



New approaches to assess the impact of land-use and forest management on water-related ecosystem services

Bart MUYS* & Robert MAVSAR**

*Katholieke Universiteit Leuven, Belgium

**EFIMED, Barcelona, Spain



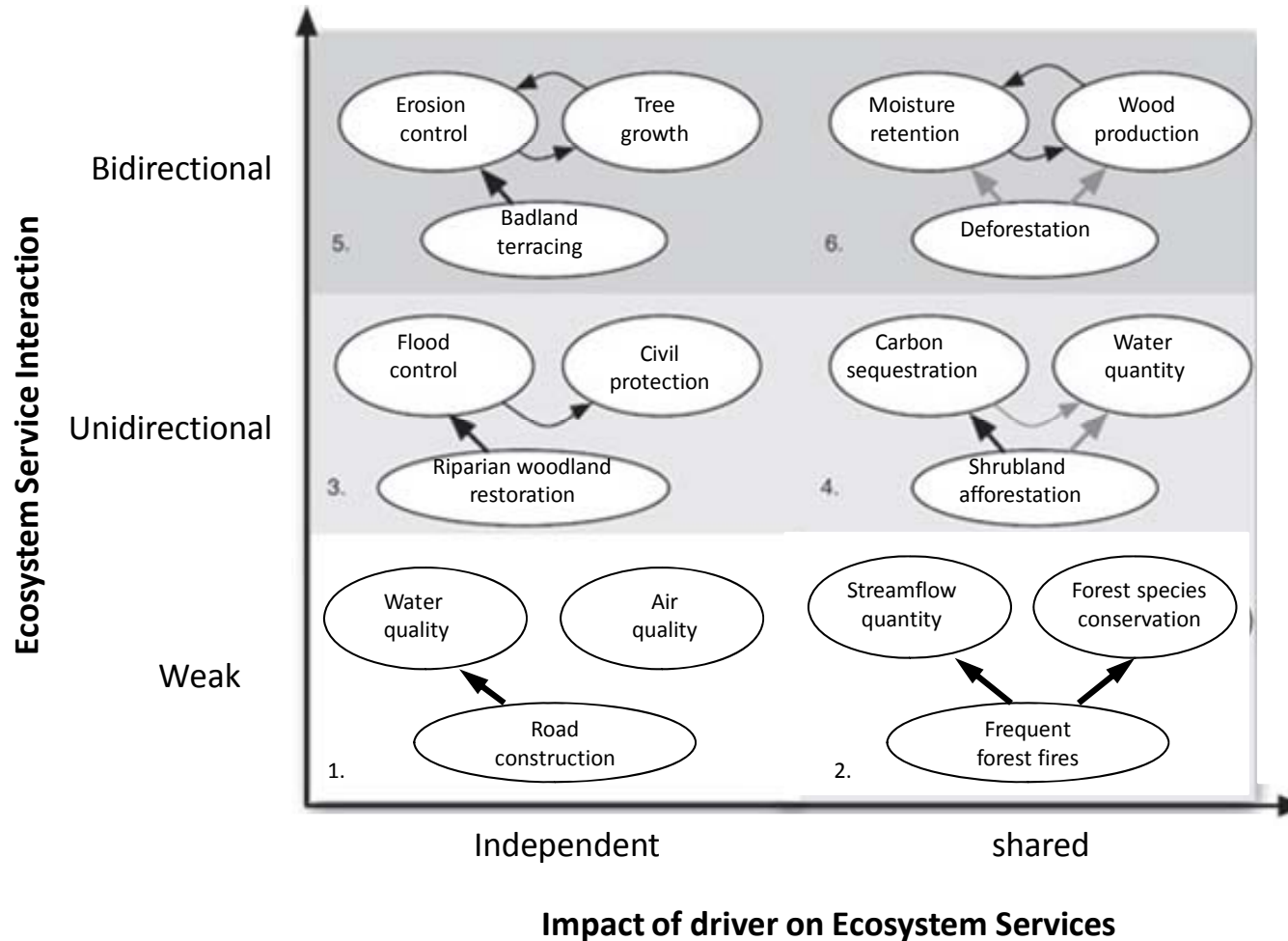
Water-related ecosystem services

Provisioning	Regulating	Cultural
Biomass Food Fibres Genetic resources Biochemicals, natural medicines, pharmaceuticals Freshwater	Air quality regulation Climate regulation Water regulation Erosion regulation Water purification and waste treatment Disease regulation Pest regulation Pollination Natural hazard regulation	Cultural diversity Spiritual and religious values Knowledge systems Educational values Inspiration Aesthetic values Social relations Sense of place Cultural heritage values Recreation and ecotourism
Supporting		
Soil formation, Photosynthesis, Primary production, Nutrient cycling and Water cycling		





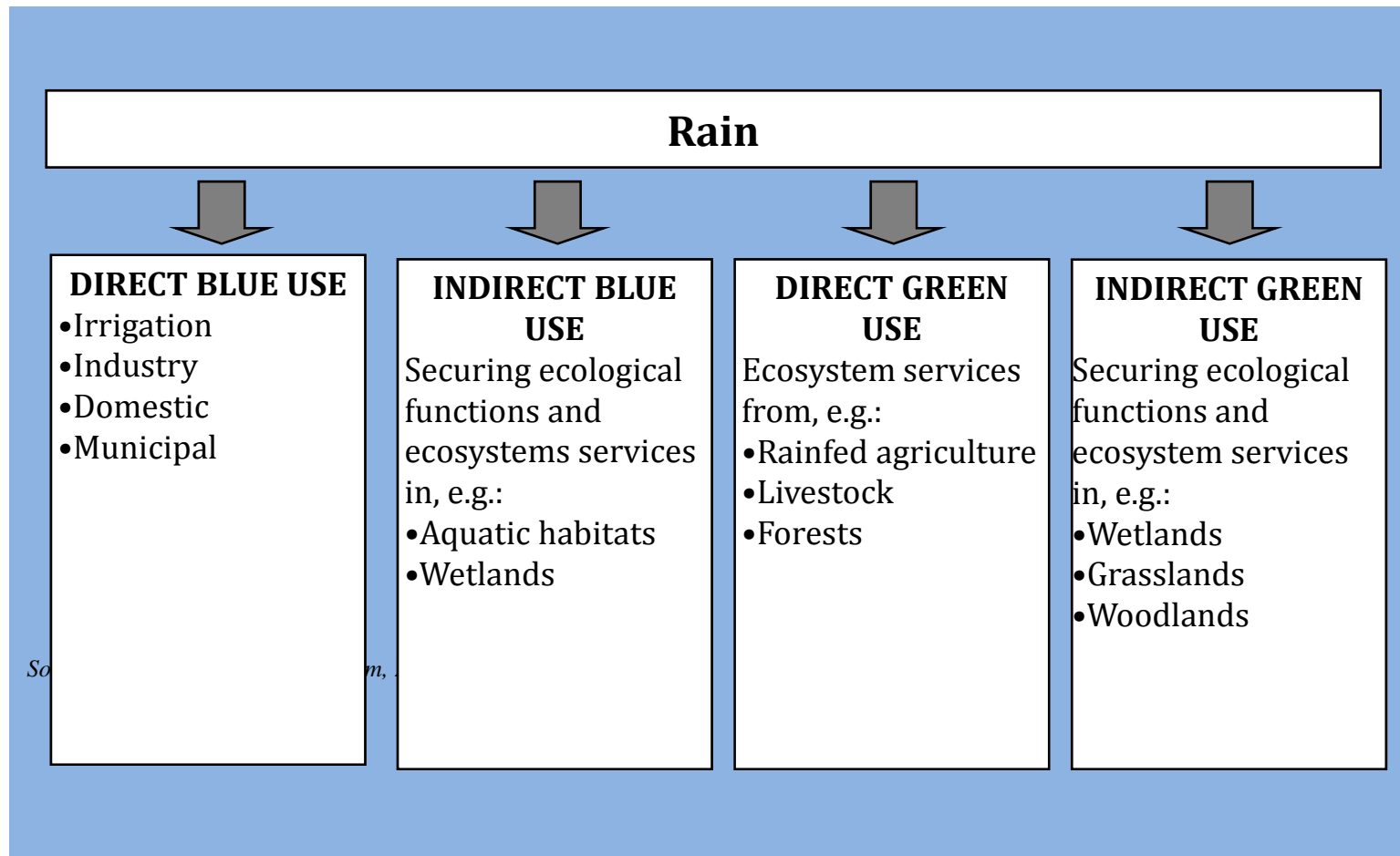
Water-related ecosystem services



The integration of water with other ecosystem services should be based on a better understanding of how ecosystem services interact with each other.



Integrated water use



Blue water and green water are needed to sustain the benefits from the ecosystem services that we need



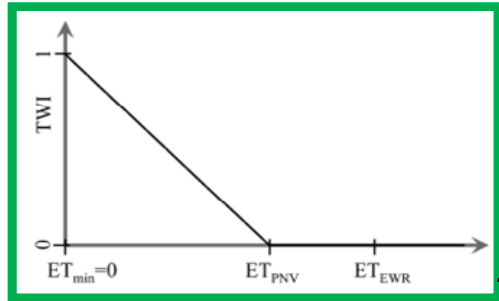
Integrated water use

Rainfall	Blue water (38%)	Available (11%)	Used		Food – irrigated (2%) Domestic and industry use (1%)
			Unused	Time-stable runoff (e.g., rivers) (8%)	
		Unavailable (27%)	Flood runoff (27%)		
	Green water (62%)	Direct (22%)	Food – rainfed (4%)		Permanent grazing (18%)
			Grasslands (11%)		
		Indirect (40%)	Forests and woodlands (17%)		
			Arid lands (5%)		Wetlands (1%)
			Unaccounted greenflow (5%)		

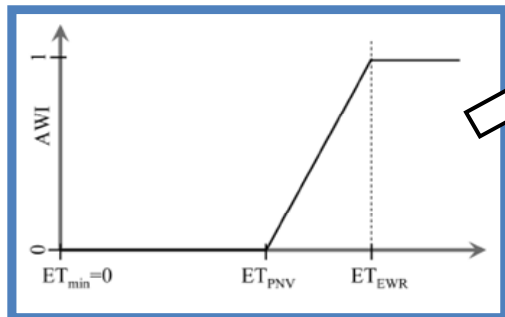
The majority of rainfall is naturally allocated for the provision of ecosystem goods and services



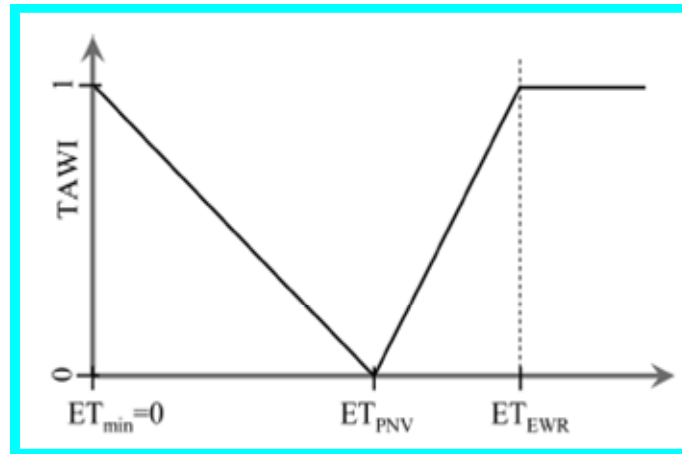
Integrated water use



Terrestrial Water Impact (TWI)



Aquatic Water Impact (AWI)



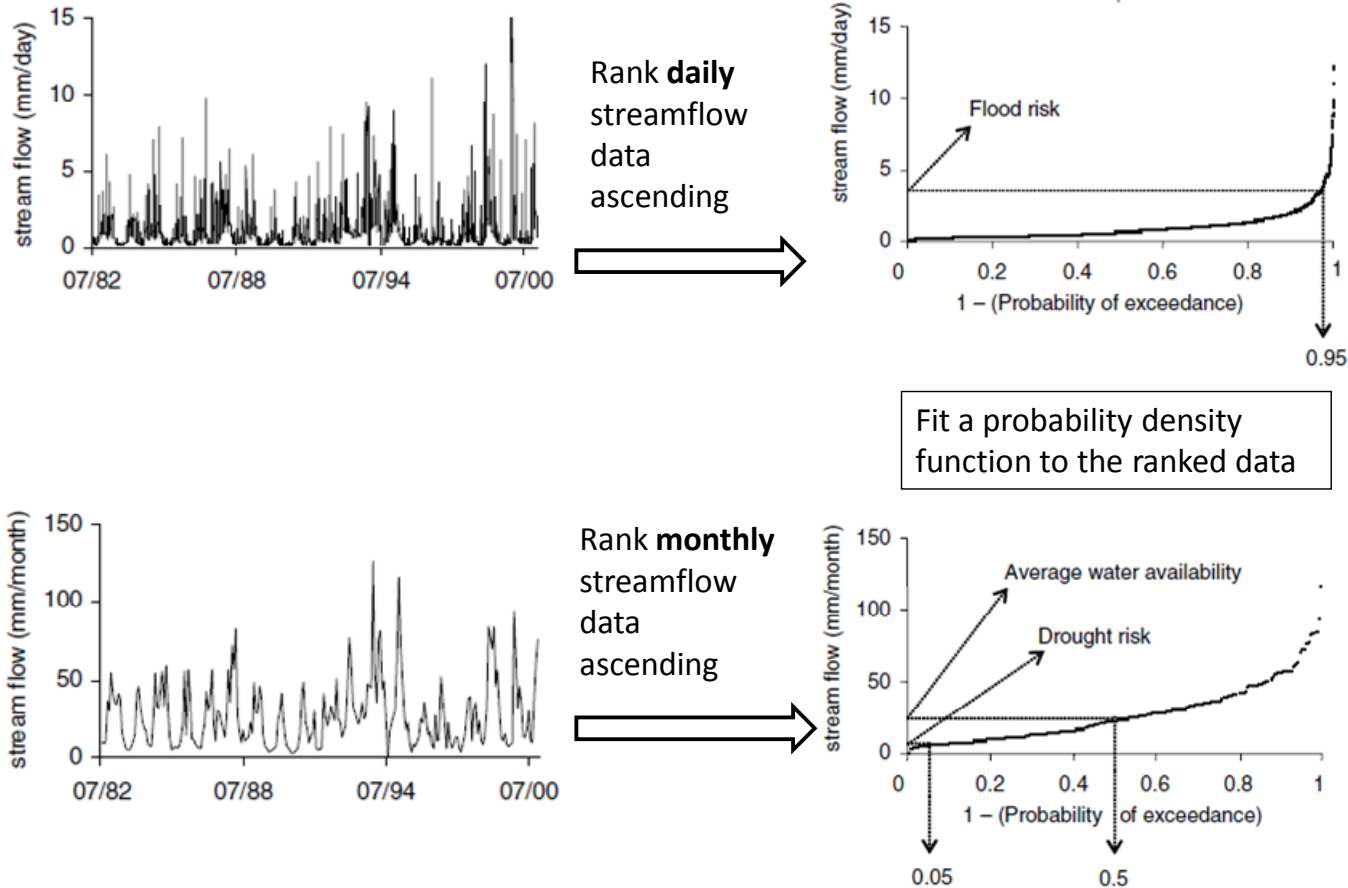
integrated Terrestrial-Aquatic Water Impact (TAWI)

Maes et al. 2009 Env Sci Techn

The challenge of integrating upstream and downstream interests, including terrestrial and aquatic ecosystems, can be met through reconciling the blue and green water paradigm.



Tools for integrated water use



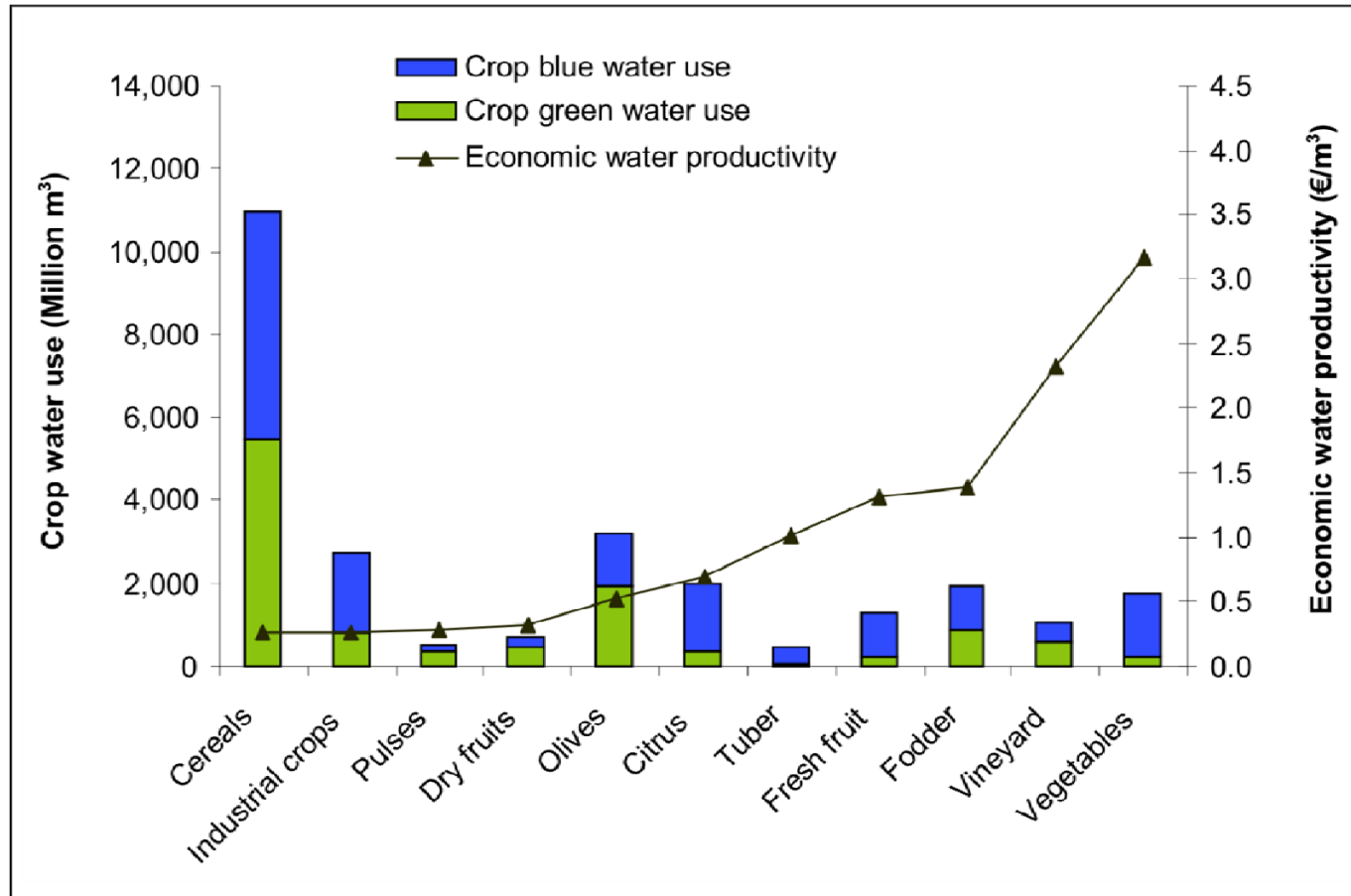
Catchment models run for different land use scenarios

Heuvelmans et al. 2003 Int. J. LCA





Tools for integrated water use



Water footprint calculations of products (example: Garrido et al. 2009)



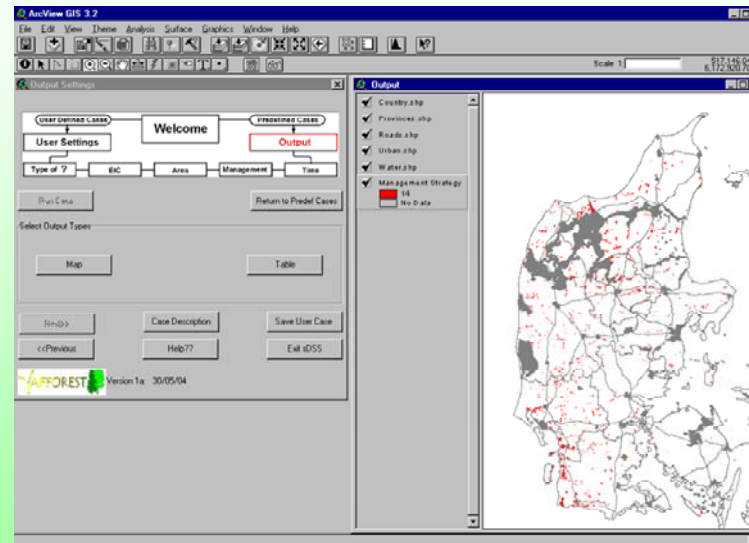


Tools for integrated water use

Example of a complex question solved in AFFOREST sDSS by goal programming optimization

What management strategy must be followed by a Danish municipality on sandy soils to produce a max. of clean drinking water and as a second priority max. C sequestration over the coming 15 years?

'How' question looking for the afforestation strategy meeting the multiple objective with high weight on maximizing water recharge and minimizing nitrate leaching, and with low weight on carbon sequestration.



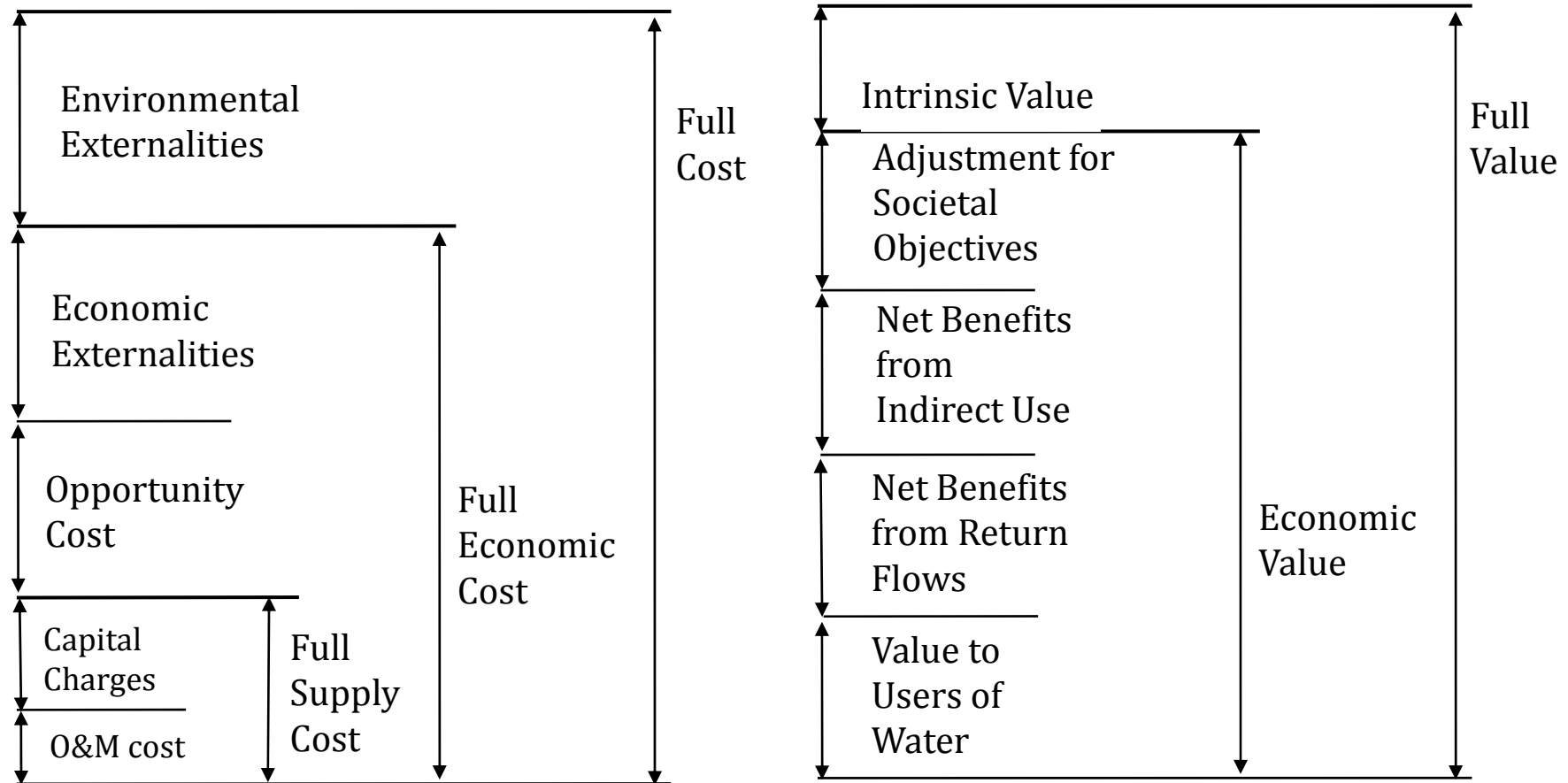
Best strategy = 14: afforestation of beech with moderate management intensity

Multi-objective landscape management tools





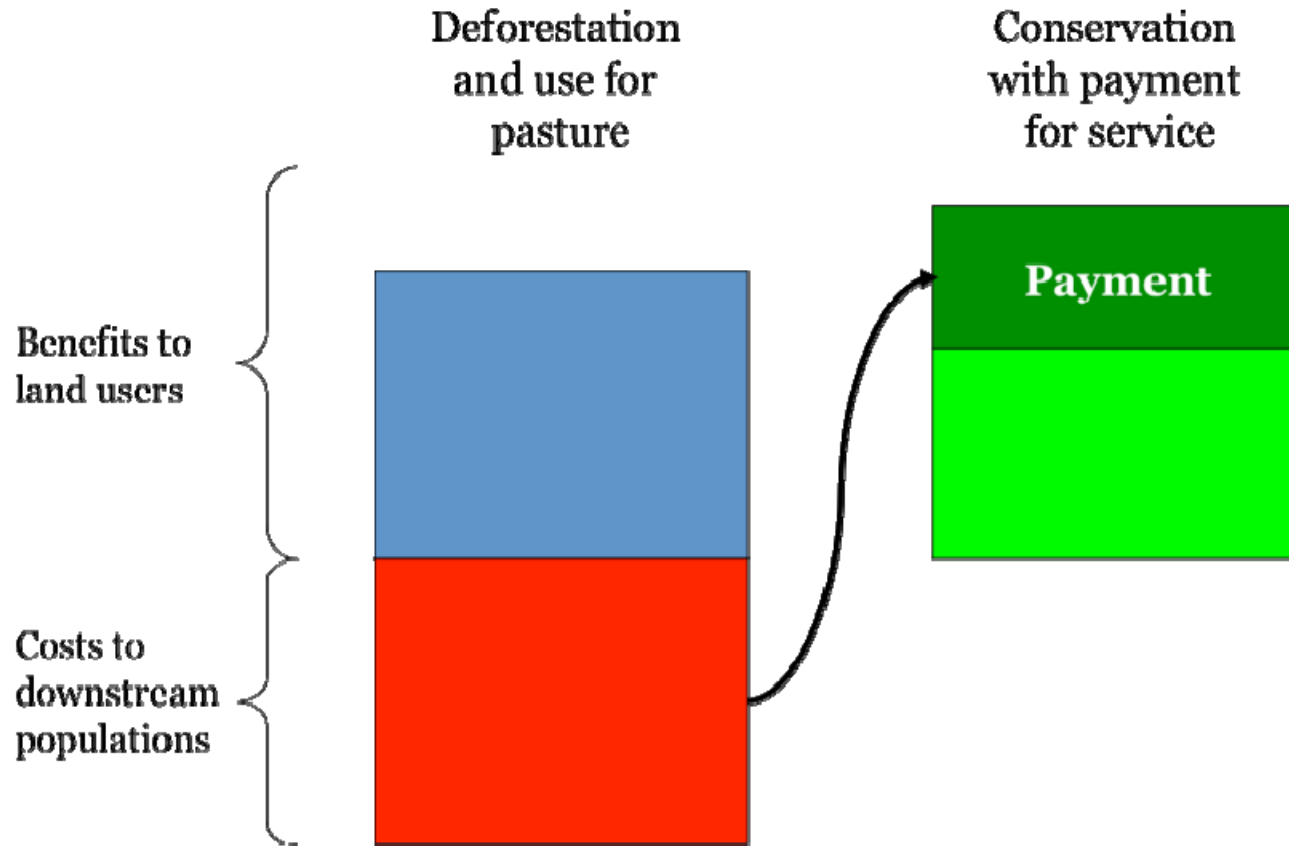
Tools for integrated water use



When valuing alternative uses of water full costs of provision and value should be considered



Tools for integrated water use



Croitoru & Young, 2011, this book

Improving the conservation of forest ecosystems as water providers, is possible through the payment by downstream users of clean water to upstream land users, and can allow internalizing what would otherwise be an externality



Some conclusions

- ⑩ Integrating ecological, socio-economic and hydrological management is a key approach towards sustainability
- ⑩ The Green water paradigm -in addition to the blue water paradigm- should receive increased attention, as green water flows sustain main ecosystem functions.
- ⑩ With regard to integration of water with other ecosystem services, a myriad of new tools for trade-off analysis and land management optimization has become available.



Thank you very much!

bart.muys@ees.kuleuven.be
robert.mavsar@efi.int

KATHOLIEKE UNIVERSITEIT
LEUVEN



EUROPEAN FOREST INSTITUTE
MEDITERRANEAN REGIONAL OFFICE – EFIMED

www.efimed.efi.int