Valuing Risk Reductions to Human Health

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OUTLINE

- Economic Assessment
  - role
  - ‘economic’ characteristics of a risk
- (Monetary) Valuation Framework/Classification for (recreational) Waterborne Risks
- Methods for Identifying ‘value’ (VSL; VOLY)
- Issues to consider in the valuation of risk reductions in (recreational) water environments

THE NEED FOR AN ECONOMIC ASSESSMENT OF WATER RISKS

- Humans face a wide range of **potentially adverse health effects** when using (recreational) water environments (WHO, 2003)

- **Monetary values** for reducing risks are **widely applied in other policy sectors** (transport; crime; environment), allowing a **quantification of the health benefits** of improvements in environmental quality/safety.

- Large literature on mortality (fatal) risk valuation, some studies on morbidity (non-fatal) risks

- No water-specific values to date to compete a **full "Impact Pathway" Assessment**

EXAMPLE IMPACT PATHWAY

Four steps:

1. emission
2. dispersion of the emission
3. estimation of impacts (dose-response functions)
4. valuation of impacts avoided

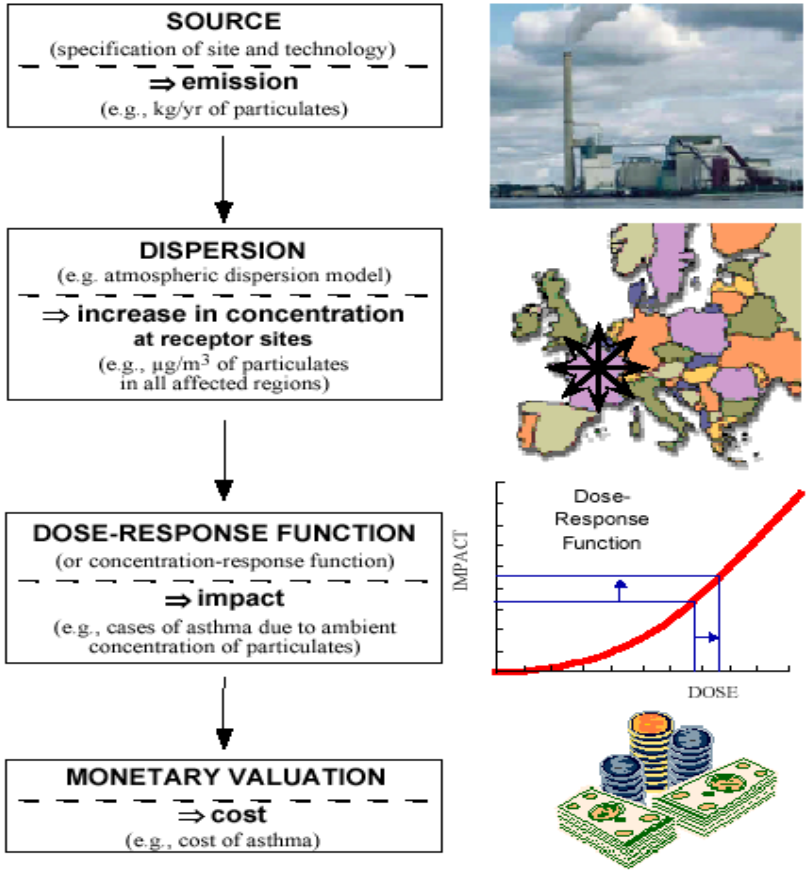


Figure 2: The impact pathway approach.

ECONOMIC CHARACTERISTICS OF RISKS

- Fatal/Non-Fatal
- Acute/Chronic
- Timing of risk reduction
- Vary across risks

- Value the **policy outcome** (risk/hazard reduction & its impact on health) to the individual/society concerned, not the policy itself

CHARACTERISTICS OF DIFFERENT WATER BORNE RISKS

Risk	Outcome	Fatal	Non-Fatal	Acute	Chronic
Drowning	Death	✓			
Spinal	Paraplegia		✓		✓
UVR	Sunburn, heatstroke Cataracts Cancer	 ✓	✓ ✓	✓	 ✓
Faecal contamination	Gastroenteritis Hepatitis		✓ ✓	✓	 ✓
Free-living organisms ……..	Ear infection PAM	✓	✓	✓	

ECONOMIC CHARACTERISTICS OF RISKS

- Valuation is based in expected utility and decision making under risk theory (one period)

- $$U(p,w) = (1-p)u_a(w) + pu_d(w) \qquad (1)$$

  $$U(p',w) = (1-p')u_a(w) + p'u_d(w) \qquad (2)$$

- (2) – (1) value/change in utility from the risk reduction

METHODS FOR IDENTIFYING "VALUE" (1)

1. **HUMAN CAPITAL APPROACH**

- Up until 1980's
- Discounted value of average lifetime earnings
  "The money value of a man" Dublin (1930)
  - "the value of a wage-earner"
  - depreciation of a machine

- **Max GDP and not necessarily welfare**
- **ex post** valuation

METHODS FOR IDENTIFYING "VALUE" (2)

2. **AVOIDED COSTS**

- Proxy for benefits
- Measure direct and indirect costs of mortality/morbidity (e.g. medical expenses, lost productivity)

- **Do not capture non-monetary costs**, such as pain and suffering
- Not based on individual's preferences, **inferior to estimates derived from theoretically correct measures of economic benefit** (e.g. willingness-to-pay)

METHODS FOR IDENTIFYING "VALUE" (3)

3. **WTP-BASED MEASURES (VSL, VOLY)**

- **Value of a Statistical Life (VSL)**

  Jones-Lee(1974;1976; 1989)

  A one-period reduction in the risk of death

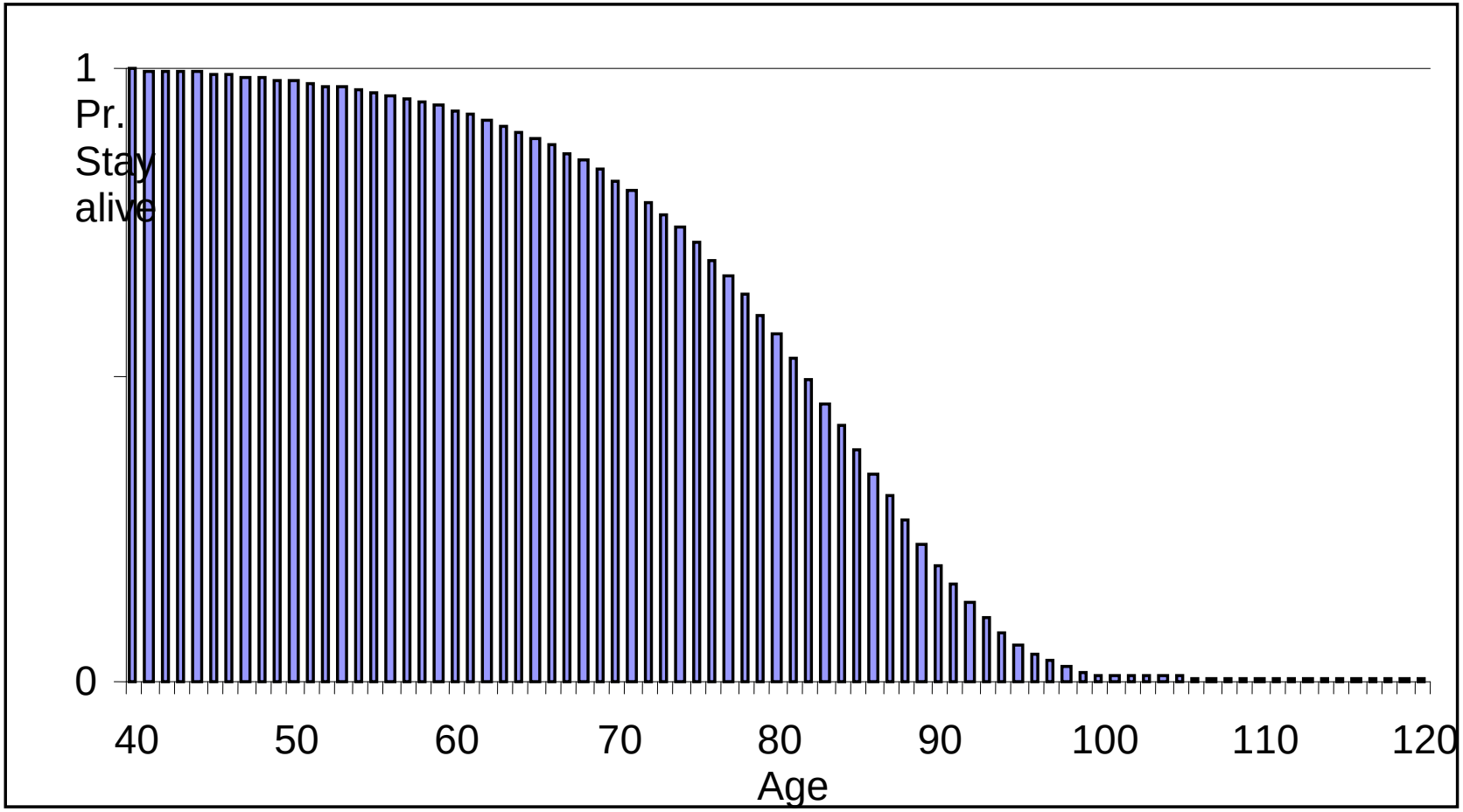
- **Value Of a Life Year Lost (VOLY)**

  Johanesson et al. (1997); Jones-Lee(1989)

  An ongoing and sustained reduction in the risk of death

NB: Both** can be shown to **increase average life expectancy

THE SURVIVAL CURVE



VALUE OF A STATISTICAL LIFE (VSL)

- *Example*

- Group of 10,000 individuals
- **individual risk change** equal to 1/10,000 in the **forthcoming period**
- reduce the **expected number of fatalities with one**

- Average willingness-to-pay= £100
- **VSL = WTP/Δp** = 100 £ /(1/10,000)= £1M
- NOT an identified life

VALUE OF A STATISTICAL LIFE (VSL) (2)

- ***Theoretical issue***

- *Initial LE*

(1) $LE = (1-p_{40}) + (1-p_{40})(1-p_{41}) + \ldots$

Change $LE \rightarrow LE_X$

- X: an absolute risk reduction $\delta(\delta \in (-p,0))$ in the *first period* hazard rate after which the hazard rates return to their previous level

(2) $LE = (1-p_{40} + \delta) + (1-p_{40} + \delta))(1-p_{41}) + \delta \in (-p_{40},0)$

EXAMPLE APPLIED VALUES

- Best point estimate for **US** is **$4m** (meta-analyses, wage risk

- EU consensus value **1.4m Euro** for **traffic accidents** and **1m Euro** for premature death related to **air pollution**

- Danish air pollution study (Andersen et al, 2004)

80% of external damage (health) value = **avoidance of premature deaths**; 20% other impacts

VALUE OF A LIFE YEAR LOST (VOLY) (1)

- A particular gain in life expectancy can be generated by various changes in the survival curve (e.g. **on-going risk reductions over a lifetime**)

- *Example*

- VOLY valuation: Directly ask for the value of a change in life expectancy **"WTP for a 1 month gain in LE?"**

- A gain in life expectancy is not a precise description of a good
- It is **NOT an "Add-on"** to the end of life

VALUE OF A LIFE YEAR LOST (VOLY) (2)

- ***Theoretical issue***

- *Initial LE*

(1) $LE = (1-p_{40}) + (1-p_{40})(1-p_{41}) + \ldots$

Change $LE \rightarrow LE_X$

- X: a permanent constant *relative* risk reduction kp(k∈(−1,0)) in hazard rates

(2) $LE = (1-(p_{40}(1+k)) + (1-p_{40}(1+k)(1-p_{41})(1+k))..,$
$+ k \in (-1,0)$

POSSIBLE TAXONOMY/ECONOMIC VALUATION FRAMEWORK FOR WATERBORNE RISKS

Risk	Outcome	Fatal	Non-Fat.	Acute	Chronic	Measure
Drowning	Death	✓				VSL
Spinal	Paraplegia		✓		✓	VSI
UVR	Sunburn, heatstroke Cataracts Cancer	 ✓	✓ ✓	✓	 ✓	VSI VSL *(VOLY?)*
Faecal contamination	Gastroenteritis Hepatitis		✓ ✓	✓	 ✓	VSI VSI
Free-living organisms	Ear infection PAM	 ✓	✓	✓		VSI VSL *(VOLY?)*

ISSUES TO CONSIDER IN THE VALUATION OF WATER RISKS

A 'one size fits all' VSL/VOLY or a suite of measures?

1 Would you expect VSL/VOLY to be given the same numerical value **across different sectors**?

- Traffic
- Environment
- Crime
- Water (Recreation)

2. Would you expect VSL to be given the same numerical value **across different countries/regions/age groups** (children, elderly)?

3. Do **'premia'** exist (e.g. cancer: dread, morbidity). Would latency impacts counter this?

ISSUES cont.

- ***Impact of other contextual features?***

3. How does baseline risk (**personal exposure**) affect value.? Is there a 'dread/'baseline risk tradeoff?

4. Do **other contextual features** affect values?
(*Voluntariness; Severity; Controllability; Public exposure; Immediacy; Personal knowledge; Expert knowledge*)

ISSUES cont.

- *Outstanding theoretical considerations w.r.t VOLY*

5. Should the fact that the **VOLY is not fully theoretically specified** yet matter, given it might be the most appropriate measure in many cases (VSL may underestimate benefits)?

CONCLUSIONS

- Economic valuation would allow a **full impact pathways assessment** of water-bourn risks

- WaterbornE risks have **differing characteristics**, suggesting both VSL and VOLY measures
- WTP-based (public preferences)

- Many **conceptual, empirical and ethical issues** to consider in their implementation