SWEDISH LIFE CYCLE CENTER

hosted by the Swedish Life Cycle Center & the project Swedish platform for the life cycle perspective, in collaboration with working group Get the prices right

Webinar
Monetary valuation of environmental impacts – models and data

2020-04-16

with Bengt Steen, professor emeritus at Chalmers University of Technology

Webinar guidelines & information

- ”Questions and Discussion” after the presentation
- Presentations available at https://www.lifecyclecenter.se/events/
- The webinar will be recorded
- You are muted as default and when it is time for questions we will be able to unmute you if you have a question
- Presentations will be sent to all participants after the webinar

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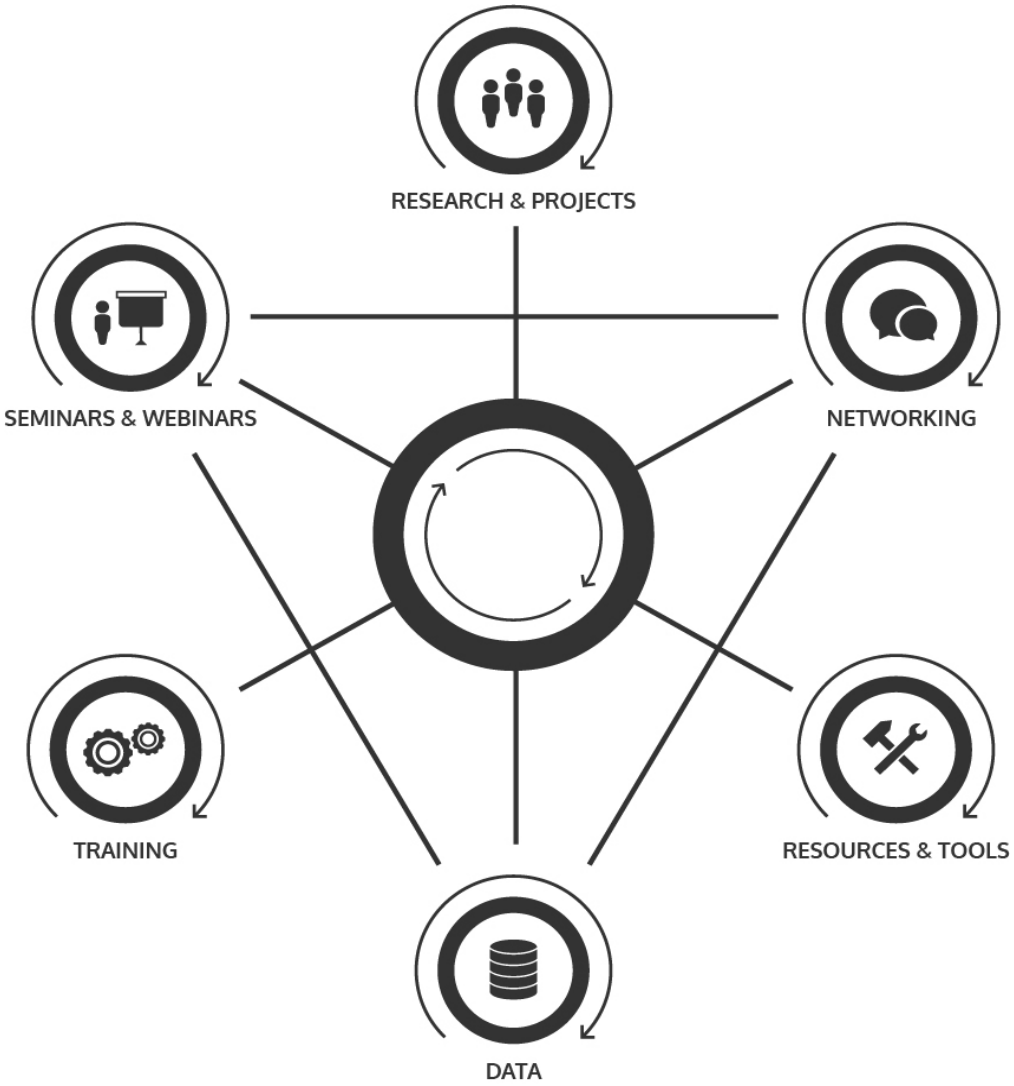

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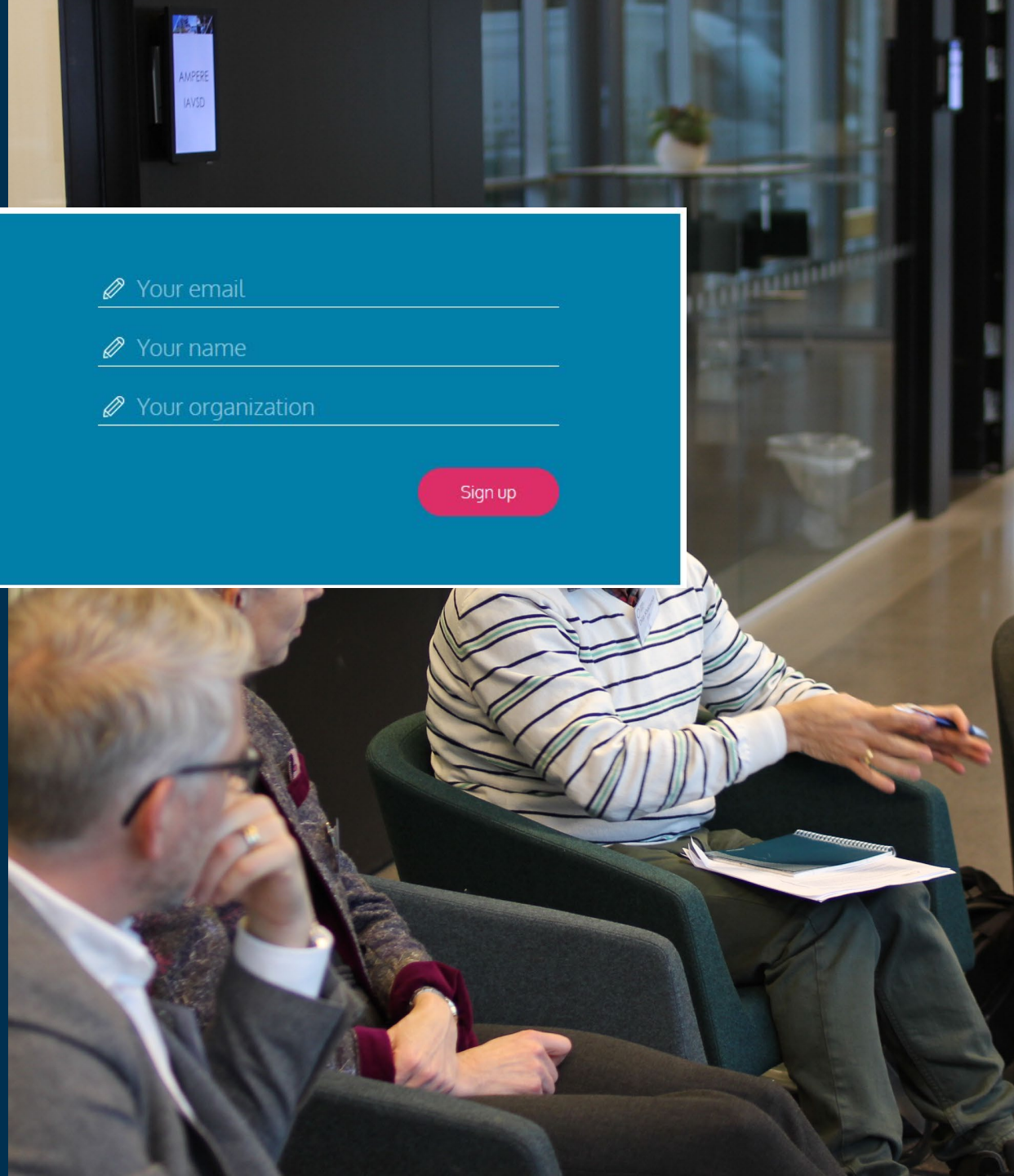

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Monetary Valuation of Environmental Impacts– Models and Data

Bengt Steen, Chalmers University of Technology

Outline

- Why monetary valuation?
- The ISO 14008 standard
- Scoping: Which impacts to value, whose values etc.
- The EPS system – an overview
- Monetary valuation: models and data
- Future developments

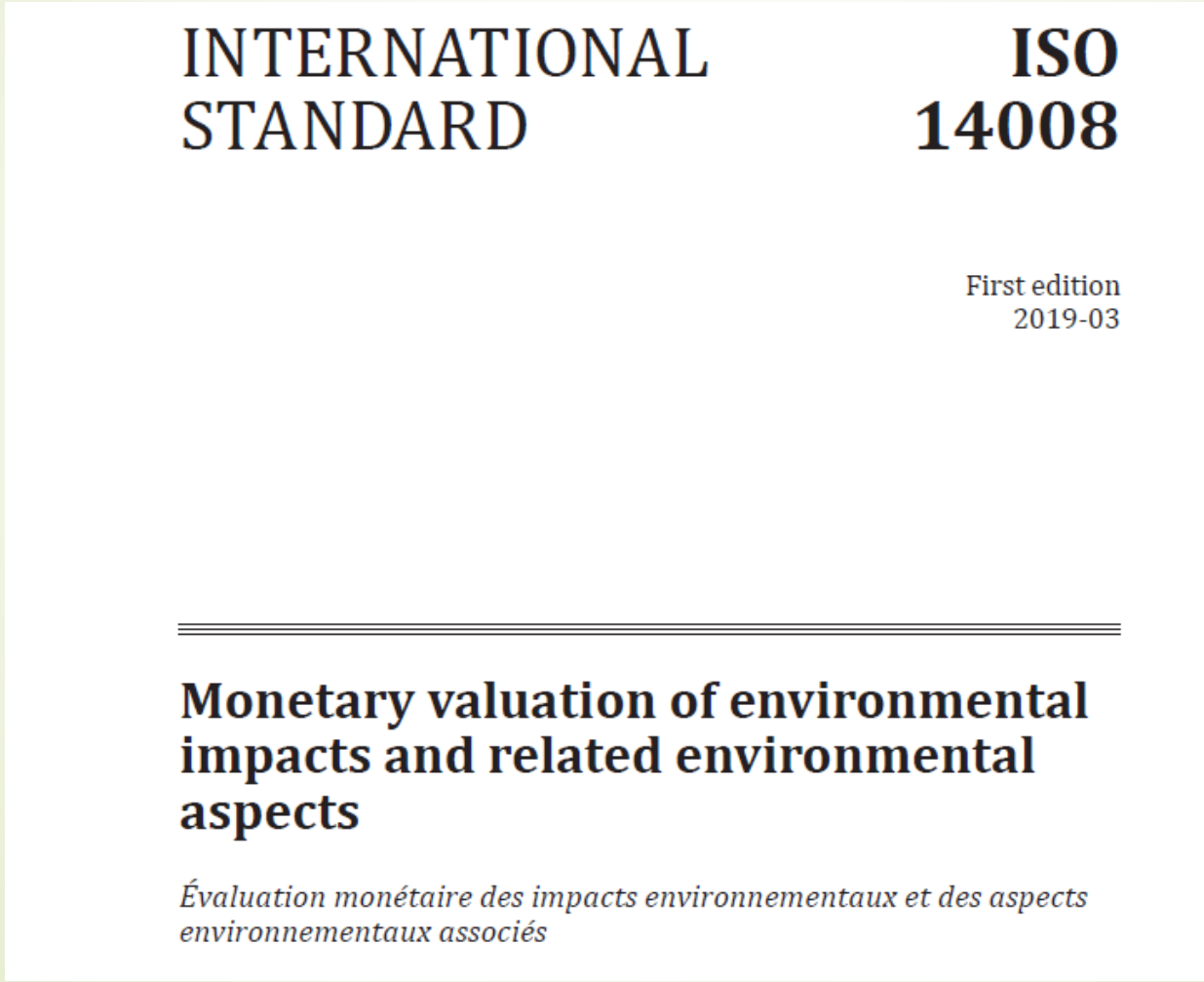
Why value environmental impacts in monetary terms?

- In sustainable development, trade-offs are necessary
- Sustainability is basically about having time to satisfy human needs. Time is money. Money is time.
- The time (or money) needed to satisfy human needs depends very much on the richness of the environment
- The monetary values of environmental impacts is consequently a good sustainability indicator for human activities

17 SDGs, 169 targets

Harmonization of monetary valuation

https://www.iso.org/standard/43243.html



INTERNATIONAL STANDARD

ISO 14008

First edition
2019-03

Monetary valuation of environmental impacts and related environmental aspects

Évaluation monétaire des impacts environnementaux et des aspects environnementaux associés

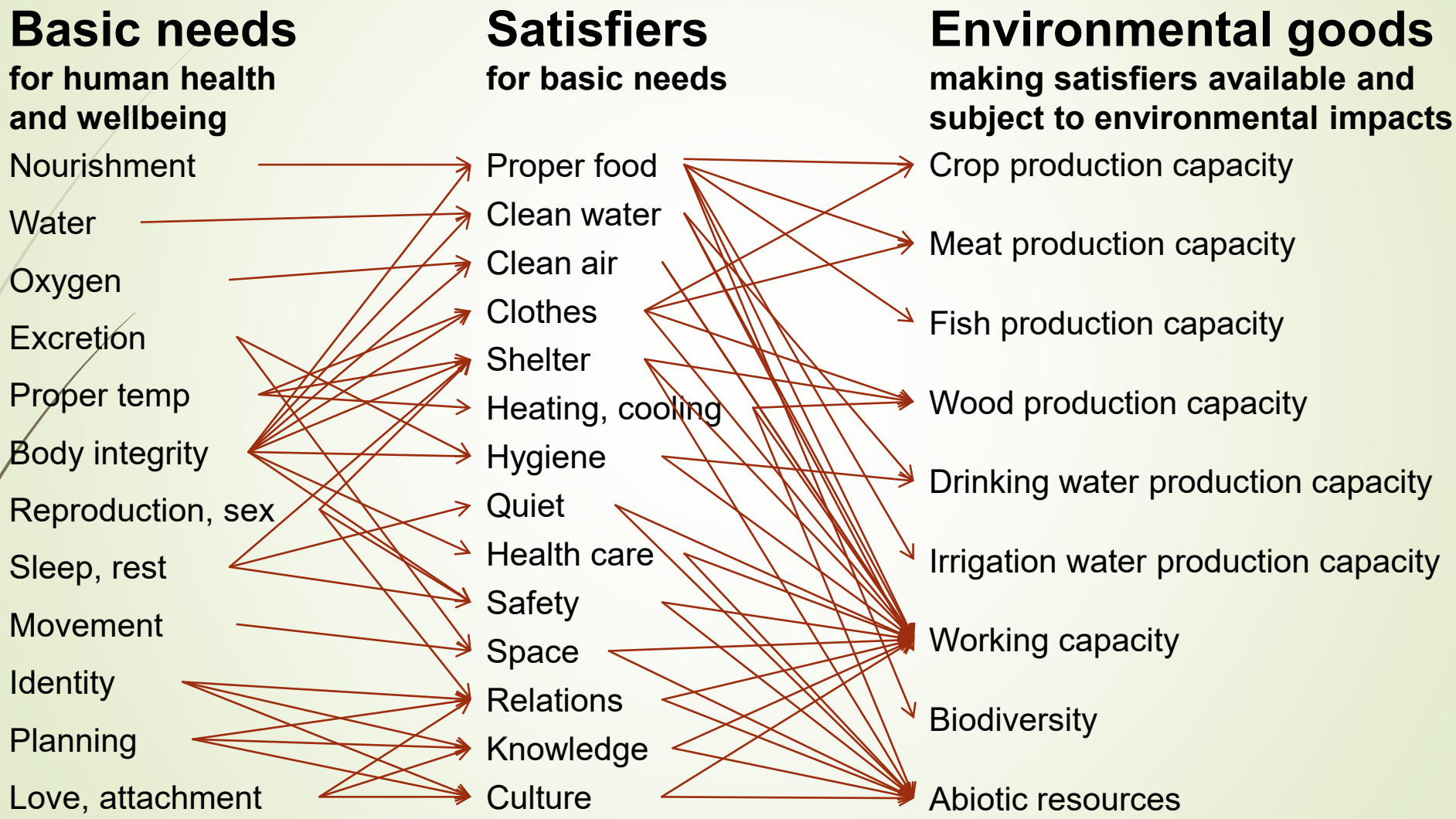
ISO 14008

- **Introduction**
- **1 Scope**
- **2 Normative references**
- **3 Terms and definitions**
- **4 Principles**
- **5 Planning a monetary valuation**
  - 5.1 General.
  - 5.2 Goal of the valuation and its intended audience
  - 5.3 Specification of the environmental impact or aspect
  - 5.4 People whose preferences and perspectives are considered
  - 5.5 Elements of the Total Economic Value captured
  - 5.6 Monetary valuation method
- **6 Requirements and procedures for monetary valuation**
- **7 Linking monetary values of environmental impacts to related environmental aspects**
- **8 Quality check**
- **9 Reporting**

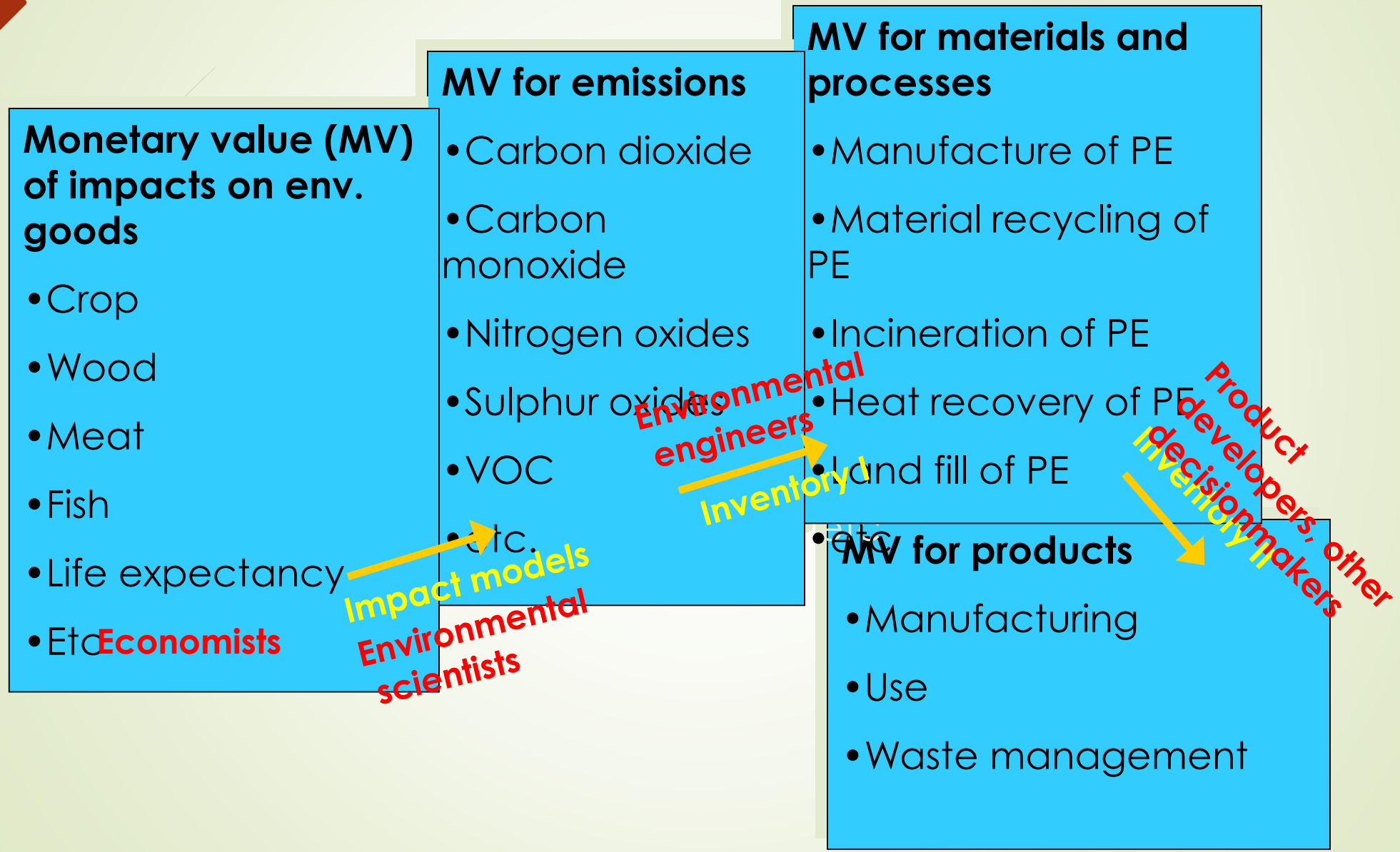
Central terms in ISO 14008

- **Good:** *natural resource* (3.1.5), *ecosystem service* (3.2.11), product or service, marketed or not, that satisfies human wants or needs
- **Environmental good** is a good supplied by the environment. May also be negative as in the case of impacts on human health.
- **Environmental impact:** change to the *environment* (3.1.1), whether adverse or beneficial, wholly or partially resulting from an organization's *environmental aspects* (3.1.4)
- **Environmental impact indicator** is a measure of an environmental impact, and in this context, subject to monetary valuation
- **Impact pathway:** a mechanism by which an elementary flow influence an environmentl impact indicator

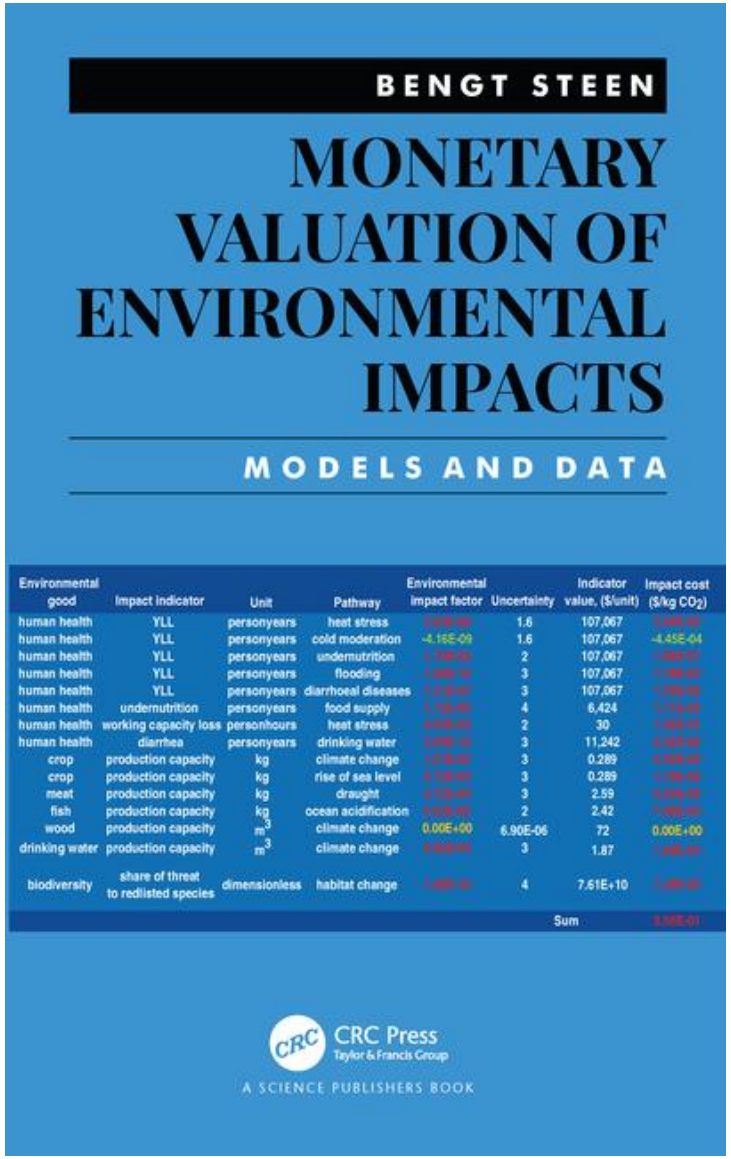
Scoping: Which environmental goods should be included?



Environmental Priority System, EPS



Adaptation of EPS to ISO 14008



Environmental good	Impact indicator	Unit	Pathway	Environmental impact factor	Uncertainty	Indicator value, ($/unit)	Impact cost ($/kg CO_2)
human health	YLL	personyears	heat stress		1.6	107,067	
human health	YLL	personyears	cold moderation	-4.16E-09	1.6	107,067	-4.45E-04
human health	YLL	personyears	undernutrition		2	107,067	
human health	YLL	personyears	flooding		3	107,067	
human health	YLL	personyears	diarrhoeal diseases		3	107,067	
human health	undernutrition	personyears	food supply		4	6,424	
human health	working capacity loss	personhours	heat stress		2	30	
human health	diarrhea	personyears	drinking water		3	11,242	
crop	production capacity	kg	climate change		3	0.289	
crop	production capacity	kg	rise of sea level		3	0.289	
meat	production capacity	kg	draught		3	2.59	
fish	production capacity	kg	ocean acidification		2	2.42	
wood	production capacity	m^3	climate change	0.00E+00	6.90E-06	72	0.00E+00
drinking water	production capacity	m^3	climate change		3	1.87	
biodiversity	share of threat to redlisted species	dimensionless	habitat change		4	7.61E+10	
						Sum	

Choice of indicators for environmental impacts and their monetary values

Environmental good	Environmental impact indicator	Monetary valuation method
Crop production capacity	Kg decrease of crop prod. cap.	Market value
Meat production capacity	Kg decrease of meat prod. cap.	Market value
Fish production capacity	Kg decrease of fish prod. cap.	Market value
Wood production capacity	m3 decrease of wood prod. cap.	Market value
Drinking water prod. cap.	m3 decrease of drinking water prod. cap.	Market value
Working capacity	Increased DALY (Disability adjusted life years)	Market value of OECD salaries
Biodiversity	Share of current threat to redlisted species	Prevention cost
Abiotic resources	Kg decrease of resource	Restauration cost

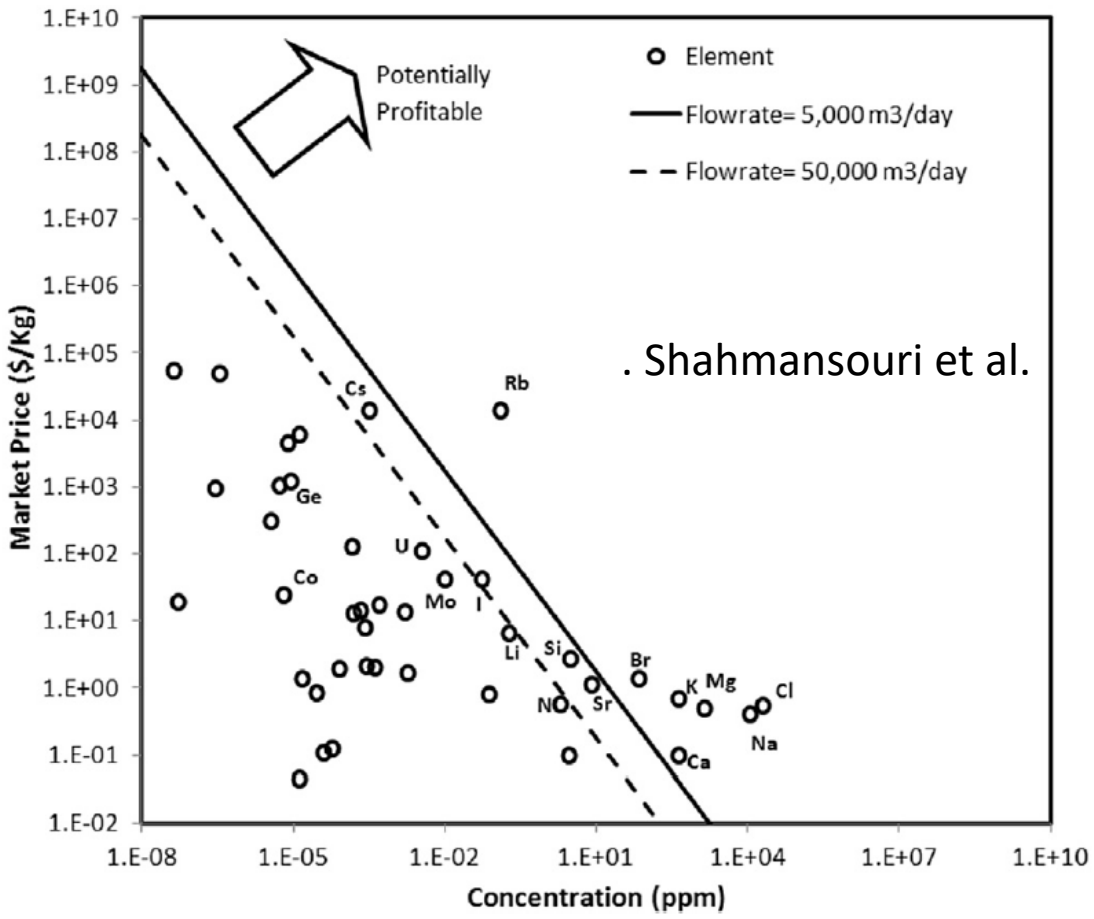
Monetary values of envrionmental impact indicators

Environmental indicator	Unit	Monetary impact value, ($)	
		Best estimate	Uncertainty
Production capacity of crops	kg	0.289	1.24
Production capacity for meat	kg	2.59	1.32
Production capacity for fish	kg	2.42	1.30
Production capacity for wood	m^3	72	1.2
Share of current threat to redlisted species	Dimensionless	7.61E+10	1.5
Production capacity for drinking water	m^3	1.87	2.26
Coal resources	kg	0.284	1.3
Lignite resources	kg	0.084	1.2
Oil resources	kg	0.8	1.3
Natural gas resources	kg	0.5	1.3
Metal resources			
Aluminum	kg metal	0.175	1.3
Iron	kg metal	1.1	1.6
Silver	kg metal	115200	2
Arsenic	kg metal	3840	2

Monetary values of trace metal ore resources

Metal name	Abundance in crust (g/ton)	Cost for ore substitution ($/kg Metal)	Metal name	Abundance in crust (g/ton)	Cost for ore substitution ($/kg Metal)
Silver	0.05	115200	**Neodymium**	26	222
Arsenic	1.5	3840	**Nickel**	44	136
Gold	0.0018	3200000	**Osmium**	0.00005	115200000
Bismuth	0.13	44308	**Lead**	17	339
Cadmium	0.098	58776	**Palladium**	0.00053	10867925
Cerium	64	90	**Praseodymium**	7.1	811
Cobolt	17	226	**Platinum**	0.0006	9600000
Chromium	83	43	**Rhenium**	0.0004	14400000
Cesium	4.6	1252	**Rhodium**	0.000018	320000000
Copper	25	144	**Ruthenium**	0.00003	192000000
Dysprosium	3.5	1646	**Antimony**	0.2	28800
Erbium	2.3	2504	**Scandium**	14	411
Europium	0.88	6545	**Samarium**	4.5	1280
Gallium	17	339	**Tin**	5.5	698
Gadolinium	3.8	1516	**Tantalum**	1	5760
Germanium	1.6	3600	**Terbium**	0.64	9000
Hafnium	5.8	993	**Tellurium**	0.001	5760000
Mercury	0.067	85970	**Thorium**	2.8	2057
Holmium	0.8	7200	**Titanium**	4100	1
Indium	0.05	115200	**Thallium**	1	5760
Iridium	0.000022	261818182	**Thulium**	0.33	17455
Lanthanum	30	192	**Uranium**	10.7	538
Lithium	20	288	**Tungsten**	2	5760
Luthetium	0.32	18000	**Vanadium**	107	54
Manganese	600	5.6	**Yttrium**	22	262
Molybdenum	1.5	3840	**Ytterbium**	2.2	2618
Niob	12	480	**Zinc**	71	46
			Zirconium	190	30

Monetary values of alkali metal resources



. Shahmansouri et al.

Fig. 1. Log–log plot showing results from the basic screening of potentially profitable elements in desalination concentrate that are analyzed/discussed further. For the el-

Element	Concentration in sea water (g/m3)	Replacement cost, ($/kg)
Li	0.18 [22]	10
Na	10800	0
K	400	0
Rb	0.12 [23]	0
Cs	0.0003	30000

Monetary values of impacts on human health

Disutility category	Unit	Weighting factor	Value, ($)	Note	Uncertainty factor
Years of life lost (YLL)	pyear		107 067	Working capacity lost at premature death.	1.3
Undernutrition	pyear	0.06	6 424	Wasting protein-energy undernutrition with some development disability.	1.1
Diarrhea	pyear	0.202	11 242	Caused by polluted drinking water	1.5
Malaria episodes	pyear	0.191	20 450	Potential impact from climate change	1.1
Gravation of angina pectoris	pyear	0.06	6 424	Average for gravation of mild to severe symptoms	1.5
Cardiovascular disease	pyear	0.1	10 707	Median value for several categories	2.4
Infarcts	pyear	0.0804	8 795	Acute myocardial infarction: days 1–2, 0.422 (0.28–0.566) + days 3-28, 0.056 (0.035–0.082),	1.3
Asthma cases	pyear	0.043	4 604	Treated asthma. Untreated 0.054	2
Chronic obstructive pulmonary disease, mild and moderate	pyear	0.17	18 201	Ambient air pollution is not expected to give any severe symptoms	2
Cancer	pyear	0.2	21 413	Mostly lung cancer, but other forms exist	2
Skin cancer	pyear	0.05	5 353	Melanoma and other skin cancers	2
Low vision	pyear	0.17	18 201	Decreased stratorpheric ozone layer	2
Poisoning	pyear	0.6	64 240	Largely from pesticides	1.2
Intellectual disability: mild	pyear	0.031	3 319	Cause by lead and mercury	4
Osteoporosis	per case	1.28	137 045	Caused by Cd	3
Renal dysfunction	per case	0.64	68 523	Caused by Cd and Hg	2

Monetary value of emission of 1 kg of CO_2

Environmental good	Impact indicator	Unit	Pathway	Environmental impact factor	Uncertainty	Indicator value, ($/unit)	Impact value ($/kg CO_2)
human health	YLL	pyear	heat stress	2.65E-08	1.6	107 067	2.84E-03
human health	YLL	pyear	cold moderation	-4.16E-09	1.6	107 067	-4.45E-04
human health	YLL	pyear	undernutrition	1.74E-06	2	107 067	1.86E-01
human health	YLL	pyear	flooding	1.66E-10	3	107 067	1.78E-05
human health	YLL	pyear	diarrhoeal diseases	1.21E-07	3	107 067	1.29E-02
human health	undernutrition	pyear	food supply	1.72E-06	4	6 424	1.11E-02
human health	working capacity loss	pyear	heat stress	4.53E-03	2	30	1.36E-01
human health	diarrhea	pyear	drinking water	2.69E-10	3	11 242	3.02E-06
crop	production capacity	kg	climate change	1.01E-02	3	0.289	2.93E-03
crop	production capacity	kg	rise of sea level	4.12E-03	3	0.289	1.19E-03
meat	production capacity	kg	draught	3.72E-04	3	2.59	9.63E-04
fish	production capacity	kg	ocean acidification	2.92E-05	2	2.42	7.08E-05
wood	production capacity	m^3	climate change	0.00E+00	6.90E-06	72	0.00E+00
drinking water	production capacity	m^3	climate change	9.06E-04	3	1.87	1.69E-03
biodiversity	share of threat to redlisted species	Dimensionless	habitat change	1.69E-16	4	7.61E+10	1.29E-05
						Sum	3.56E-01

Total value of global emissions and resource extractions

Flow	Unit	Value/unit	Global flow	Value, $
CO_2	kg	3.75E-01	3.26E+13	1.22E+13
PM2.5	kg	2.74E+02	3.80E+10	1.04E+13
Au	kg	3.20E+06	2.60E+06	8.32E+12
Rh	kg	3.20E+08	2.50E+04	8.00E+12
Urban land use >0.5 million	m2yr	1.18E+01	4.68E+11	5.52E+12
Sb	kg	2.88E+04	1.63E+08	4.69E+12
Urban land use<0.5 million	m2yr	8.00E+00	4.68E+11	3.74E+12
CH_4	kg	1.06E+01	3.33E+11	3.54E+12
Fe	kg	1.10E+00	3.00E+12	3.30E+12
Oil	kg	8.00E-01	4.01E+12	3.21E+12

Conclusions

- The total decrease of the natural capital 2015 was 8.92E+13 $.
- The global GDP 2015 was 7.56E+13 US$.
- It looks as we are destroying more values than we are creating.
- However, in valuing clean air and water via impacts on human health, values for working capability of OECD inhabitants were used. This means that the environmental impact values are not directly comparable with the global GDP.
- A better value for global economic capability would be the working capacity of an average OECD inhabitant multiplied with the global population: 107067*7.2E+09 = 7.71E+14 $.
- This is 10.2 times higher than the global GDP.
- When applying 7.71E+14 $ for values created globally, the decrease of natural capital is now 11.6% of this new economic capability.
- But there is still a problem in that we are borrowing 11.6 % each year from the natural capital, while we are not increasing our economic capability more than a few %. This is not sustainable.

Applications

- In product design, e.g. by Volvo AB and Volvocar
- For investments, e.g. by AkzoNobel
- In ESG accounting e.g. by Harvard Business school
- In education, e.g. by Chalmers and MIT
- For Environmental Management enligt ISO 14001

Further reading

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QUESTIONS & DISCUSSION

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