Improving the quality of science for governance

2. Complexity, Post-Normal Science, Quantitative Storytelling

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www.ecgc.eu

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Content of presentation

1. The implications of complexity for the use of science for governance

2. Post-Normal Science – acknowledging the challenge

3. Methodological approaches for a responsible quantification

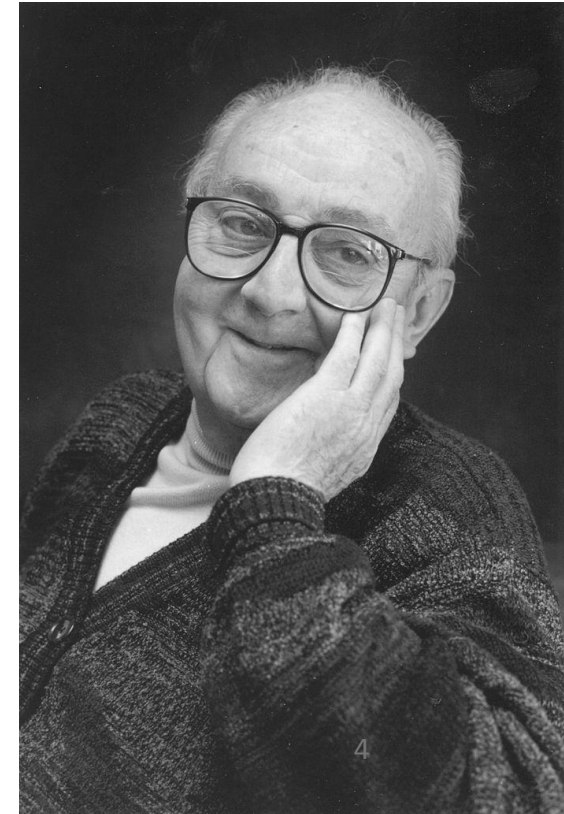# #1

THEORETICAL CONCEPT – SCIENCE FOR GOVERNANCE

The implications of complexity for the use of science for governance

When dealing with the analysis of complex systems operating across scales we should abandon the Cartesian dream of prediction and control

The challenge of complexity for sustainability analysis

René Descartes

-->

George Box
*"All models are wrong,
but some are useful."*

The need for a complexity revolution . . .

Scientific analysis cannot tell us what is "the best thing to do". We should avoid the trap of "solving" the complexity associated with our interaction with the external world by adopting simplistic models.

Any policy decision requires considering at least three non-equivalent aspects:

1. The quality of the ==justification== — choice of concerns to be addressed, resulting from the political management of feelings and emotions ☐ **WHY we have to do it**;

2. The quality of ==normative narratives== — choice of actions to be taken, based on power relations and knowledge claims considered as relevant ☐ **WHAT we need to do**;

3. The quality of ==explanation narratives== — choice of scientific evidence used for selecting the first two narratives ☐ **HOW do we know WHAT we need to do and WHY**.

Scientific analysis cannot tell us what is "the best thing to do" (1)

Challenges for Scientific Advice:
SOCIAL INCOMMENSURABILITY

WHY

The choice of **JUSTIFICATION NARRATIVES**
the priority over existing concerns
depends on the identity of the story-teller . . .

EXPERTS' ADVICES – at the SAGUF World Food Conference, Zurich, October 9-10, 1996

DIFFERENT STORYTELLERS!

Story-telling about National Policy

	ADVICE	CONCERN
I.F.P.R.I. - U.S. scientist	**Keep prices of food commodities LOW**	**Protecting the urban poor**
Ag. Econ. - Prof. Pakistan		mers
Wuppertal Inst. – Germany	REDUCING imports from the South	sm
Ag. Dev. - Prof. Ghana	**INCREASING imports from the South**	**Developing the agricultural sector**

The salience of a scientific advice depends on the priority that the storyteller gives to a specific concern

Story-telling about Social Policy

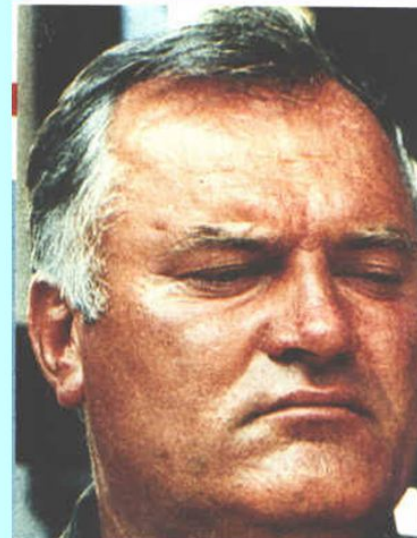|	ADVICE	CONCERN
NGO - Swiss Feminist	**PRESERVING local cultural heritage**	**Protecting cultural diversity**
Sociologist - Prof. India	**FIGHTING local cultural heritage**	**Protecting wives burned alive together with dead husbands**

IT IS NOT ABOUT "FACTS" IT IS ABOUT PERCEPTIONS!

Ratko MLADIC: "a dangerous criminal" on the website of Interpol

IT IS NOT ABOUT "FACTS" IT IS ABOUT PERCEPTIONS!

Ratko MLADIC: "a national hero" in a wall calendar in a bakery in Serbia

Scientific analysis cannot tell us what is "the best thing to do" (2)

Challenges for Scientific Advice:
TECHNICAL INCOMMENSURABILITY

HOW
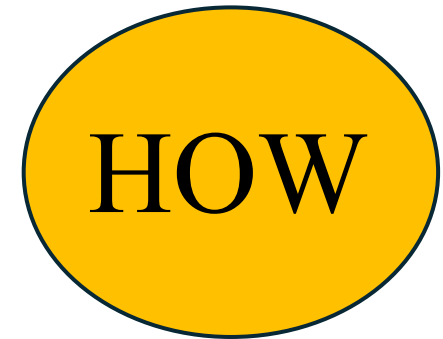
The robustness of the **EXPLANATION NARRATIVES**
(the usefulness of the representation of a fact
depends on the chosen scale . . .)

EXPLANATION NARRATIVES
TECHNICAL INCOMMENSURABILITY

There are always different explanations and representations of
a given issue depending on the chosen explanation narrative

The truth of the representation of a "fact" depends on the usefulness
of the chosen perception of the external world, for a given purpose

https://magic-nexus.eu/documents/quality-scientific-advice-policy-insights-complexity

The epistemological challenges of complexity – the "measured length" of a coastline **is not a fact!**

It depends on the tide!

Conflicting knowledge claims can be validated through successful action but this does not make them "facts"

dx = 100 km, length = 2,800 km

The measure (fact) used by a captain of a large oil tanker reading a nautical chart (functional identity)
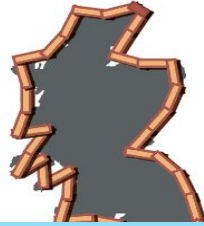
The measure (fact) used by a bus driver reading a road map (functional identity)

The experience (fact) of a person walking around the coastline

Benoit Mandelbrot

Quantitative assessment carried out within different narratives

Norman, 1978;   **0.3 MJ;**
Revelle, 1976;   **0.5 MJ;**
Extra metabolic energy due to the working (versus basal metabolism)

Batty et al., 1975; Dekkers et al., 1978;   **1.2 MJ;**
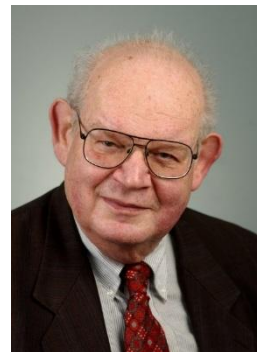**Metabolic energy of the worker in a day divided the hours of work**

Williams et al., 1975;   **3.9 MJ;**
Metabolic energy of the household in a day divided the hours of work

Pimentel and Pimentel, 1996;   **40 MJ;**
Assessment including the commercial energy spent to produce the food

Fluck, 1981;   **400 MJ;**
Commercial energy used by society divided by the working hours

Odum H.T., 1996;   **20 GJ.**
Solar energy used by natural processes to support workers divided by the working hours

Rigorous assessments of the "energy equivalent of human labor" go from 0.2 MJ ☐ 20 GJ (1/200,000)

The challenge of complexity (= multiple scales) for sustainability science . . .
In quantitative analysis: *Non-equivalent descriptive domains = Non-reducible models*

Dietary intake in the USA relevant for nutritional analysis

Different levels of analysis same observation method

Gross biophysical production needed by the US food system relevant for sustainability analysis

116 kg/year p.c

Quantitative assessments

grain consumption per capita per year in the USA

1,015 kg/year p.c
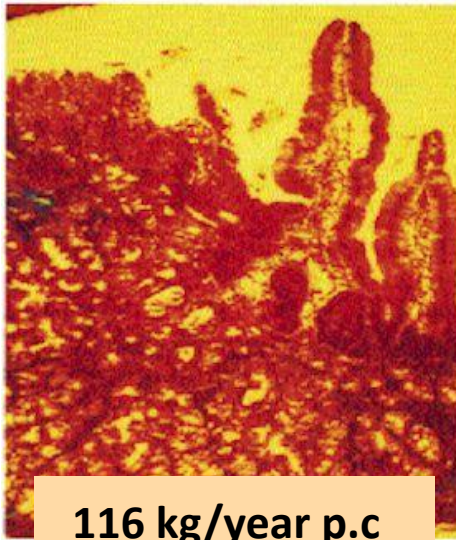
Dietary intake in the world (average) relevant for comparison (equity issue)

Different levels of analysis different observation methods
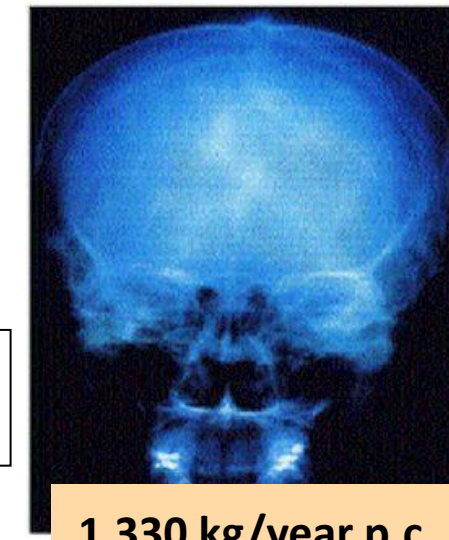
Gross biophysical production needed to keep economically viable the US agricultural sector relevant for economic analysis

345 kg/year p.c

1,330 kg/year p.c

We must learn how to handle non-equivalent descriptive domains (using *grammars*)
RELATIONAL ANALYSIS — Expected relations over functional and structural elements

Characterizing the pattern of production and consumption of grains in the USA and China

final consumption in the diet of individuals
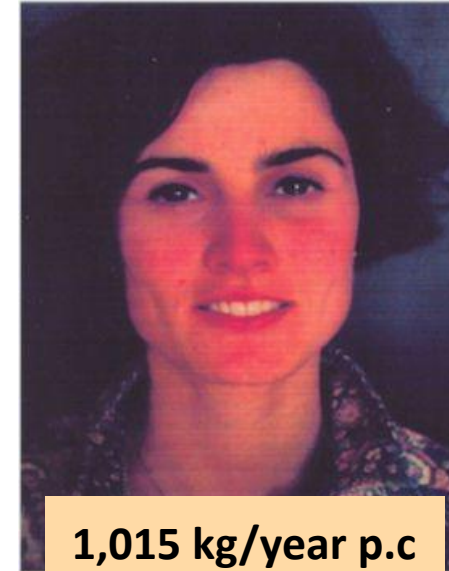
Household Sector

final consumption of the society

Food System

EXPORTS

USA
300 kg p.c./year

China
10 kg p.c./year
IMPORTS

Market Driven Flows

China
340 kg.c./year
DOMESTIC SUPPLY

USA
1,320 kg p.c./year

Resource Driven Flows

USA
1020 kg p.c./year

Biophysical Consumption Food System

China
350 kg p.c./year

USA
120 kg p.c./year

China
250 kg p.c./year

USA
900 kg p.c./year

China
100 kg p.c./year

The rest of the food system
internal consumption as input (feed, seeds alcoholic beverages)

PRESSURE

Factors allowing the supply

STATE

Factors determining the consumption

Scientific analysis cannot tell us what is "the best thing to do" (3)

Challenges for Scientific Advice:
THERE ARE MULTIPLE VALID NARRATIVES
ABOUT THE HANDLING OF A GIVEN ISSUE . . .

The choice of a **NORMATIVE NARRATIVE**
depends on the pre-analytical choices of
JUSTIFICATION and EXPLANATION narratives. . .

WHAT

IT IS ABOUT PRIORITIES OVER CONCERNS!

Using biotechnology in agriculture: a reality of safety for the future . . .

WE SHOULD INVEST MORE IN THEM!

THE VIEW OF THE INDUSTRY

IT IS ABOUT PRIORITIES OVER CONCERNS!

WE SHOULD BAN THEM!

Antitransgenic town*
(where the use of GMOs is banned)

THE VIEW OF THE VOTERS LIVING IN *CIAMPINO*

Challenges for Scientific Advice

THERE ARE MULTIPLE VALID COMBINATIONS OF JUSTIFICATION AND EXPLANATION NARRATIVES RELATED TO THE SAME EVENT

Different valid combinations of justification narratives and explanation narratives can generate the co-existence of contrasting ==normative== narratives
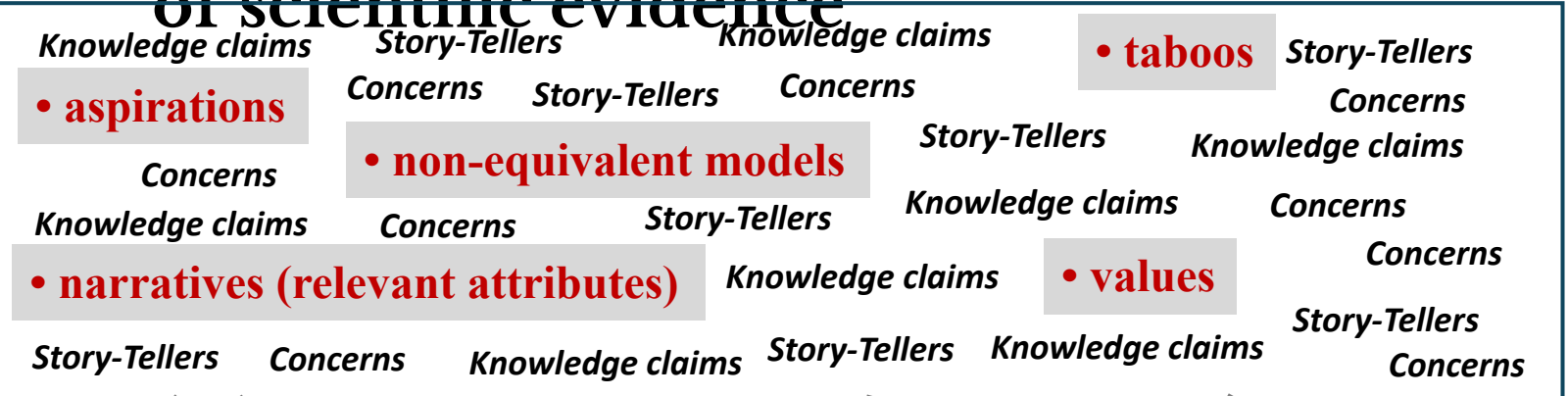
The choice of just a normative narrative depends on the chosen identity of the story-teller . . .

https://magic-nexus.eu/documents/quality-scientific-advice-policy-insights-complexity

Are these robust narratives about what to do?

NARRATIVE	Storyteller	Storyteller
EXPLANATION 1 --> "no oxygen supply in the brain" *Space-time scale*: VERY SMALL *Example*: EMERGENCY ROOM	**Tax expert**	**Doctor in the emergency room**
EXPLANAT... *Space-time*...		**...armaceutical researcher**
EXPLANATION 3 --> "individual is a heavy smoker" *Space-time scale*: MEDIUM *Example*: MEETING AT HEALTH MINISTRY	**Doctor in the emergency room**	**Tax expert**
EXPLANATION 4 --> "humans must die" *Space-time scale*: VERY LARGE *Example*: SUSTAINABILITY ISSUES	**Pharmaceutical researcher**	**Philosopher**

> Narratives are neither true or false, their usefulness depend on the nature of the concern making them relevant

Pre-analytical choices determining the production and use of scientific evidence

Knowledge claims
• **aspirations**
Concerns
Knowledge claims
• **narratives (relevant attributes)**
Story-Tellers   Concerns
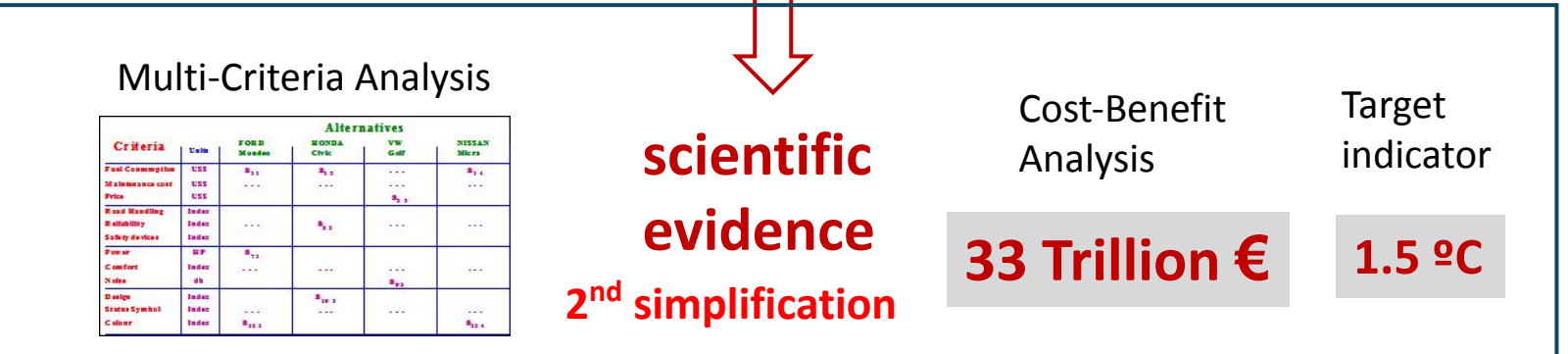
Story-Tellers
Concerns   Story-Tellers
• **non-equivalent models**
Concerns   Story-Tellers
Knowledge claims
Knowledge claims   Story-Tellers

Knowledge claims
Concerns
Story-Tellers
Knowledge claims
• **values**
Knowledge claims

• **taboos**   Story-Tellers
Concerns
Knowledge claims
Concerns
Concerns
Story-Tellers
Concerns

"social interactions"

an information space open and expanding

1st simplification

WHAT IS THE PROBLEM

* **What is the problem to be solved**
* **What are the alternatives to consider**

POSSIBLE SOLUTIONS

Selecting an agreed upon set of options and objectives

Epistemic Boxing

Selecting an agreed upon set of models and targets
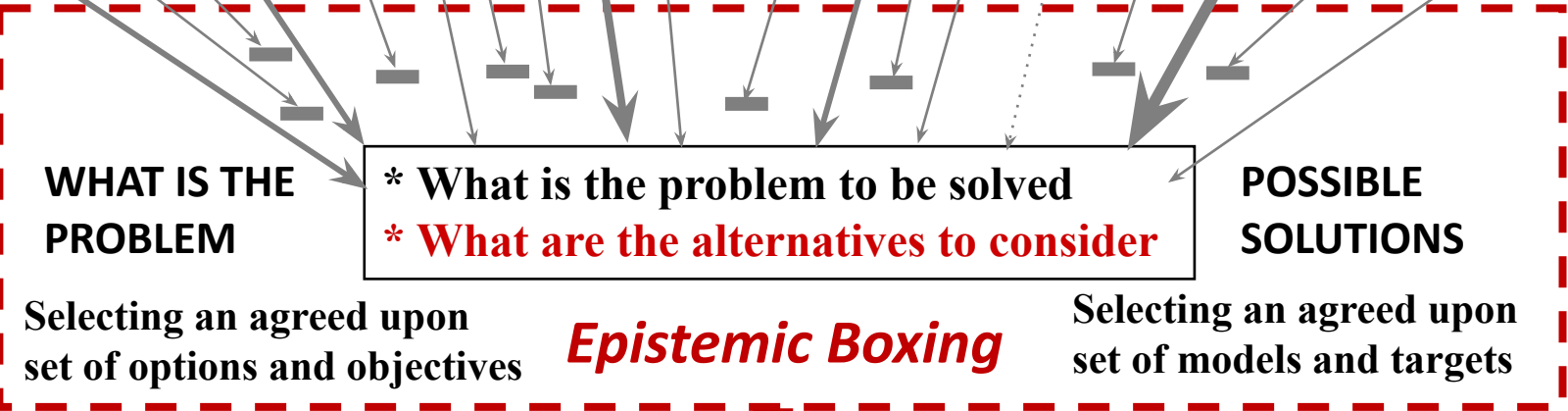
closing the information space – chosing the epistemic box

RE-OPENING THE EPISTEMIC BOX

Multi-Criteria Analysis

scientific evidence

2nd simplification

Cost-Benefit Analysis

33 Trillion €

Target indicator

1.5 ºC

"FACTS" (whose facts?)
"PROBLEMS" (whose problems?)
"SOLUTIONS" (whose solutions?)
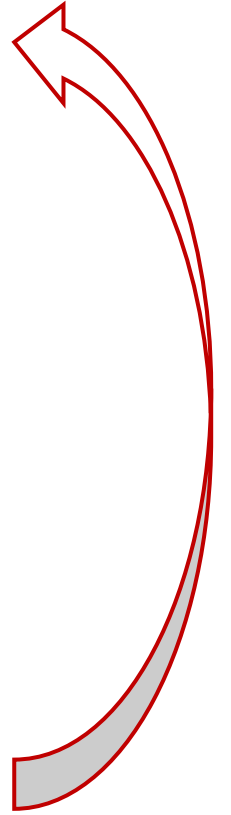
Double-check policy narratives in order to avoid the "epistemic boxing"
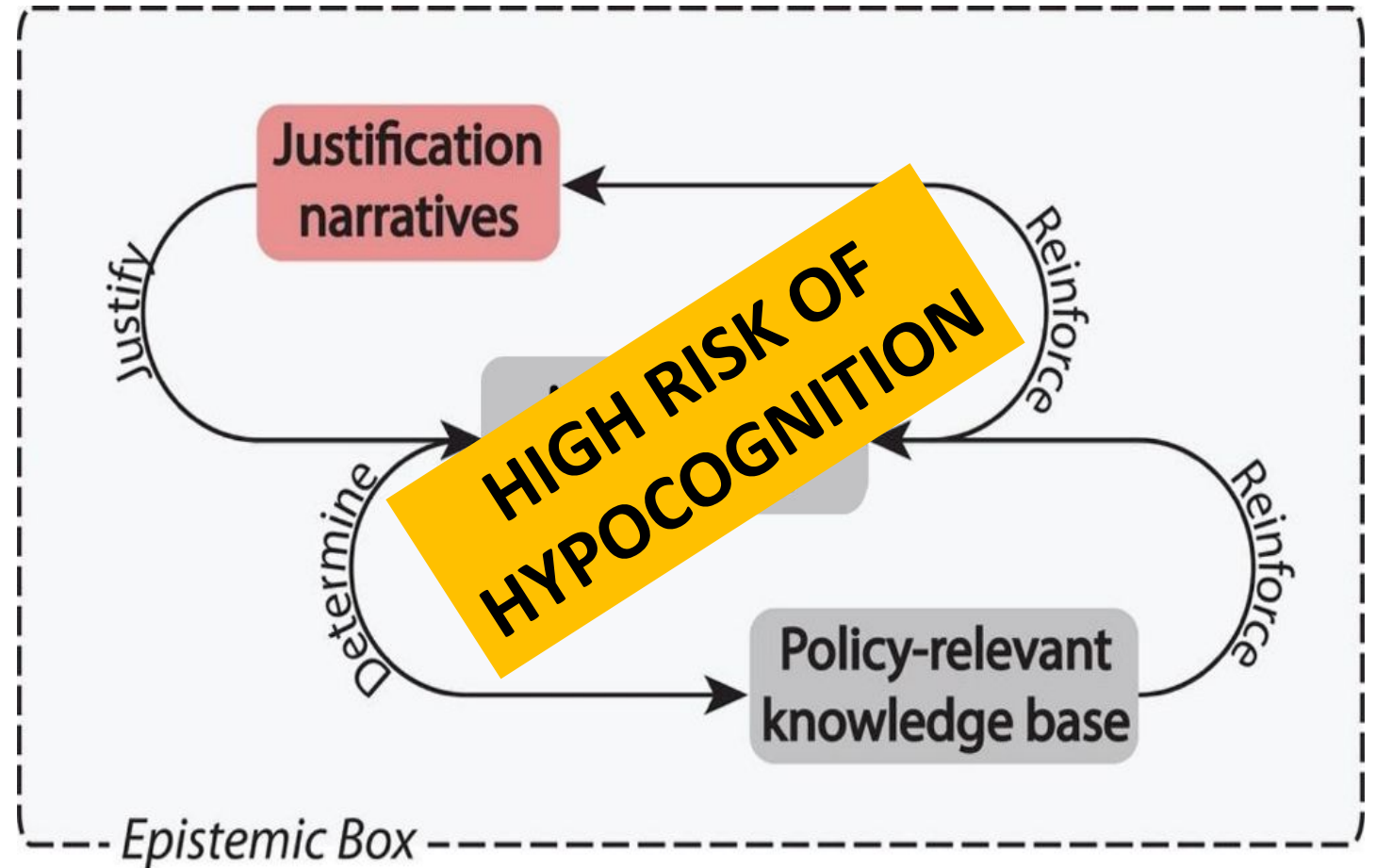
Justification narratives — **WHY** should we do something

Normative narratives — **WHAT** should be achieved

Explanation narratives — **HOW** will it be achieved

Impredicative lock-in

A scientific knowledge claim should be described in such a way that it must be capable of being defined and understood "outside of its original analytical frame" ☐ **across different epistemic boxes**

Scientific evidence cannot be based solely on the use of a limited number of epistemic boxes (framings). It should address the co-existence of different story-tellers with different purposes and perceptions in society

ALWAYS REMEMBER THAT ANY PRE-ANALYTICAL FRAMING GENERATES HYPOCOGNITION!!!

George Lakoff

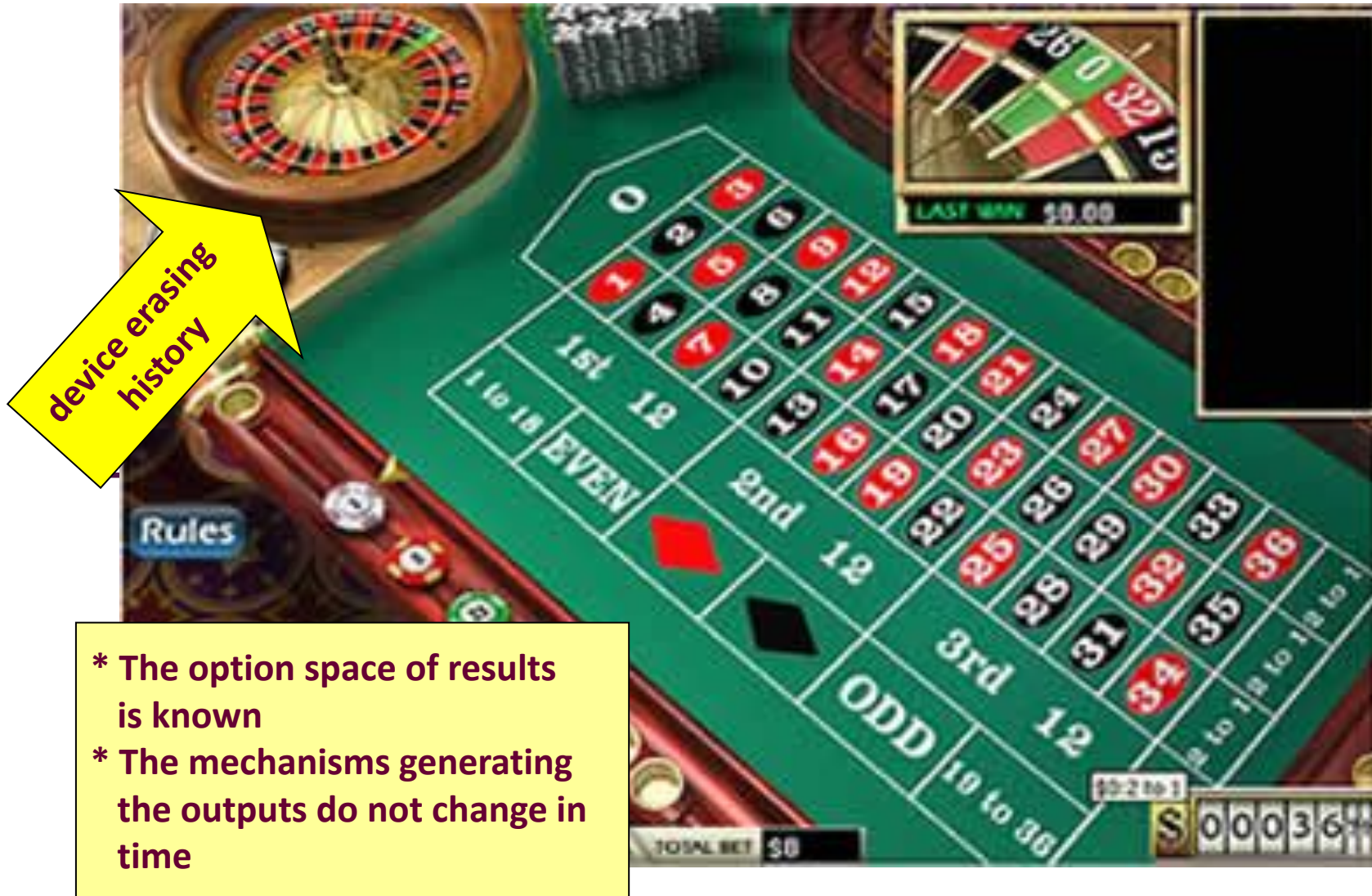# #2

THEORETICAL CONCEPT – POST-NORMAL SCIENCE

DEALING WITH THE CHALLANGES POSED BY SUSTAINABILITY TO SCIENCE FOR GOVERNANCE

**Conventional risk analysis is
useless when dealing with situations
in which we are dealing with heavy
uncertainty or even sheer ignorance . . .**

Purple Down desert, Australia

Science can predict with accuracy eclipses . . .

device erasing history

* The option space of results is known
* The mechanisms generating the outputs do not change in time

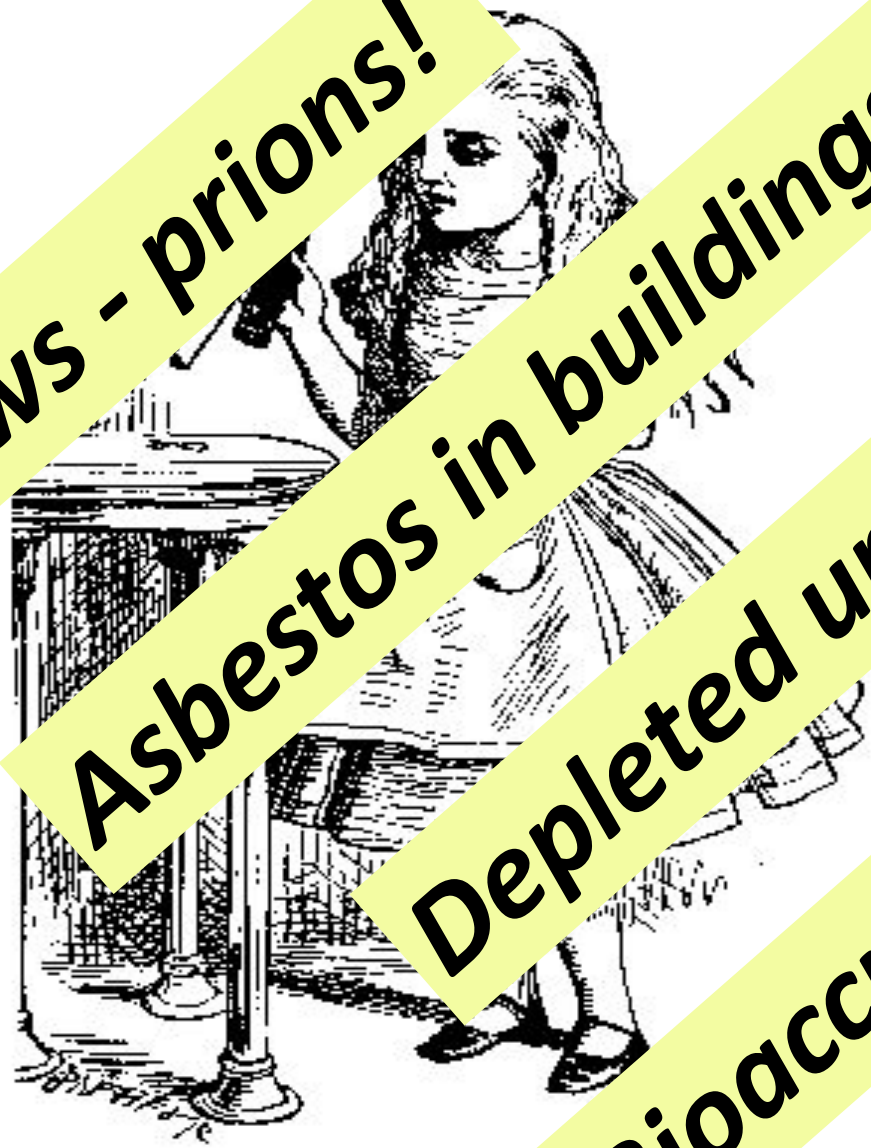When assessing "RISK" you must know ahead:
(i) what can happen; (ii) frequencies of outputs

Even if we know the possible. outcomes (weather forecast) when dealing with long periods it becomes impossible to guess future states (because of path dependence in events taking place in multiple scales)

The problem with complexity: "the butterfly effect"

Nobody can predict the weather in London in 60 days . . .

IGNORANCE

is not about be... ...at ...nating pr... ...s

It is abou... ...ng able ... know... ...be a rel... tr... ...he futur...

IGNOR... ...ns not havi... ...ghtest idea ... ...re outcomes. . .

Mad Cows - prions!

Asbestos in buildings

Depleted uranium

Bioaccumulation of pesticides

CFC ozone depletion

Alice deciding whether... ...nking from th... "DRINK ME" bottle

AGAINST IGNORANCE WE CANNOT TRUST THE OPINION OF EXPERTS . . .

Marie Curie born in 1867

Without any doubt the best world expert of radioactivity at her time

Nobel prize in Physics 1903
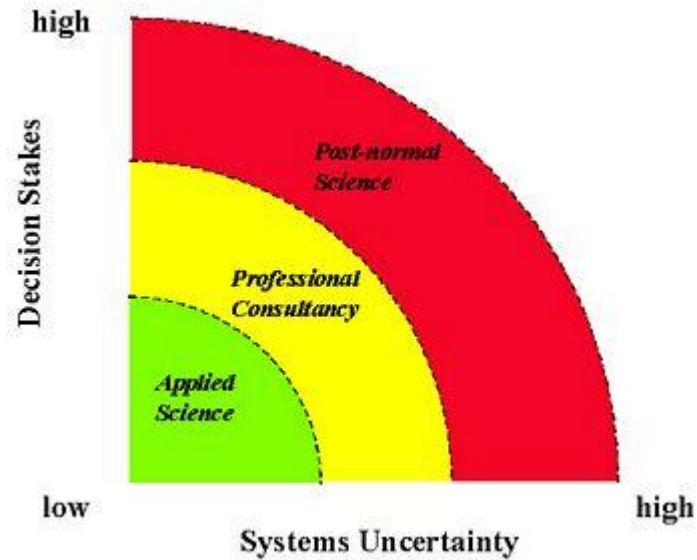
Nobel prize in Chemistry 1911

Died of leukemia in 1934 '*worn and almost blind, with fingers devastated by "her" beloved RADIO***'. The same fate happened to her daughter, her husband and many in her laboratory**

The challenges flagged by the concept of Post-Normal Science

Silvio
Funtowicz

PNS
diagram

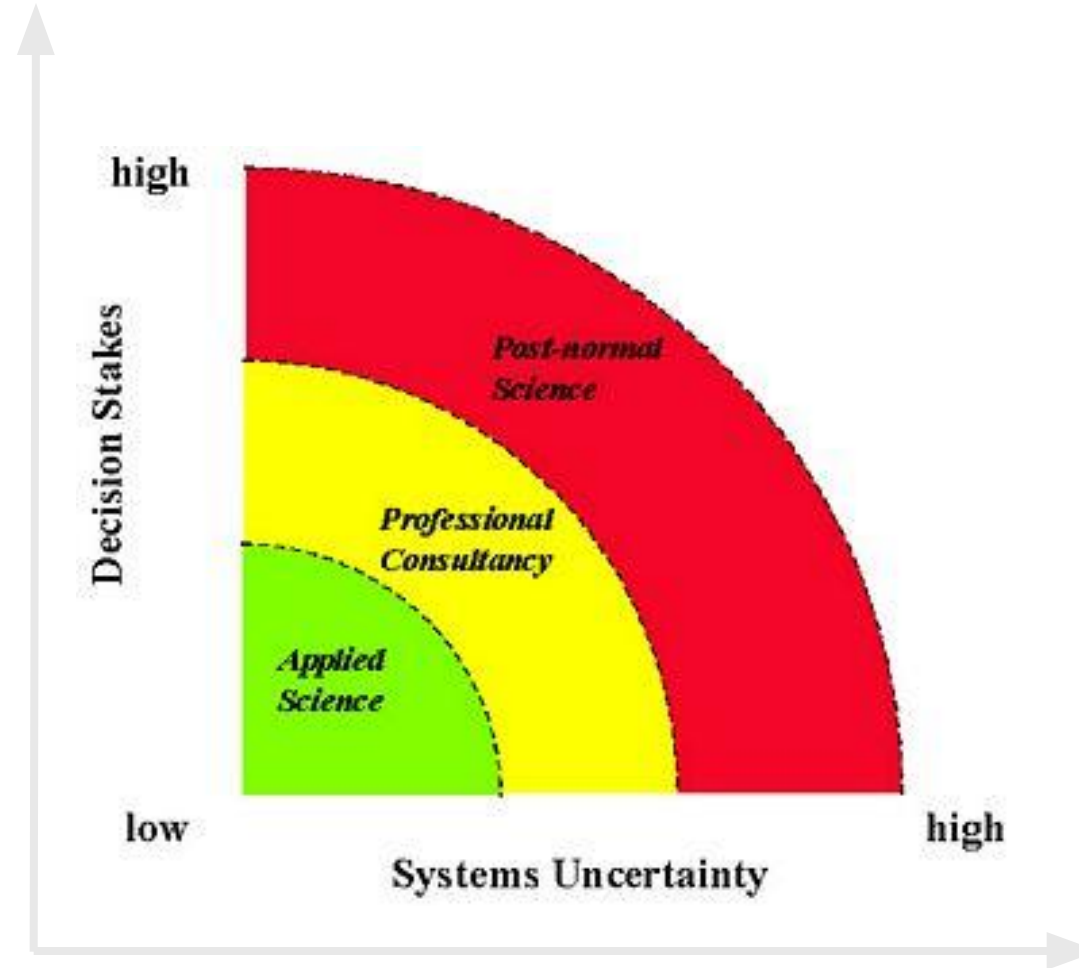Jerome
Ravetz

Who decides the validity of knowedlge claims and **how**?

PLAUSIBILITY
of data, models and scenarios

RELEVANCE
of the chosen issue definition, policy options, (goals, taboos)

LEGITIMACY
of the process of production and consumption oinformationf scientific

Who decides the RELEVANCE of narratives, USEFULNESS of perceptions and PERTINENCE of representations and **how**?

POLITICAL SPHERE - WHY

SCIENTIFIC SPHERE - HOW

social practices   *political process*

PNS SPHERE - WHAT

expert   *scientist*

Identification of concerns → Prioritization of concerns → Framing of the problem ← Identification of relevant knowledge claims ← Useful representations

Pre-analytical choices

Pre-analytical choices
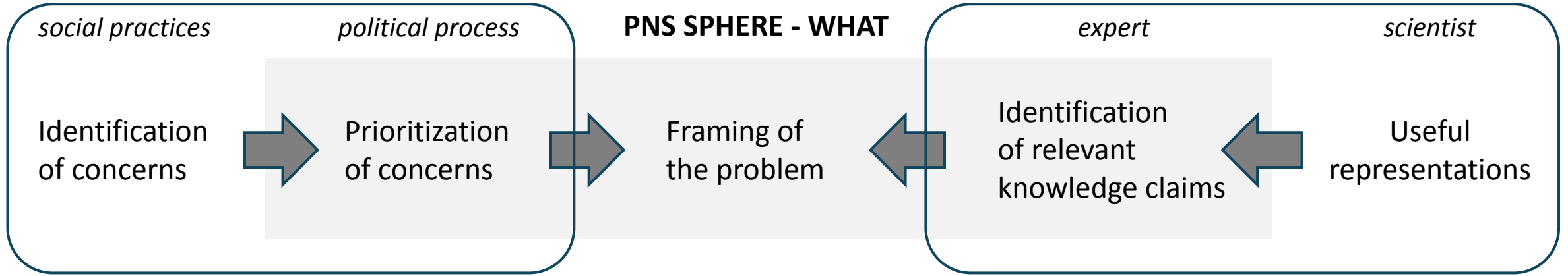
← Defining RELEVANCE (values) →
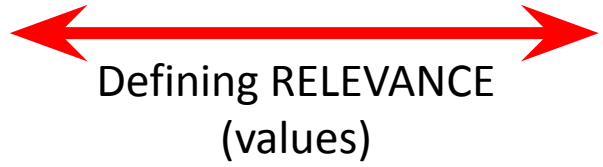
Fitness for purpose

SOLUTION?

← Defining PERTINENCE (models/data) →
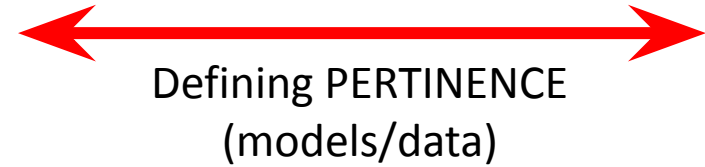
PITFALLS

PITFALLS

HEGEMONIZATION (lack of diversity)

UNFAIRNESS (bias in prioritization)

HYPOCOGNITION (bad framing)

UNCERTAINTY (knowledge claim)

LACK OF RIGOR (poor analysis)

↕

↕

↕

↕

↕

SOLIDARITY (caring)

DELIBERATION (democracy)

QUALITY GOVERNANCE (Quantitative Storytelling)

REFLEXIVITY (humility)

RESPONSABILITY (moral commitment)

ANTIDOTES

ANTIDOTES

Mechanisms of legitimization of social system (hierarchy of power)

IN PRE-INDUSTRIAL SOCIETIES

GOD

⬇

King

The "king" is required to guarantee the social contract after receiving a direct endorsement from GOD

⬇

organization of the state
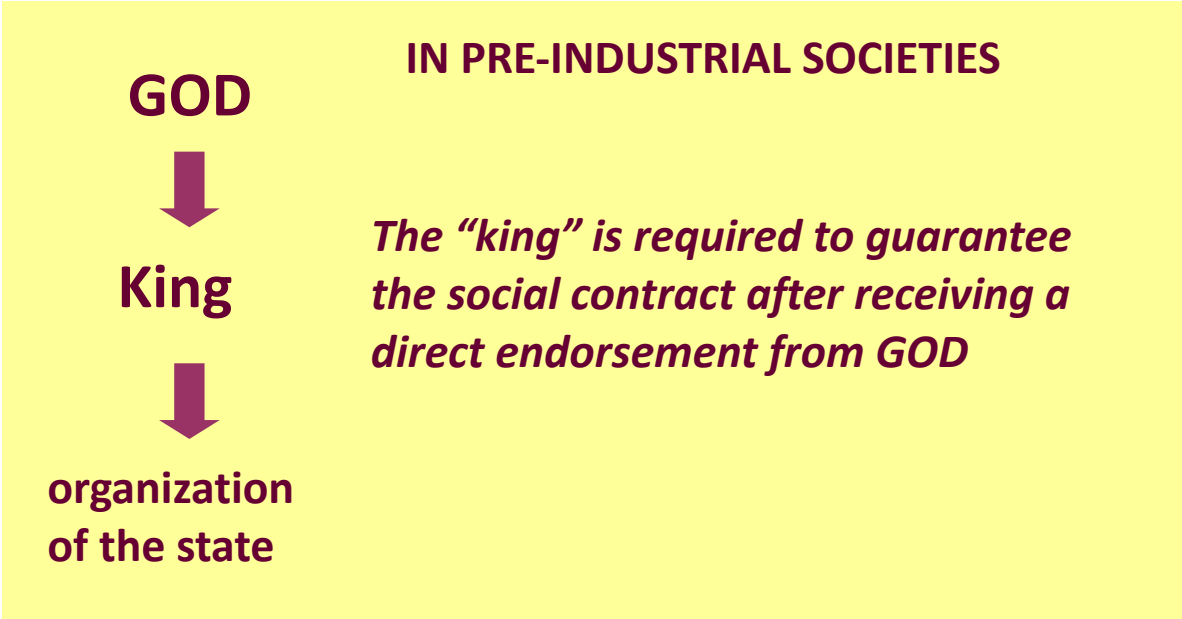
political implications

AFTER THE ILLUMINISTIC REVOLUTION

TRUTH <--> GOOD

↕   ↕

SCIENCE <--> GOVERNMENT

organization of the state

The TRUTH can be known and used for the good of the community
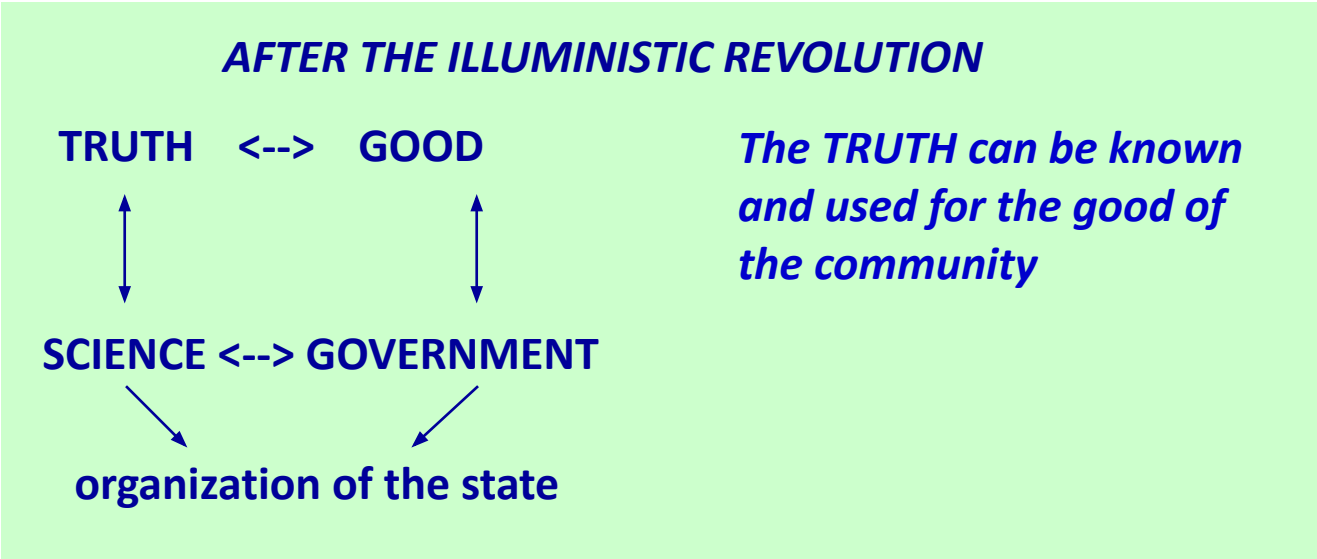
The challenge associated with Post-Normal Science

TRUST <--> Dialogue <--> QUALITY

**keep in the society an
ORGANIZED DIVERSITY**

**looking for WISE SOLUTIONS
negotiating under uncertainty**
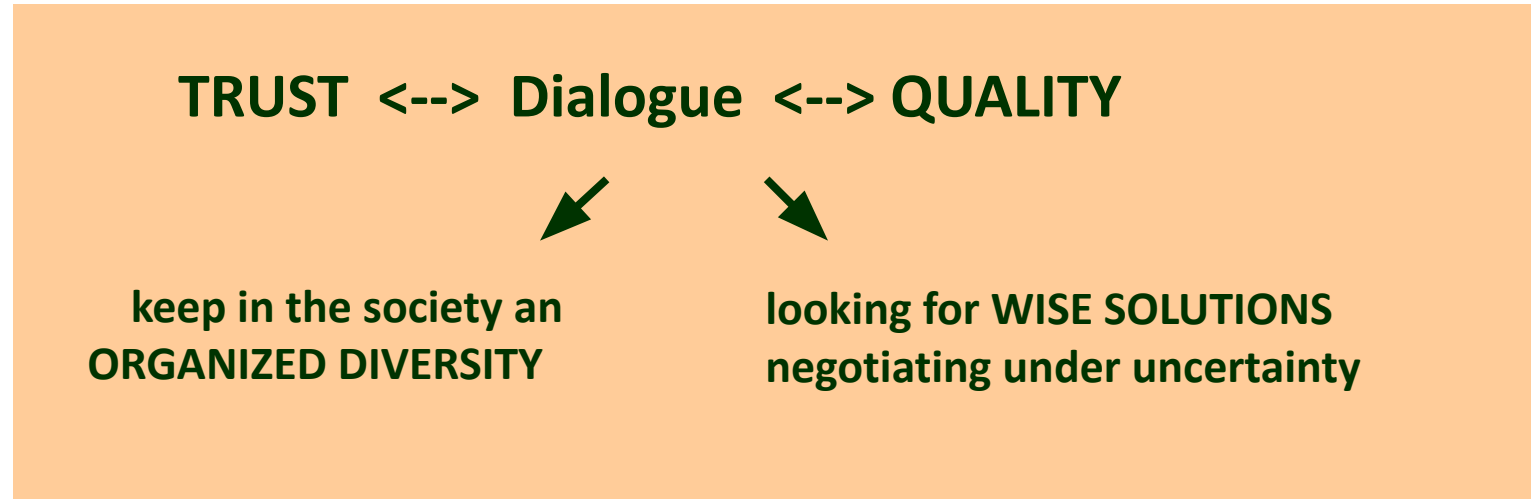
"**Quality**" and "**Trust**" referring to the **process**
replace "**Rigor**" and "**Truth**" referring to the **output**

It is not about optimizing protocols indicating "*the best course of action*"

It is about sound and fair procedures for deliberation (pros & cons)
about "*wise strategies*"

Sustainability is about learning how to update the identity of a society while remaining functional – *i.e. changing the airplane while flying* – forcing individuals and institutions to deal with the "tragedy of change"

Nobody likes undergo the tragedy of change! For this reason, we should stay away from the fatal attractors of "noble lies" . . .

1. *Implausible Sociotechnical imaginaries* ideological colonization of desirable implausible futures determining a systemic neglecting of possible alternative futures

2. *Granfalloons/Policy legends* enhancing the generation of *unknown knowns* – i.e. a systemic ignoring of available but uncomfortable knowledge

3. *Economics of technoscientific promises* assuming that the solution to all our problems will be given to us by the market though the generation of an endless supply of silver bullets

#3

METHODOLOGICAL APPROACHES

The problems with Social-Multicriteria Evaluation and the reasons for Quantitative Storytelling

A quick overview of basic concepts of Multicriteria Evaluation

How to deal with the coexistence of non-equivalent criteria of performance when making a choice

Economic Criterion

Safety Criterion

Cultural Criterion

Driving quality Criterion

Fuel consumption

Maintenance costs

Price

Design

Status Symbol

Colour

Noise

Comfort

Speed / acceleration

Safety devices

Reliability

Road handling
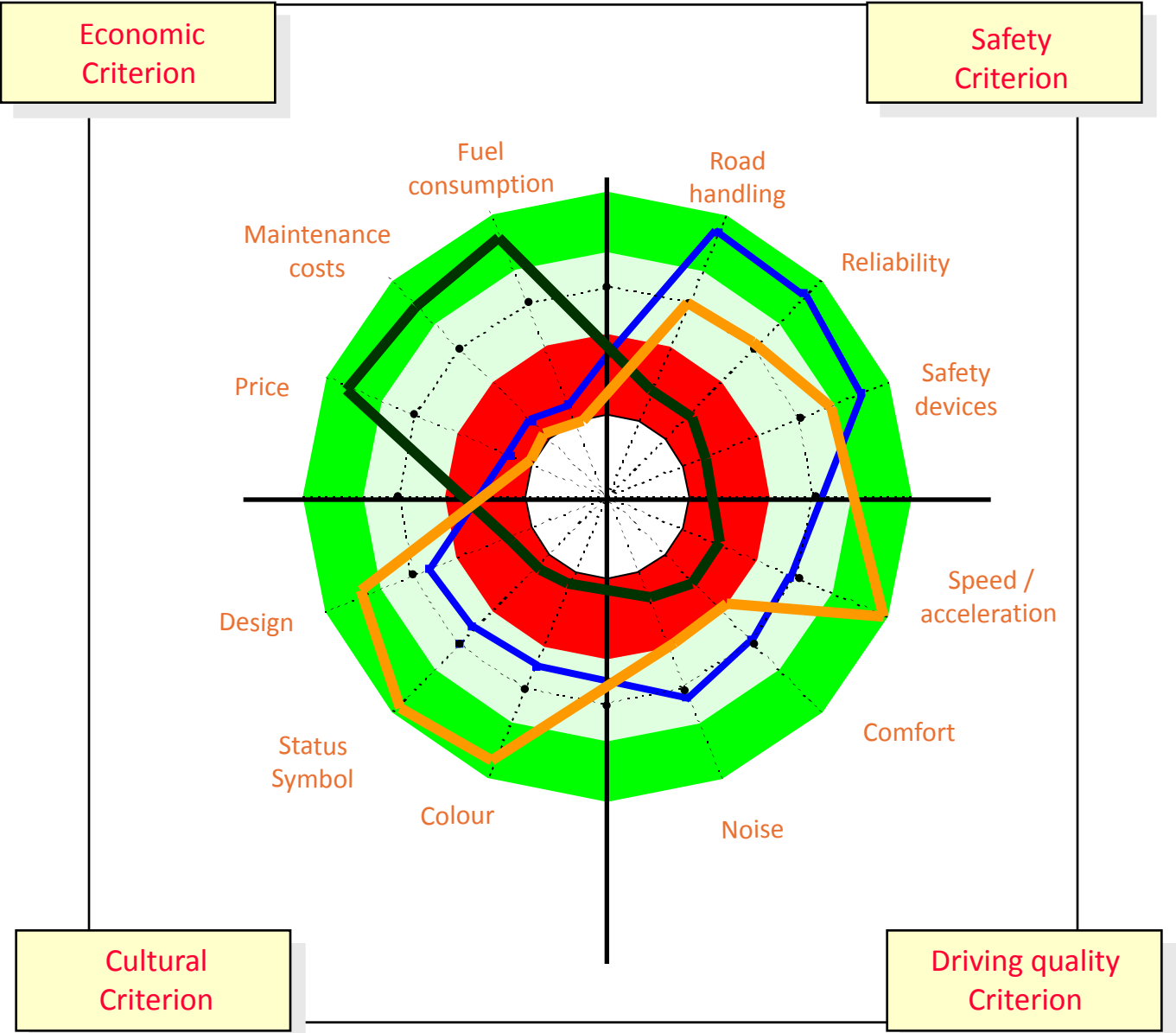
In integrated assessment the pre-analytical definition of the UTILITY FUNCTION for the buyer is the crucial step of the process

Can we use the same multi-criteria space for characterizing the choice between a TRABANT and a FERRARI?

Fuel consumption

Road handling

Maintenance costs

Reliability

Price

Safety devices

Safety Criterion

Design

Speed / acceleration

Status Symbol

Comfort

Colour

Noise
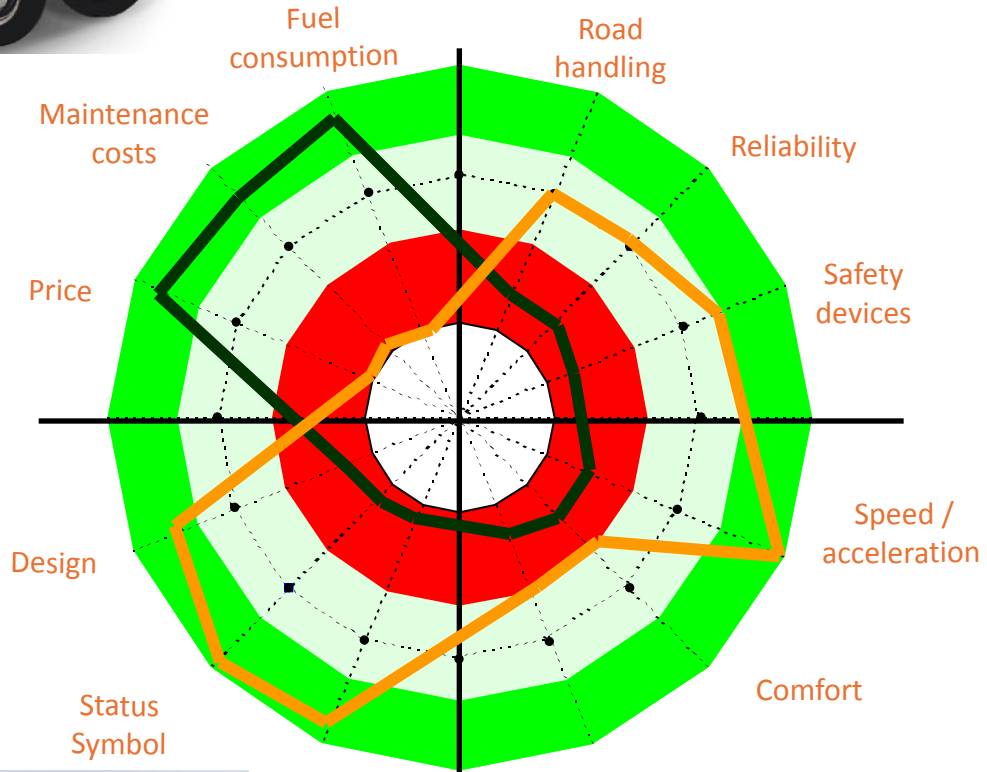
Driving quality Criterion

Can we use the same multi-criteria space
for characterizing the choice between
a TRABANT and a FERRARI?

NO
WAY!

It does not provide enough information to either
those interested in buying a TRABANT, nor
those interested in buying a FERRARI

The two types of buyer will require a different
selection of indicators and attributes: they have
a different perception of the quality of a car

Relevant for the Environment

Relevant for the Consumer

Relevant for the Producer

Relevant for the Country

GHG emissions

Final Price

Deforestation (for feed)

Quality milk

N-Pollution

Convenience

Need of subsidies

Food Security (supply)

Production cost

Food safety

Job creation

Rural development

Industrial milk production

Household milk production

A quick overview of the available tools
used in Societal Multicriteria Assessment

"Multi-Criteria Impact Matrix" (REPRESENTATION)

"Social Impact Matrix" (checking the PERCEPTION of CONCERNS)

"Multi-Criteria Impact Matrix" (REPRESENTATION)

indicators

ALTERNATIVES

CRITERIA		observable quality	Units	FORD Mondeo	HONDA Civic	VW Golf	NISSAN Micra
	economic	Fuel Consumption	US$	$a_{1\,1}$	$a_{1\,2}$	. . .	$a_{1\,4}$
		Maintenance cost	US$	. . .	. . .	. . .	. . .
		Price	US$			$a_{3\,3}$	
	safety	Road Handling	Index				
		Reliability	Index	. . .	$a_{5\,2}$	. . .	. . .
		Safety devices	Index				
	driving quality	Power	HP	$a_{7\,1}$			
		Comfort	Index	. . .	. . .	. . .	. . .
		Noise	db			$a_{9\,3}$	
	cultural	Design	Index		$a_{10\,3}$		
		Status Symbol	Index	. . .	. . .	. . .	. . .
		Colour	Index	$a_{12\,1}$			$a_{12\,4}$

data used to formalize the semantic framing

"Social Impact Matrix" (checking the quality of PERCEPTION)

reflecting an overall assessment of the set of alternatives in relation to goals, beliefs, taboos	defining a finite/closed option space ALTERNATIVES				Power relations: Conflict and Institutional analysis
	Ford Mondeo	VW Golf	Honda Civic	Nissan Micra	
WIFE	Yes +	No	Yes/No	Yes ++	Veto Power !!!
HUSBAND	Yes +	Yes/No	No	Yes/No	Very Relevant
Older daughter	No	Yes/No	Yes ++	Yes ++	Partially relevant
Younger daughter	It must be red	It must be red	It must be red	It must be red	Irrelevant but what if...

STAKEHOLDERS
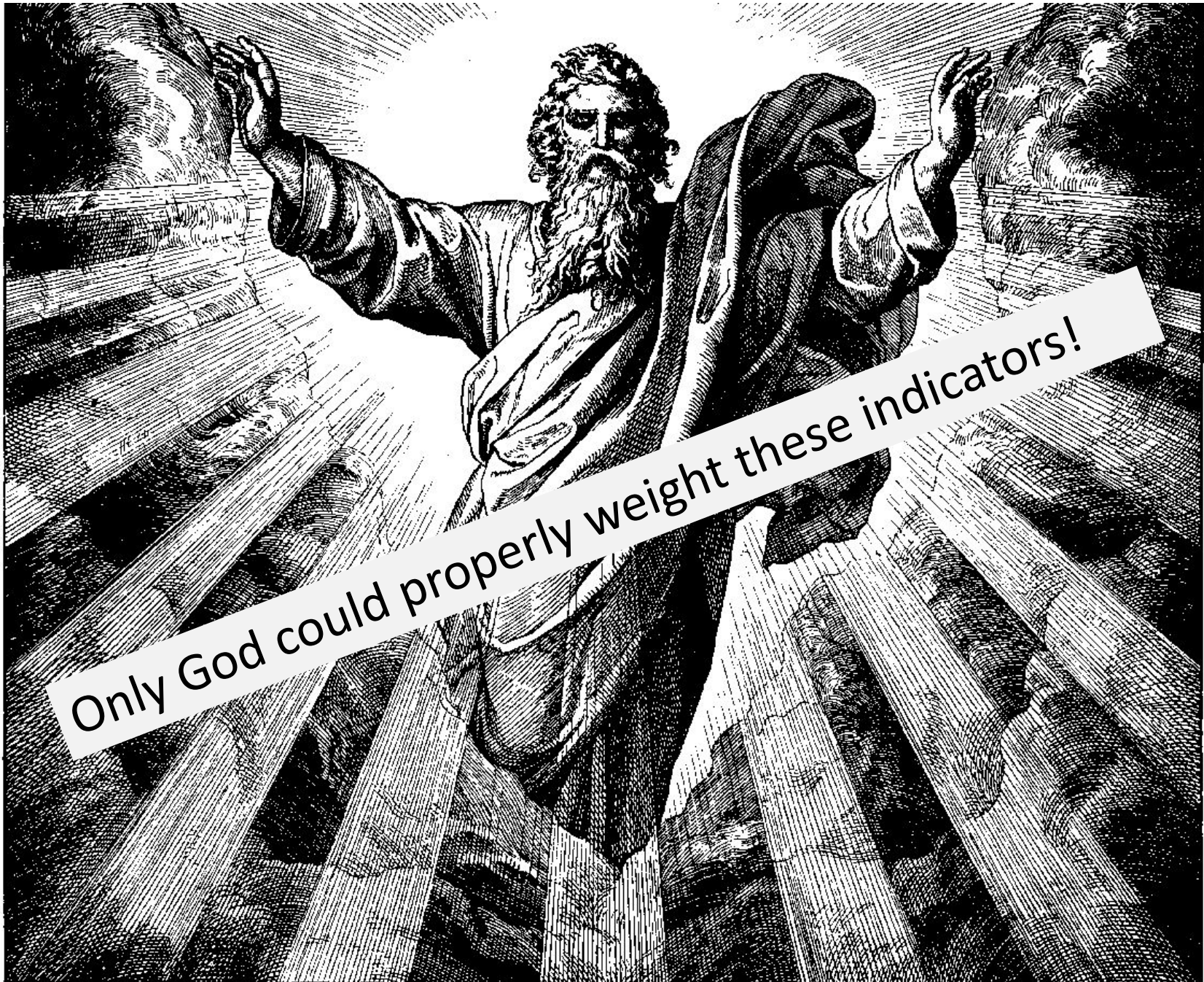
Only God could properly weight these indicators!

Assumption typical of NORMAL SCIENCE looking for OPTIMAL SOLUTIONS

1 It is possible to obtain a sound and reliable: "issue definition, problem structuring, and pre-analytical choice of narratives"

2 the given "issue definition, problem structuring, and pre-analytical choice of narratives" is agreed upon by those that will use the scientific analysis

3 the role of the scientist is only that of using the given "issue definition, problem structuring, and pre-analytical choice of narratives" for generating models, analyses, data, indicators leading to the optimal choice.

4 an acceptable quality of the narratives and acceptable levels of ignorance can be guaranteed by using more complicated models and bigger computers

SCIENTISTS MUST CRUNCH NUMBERS FOR PRODUCING BETTER ANALYSES

Quantitative analyses are used to individuate the best course of action

NO!

Quantitative Story-Telling: a different use of science for governance

"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".

George Lakoff

Joseph Stiglitz

Stay away from hypocognition!

Checking the quality of the narratives used in a policy domain
1– QUALITY OF THE CHOICE OF POLICY

Quality of the proposed policies within the chosen SMC framework

* What are the gains and losses across the various indicators of performance (impact matrix)

* Who are the winners and losers among the various social actors (equity matrix)

Discuss interpretations and implications

Identify key themes relevant to policy

Decide what to represent in societal metabolism analysis

Compile data, carry out societal metabolism accounting

Contextualise and present intensity & extent metrics
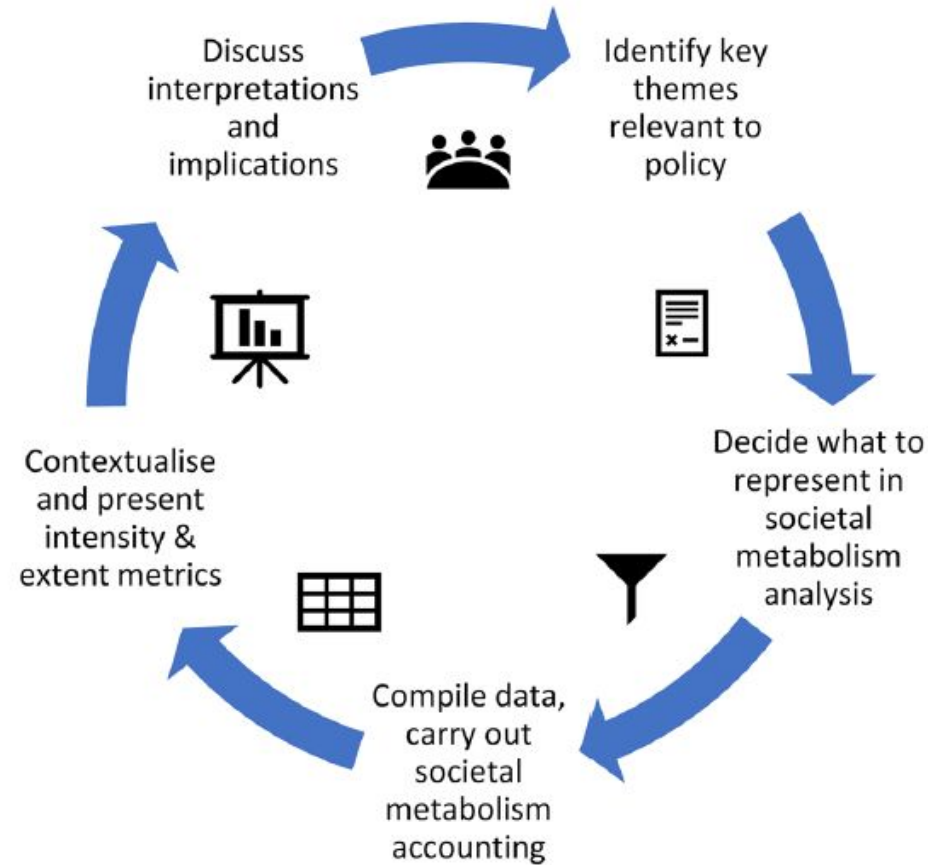
Quality of the proposed policies when adopting different QST

* Are they feasible? (compatible with external limits)

* Are they viable? (compatible with internal limits)

* How do the policies look when considering an evolutionary view?

Checking the quality of the narratives used in a policy domain
2 – QUALITY OF THE REPRESENTATION

Quality of the process of epistemic boxing

Choice of representation

* What information is missing for obtaining a better informed decision?

Transparency of the analysis (choice of models and data)

* Can we implement procedures based on participatory processes allowing a more robust process of co-production of knowledge and a fairer deliberation?

Checking the quality of the narratives used in a policy domain
3 – QUALITY OF THE PROCESS

Choice of concerns

* What are the problems to be solved?
* What is the priority that has been given to existing concerns?

Fairness of the process

* Whose concerns are acknowledged?
* Whose concerns are ignored?
* Whose problems will be solved first?

Quality of the process

* Who has chosen the given story-telling?
* How has it been chosen?
* Why has it been chosen?

Storytelling Steps

Step One:
Come up with an idea
Write a Proposal

Step Two:
Research/Explore/Learn

Step Three:
Write/Script

Step Four:
Storyboard/Plan

Step Five:
Gather/Create Images
Gather/Create Audio
Gather/Create Video

Step Six:
Put It All Together

Step Seven:
Share

Step Eight:
Feedback and Reflect

A Process

edtechteacher

Explaining the story in plain terms . . .

Sustainability has to do with learning how to meet the challenges associated with understanding, deciding and acting in an adequate time to change

Sustainability implies facing the tragedy of change:
you have to accept to lose something in order to be able to keep something else

Being able to understand and to decide what we want to retain while becoming something else, and how much we want to pay for it, is at the core of sustainability science

The quality of scientists when discussing sustainability depends also on their moral strength
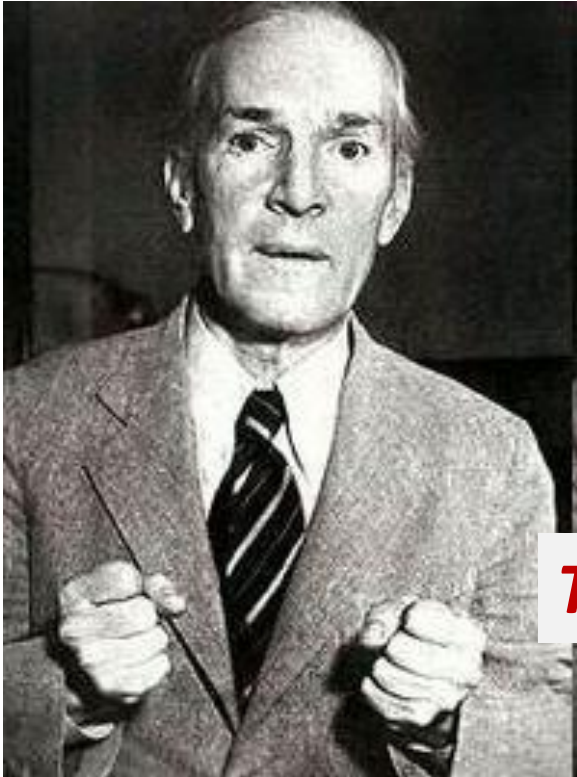
How is it possible that so many scientists endorse CIRCULAR ECONOMY as a sustainability solution if the concept is at odd with the laws of thermodynamics?

THE MORAL DIMENSION . . .

"It's difficult to get a man to understand something if his salary depends on him not understanding it"

Upton Sinclair

The quality of scientists when discussing sustainability depends also on their common sense

Stay away from implausible
sociotechnical imaginaries
endorsing policy legends
and avoiding toxic truths

COMMONSENSE KNOWLEDGE . . .

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Reviews p87

Buzz Aldrin,
Apollo 11
moonwalker,
would like a
word with you.

You Promised Me Mars Colonies.
Instead, I Got Facebook.
We've stopped solving big problems.
Meet the technologists who refuse to give up. p26

The quality of scientists when discussing sustainability depends also on their courage

WE NEED HERO SCIENTISTS . . .

if you see fraud and do not say
fraud then you are a fraud

CONGRATULATIONS!

Thanks for your heroic attention

<Mario.Giampietro1@gmail.com>