Basic economic principles and socio-economic impact assessments in chemicals policy

Mattias Carlsson Feng

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mattias.carlsson-feng@kemi.se

KEMI
Kemikalieinspektionen
Swedish Chemicals Agency

What I will talk about today

- **A brief introduction to economics and chemical policy**
- **Some basic principles in economics**
- **Socio-economic assessment – concepts and case studies**

What is economics about?

Economic value – what is that?

- Utility, satisfaction of human needs, happiness

- Food, clothes, security, social networks, clean water and air, ...

- Something has a value if someone is willing to sacrifice something else (money, time etc) to get it

What is economics about?

Some basic economic principles

a) Economic decisions require trade-offs
b) The cost of something is what you give up to get it
c) Individuals and firms react on incentives
d) (Free) Markets are normally a good way of organizing economic activities – but in some situations the state can improve market outcomes
e) A country's standard of living depends on how good it is at producing goods and services

Basic principles

a) Economic decisions require trade-offs.

- To get something you have to give up something else

Consequences for chemical policy:

- Goal conflicts.
- (Some) chemicals have negative externalities
- There is never ”enough” funding for chemicals management

Basic principles

b) The cost of something is what you give up to get it (opportunity cost)

- Both obvious and implicit costs should be taken into account

Consequences:

- The costs of chemical use includes the impacts on human *health* and the *environment*.

- Budget restriction ➔ The opportunity cost of increasing control of chemical A is the increased risk associated with reduced control of other chemicals.

Basic principles

c) Individuals and firms reacts on incentives.

- Behaviour changes when costs and benefits of actions changes

Consequences:

- We can use economic policy instruments (such as taxes) to influence use of chemicals

Basic principles

d) (Free) Markets are normally a good way of organizing economic activities – but in some situations the state can improve market outcomes.

Consequences:

- Regulations and other policies can improve social welfare

Basic principles

e) A country’s standard of living depends on how good it is at producing goods and services.

- Standard of living is closely related to productivity – economic value produced per hour of work.
- True on a global level, but local exceptions from this ”rule” exist, for example natural resource rich countries & tax havens

Consequences:

- Chemical policy should – along with ’correcting’ for negative externalities – support technological progress and productivity improvements.

Socio-economic assessment

- Socio-economic assessments can guide decision making

- For example by clarifying the trade-offs involved

- But it is important to note that the assessment itself is not a decision

- Decision are taken by policy makers based on a legal mandate

Socio-economic assessment Concepts

- Socio-economic effectiveness analysis
  - What is optimal/effective use of resources?
  - How ambitious should our goal for environmental quality be?
  - How much resources should we set aside for this?
- Cost-effectiveness analysis
  - How can the goal (from above) be achieved at lowest cost possible?
  - What is the best combination of measures or policies?
- Socio-economic impact assessment (of a proposal)
  - What impacts will there be on society?
  - Who will be affected?
  - Impacts can be e.g. social (health), economic, environmental…
- Socio-economic evaluation
  - How well is an existing measure or policy working?
  - Empirical evidence, statistics, results…

Socio-economic impact assessment Process

A. Problem formulation (health/environment) and target setting
B. Baseline scenario (reference alternative, business as usual)
C. Possible measures and policy options
D. Impacts: changes in environmental, health and economic effects resulting from changed policy (compared with the baselin scenario)

Source: European Commission

We will focus on A-D today

In practice – Cadmium in agricultural soils

A. Problem formulation

- Cadmium intake via food increases the incidence of a range of adverse health effects, including:
  - bone fractures,
  - breast cancer, and
  - renal failure (kidney damage)

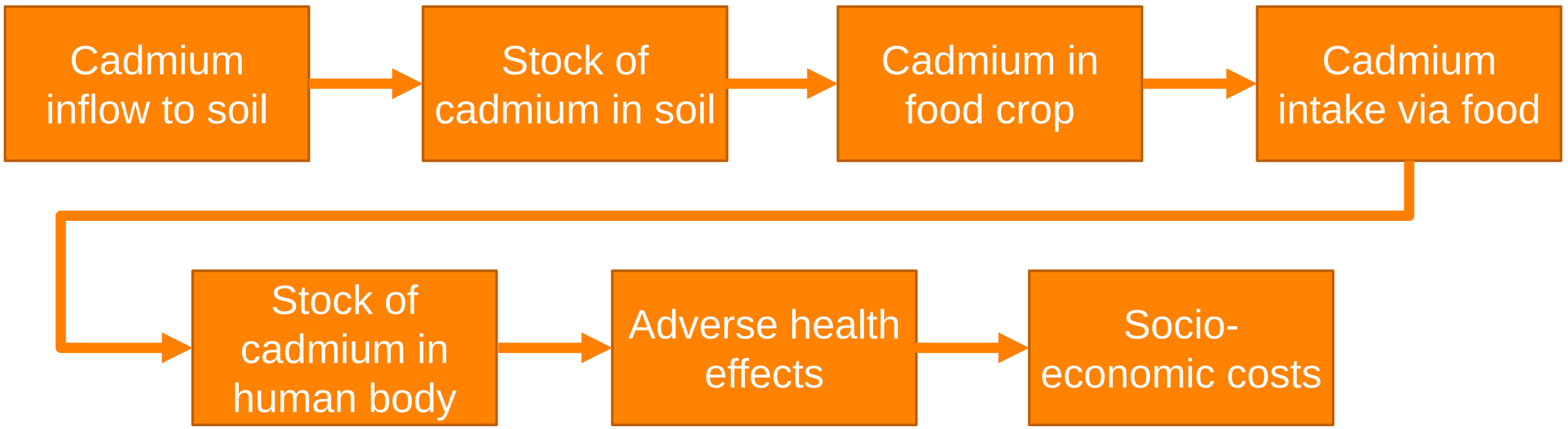
- Cadmium levels in crops are strongly correlated to the cadmium levels in agricultural soils

- Cadmium levels in agricultural soils are strongly affected by human activities

Socio-economic impact assessment

In practice – Cadmium in agricultural soils

A. Problem formulation



B. Baseline scenario

- The Baseline scenario describes what we think will happen if no (new) policies are introduced

- Sometimes referred to as ‘the reference alternative’ or ‘business as usual’

- The description of the baseline scenario is often based on:
  - the current situation (e.g. used quantities or emission levels)
  - identfification of the most important factors that we think influence this situation (e.g. demand for the produced good)
  - an attempt to project how these factors will change in the future, often based on current trends (e.g. will demand increase/decrease?, or what will be the effect of expected technological development?)

Socio-economic impact assessment

In practice – Cadmium in agricultural soils

B. Baseline scenario – the current situation

Approximated annual quantity of cadmium added to agricultural soils in EU27

Source of cadmium	gram/hectare/year
Atmospheric deposition	0.23
Mineral fertilizer	0.82
Other fertilizers and lime	0.17
Total	**1.22**

- Apart from athmospheric deposition, the cadmium input is as a by-product from application of different types of soil fertilizer (and lime).

- Mineral fertilizer is the major source (67%)

Socio-economic impact assessment

In practice – Cadmium in agricultural soils

B. Baseline scenario – identification of the most important and their future development

What will cadmium input to agricultural soils be in the future? (Example from the EU)

- Athmospheric deposition (mainly from metall industry & use of fossil fuel)
  - Decreasing trend over the last decades.
  - Can we expect further decreases? Probably due to reduced use of fossil fuels.

- Mineral (phosphate) fertilizer
  - How much mineral P-fertilizer will be used?
  - Cadmium content depends on the phosphate rock from which the fertilizer was produced – very large variations
  - Will the cadmium content in mineral fertilizers used in the future be higher, lower or the same as today? Depends on which mineral sources are used and/or if decadmiation technology is implemented. (Uncertain)

In practice – Cadmium in agricultural soils

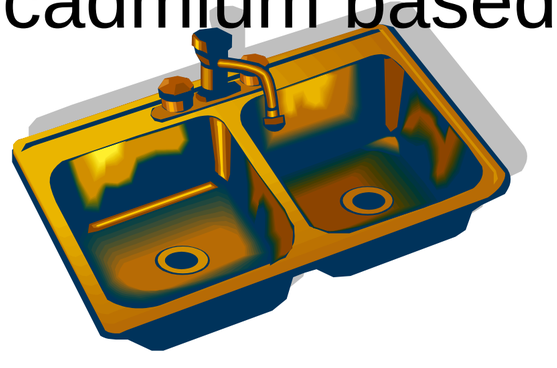
C. Possible measures and policy options

Technical measures (examples)

- Reduce industrial emissions of cadmium to air

- Use mineral fertilizer with lower cadmium content
  - Use phosphate minerals with low cadmium content
  - Decadmiate phosphate minerals

- Reduce emissions of cadmium to waste water
  - For example: reduce the emissions from cadmium to waste water from use of cadmium based artists' paints



In practice – Cadmium in agricultural soils

C. Possible measures and policy options

Administrative policy options (examples)

- Quotas on industrial emissions of cadmium to air
- Limits on cadmium content in mineral fertilizers. For example in terms of grams of cadmium per ton of phosphorous

Max X mg Cd/kg

- Require waste water treatment plants to use best available technology (BAT) for removing cadmium from sewage sludge

In practice – Cadmium in agricultural soils

C. Possible measures and policy options

Economic policy instruments (examples)

- Introduce a tax on cadmium content in mineral fertilizer. For example in terms of X € per gram of cadmium
- Introduce a tax on industrial cadmium emissions to air
- Subsidize the implementation of BAT in waste water treatment plants

Socio-economic impact assessment Process

- ✓ Problem formulation (health/environment) and target setting
- ✓ Baseline scenario (reference alternative, business as usual)
- ✓ Possible measures and policy options
- **D. Impacts: changes in environmental, health and economic effects resulting from changed policy (compared with the baseline scenario)**
- E. Distributional effects (for whom and when?)
- F. Uncertainties in the analysis
- G. Compare alternatives and conclusions

Source: European Commission

In practice – Cadmium in agricultural soils

- D. Impacts…

Limit values on cadmium content in fertilizers

	Costs	Benefits
Government	Administrative costs	Reduced health care costs
Fertilizer producers/ Distributors	Higher costs for raw materials or decadmiation	Higher fertilizer prices (?)
Farmers	Higher fertilizer costs (?)	
Food consumers	Higher food prices (?)	Reduced health care costs; Reduced number of days on sick leave; Improved quality of life

In practice – Cadmium in agricultural soils

- D. Impacts…

Tax on cadmium content in fertilizers

	Costs	Benefits
Government	Administrative costs	Reduced health care costs; Tax revenue
Fertilizer producers/ Distributors	Tax payment; Higher costs for raw materials or decadmiation (?)	Higher fertilizer prices (?)
Farmers	Higher fertilizer costs (?)	
Food consumers	Higher food prices (?)	Reduced health care costs; Reduced number of days on sick leave; Improved quality of life

In practice – Cadmium in agricultural soils

- D. Impacts…

Tax on cadmium content in fertilizers

- Gross cost (for buyer) or revenue (for government) of tax
  = Present P-use in kg * Cd/P-concentration * tax/kg Cd

- Both buyers and suppliers adapt to the introduction of a tax
  - Suppliers (producers and distributors) can choose to
    - Use mineral P-sources with lower Cd/P-concentration
    - Use decadmiation technology to reduce Cd/P-conc.
  - Buyers (farmers) can choose to
    - Buy P-fertilizer with low Cd/P-concentration to avoid the tax
    - Reduce the overall use of P-fertilizers
  - The extent of these adaptations depend on the tax level

Socio-economic impact assessment

In practice – Cadmium in agricultural soils

- D. Impacts…

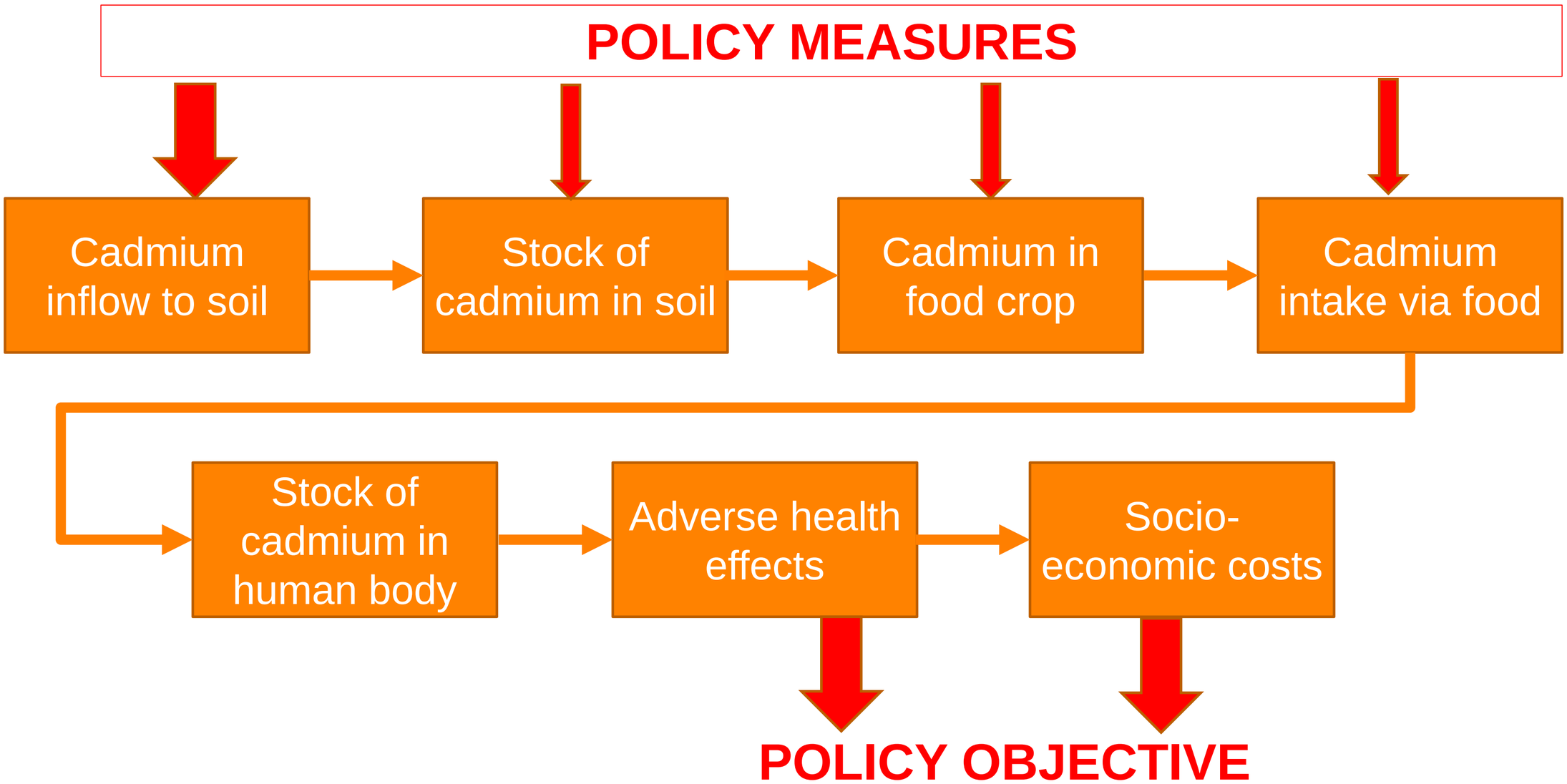
- There are methods to apply monetary values to health effects. One way of doing it is to define three types of costs of adverse health effects:
  - Direct costs – hospitalisation, medication etc
  - Indirect costs – production losses due to sick leave, early retirement, premature death etc
  - Intangible costs – losses of life years and in quality of life. Measured in terms of quality/disability adjusted life years (QALYs or DALYs).

- Estimated values based on literature reviews (for EU27):

€ per case, 2012	Fractures	Breast cancers
Direct costs	12 000	20 000
Indirect costs	~0	24 000
Intangibles	0.34 QALYs	1.68 QALYs
- monetized	*17 000*	*84 000*
Total	**29 000**	**128 000**

Socio-economic impact assessment

In practice – Cadmium in agricultural soils



Socio-economic impact assessment Process

- ✓ Problem formulation (health/environment) and target setting
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- ✓ Possible measures and policy options
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- ✖ Distributional effects (for whom and when?)
- ✖ Uncertainties in the analysis
- ✖ Compare alternatives and conclusions

Source: European Commission

In practice – PFAS in Fire Fighting Foams

- Another case

- Another type of impact assessment, but within the same framework as the previous case

- Proposal for new national regulation in Sweden
  - Submitted to the Minister of the Environment and Energy in January 2016
  - Currently being processed by the Government
  - Report in Swedish with a summary in English (KemI Report 1/16)

In practice – PFAS in Fire Fighting Foams

A. Problem formulation

- PFAS are known to be extremely persistent substances, but data on bioaccumulation and toxicity is lacking for most of them

- Some sub-groups are addressed by regulation, for example:
  - PFOS, PFOA and related substances

- The substitutes of the regulated substances are primarily PFAS of shorter chain lengths
  - These are probably less problematic than PFOS and PFOA, but
  - risks related to exposure to the short-chained PFAS is probably cumulative with the long-chained ones

In practice – PFAS in Fire Fighting Foams

A. Problem formulation

- PFAS have been found in the drinking water sources of several Swedish municipalities

- Mainly near fire fighting training sites (including airports)

- In some cases the action limit of the National Food Agency (NFA) have been exceeded, for example
  - Uppsala ➔ costly coal-filter treatment
  - Ronneby ➔ new drinking water source exploited

In practice – PFAS in Fire Fighting Foams

B. Baseline

- Estimated use and stock of fire fighting foams containing PFAS, identified main users (m^3 foam concentrate, 2014):

	Annual use	Inventory
Municipal Fire Fighting Services	47	295
Armed Forces	3.3	35
Petroleum Industry (refining and distribution)	2.3	489

- Other areas of use:
  - Civil airports – PFAS based foams have been largely phased out
  - Civil shipping – some use, largely unknown
  - Other heavy industries – largely unknown, but probably similar use/stock proportion as in the petroleum industry

In practice – PFAS in Fire Fighting Foams

B. Baseline

- State of drinking water sources, in terms of risk of exceeding NFA action limit:
  - Very little information, at the time of writing
  - The Swedish EPA published a report which probably gives more info on this in March 2016

In practice – PFAS in Fire Fighting Foams

C. Possible measures and policy options

- PFAS are used in so called class B foam, intended for for fires in liquid (such as petroleum fires) and solid substances that can turn liquid.

- Possible technical measures to reduce emissions to the environment:
  i. Avoid use of class B foam during training
  ii. Avoid use of class B foam in emergency situations where they are not necessary (for example fires in buildings)
  iii. Substitute to fluorine free class B foams
  iv. Collect foam after use and send for destruction

Socio-economic impact assessment

In practice – PFAS in Fire Fighting Foams

C. Possible measures and policy options

- Identified policy measures:
  - ~~Criteria for public procurement~~
  - ~~Economic policy instruments~~ (such as a tax on foams with PFAS)
  - Education and information activities — **Only as a complement**
  - Restrictions on use — **For further analysis**
  - Requirement to collect foam after use and send for destruction

In practice – PFAS in Fire Fighting Foams

D. Impacts...

- ***Restriction – complete ban***
  - Stop the emissions to the environment ➔ substantially limit the need for mitigation actions in the drinking water supply system
  - One-time costs due to:
    - substitution of foam inventories
    - destruction of existing foam in inventory
    - decontamination of vehicles and other equipment
    - technical adjustments in vehicles and other equipment
  - Running costs
    - alternatives to foams with PFAS are more costly
    - enforcement and supervision by public authorities
  - Safety requirements will not be met in some areas of use
    - Petroleum industry
    - Air Force

In practice – PFAS in Fire Fighting Foams

D. Impacts...

- Exemptions to limit the negative effects of a complete ban

  – To meet legal safety requirements (and to cover some uncertainties), allow use
    - in emergency situations for intended use (i.e. fires in liquids)
    - in certain training exercises in the Air Force
    - in the shipping sector
    - when testing functionality of fixed fire fighting devices (sprinkler systems etc)

  – To avoid one-time costs and to target on the actual emissions
    - Allow use if foam is collected and sent for destruction afterwards

In practice – PFAS in Fire Fighting Foams

D. Impacts...

- ***Restriction – with exemptions***
  - Emissions avoided from
    - training activities in Municipal Fire Fighting Services
    - functional testing of vehicles
  - One-time costs due to:
    - technical adjustments in vehicles and other equipment
  - Running costs (<3 million SEK/year)
    - alternatives to foams with PFAS are more costly
    - destruction of foams collected after use
    - enforcement and supervision by public authorities

- Proposed by KemI
- Along with a review of the exemptions in 2019

Concluding remarks on impact assessments

- Socio-economic impact assessments make the trade-offs inherent in risk management policy explicit

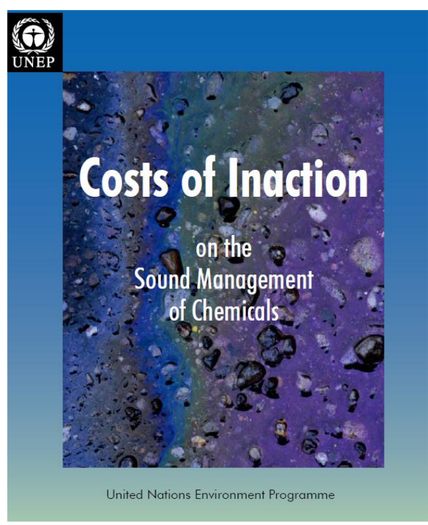
- Not possible to get a complete description of the impacts

- The aspects judged to be the most important ones have to be prioritized

- The assessment has to be ”tailor-made” to specific aspects of a certain risk management problem

- Lack of data is often a constraint ➔ value transfer is often a useful method

In practice – Injuries to smallholder pesticide users in sub-Saharan Africa



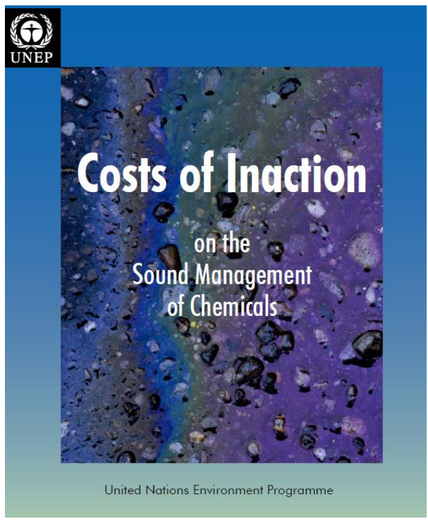
Cost of inaction – injury to smallholder pesticide users

- A brief description of the method
- An example of value transfer
  - Useful when the availability of primary data is lacking, which is often the case
  - Results should be treated with a bit of caution but can provide a reasonable indication of the size if the impacts

In practice – Injuries to smallholder pesticide users in sub-Saharan Africa

Cost of inaction – injury to smallholder pesticide users

- Farm workers on small land holdings (excl. livestock farmers)
- 37 countries in sub-Saharan African countries
- Costs of injury from poisonings:
  - Lost work days
  - Outpatient medical treatment
  - Inpatient hospitalization



In practice – Injuries to smallholder pesticide users in sub-Saharan Africa

Injuries to smallholder pesticide users – A closer look at the analytical framework

Assumptions used:

Degree of incident	Serious	Moderate	Minor
Annual share experiencing pesticide related incidents	1.2%	12%	62%
Work days lost per incident	21 days/yr	14 days/yr	7 days/yr

Cost data from Zambia in 2005 (US$)	
Daily agricultural wage	3.27
Average cost per outpatient healthcare	7.40
Average cost per inpatient hospitalization care	14.80

Cost data are then scaled by GDP per capita to extrapolate across 37 sub-saharan African countries.

In practice – Injuries to smallholder pesticide users in sub-Saharan Africa

Annual cost of lost work days

=

Number of farm workers on small land holdings using pesticides

multiplied by

Annual share of farm workers on small land holdings experiencing pesticide related incidents

multiplied by

Work days lost per incident

multiplied by

Daily agicultural wage

Socio-economic impact assessment

In practice – Injuries to smallholder pesticide users in sub-Saharan Africa

Annual cost of outpatient treatment

=

Number of farm workers on small land holdings using pesticides

multiplied by

Annual share of farm workers on small land holdings experiencing moderate pesticide related incidents

multiplied by

Cost per outpatient treament

In practice – Injuries to smallholder pesticide users in sub-Saharan Africa

Annual cost of hospital treatment

=

Number of farm workers on small land holdings using pesticides

multiplied by

Annual share of farm workers on small land holdings experiencing serious pesticide related incidents

multiplied by

Cost per hospital treatment

Summary

- Many uses of chemicals and chemical products contain a goal conflict – benefits of products against human health and/or environmental costs

- Socio-economic impact assessments can guide us to appropriate policy responses to these goal conflicts

- Every assessment needs to be tailored to the risk management issue

References

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