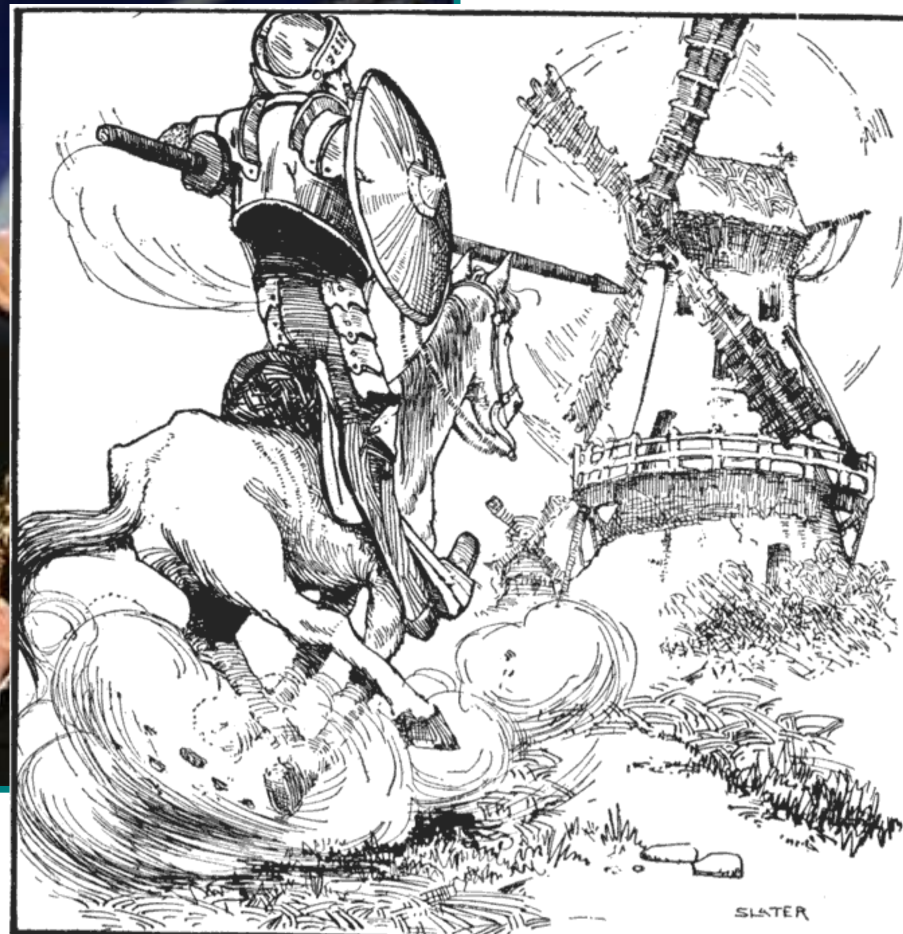
There is uncertainty about GMOs?

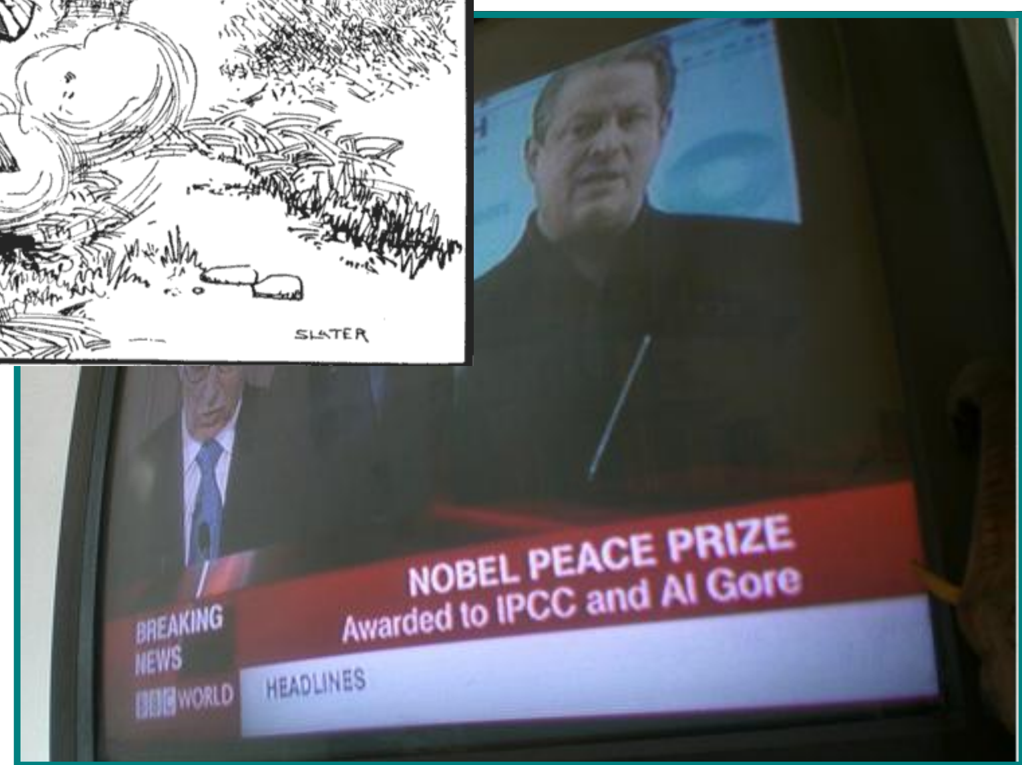
WHAT IS RELEVANT FOR THE CONSUMERS?

* *Why do we need GMOs? What are the benefits?*
* *Who will benefit from their use?*
* *Who decided that they should be developed and how?*
* *Why were we not better informed about their use in our food, before their arrival on the market?*
* *Why are we not given an effective choice about whether or not to buy and consume these products?*
* *Do regulatory authorities have sufficient powers and resources to effectively counter-balance large companies who wish to develop these products?*

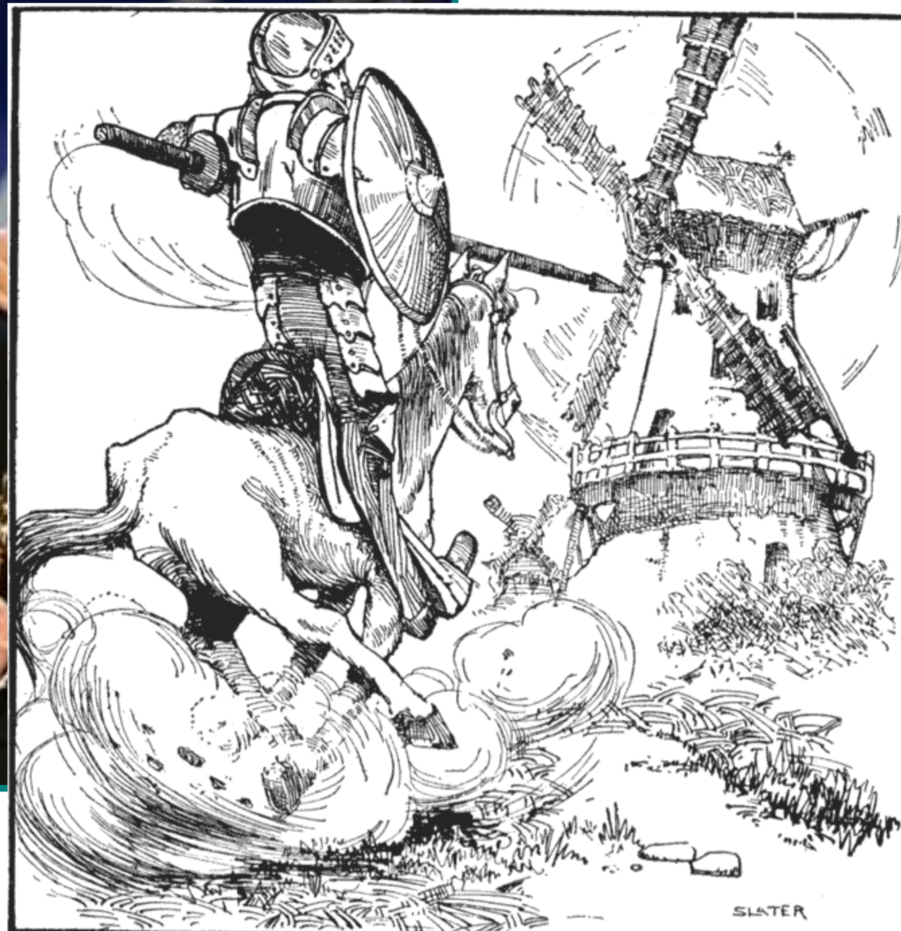
There is uncertainty about climate change?

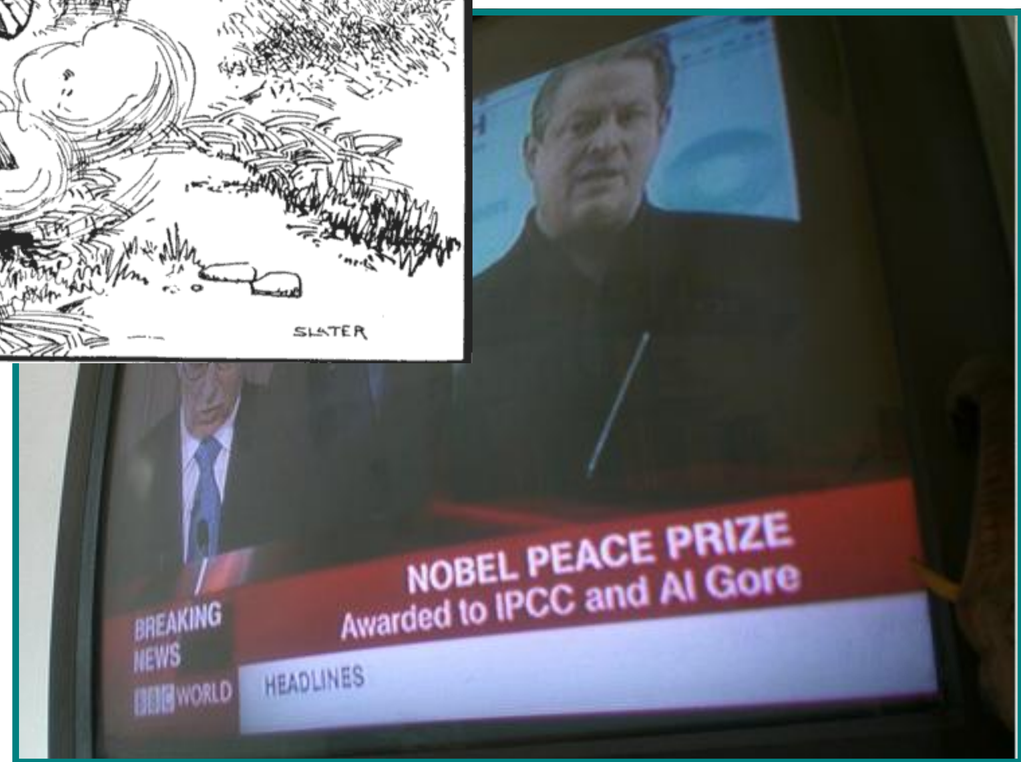

NOBEL PEACE PRIZE
Awarded to IPCC and Al Gore
BREAKING NEWS
HEADLINES





OSCAR + NOBEL = PERPLEXITY





OSCAR + NOBEL = PERPLEXITY

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News and comments on global climate change, global warming and greenhouse effect

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Climate change the world's greatest challenge, says Brown

By Emily Ashton, Press Association

Who decided that climate change is "the" single most relevant problem of our time?

Are we sure about the absolute priority of this issue for humankind?

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Awareness, Opinions About Global Warming Vary Worldwide

Many unaware, do not necessarily blame human activities

by Brett W. Pelham

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This article is the first of a two-part series on views about global warming. The first focuses on awareness of the issue and its causes. The second will examine the relationship between these views and objective indicators of a nation's energy efficiency.

WASHINGTON, D.C. -- Gallup Polls conducted in 127 countries in 2007 and 2008 reveal that more than a third of the world's population has never heard of global warming. The percentage of people who report knowing "something" or a "great deal" about global warming ranged from a low of 15% in Liberia to a high of 99% in Japan. Across these 127 countries, the median percentage of people who report knowing about global warming is 62%. This leaves a worldwide median of 38% who either report having never heard about it or did not have an opinion.

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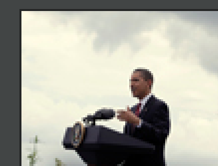

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Only the rich people are aware and worried of climate change!

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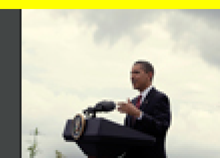

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Climate Change is the Major Problem Facing the World

by David Attenborough

I was sceptical about climate change. I was cautious about crying wolf. I am always cautious about crying wolf. I think conservationists have to be

CommonDreams.org
Join the movement. For the greater good.

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Americans Rank Climate Change as Top Environmental Problem

LiveScience Staff
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Monday, May 16, 2011

Featured Views

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However, rich people **used to be** worried of climate change

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in the year 2006!

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Released: January 22, 2009

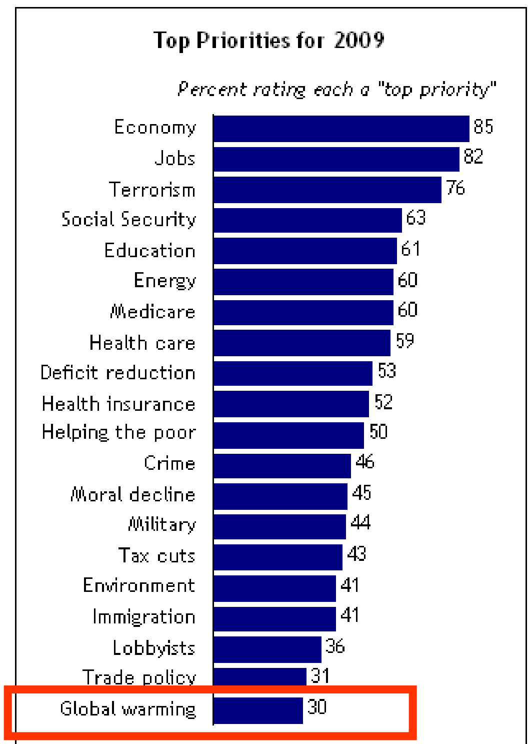
Less in the year 2009!

Economy, Jobs Trump A[...] Priorities In 2009

Environment, Immigration, Health Care Slip Down the List

OVERVIEW

As Barack Obama takes office, the public's focus is overwhelmingly on domestic policy concerns – particularly the economy. Strengthening the nation's economy and improving the job situation stand at the top of the public's list of domestic priorities for 2009. Meanwhile, the priority placed on issues such as the environment, crime, illegal immigration and even reducing health care costs has fallen off from a year ago.



While it is not unusual for the public to prioritize domestic over foreign policy, the balance of opinion today is particularly one-sided. Roughly seven-in-ten Americans (71%) say that President Obama should focus on domestic policy, while just 11% prioritize foreign policy. By comparison, last

last priority over 20!

REPORT MATERIALS

- Complete Report
- Topline Questionnaire
- Dataset: January 2009 Political

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Less in the year 2010

June 4, 2010

Federal Debt, Terrorism Considered Top Threats to U.S.

Republicans perceived as best party to deal with both

by Lydia Saad

PRINCETON, NJ -- Terrorism and federal government debt tie as the most worrisome issues to Americans when they consider threats to the future wellbeing of the U.S. Four in 10 Americans call each an "extremely serious" threat, with healthcare costs ranking a close third.

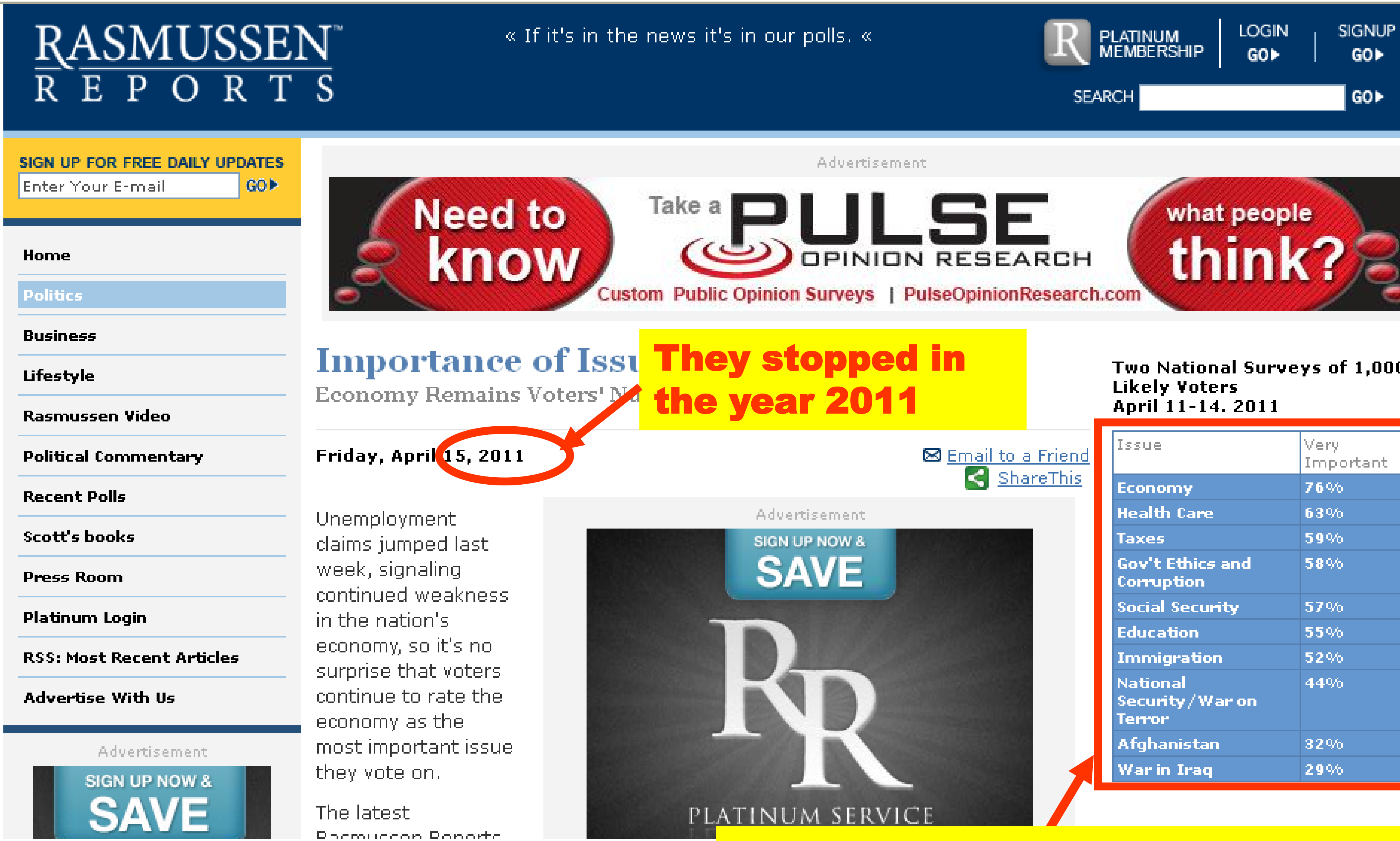
Perceived Threats to U.S. Future Wellbeing

How serious a threat to the future wellbeing of the United States do you consider each of the following -- extremely serious, very serious, somewhat serious, not very serious, or not a threat at all? How about ___?

	Extremely serious	Very serious	Somewhat/ Not very serious/ Not a threat at --
	%	%	%
Terrorism	40	39	21
Federal government debt	40	39	20
Healthcare costs	37	42	21
Unemployment	33	50	17
Illegal immigration	29	34	37
The size and power of the federal government	29	32	38
Having U.S. troops in combat in Iraq/Afghanistan	26	40	31
The environment, including global warming	21	30	49
The size and power of large corporations	21	31	47
Discrimination against minority groups	17	29	53

USA Today/Gallup, May 24-25, 2010

Mentioned but only as an environmental issue . . .



RASMUSSEN REPORTS

« If it's in the news it's in our polls. «

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Importance of Issu[...]

Economy Remains Voters' N[...]

Friday, April 15, 2011

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Unemployment claims jumped last week, signaling continued weakness in the nation's economy, so it's no surprise that voters continue to rate the economy as the most important issue they vote on.

The latest Rasmussen Reports [...]

**Two National Surveys of 1,000 Likely Voters
April 11-14, 2011**

Issue	Very Important
Economy	76%
Health Care	63%
Taxes	59%
Gov't Ethics and Corruption	58%
Social Security	57%
Education	55%
Immigration	52%
National Security/War on Terror	44%
Afghanistan	32%
War in Iraq	29%

They stopped in the year 2011

climate change is no longer included among the possible 10 most relevant issues!

In the world more than 700 million women are forced to get married below 15 year of age without the option of chosing their husband

Europeans are experiencing again war in Europe

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The degradation of ecosystem services could grow significantly in the next 50 years and be a hindrance to development

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In the world 500 million women still cannot read

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Global military expenditure was $1776 billion in 2014

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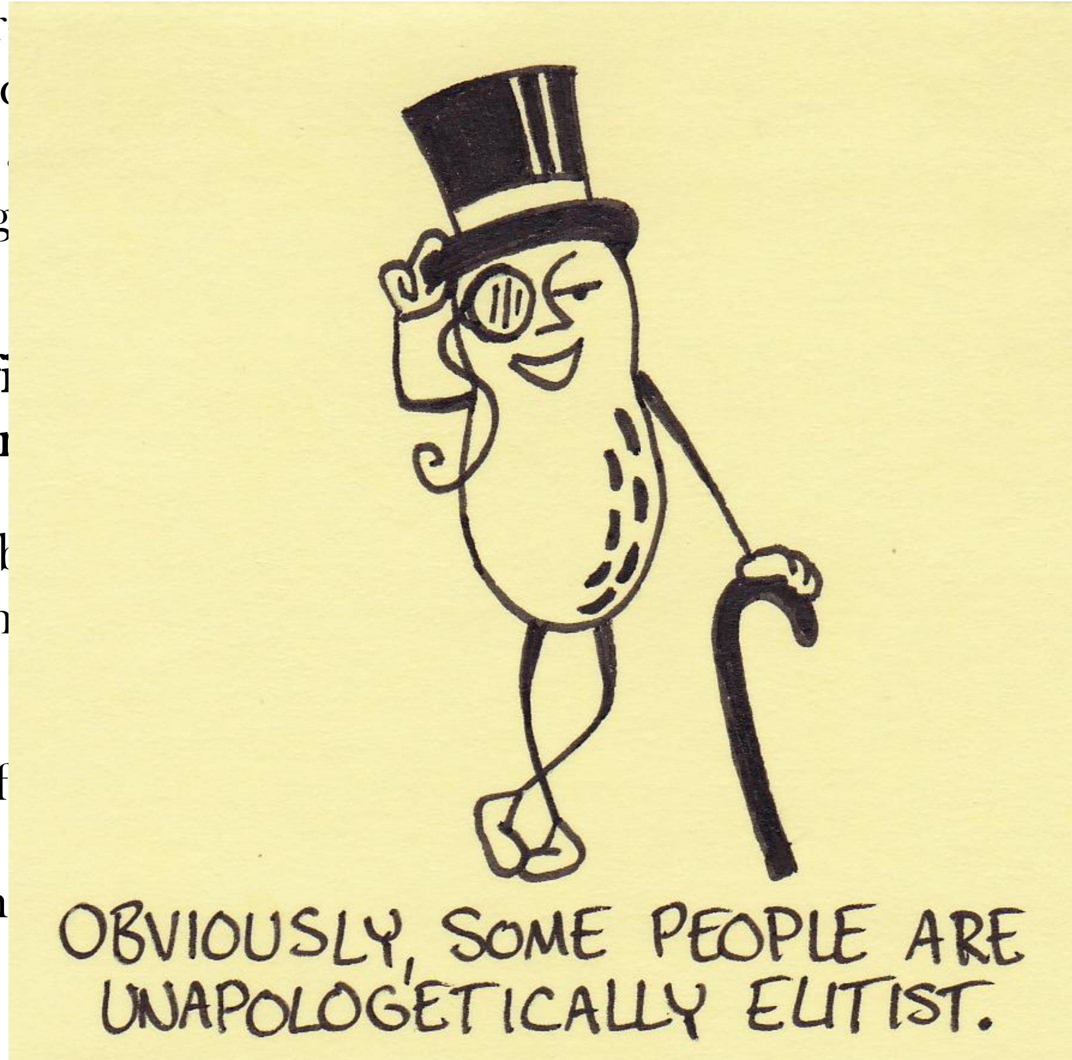

How many people do really believe that "the most" relevant problem that humankind has to face now is to prevent a 78 cm rise in the sea level in the year 2100?