

# Assessing the Environmental Performance of Biomass Supply Chains

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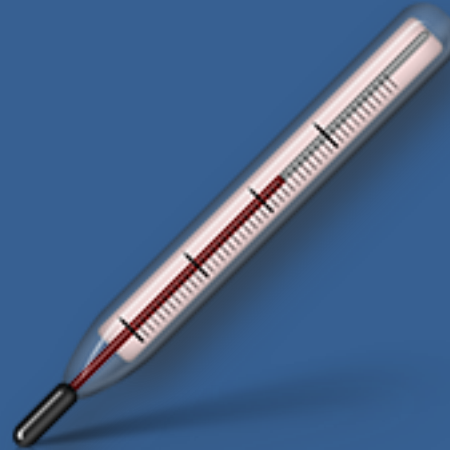
## An Effort under Construction

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Assessing environmental  
performance...



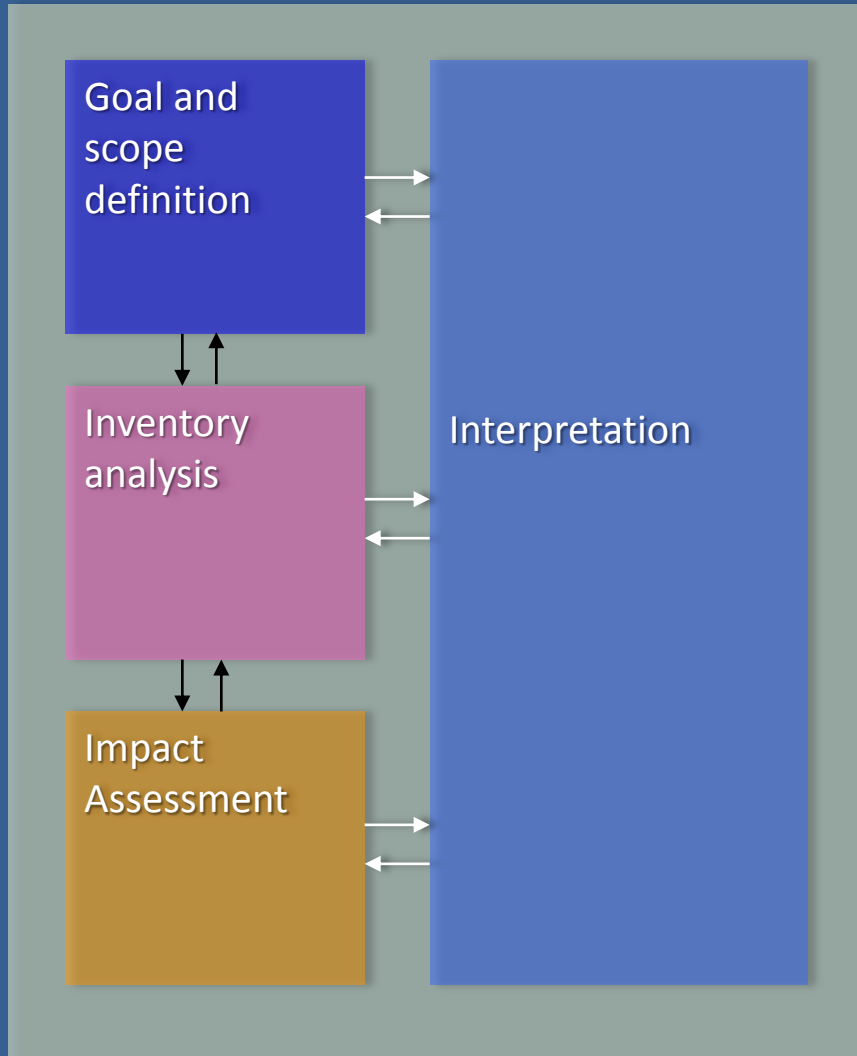
...is more than carbon accounting

(Sustainability) certification schemes do not assess environmental performance...



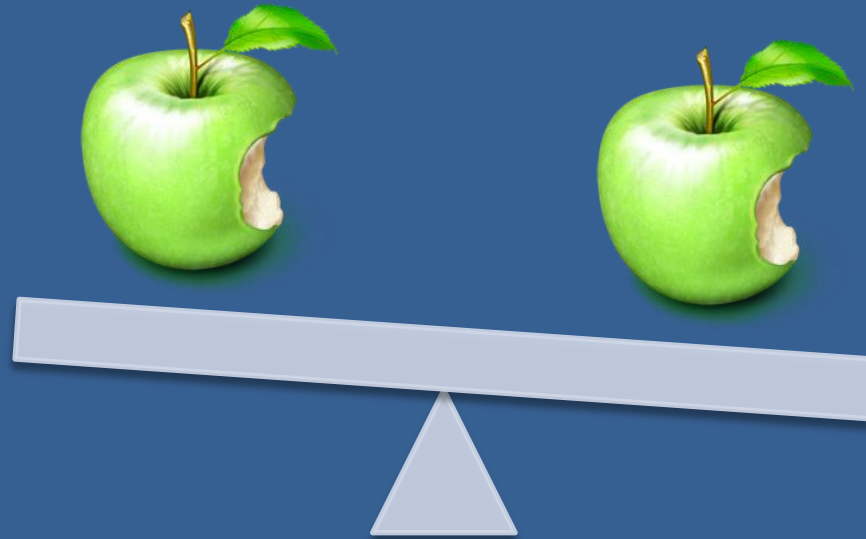
...but primarily examine compliance with a norm

# LCA assesses distinct environmental impacts...



...quantitatively,  
transparently and  
reproducible

LCA is designed to compare products, processes or services...



# „Attributional or „consequential“ LCA...

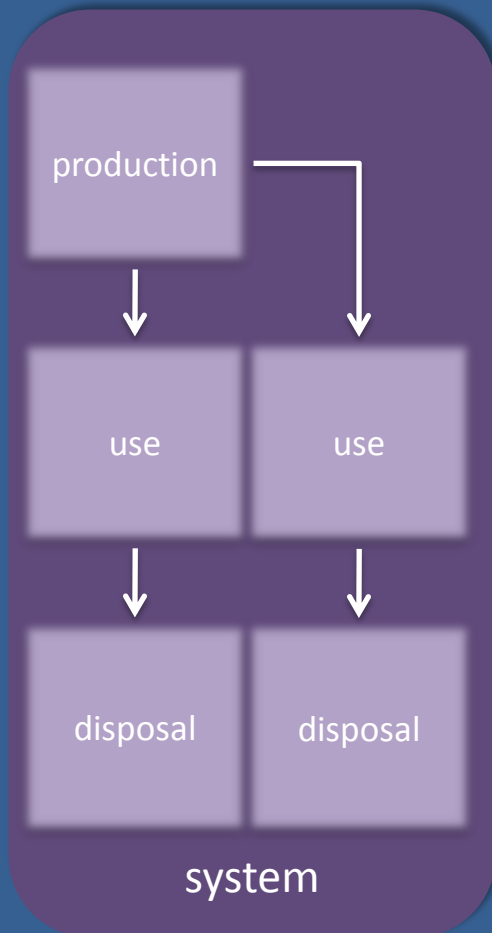
„attributional“ LCA	„consequential“ LCA
Assessment, evaluation and comparison of absolute environmental impacts	Assessment and evaluation of marginal changes of environmental impacts

...which one to choose?

If you want to account impacts...



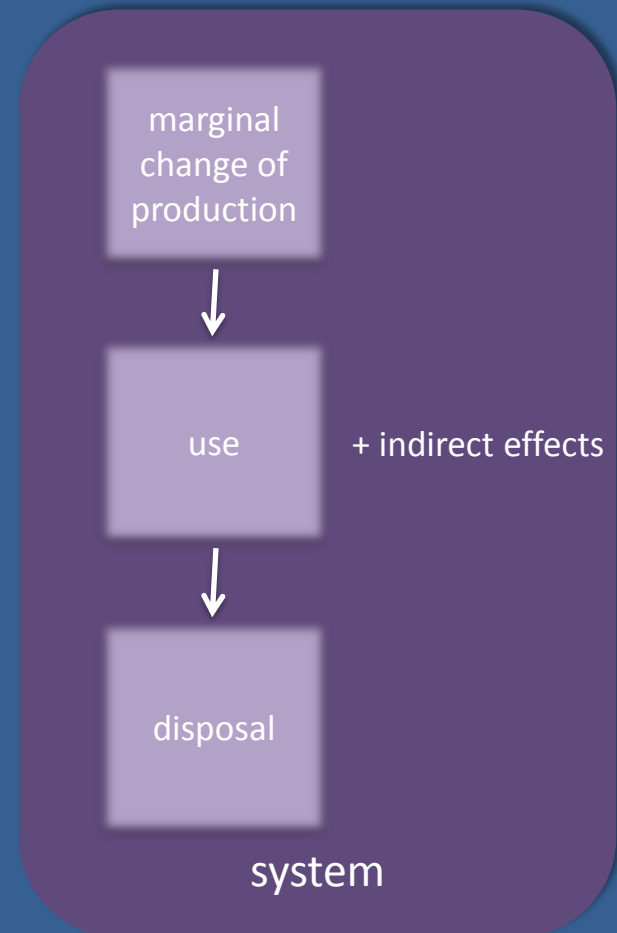
„attributional LCA“



If you want to assess impacts of a change...

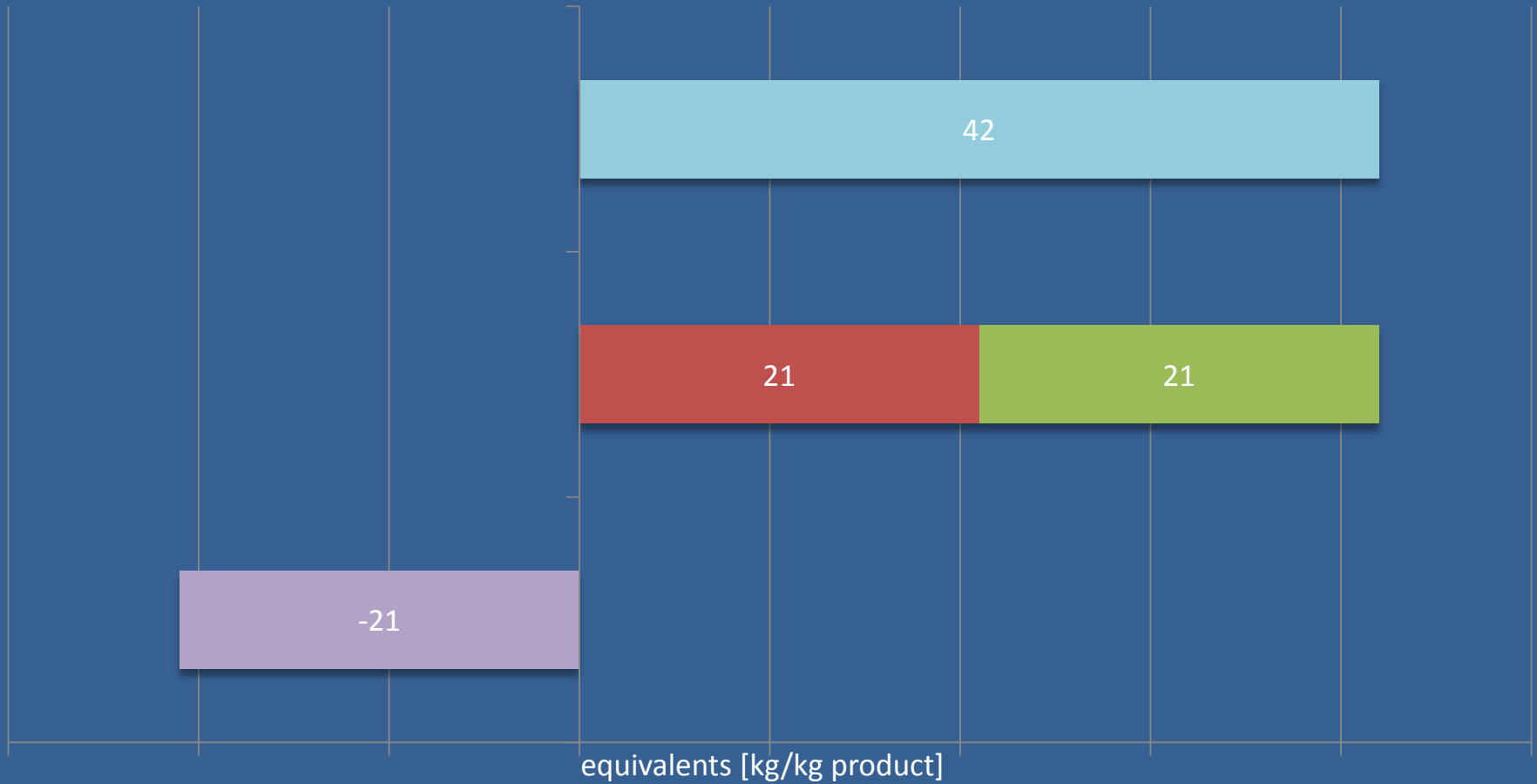


„consequential LCA“



# ...however, the results are incomparable

Simplified LCIA results for product B applying an attributional or consequential approach



■ Marginal Product A

■ Product B

■ Co-product C

■ Product B's credit for substitution of A by C



Hence, you must not mix absolute and relative values...

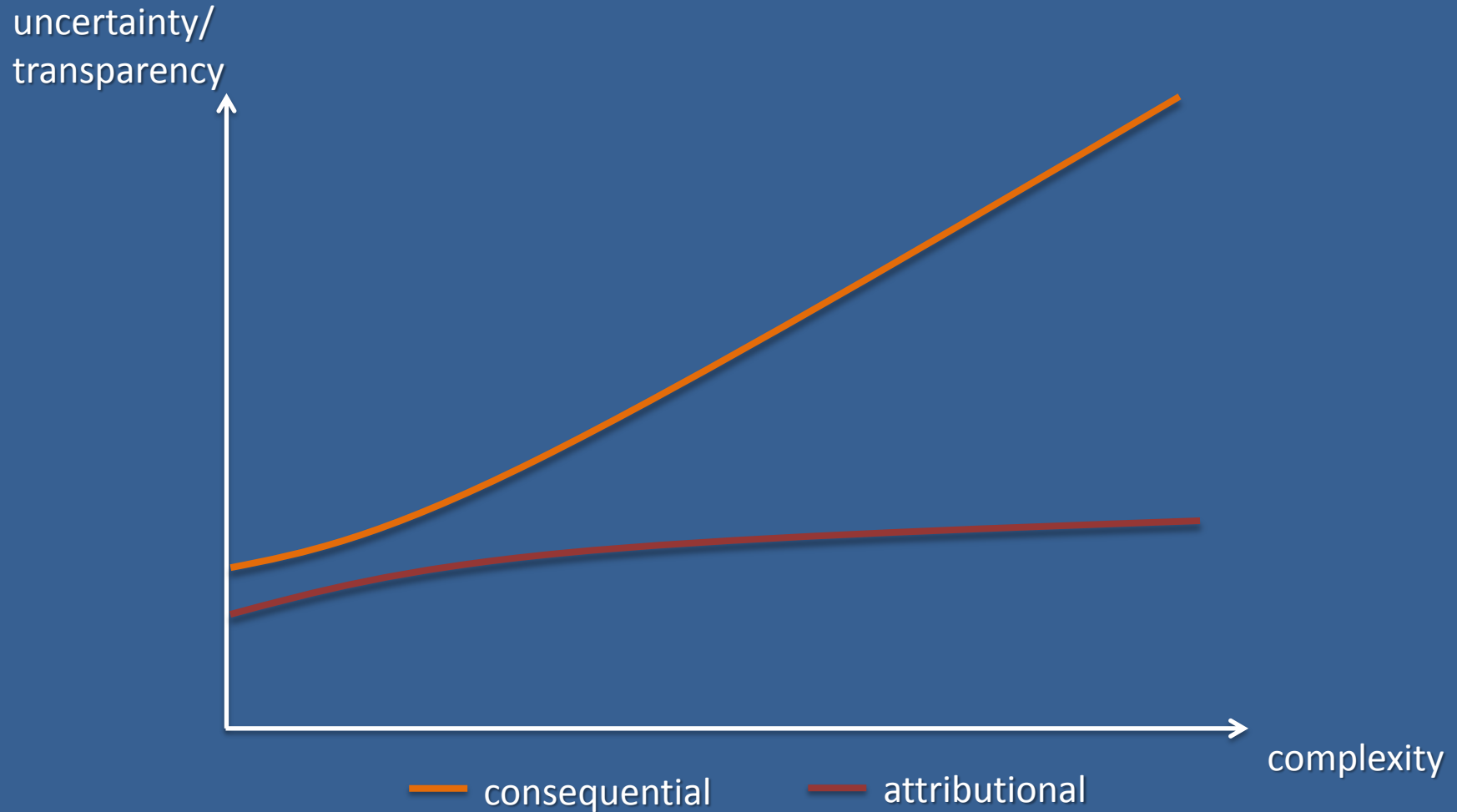
$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$$

absolute values

relative value

...to gain the total environmental impact

# „Attributional or „consequential“ LCA...



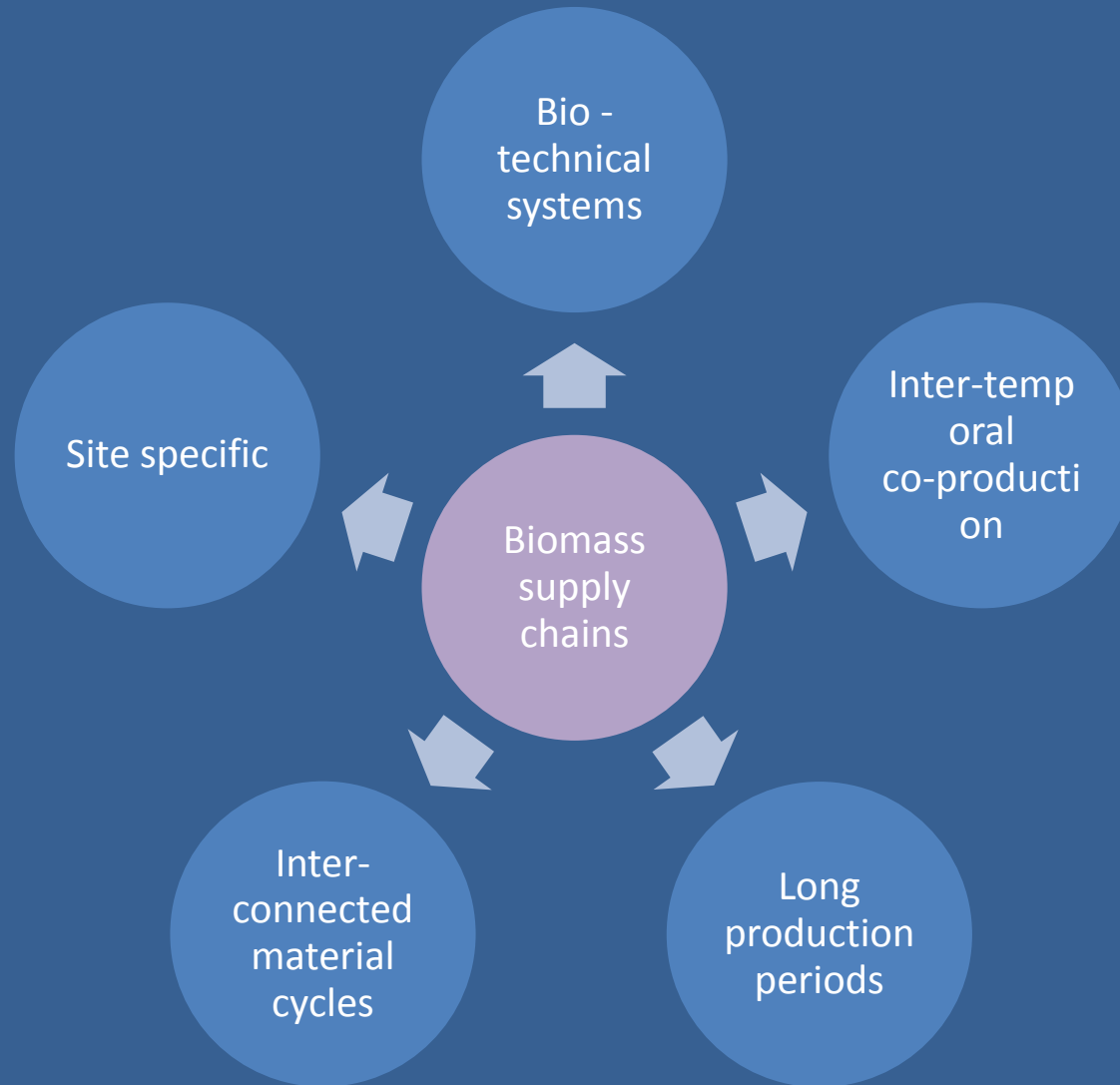
...a choice between the devil and the deep blue sea?

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graph LR; LCA[LCA] --> Biomass[Biomass Supply Chains];
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LCA

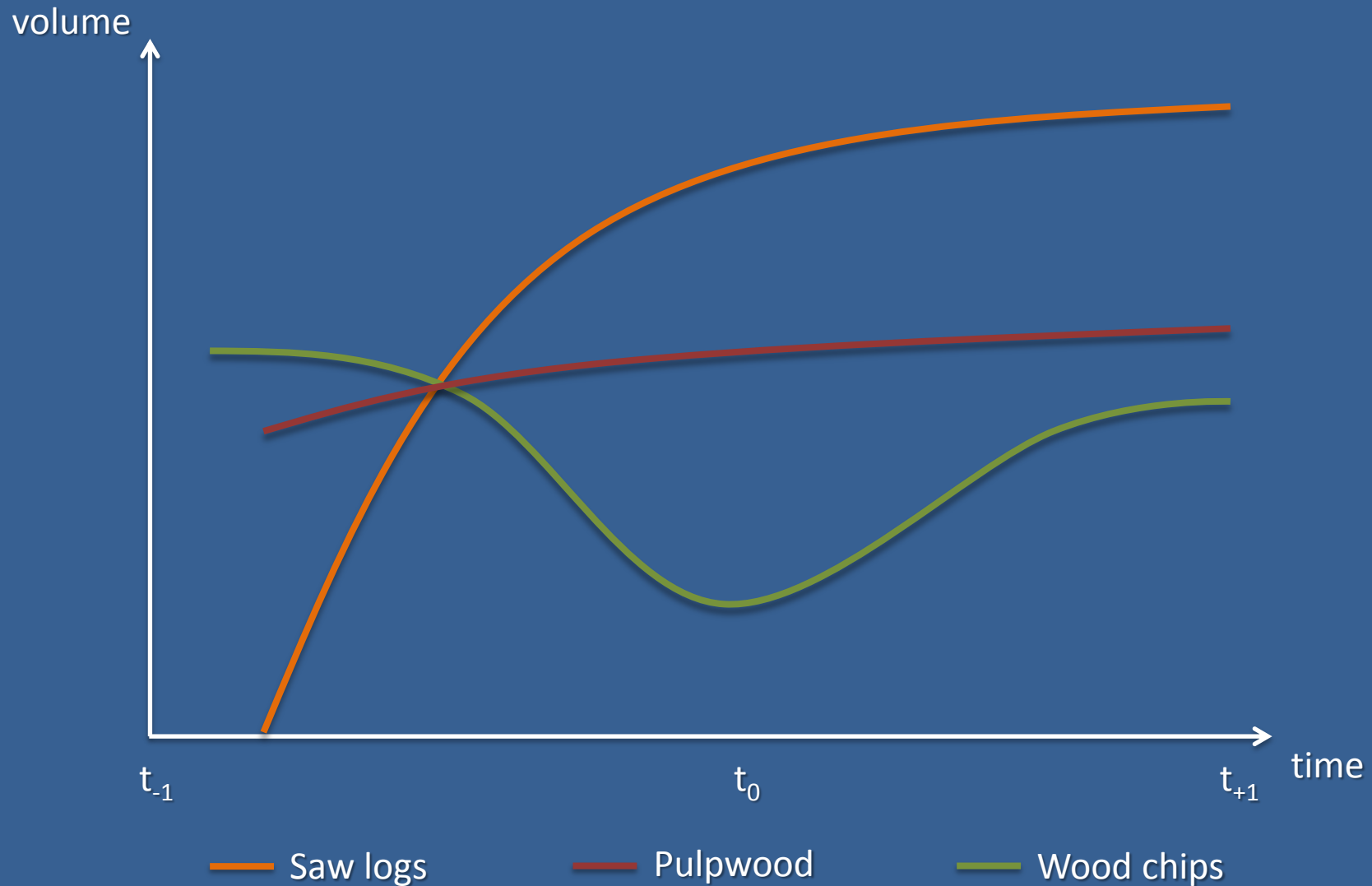
Biomass  
Supply  
Chains

# LCA and biomass supply chains...

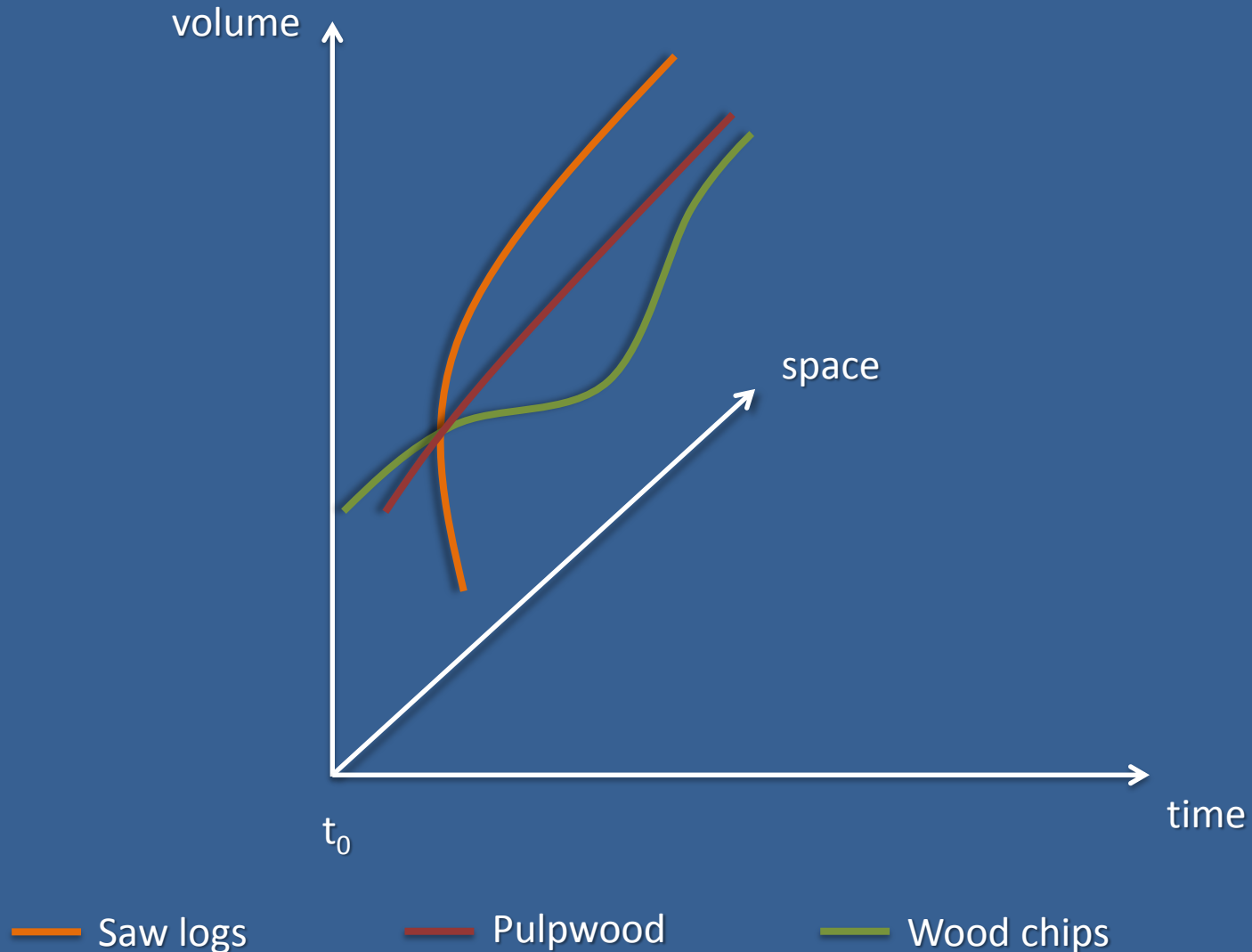


...not the usual story

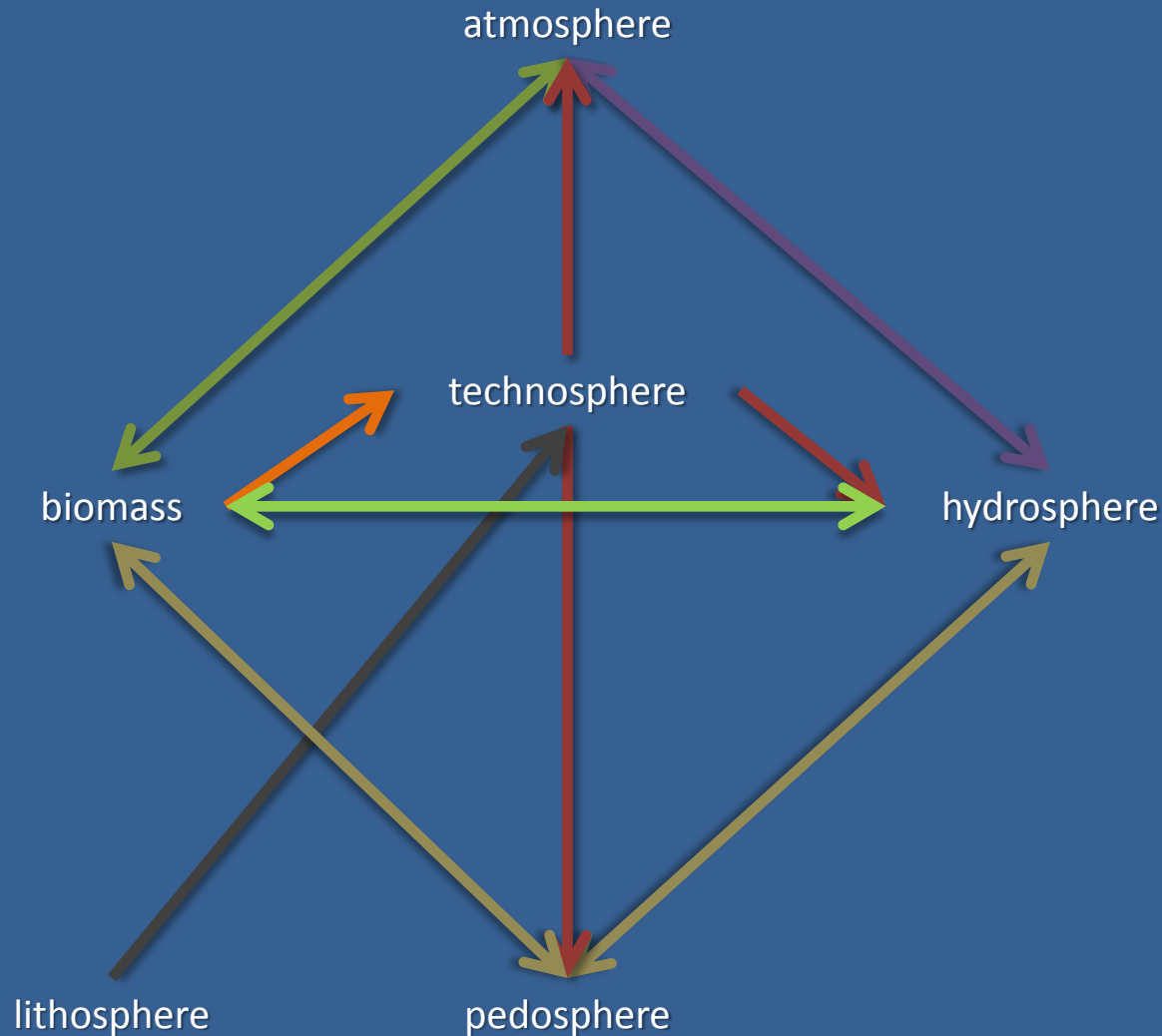
# First challenge: Long production periods and inter-temporal co-production of biomass...



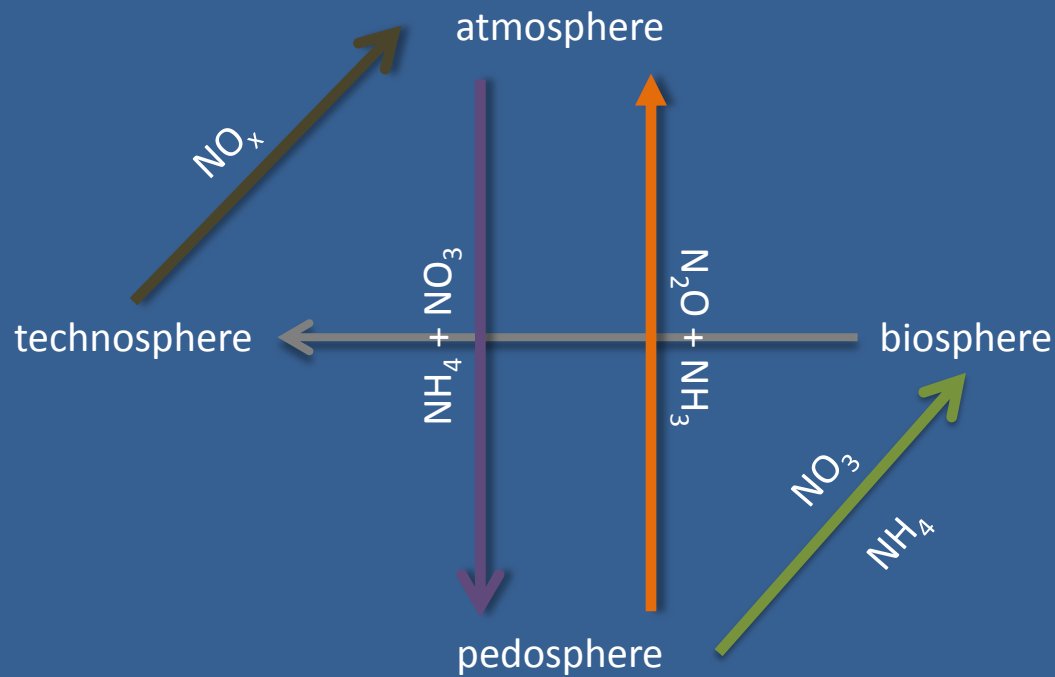
# One Solution: Conversion of temporal step-by-step into spatial side-by-side...



# Second challenge: interconnected (feedback) material and energy cycles...



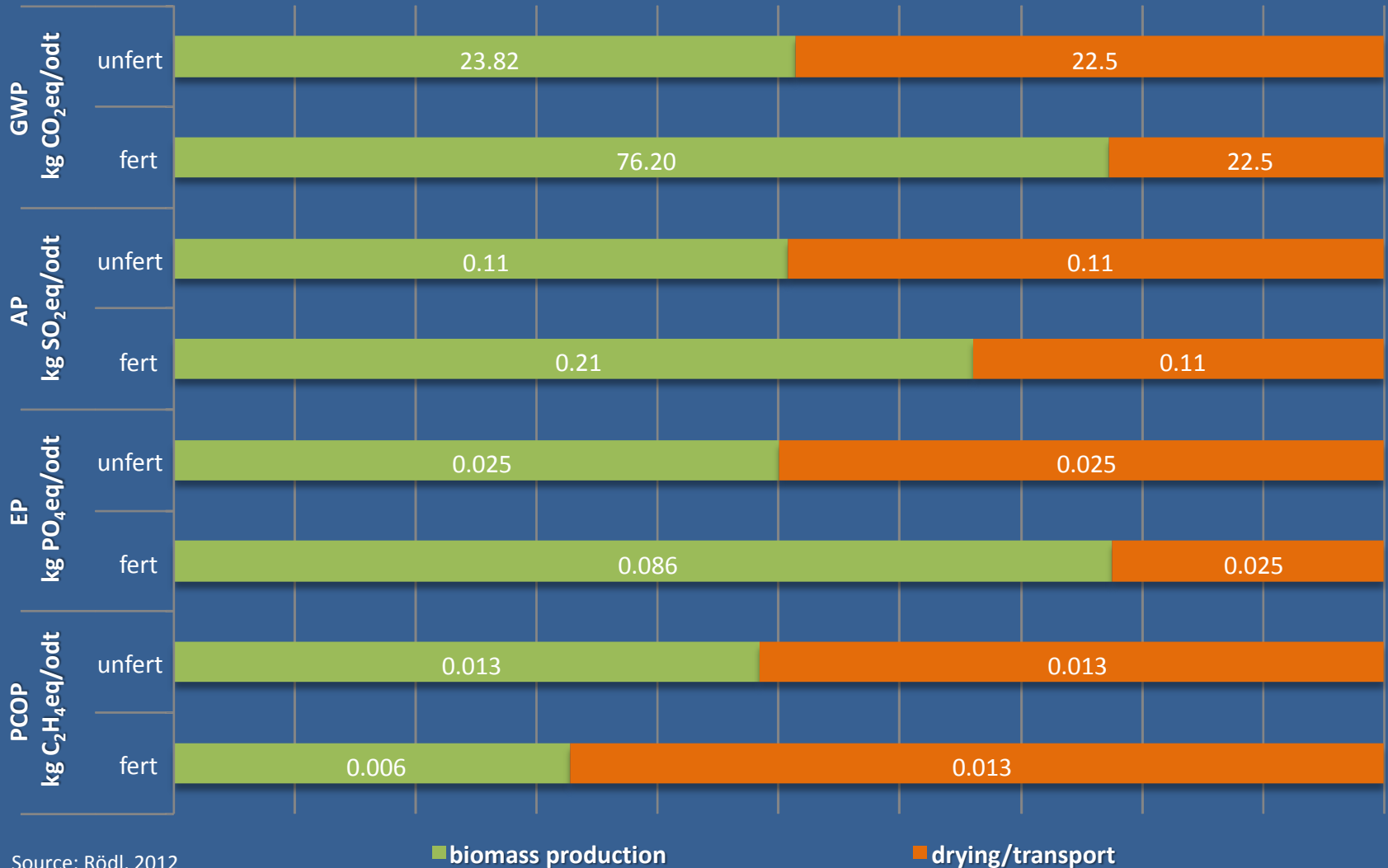
# The nitrogen (feedback) cycle: $\text{NO}_x$ , $\text{N}_2\text{O}$ , $\text{NO}_3$ , $\text{NH}_4$ , $\text{NH}_3$ ...



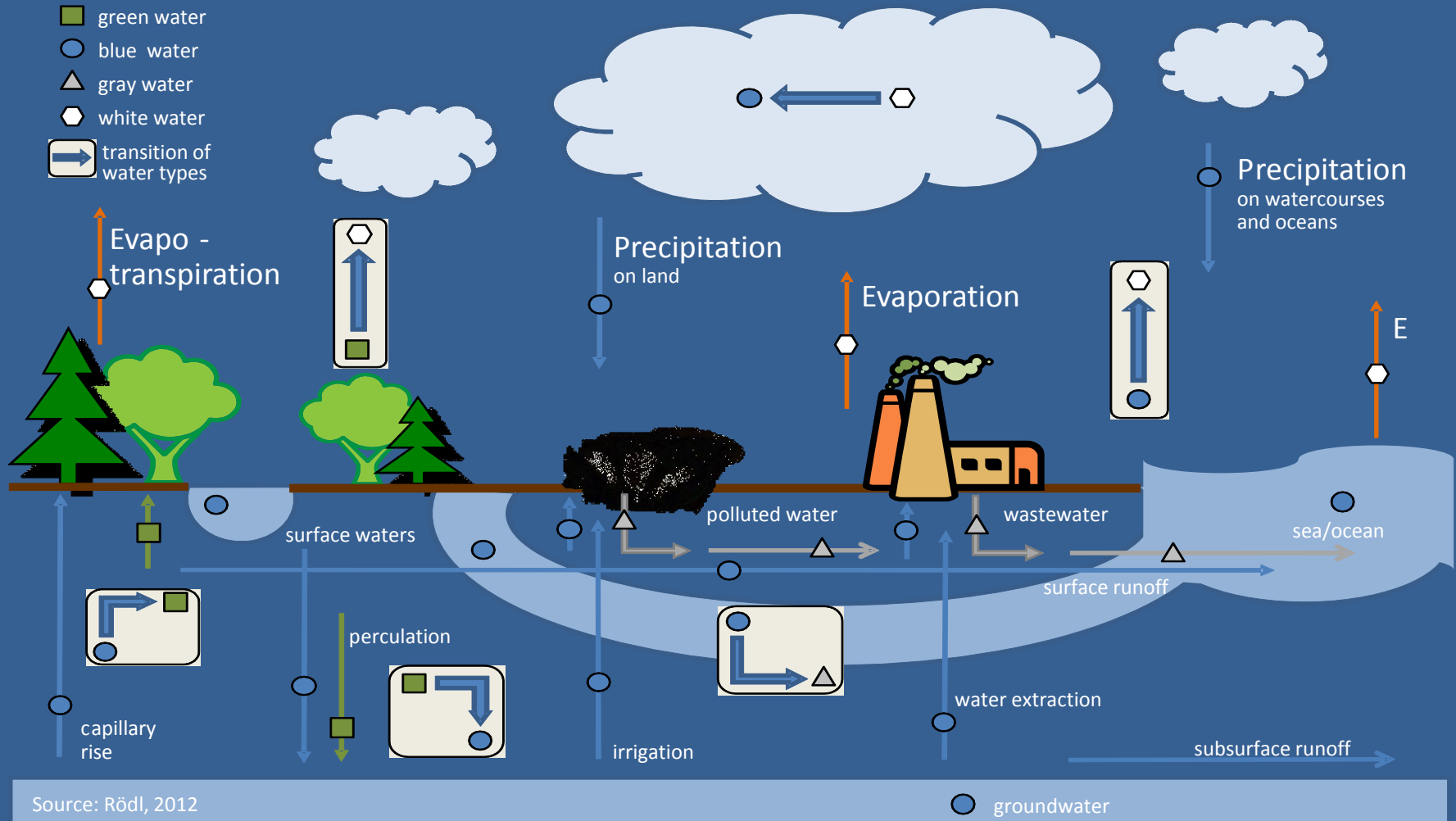


# The nitrogen (feedback) cycle in LCA terms:

Impacts of biomass production, drying and transport in unfertilized (unfert.) and fertilized (fert.) short rotation coppice per oven dry ton (odt) of biomass



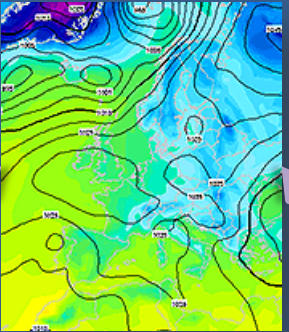
# The water footprint might be too simple for reality...



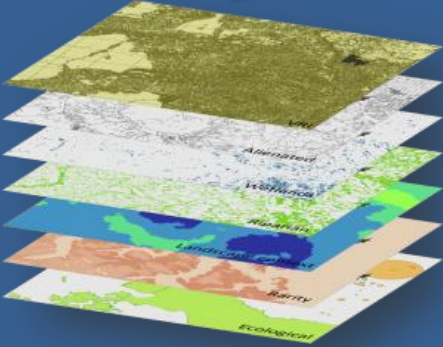
... but an all-in-one assessment is still hard to achieve

# An alternative approach might do the job...

Meteorological model



Gmbh.wetteronline.de



essa.com

Land cover model



swat.tamu.edu

Soil and water assessment tool



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graph LR; A[LCA] --> B[Decision-making]
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LCA

Decision-  
making

Do I use the right instrument to support a decision?

- do not mix attributional and consequential LCA
- be aware of the uncertainty and poor transparency intrinsic to consequential LCA
- be aware that attributional LCA cannot assess impacts of a policy

# What are the challenges and limitations assessing biomass supply chains?

- LCA is able to assess major environmental impacts of biomass supply chains
- LCA still has limitations when assessing complex impacts on land use, biodiversity, water
- decision makers should be aware of these limitations and look for alternative sources of information before taking decisions



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