Internalizing the costs of extreme weather in cost-benefit analysis (CBA) of transport investments

TRB Annual Meeting, Washington DC, Jan 13

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Bio of Pekka

Research Professor	University of Oulu
Principal Scientist	VTT Technical Research Centre of Finland
Vice-President	Jaakko Pöyry Group subsidiary JP-Transplan
Corporate Analyst	Finnish Railways (VR Group)
Road Policy Engineer, R&D Manager	Finnish Road Administration S-E district
Cost Engineer	Finnmap Ltd.

Adjunct professor, Technical University of Tampere, dept. of logistics and business information management, *transport and logistics*

EWENT – Extreme Weather impacts on European Networks of Transport http://ewent.vtt.fi

1) **Identification of hazardous weather phenomena, their probability and consequences**

2) **Assessment of impacts of extreme weather events on EU transport system - these impacts were monetised**

3) **Devise of strategic options for stakeholders, but in particular for the EC**

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FORECA CONSULTING

FINNISH METEOROLOGICAL INSTITUTE

World Meteorological Organization
Working together in weather, climate and water

SEVENTH FRAMEWORK PROGRAMME

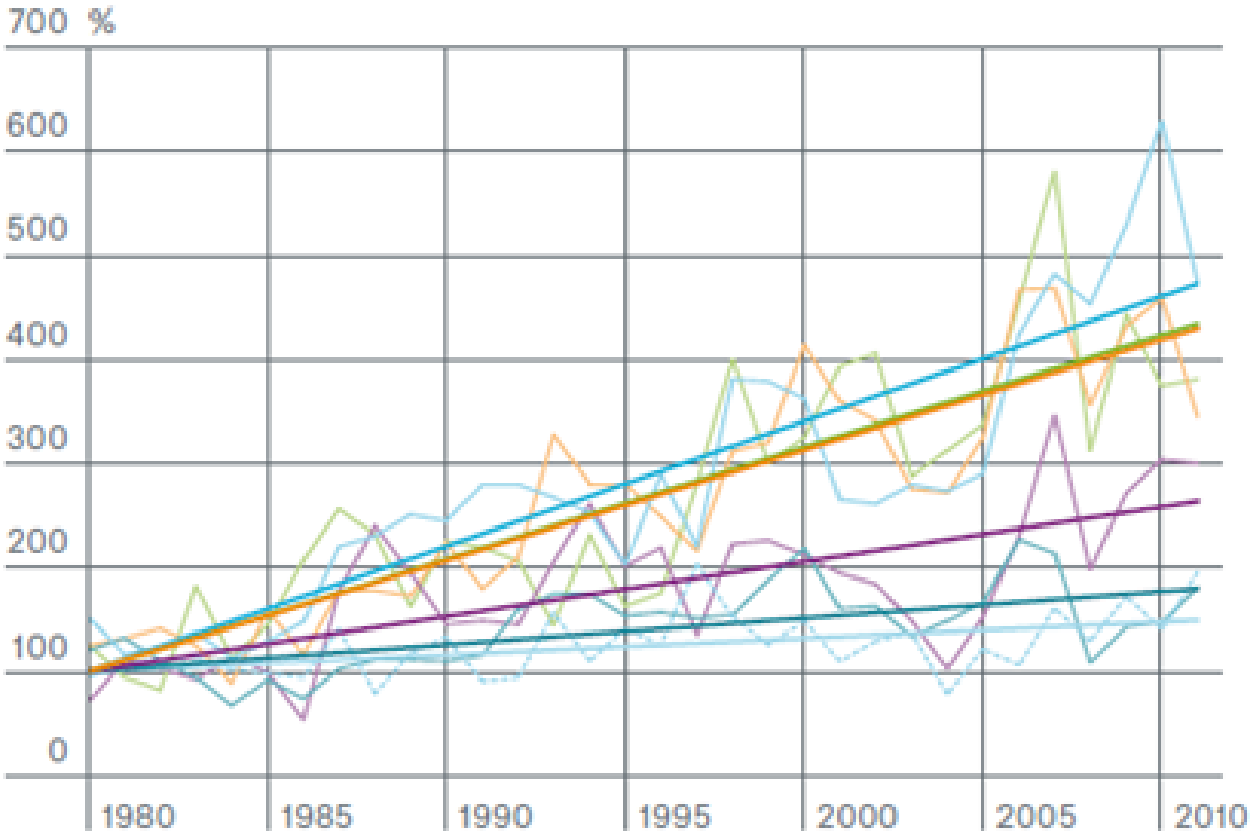
Weather-related losses in the increase – or just accounted for more often than before?

Upward trends in weather-related loss events per continent, 1980-2011

Remark: This analysis considers events in the United States, Canada, the Caribbean and Central America.

- North America
- Australia/Oceania
- Asia
- Africa
- Europe
- South America

Source: Munich Re, NatCatSERVICE



Source: MunichRe 2012

	Present costs due to extreme weather, including all phenomena (ca. 2010)				
	Accidents	Time costs	Infrastructure		Freight & logistics
			Physical infra	Maintenance	
Road	>10 bill.	0.5-1.0 bill.	ca. 1 bill.	ca. 0.2 bill.	1 – 6 bill.
Rail	>0.1 bill.	>10 mill.		>0.1 bill.	5 – 24 mill.
IWT	ca. 2 mill.	na	na	na	0.1 - 0.3 mill.
Short sea	>10 mill.	na	na	na	0.2 - 1 mill.
Aviation	na	>0.6 bill.	na	na	0.5 – 2.3 mill.
Light traffic	>2 bill.	-	na	na	-
TOTAL	>12 bill.	>1 bill.	ca. 1 bill.	>0.3 bill.	1-6 bill.
The EU-27 grand total more than 15 bill. € p.a.					

Source: Nokkala et al. 2012

How do we account costs in CBA?

$$B/C = \frac{\text{present value of benefits and cost savings}}{\text{investment cost}} = \sum_{t=0}^{n}\left[\frac{\Delta D_t + \Delta T_t + \Delta M_t + \Delta A_t + \Delta E_t + \Delta N_t}{(1+r)^t} + R_n\right] / C$$

C = investment cost, assuming it to be a lump sum in year 0 (it can be also distributed for several years and discounted as other items); ΔD = change in driving costs (wear and tear of vehicles, fuel consumption, etc.; ΔT = change in time costs; ΔM = change in maintenance costs of the asset in question; ΔA = change in accident costs; ΔE = change in emission costs; ΔN = change in noise costs; Rn = residual value of the asset at the end of the analysis period, in year n; r = is the required return on investment, i.e. the discounting rate; t = the number of the year; n = number of years chosen for the analysis. B/C = benefit-cost ratio; B/C ratio value exceeding 1 indicates a profitable investment.

The extreme weather (EW) costs are already internalized "conceptually"?

$$B/C = \frac{\text{present value of benefits and cost savings}}{\text{investment cost}} = \sum_{t=0}^{n}\left[\frac{\Delta D_t + \Delta T_t + \Delta M_t + \Delta A_t + \Delta E_t + \Delta N_t}{(1+r)^t} + R_n\right] / C$$

EW delays both passenger and freight services

EW increases maintenance costs

EW presents major accident costs (~1%...10%)

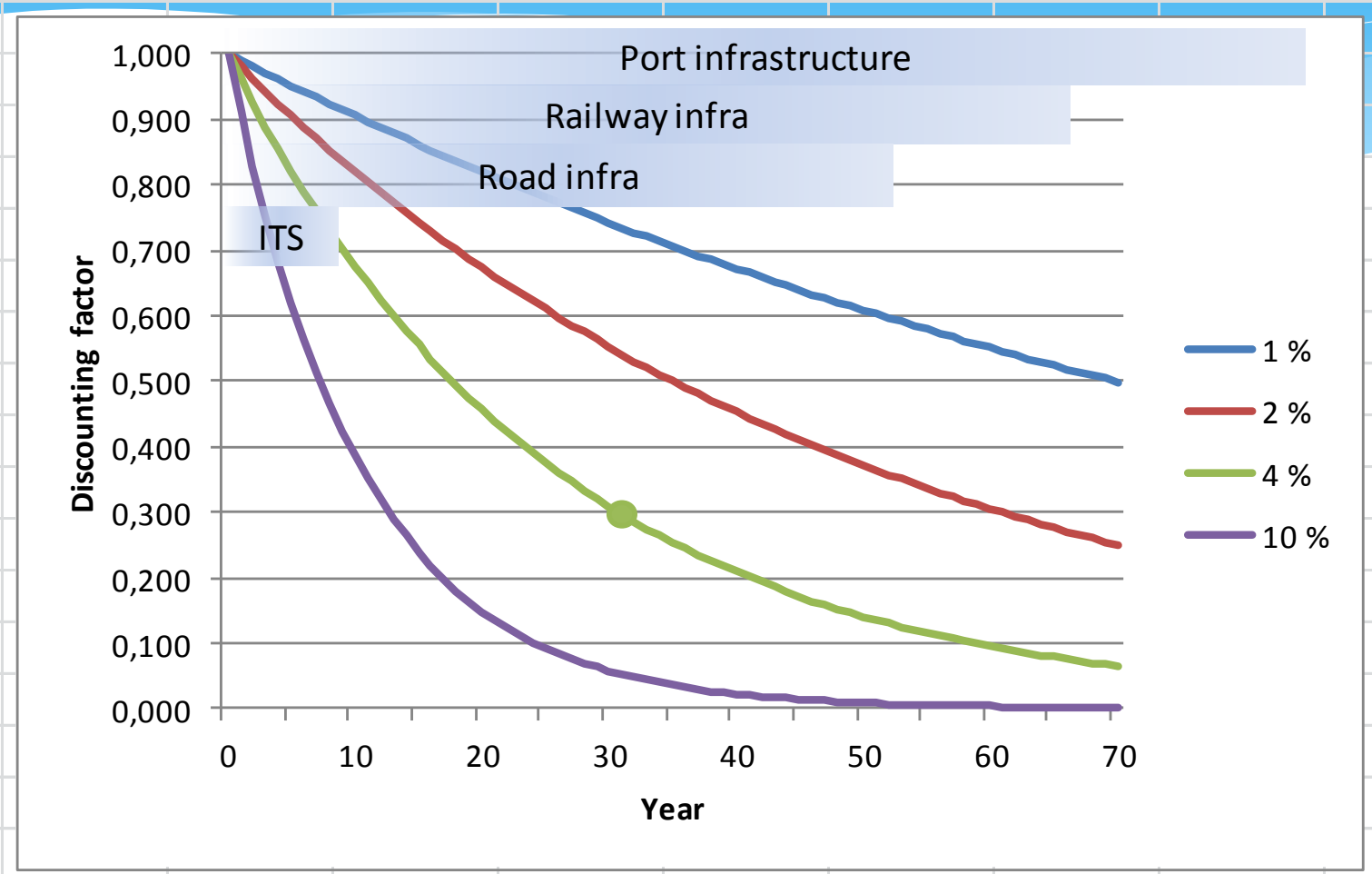
EW presents physical damage risk

Copyright / reference: P. Leviäkangas / EWENT consortium

EW costs are not, however, internalized ”operationally” because we do not know exactly their share of the total costs in a particular project (or action) and we do not have the tools to assess how system improvement will impact the system with regard to EW costs.

In other words, which type of investments (actions) will make the transport system more resilient, reliable and safe? How much more?

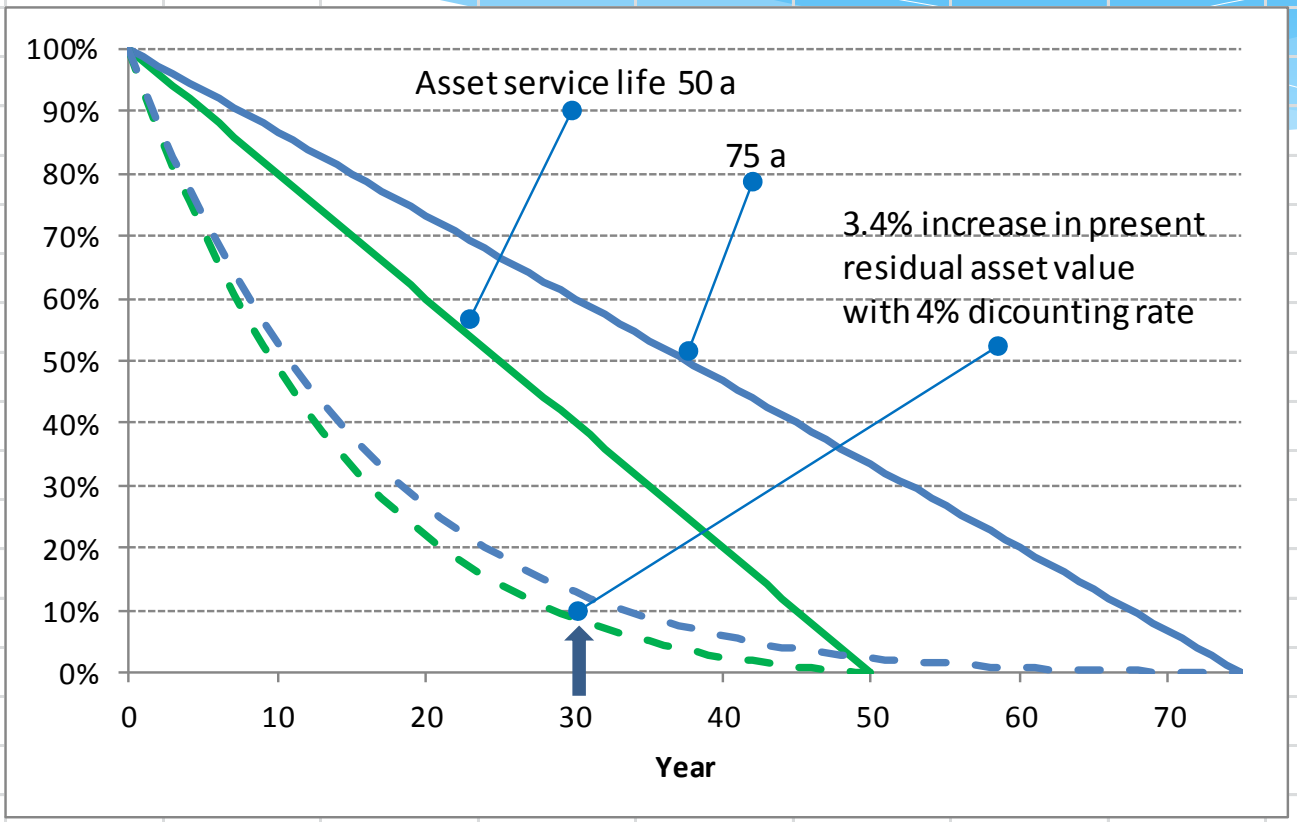
CBA accounting period seldom matches with true service life



One example idea how to crack the nut

*** Resilience improvement**
⇒ increasing the service life and residual value of the asset

Extending asset's service life (more resilience) => increase of asset's present residual value



What it means in plain words…

… is that increasing resilience of the asset so that we can expect the asset to be of service 75 years instead of 50 years entitles a 3.4% higher investment cost today, if we do the accounting for 30 years with 4% rate (ceteris paribus)

(Investment – residual value) / years of service

Investment	100 M€	110 M€
Service life	50 a	70 a
4% discounting factor after 30 a	0.308	0.308
Remaining service life after cost-benefit accounting	20 a	40 a
Present residual value	100 M€ × 20 a / 50 a × 0.308 = 12.32 M€	110 M€ × 40 a / 70 a × 0.308 = 19.36 M€
(Investment – Present residual value) / service year, i.e. net investment per year of service	(100 - 12.32) M€ / 50 a = 1.7536 M€/a	(110 - 19.36) M€ / 70 a = 1.2949 M€/a

26% lower net investment cost per year

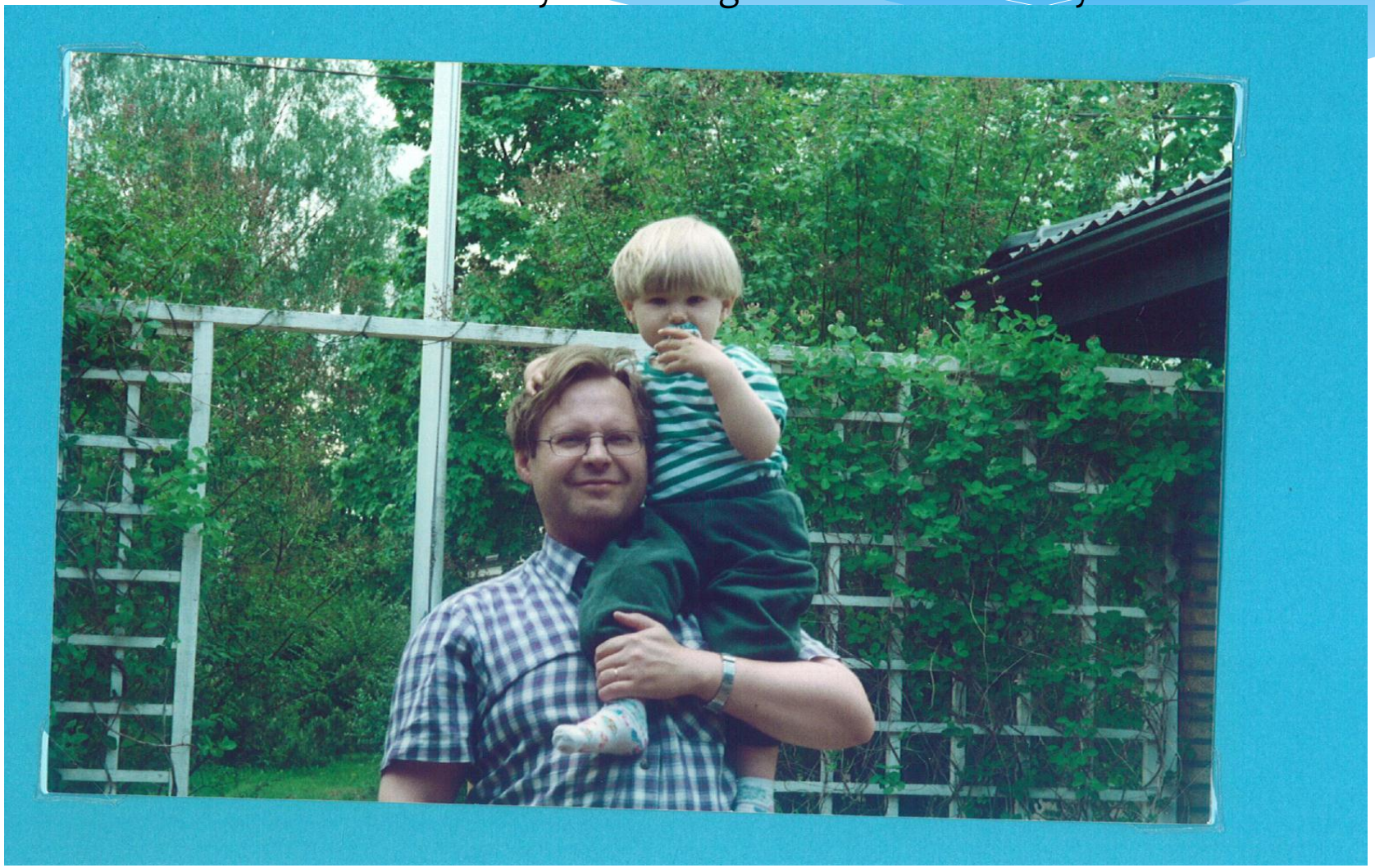
What it means in plain words…

… is that instead of looking at the initial up-front costs only or net present value of 30 years, a whole life-cycle view should be taken; looking at annualized present value costs over the life-cycle could save us from the "tyranny of discounting rate".

Some additional ideas

- Enhanced maintenance programs and increased resilience => extended service life => net costs / service year?
- From risk-neutral CBA to risk-averse CBA?
- Already stated ideas:
  - Value of reliability, accessibility, connectivity, etc.?
  - Lowering discounting rates and extending CBA accounting period
  - Supplementing CBA with multi-criteria analysis (MCA)

How risk-averse should we be?

Thank you!

"to whom are you building infrastructure Daddy?"