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‘Preliminary’ results of SUPRIM’s ‘consensus’-based search for an LCIA method for abiotic resource use

This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

Content

- Introduction and Problem
- Approach
- Results and Discussion
- Conclusions

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Introduction and Problem

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- Until recently, there was no consensus on how the issues around resource accessibility and availability should be assessed in life cycle impact assessment
  - Recently, the UNEP task force on mineral resources successfully completed a consensus-finding process (article submitted): (slightly) different timing, procedure and stakeholders

- Existing methods have been criticized by mining industry representatives and researchers, and new methods keep being added to the already existing quantity

- SUPRIM project aims to find a common understanding (amongst the LCA and mining communities) on the underlying issues associated with resource use, to form the basis for agreed life cycle impact assessment method(s)

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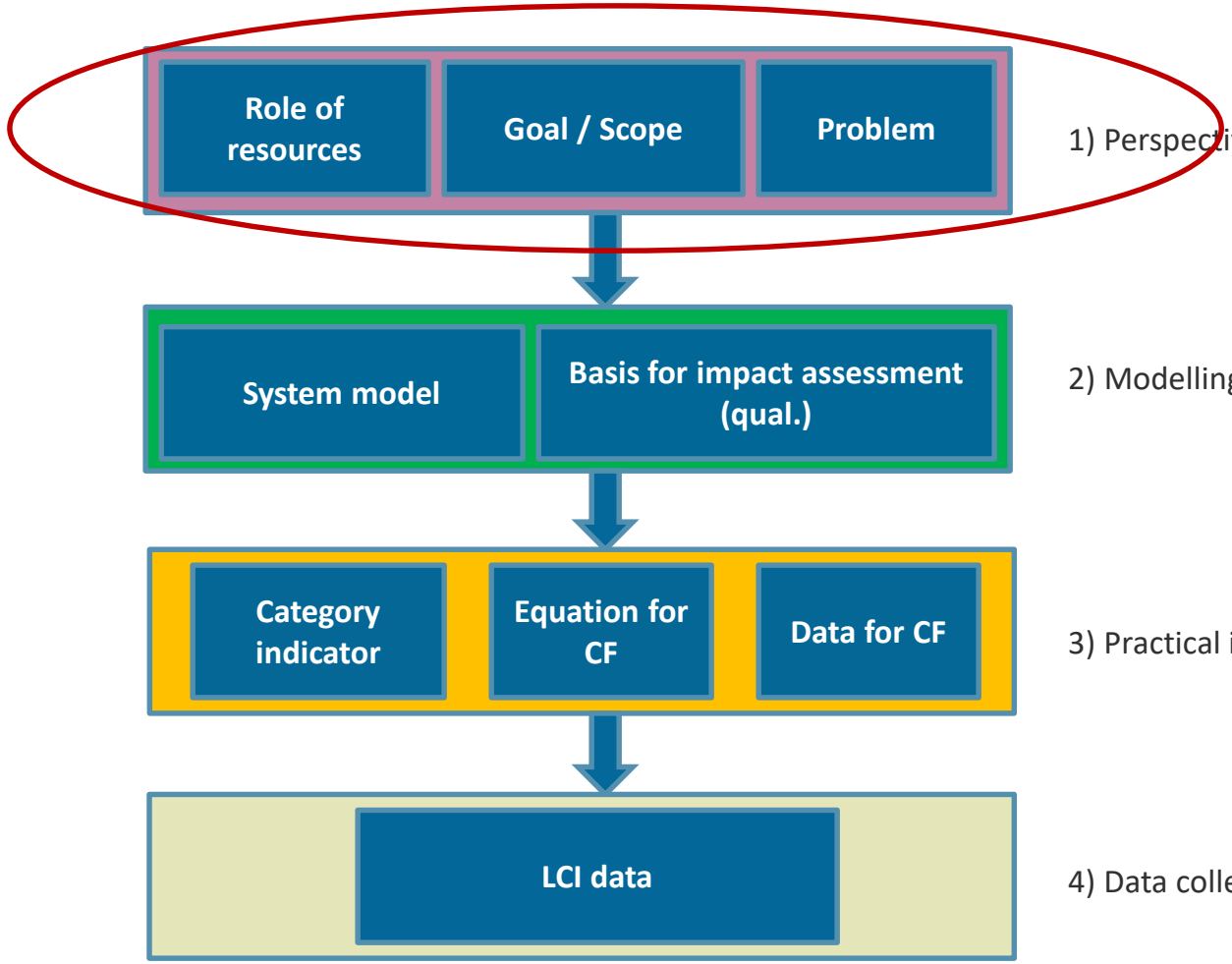
Framework - Perspectives



1) Perspective on resources

2) Modelling concept

3) Practical implementation

4) Data collection in line w. method

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Workshop on 'Perspective – role of resources

Role of resources - applying the criteria

A. abiotic resources are valued by **humans** for their functions used (by humans) **in the technosphere**, primary production only

e.g. depletion

B. abiotic resources are valued by **humans** for their functions used (by humans) **in the technosphere**, primary and secondary production

e.g. dissipation

C. abiotic resources are valued by **humans** for their in-situ functions **in the environment**, primary production only

ecosystem services (non-provisioning)

D. abiotic resources are valued by **humans** for their functions in the **technosphere** and their in-situ functions **in the environment** considered useful to humans, primary production only

Combined view

E. abiotic **resources** are valued for their own sake **in the environment**, regardless of their usefulness in nature or technosphere, primary production only

Intrinsic value

Combination	Stakeholder *Who is interested?*	System of Concern *System where they are valued*	Production system *Source for production*	Perspective types, based on role of resources
1	**Human**	**Environment**	**Primary**	D^{π}
2	**Human**	**Technosphere**	**Primary**	A^{π}
3	**Human**	**Environment & Technosphere**	**Primary**	C^{π}
4	~~Human~~	~~Environment~~	~~Primary & Secondary~~	F^{β}
5	**Human**	**Technosphere**	**Primary & Secondary**	B^{π}
6	Human	Environment & Technosphere	Primary & Secondary	G^{γ}
7	**Resource**	**Environment**	**Primary**	E^{π}
8	Resource	Technosphere	Primary	H^{α}
9	Resource	Environment & Technosphere	Primary	I^{α}
10	Resource	Environment	Primary & Secondary	J^{α}
11	Resource	Technosphere	Primary & Secondary	E^{α}
12	Resource	Environment & Technosphere	Primary & Secondary	L^{α}
13	Nature	Environment	Primary	M^{α}
14	Nature	Technosphere	Primary	N^{α}
15	Nature	Environment & Technosphere	Primary	O^{α}
16	Nature	Environment	Primary & Secondary	P^{α}
17	Nature	Technosphere	Primary & Secondary	Q^{α}
18	Nature	Environment & Technosphere	Primary & Secondary	R^{α}

π --> A description/ interpretation Perspective Types A-E is given in the input paper
α --> Not described in the analysis, more challenging to interpret
β --> Does not appear to be a viable option
γ --> Not discussed in the text, but could be created if C was extended to secondary production

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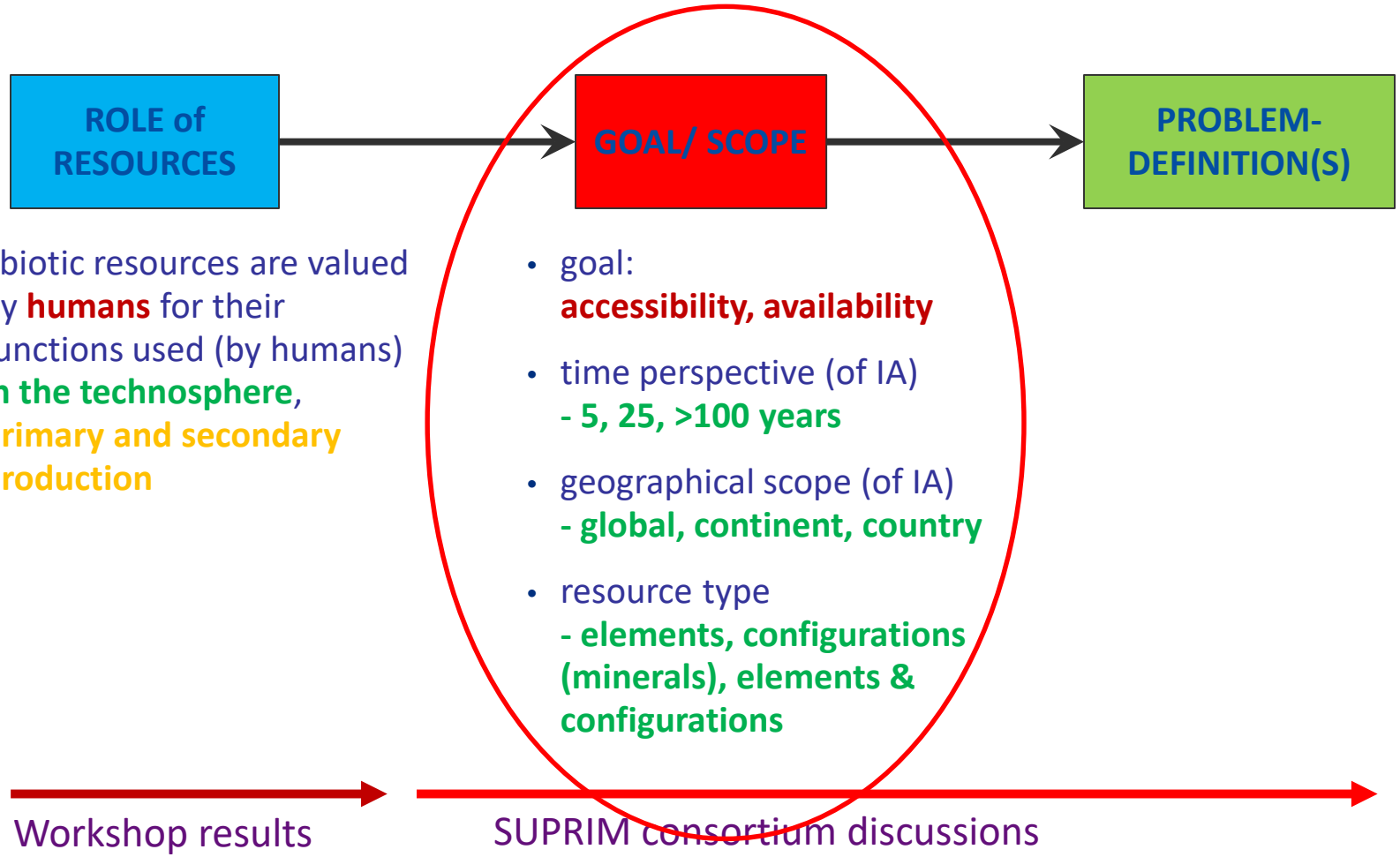
Perspectives: towards problem definition SUPRIM



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4 B-perspectives selected by SUPRIM

Perspective	Availability/ accessibility	Resource scope: elements, configurations or both	Geographical scope: Country, continent or global scale	Temporal scope:
B1	accessibility	elements	global	500 years
B2	accessibility	configurations	global	500 years
B3	accessibility	elements	global	25 years
B4	accessibility	configurations	global	25 years

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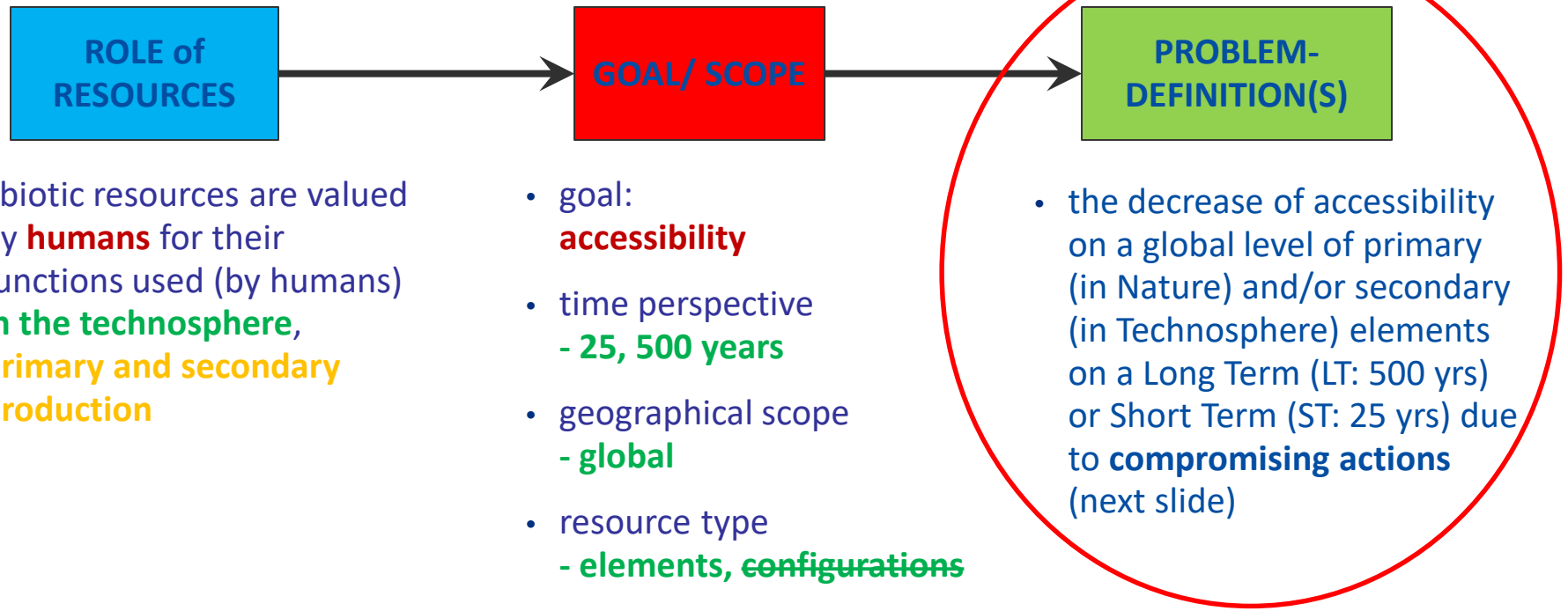
Perspectives: towards problem definition SUPRIM



- abiotic resources are valued by **humans** for their functions used (by humans) **in the technosphere**, **primary and secondary production**

- goal: **accessibility**
- time perspective **- 25, 500 years**
- geographical scope **- global**
- resource type **- elements, ~~configurations~~**

- the decrease of accessibility on a global level of primary (in Nature) and/or secondary (in Technosphere) elements on a Long Term (LT: 500 yrs) or Short Term (ST: 25 yrs) due to **compromising actions** (next slide)

Workshop results → SUPRIM consortium discussions

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Compromising actions

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"Human actions related to the use of resources resulting in an increase or decrease of accessibility of resources for future generations"

- **exploration:** increase of accessible stocks through exploration and feasibility studies
- **dissipation to environment:** decrease of accessible stocks through emissions
- **hibernation[1] in technosphere:** decrease of accessible stocks through the application of resources that (temporary) hamper the recyclability of the resource.
- **occupation:** temporary decrease of accessible stocks through competitive use of resources in materials and products

In conventional LCA not taken into account, but in policies often mentioned

[1] including dissipation in technosphere

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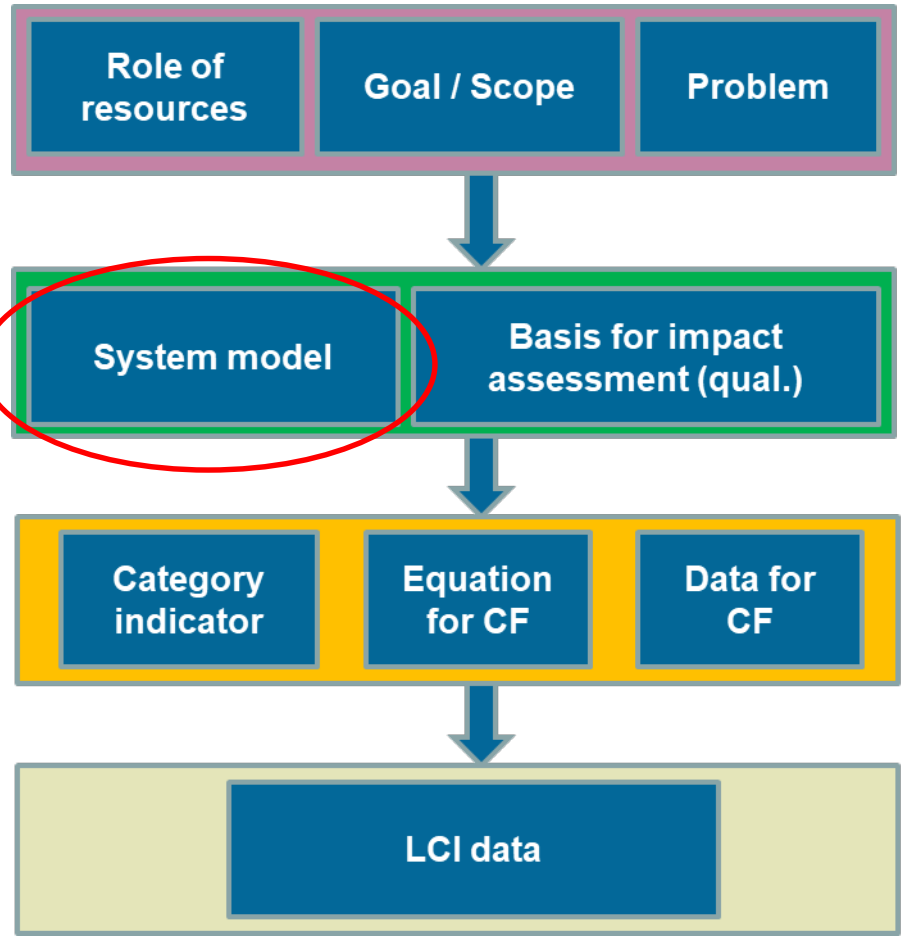
Framework – Modelling concept – System model

The system model defines the relevant flows and stocks to be assessed by the LCIA method, and how these flows and stocks of resources are positioned in or between the environment and/or the technosphere.



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System model for a resource (element)

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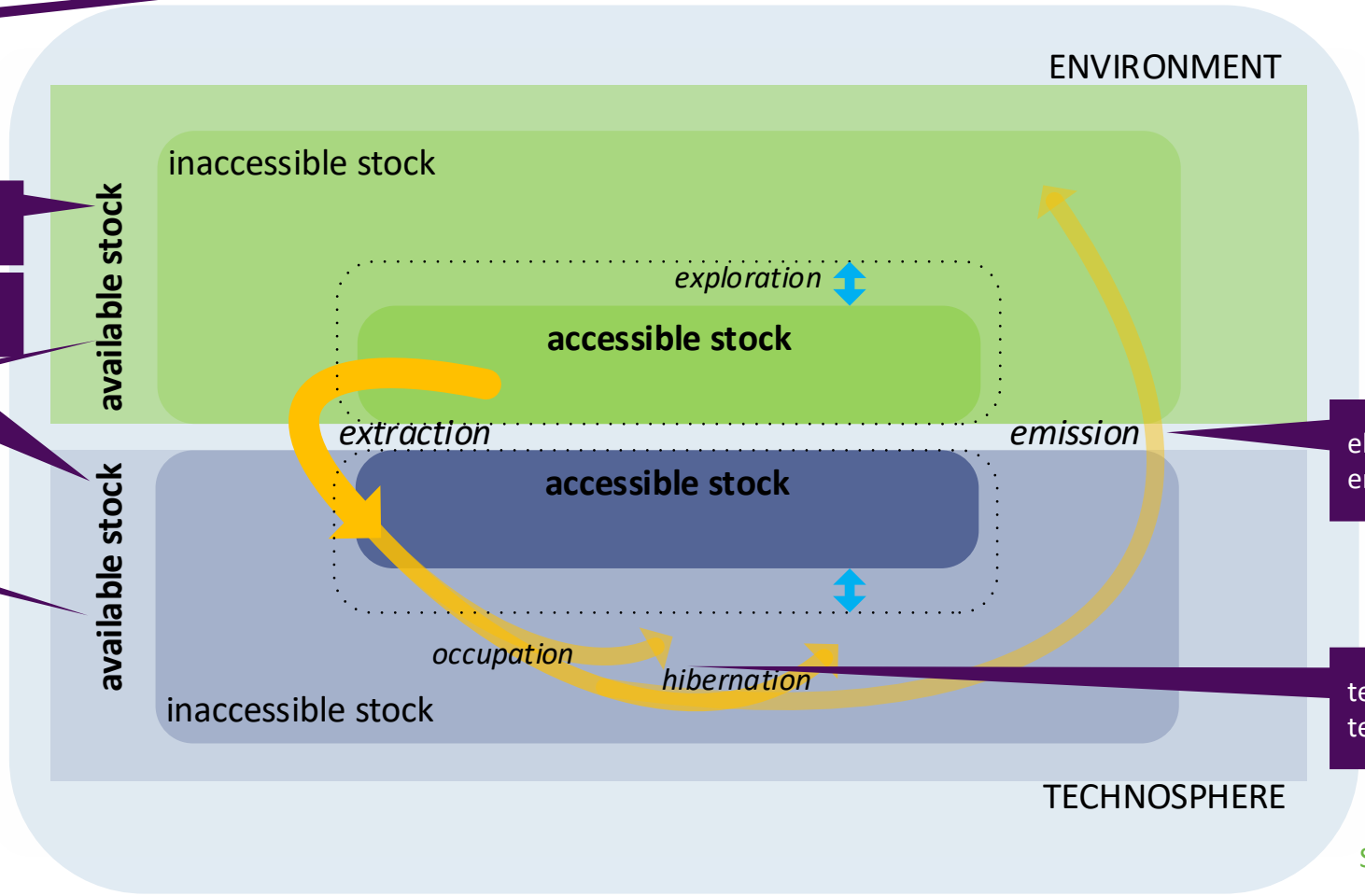
elements cannot be transformed

stocks in environment:
lithosphere, ocean and atmosphere

stocks in technosphere:
in use products, hibernating, landfill

part of available stock is accessible/inaccessible



elementary flows between environment and technosphere

technosphere flows within technosphere

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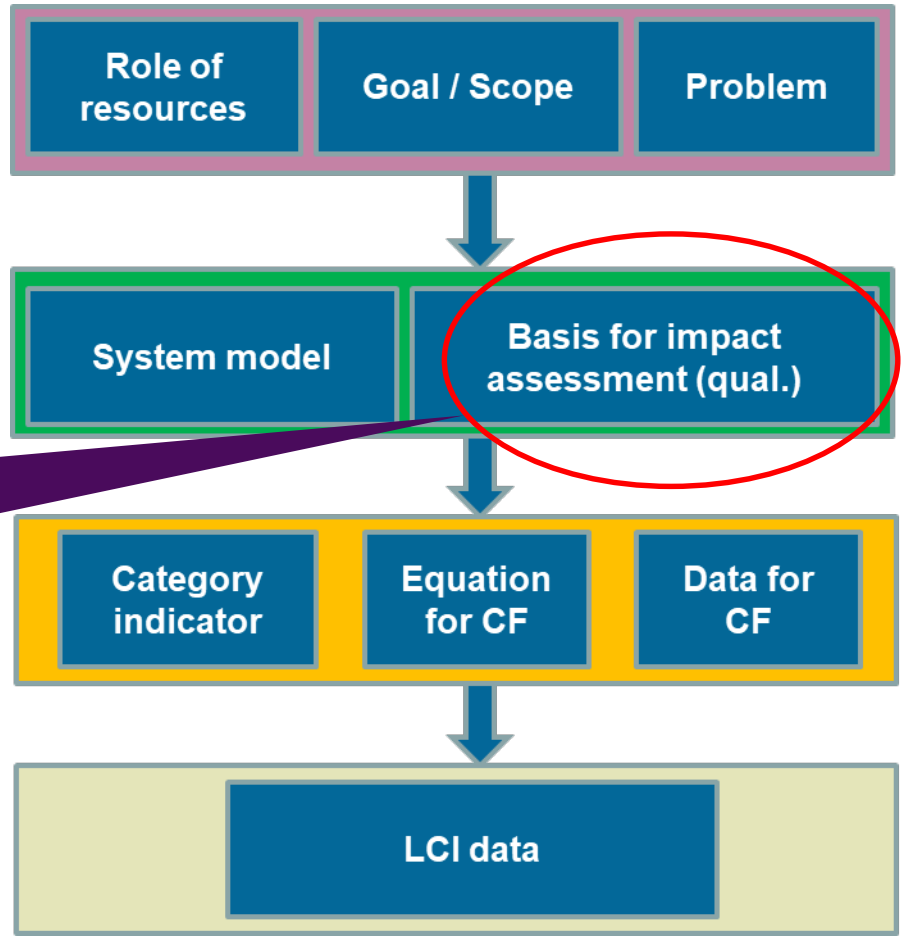
Framework – Modelling concept – Basis for IA



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The criterion according to which the use of one resource is evaluated against the use of another.

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Basis for impact assessment

- Accessibility is a function of the global accessible stock and the change in global accessible stock
- Global accessible stock: function of exploration (particularly on the short term)
- Change in global accessible stock: function of env. dissipation, tech. hibernation, occupation in use
    - Successive compromising actions of successive applications within the Time Horizon considered due to present demand ("how to deal with present and future resource applications within a time horizon?")
- Three different impact categories are defined because of a hierarchical levels of irreversibility:

1. *(Assumed) irreversible inaccessibility of a resource*: **environmental dissipation**
2. *Potentially reversible but temporary (within TH) inaccessibility of a resource*: ***technosphere hibernation*** *(including also dissipation in the technosphere)*
3. *Reversible but temporary inaccessibility of a resource*: ***occupation in use***.

- *Believed to be ultimately inaccessible ("loss")*
- *Fits in conventional LCI (emissions)*

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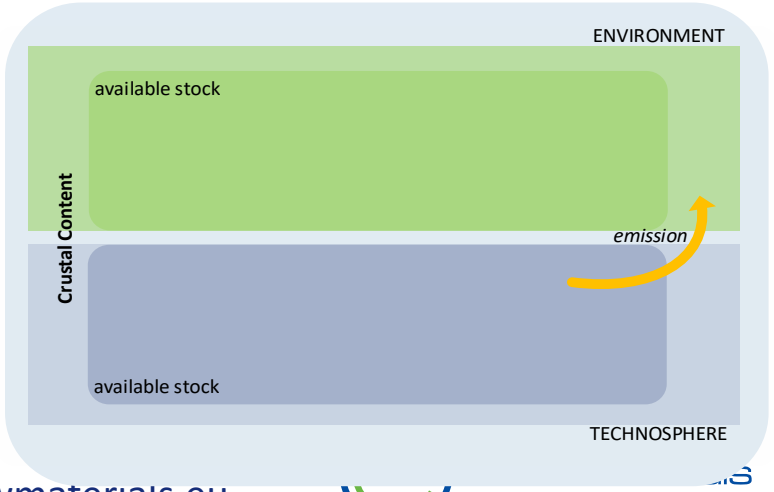
Basis for Impact Assessment for B1 (elements, LT)

- **Accessible stock** in the environment and technosphere: assumed to approach the Crustal Content
- **Exploration:** not relevant when Crustal Content is taken as a basis
- **Tech. hibernation:** negligible, due to continuous technological developments
- **Env. dissipation:** emissions related to the successive applications in the future of the resource that is extracted at present
- **Occupation in use:** not relevant, all what is extracted will eventually be emitted

In summary: only emissions, are believed to lead to ultimate inaccessibility of a resource in the B1 perspective (Long Term (500 yrs), elements)



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Framework – Practical implementation

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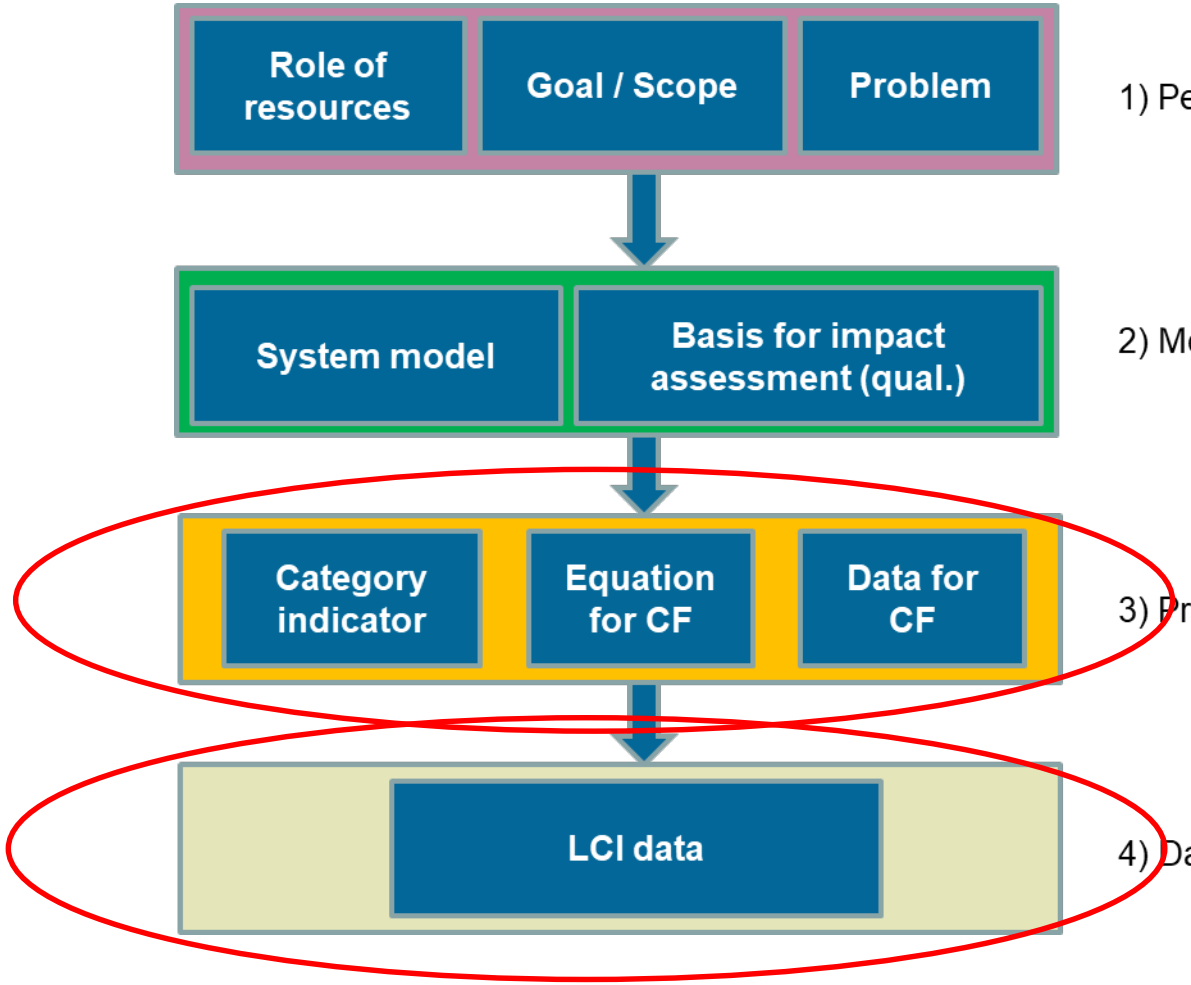

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General equation for characterization factor

$$CF_{t,T,i} = f(C_{t,T,i}, S_{t,T,i})$$

- $C_{t,T,i}$: fraction of the present (t) global primary extraction and secondary use of resource i over time horizon T, made inaccessible
- $S_{t,T,i}$: severity of making 1 kg of resource i inaccessible for time horizon T (this could be its total accessible stock (R) in Nature and Technosphere, either or not complemented by the present (t) total production (P) of that resource, as in the ADP)

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Equation for characterization factor (best)

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- Cumulative Environmental Dissipation Potential (EDP) is constructed as follows:

ideal: ultimate extractable reserves
proxy: Crustal Content

$$EDP_{T,i} = \frac{E_{T,i} \Big/ R^2_{i,tot,t+T}}{E_{T,ref} \Big/ R^2_{ref,tot,t+T}}$$

- $E_{T,i}$: the cumulative global emissions of resource *i* (kg/yr) based on the present (t) extraction over the Time Horizon (T)
- $R^2_{i,tot,t+T}$: the total accessible stock in nature and technosphere in year $t + T$, which is approximated by the Crustal Content (kg)

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Eq. for characterization factor (2nd best)

- For the Long Time horizon (**infinity**) $\boldsymbol{E_{T,i} = M_{i,t}}$, and thus the cumulative Environmental Dissipation Potential (EDP) equals the characterisation equation as defined for the Abiotic Depletion Potential (ADP):

ideal: cumulative emissions of present extraction over time horizon e.g. 500 yrs
proxy 1. we use infinite as proxy for 500 yrs
proxy 2. we assume cumulative emissions of present extraction in year infinite equal present extractions

$$\boldsymbol{EDP_{T,i} = \frac{M_{i,t} \Big/ R^2_{i,tot,t+T}}{M_{ref,t} \Big/ R^2_{ref,tot,t+T}} \approx ADP_{i,t}}$$

- $\boldsymbol{M_{i,t}}$: the global present (t) extraction of resource i (kg/yr)

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Equation for impact category results

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$$ED_T = \sum_i EDP_{T,i} \times e_i$$

emission is a conventional elementary flow in LCA

$$ED_T = \sum_i ADP_{i,t} \times e_i$$

please note that in the present AD impact score the ADP is multiplied by the extraction p_i

- $EDP_{T,i}$: the Dissipation Potential of element i (-) based on the cumulative global emission of the present extraction over the Time Horizon(25 or 500 yrs)
- $ADP_{i,t}$: the Abiotic Depletion Potential of element i (-) based on the global present extraction
- e_i: the quantity of element *i* emitted per Functional Unit in an LCA case study (kg)

- availability CFs: updated ADPs (Oers *et al.,* in prep)
- availability LCI data: in LCI databases (e.g. Ecoinvent) the emission data in unit processes necessary to calculate ED scores might be a bottle neck, emissions are far from complete (IN ≠ OUT)

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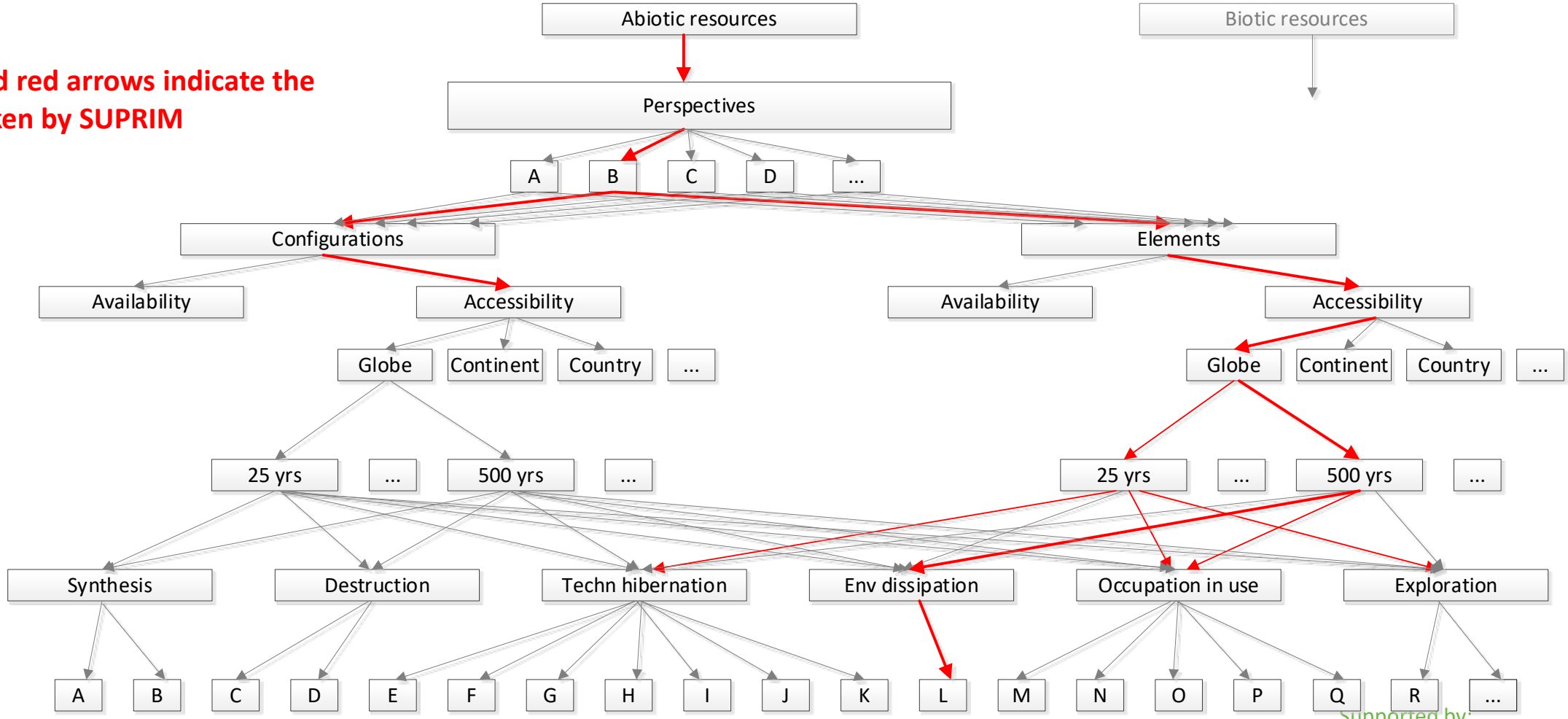
Map of SUPRIM's progress through the framework

bold and red arrows indicate the path taken by SUPRIM



elaborated method with list of CFs

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Conclusions

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- Common understanding has been reached about the **role of resources and the problem definition**
- General equations for **characterization models** are developed for 3 different impact categories: *environmental dissipation, technosphere hibernation, occupation in use*
- all **three impact categories** might be relevant for the *short term*; for the *long term* only the impact category environmental dissipation is assumed to be relevant
- For inaccessibility of resources for future generations on the long term, one (2nd best) **operational set of characterization factors** for the impact category *environmental dissipation* is available
  - Practical application might still be hampered by insufficient **LCI data** on emissions
- **SUPRIM's path** in the framework **is one out of many possible** others, and does not represent global consensus; **framework could/should be used** to guide that process

SUPRIM's key result 1: **Practical method**

SUPRIM's key result 2: **Framework**

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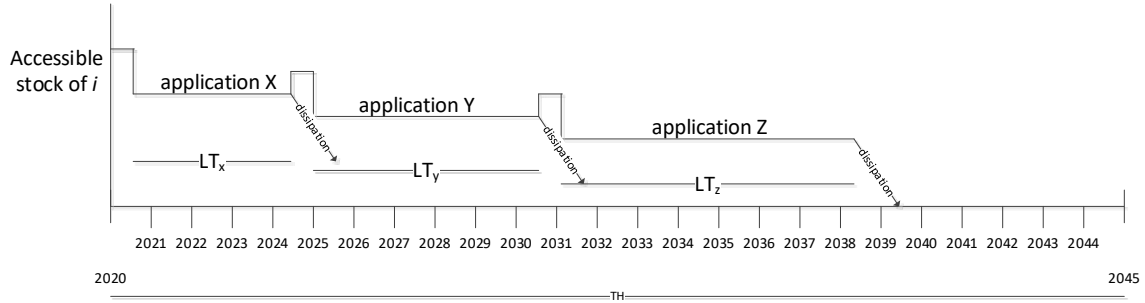
- 2 articles and a deliverable

How to deal with present and future resource applications within a time horizon?

- **A**: present compromising actions (CAs) from present applications within the time horizon considered due to present demand
- **B**: successive compromising actions of successive applications within the Time Horizon considered due to present demand

Subsequent applications of resource *i* over time



- **C**: future CAs due to future demand (use) based on future technology, stocks, extractions, emissions and flows (*extrapolation of historic data*)
- **D**: future CAs due to future demand (use) based on future technology, stocks, extractions, emissions and flows (*scenarios*)

back

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