



# Why discount nature differently?

## Relative price increase for nature and ecosystem services in CBA

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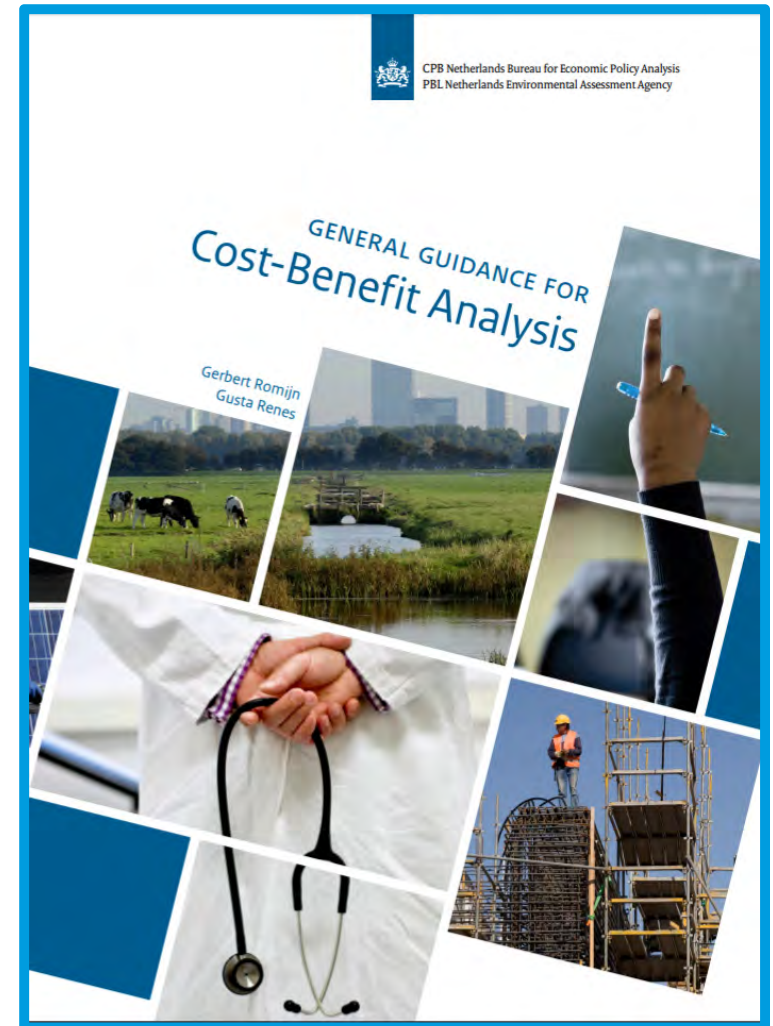
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# Background (1)

## General Cost-Benefit Analysis guideline

Supplemented by sectoral guidelines on

- Environment
- Social security, housing and health
- Nature
- Energy
- Infrastructure, spatial planning and transport





## Background (2)

Advice of the 'Discount rate working group' to the government:

*For the discounting of nature, the working group recommends using the **standard discount rate**, while allowing for an **annual 1% price increase for nature**. This results in an effective discount rate of 2%.*

*Nevertheless, nature should be discounted at the standard rate and without applying price rises, if it can be demonstrated that the features of nature in question are **substitutable**.*





## Questions

- Is the decision to adopt a relative price increase of 1% for nature justifiable for the Dutch situation?
- Are there situations for which we should deviated from the 1% price increase?

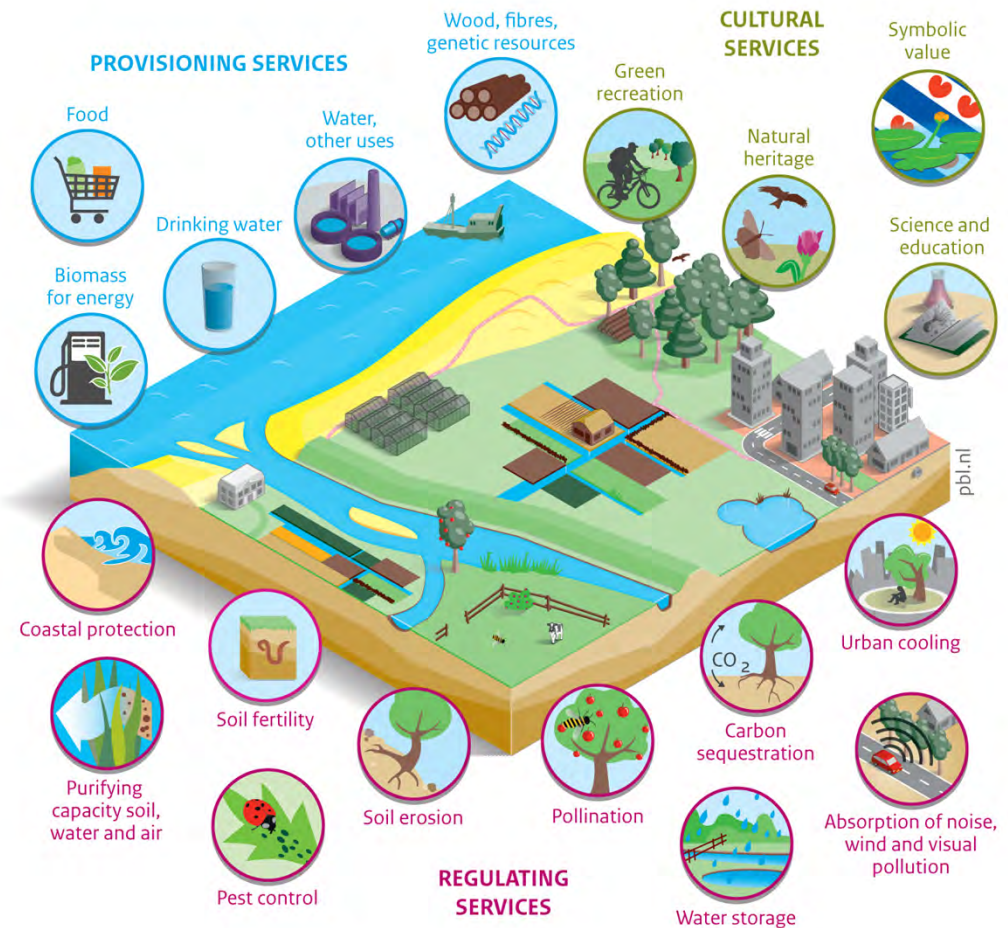




# Conceptual framework (1)

## Nature

- Flow of ecosystem services
- Stock of biodiversity

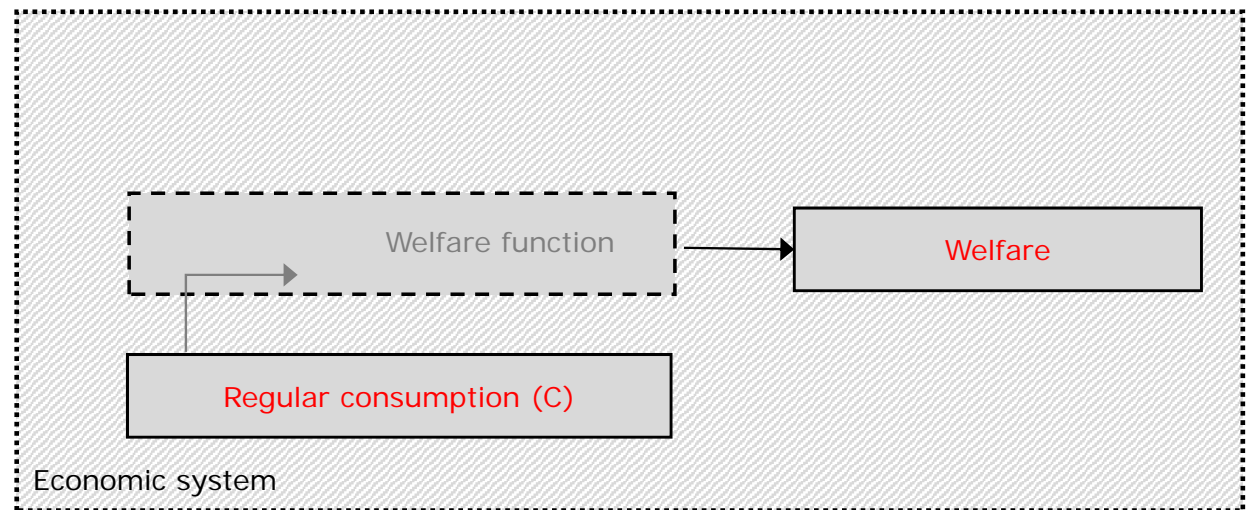




# Conceptual framework (2)

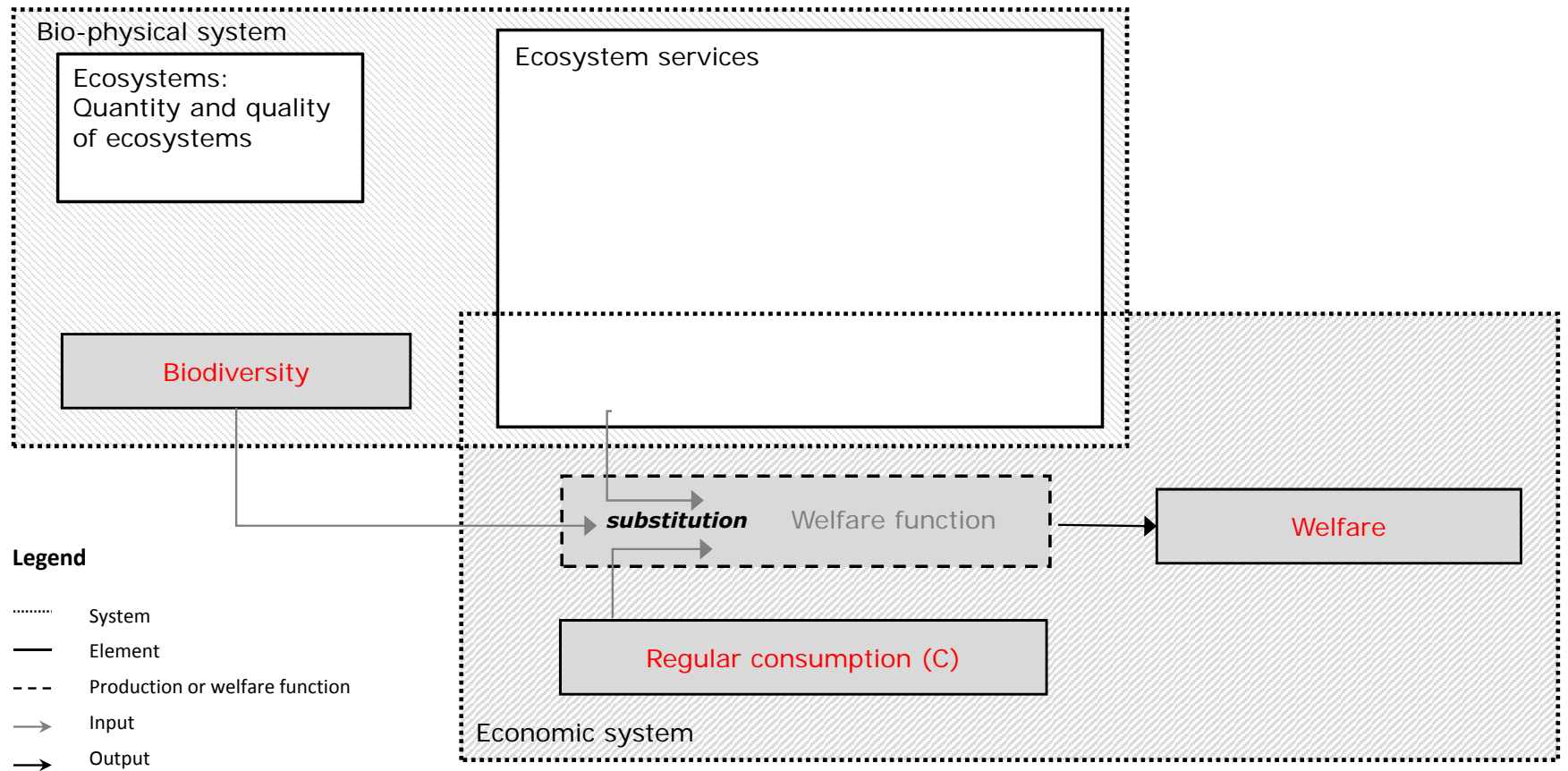
## Legend

- ..... System
- Element
- - - Production or welfare function
- Input
- Output



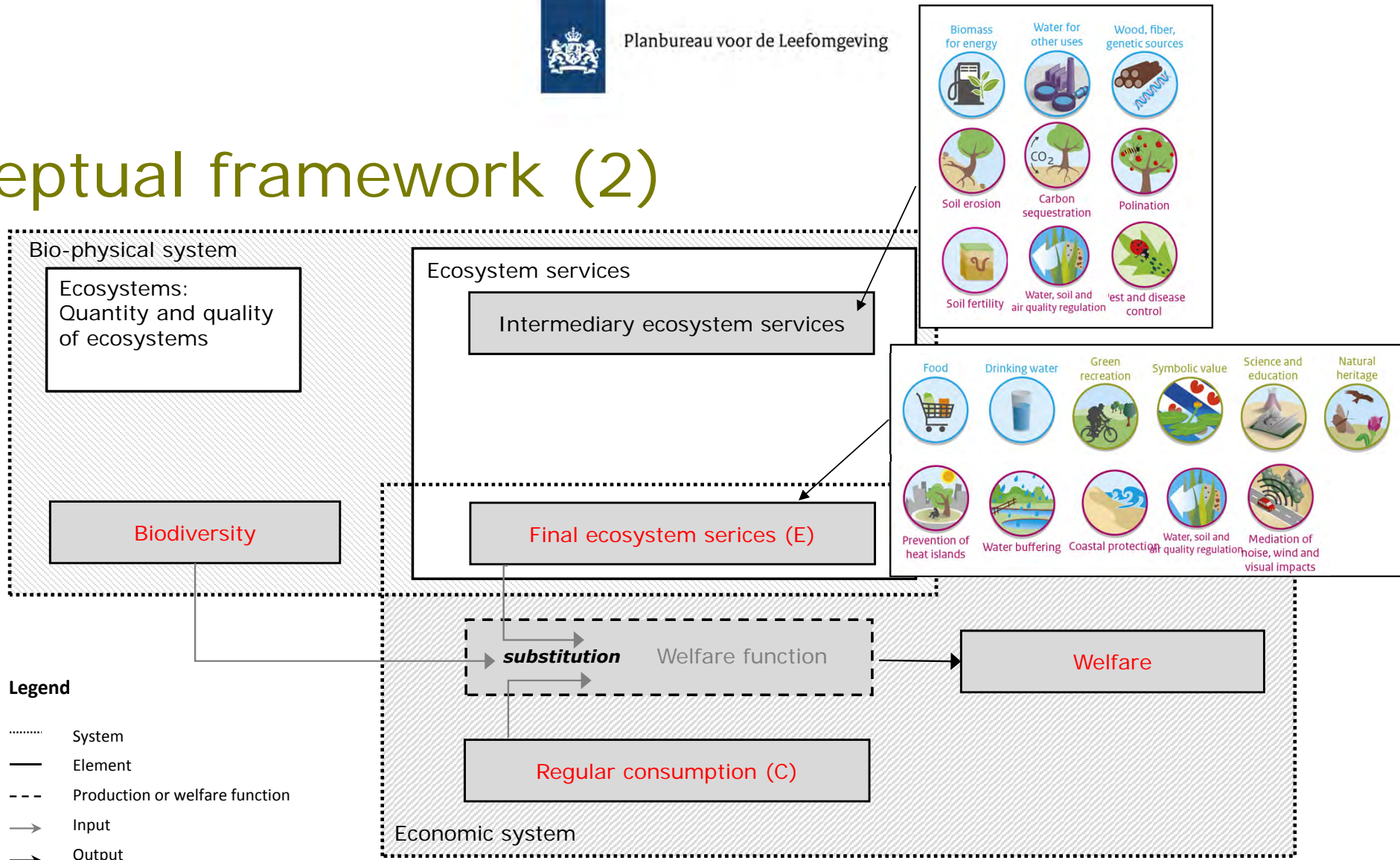


# Conceptual framework (2)





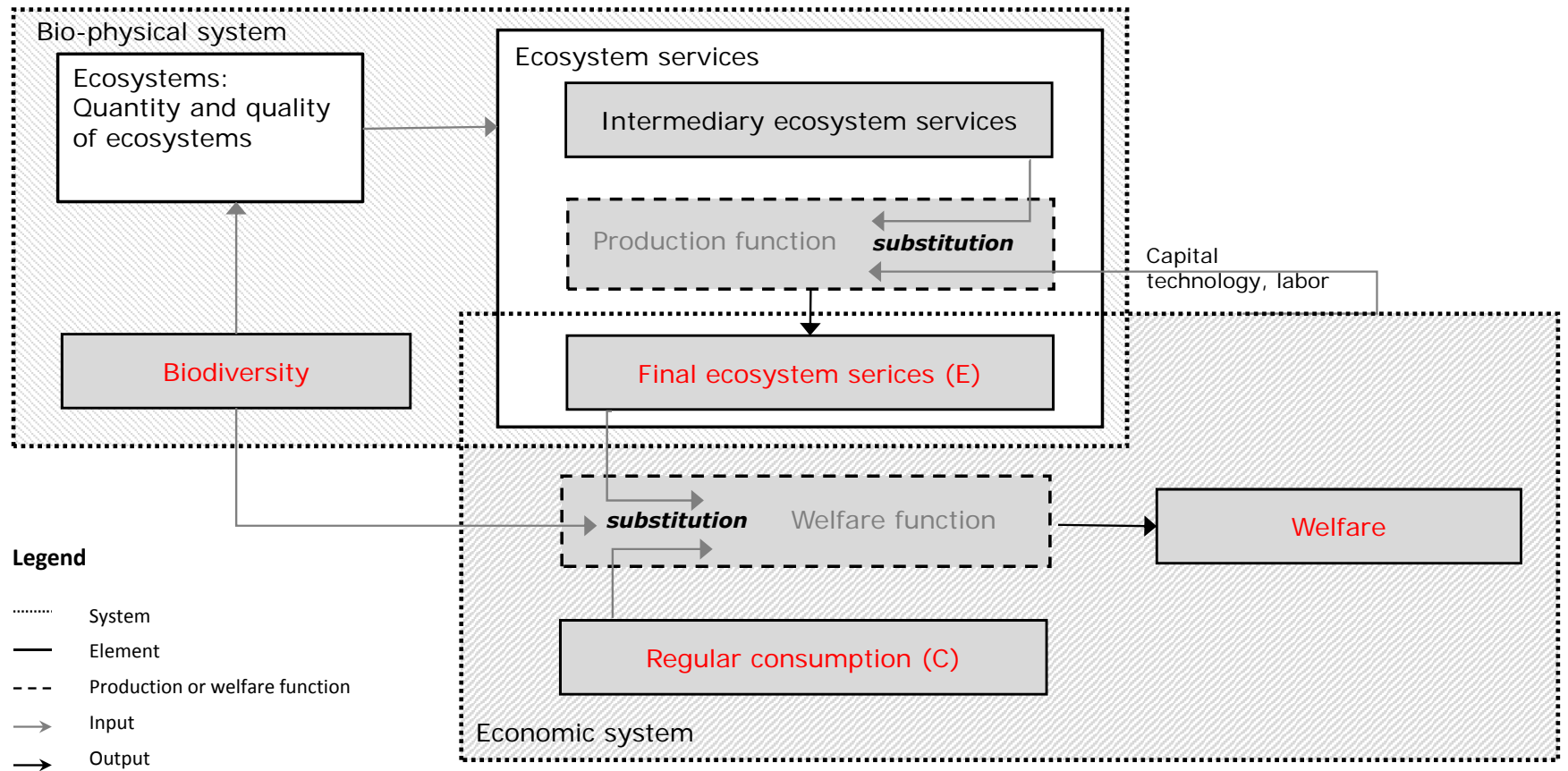
# Conceptual framework (2)







# Conceptual framework (2)





## Analytical framework (1)

Ramsey growth model

$$W = \int_{t=0}^{\infty} U(C_t) e^{-\rho t} dt$$

Ramsey rule

$$r = \rho + \gamma g$$





## Analytical framework (2)

Ramsey growth model

$$W = \int_{t=0}^{\infty} U(C_t, E_t) e^{-\rho t} dt$$

Ramsey rule

$$r_C = \rho + \gamma_{CC}g_C + \gamma_{CE}g_E,$$

$$r_E = \rho + \gamma_{EC}g_C + \gamma_{EE}g_E$$





## Analytical framework (3)

Ramsey rule with a CES utility function:

Difference in growth rates from consumption ( $g_C$ )  
and ecosystem services ( $g_E$ )

$$r_C - r_E = (g_C - g_E) \times \frac{1}{\sigma}$$

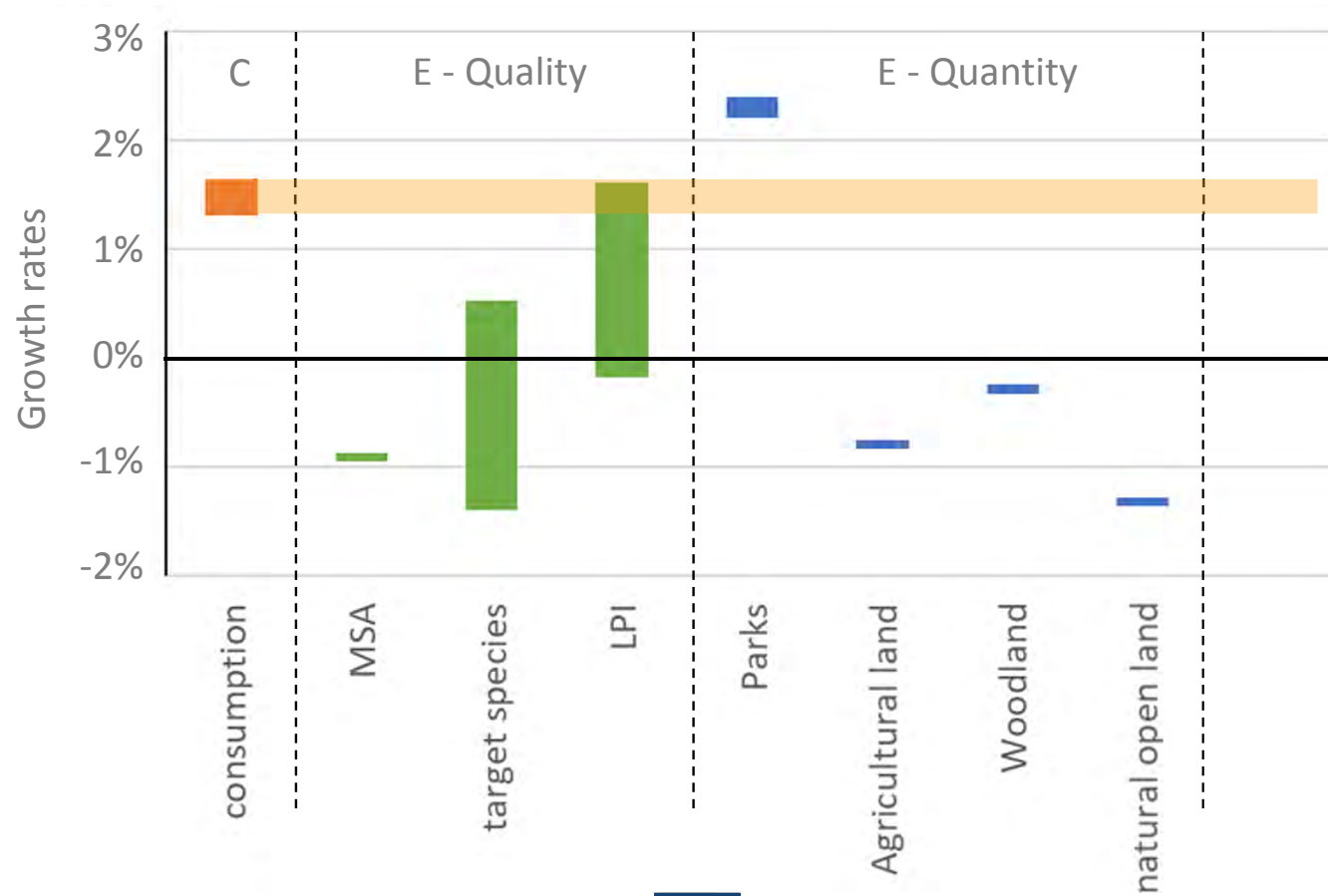
Relative price increase of  
ecosystem services

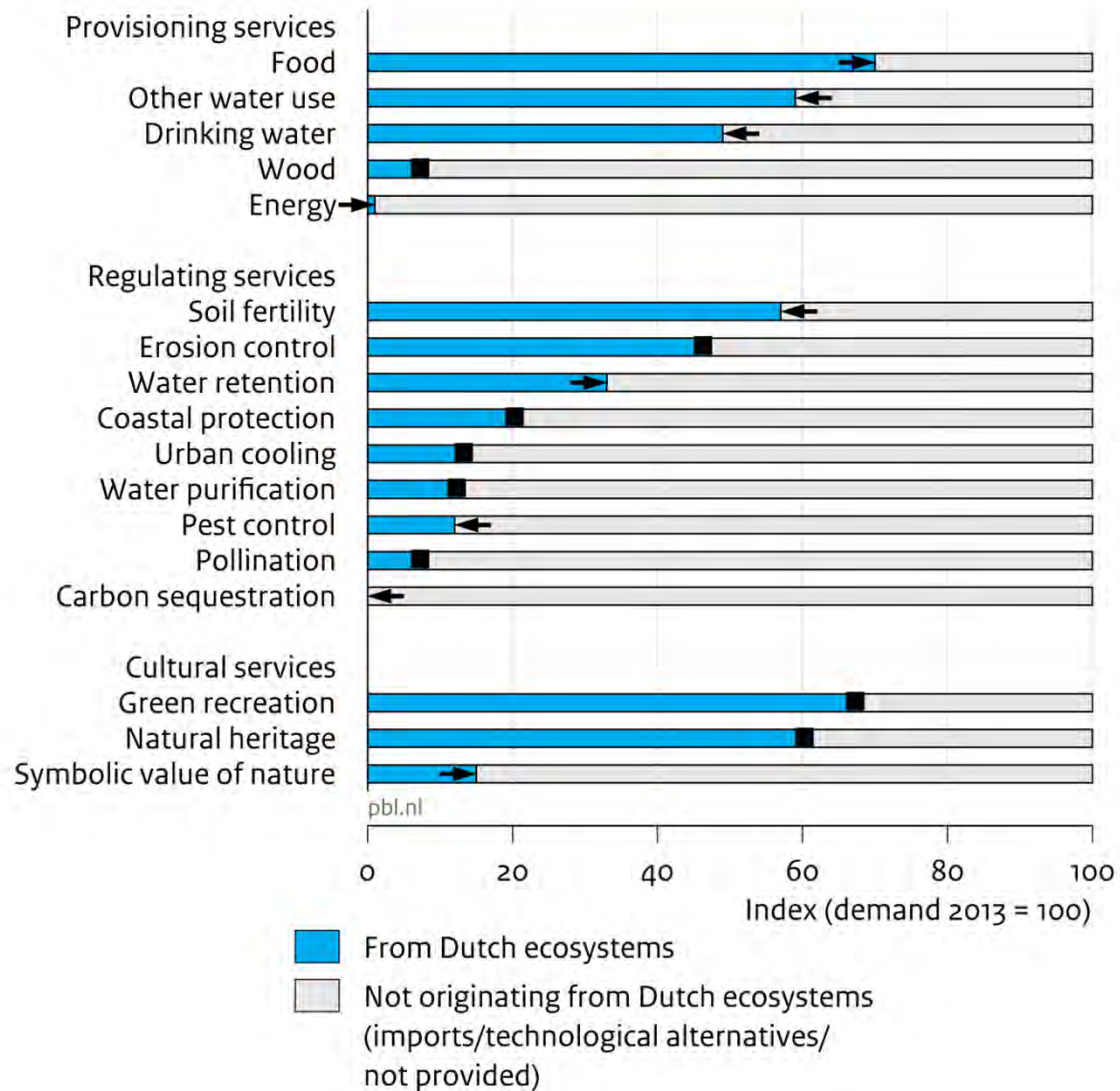
Substitution elasticity between  $C$   
and  $E$  in the utility function





# Differences between growth rates





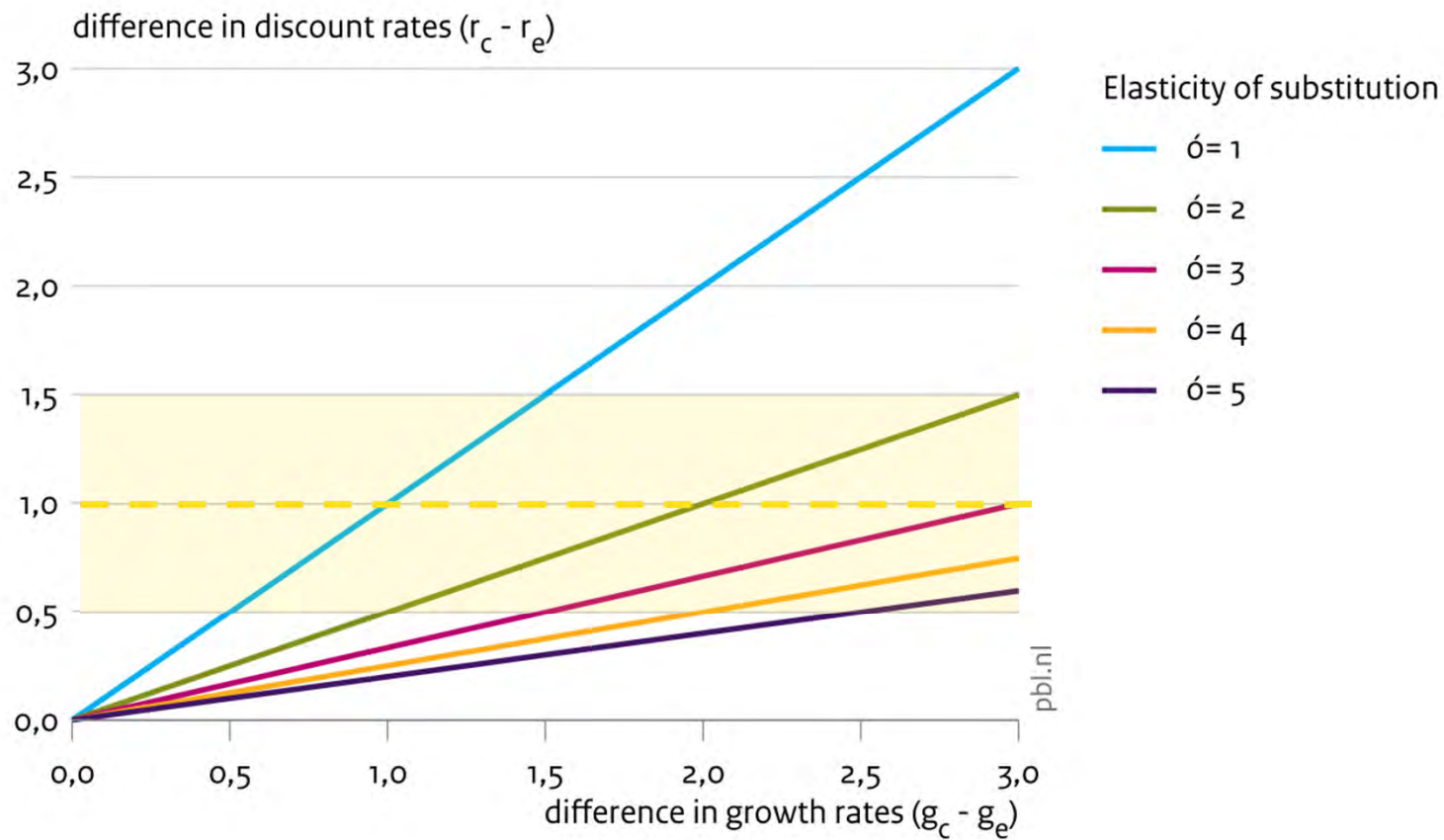


## Substitution elasticities

Ecosystem service	Elasticity of substitution $\sigma$
Air quality improvement	0.86
Landscape amenities	1.11
Biodiversity	1.37
Collective ecosystem services	1.47
Water quality improvement	1.69
Collective marine ecosystem services	2.38
Biodiversity	2.63
Contingent value of predator species	2.70
Air quality improvement	3.13
Collective woodland ecosystem	3.23
Water quality improvement	3.70
Air quality improvement	3.70
Water quality improvement	3.85
Recreation services improvement	4.17
Preservation of wetlands	4.55
Water quality improvement	4.76
Air quality improvement	5.00
Water quality improvement	7.14



# Relative price increase for ecosystem services







# Advice

## General advice

A relative price increase of 1% for ecosystem services that are to a limited extent substitutable and that grow slower than consumption.

Especially

- Outdoor recreation,
- Services affecting local air quality, water purification, cooling, noise,
- Cultural services (aesthetics of nature and landscapes).

Green recreation



Symbolic value



Natural heritage



Mediation of noise, wind and visual impacts



Water, soil and air quality regulation



Prevention of heat islands





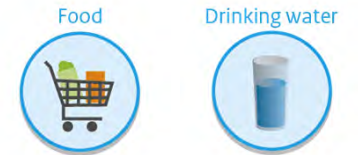
# Advice

## Exception 1

No relative price increase for production services, drinking water and water safety. They are substitutable, not scarce or included in CBA in another way.

## Exception 2

A relative price increase exceeding 1% for services that are hardly substitutable and have a much lower growth rate than consumption. Especially local services in urbanized areas that are becoming very scarce and biodiversity in protected areas.





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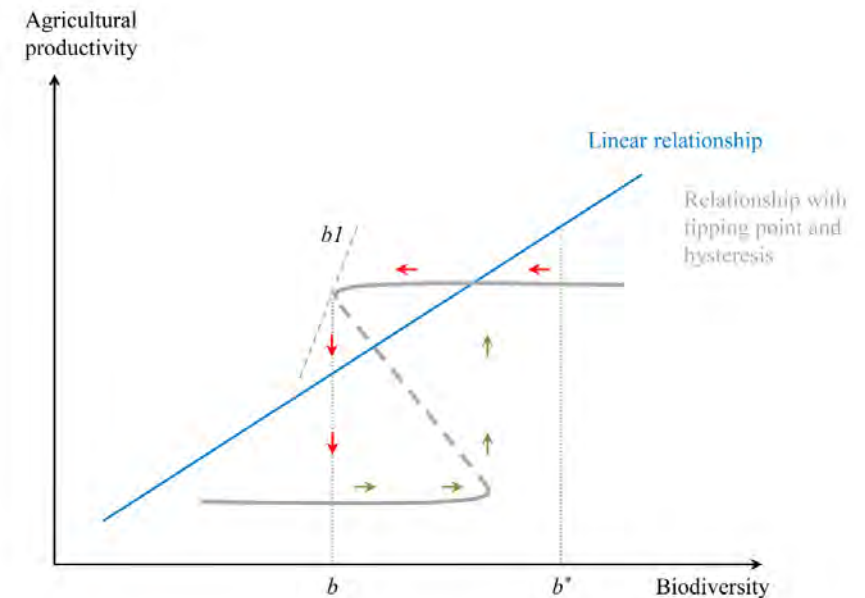
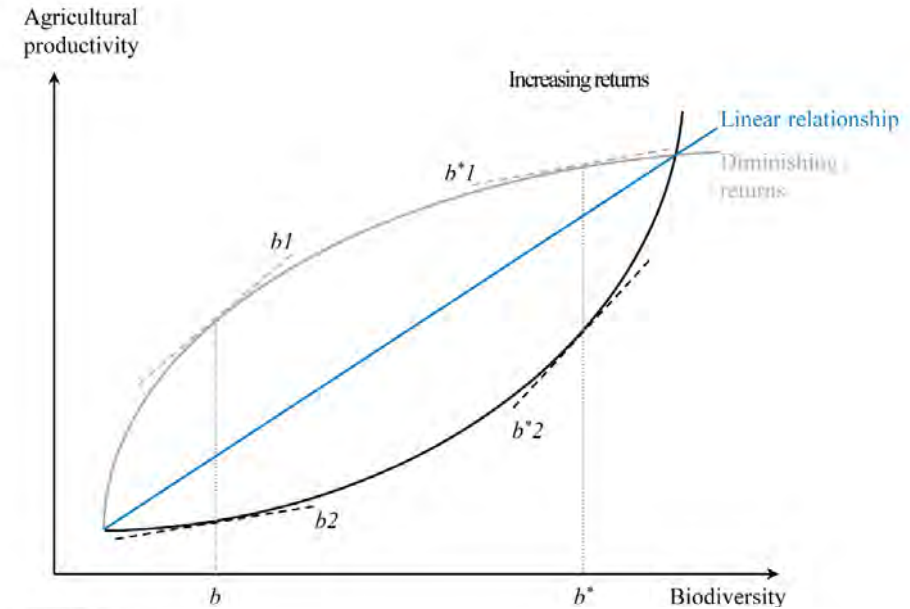
# Extensions

- Substitution in the production function
- Non-linear production functions and hysteresis/tipping points

- $$W = \int_{t=0}^{\infty} U(C_t, E_t^f) e^{-\rho t} dt,$$

$$C_t = h(K_t, L_t, E_t^i),$$

$$E_t^f = h(K_t, L_t, E_t^i),$$





Thank you for your attention

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