Pharmaceuticals in the Environment: Potential and requirements of 'soft' technology targeting user behaviour

Results from the EU FP7 project "PHARMAS"

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PHARMAS

SEVENTH FRAMEWORK PROGRAMME

The PHARMAS project…

Natural science

… will close knowledge gaps related to 12 target molecules (antibiotics and anti-cancer drugs), by e.g.:

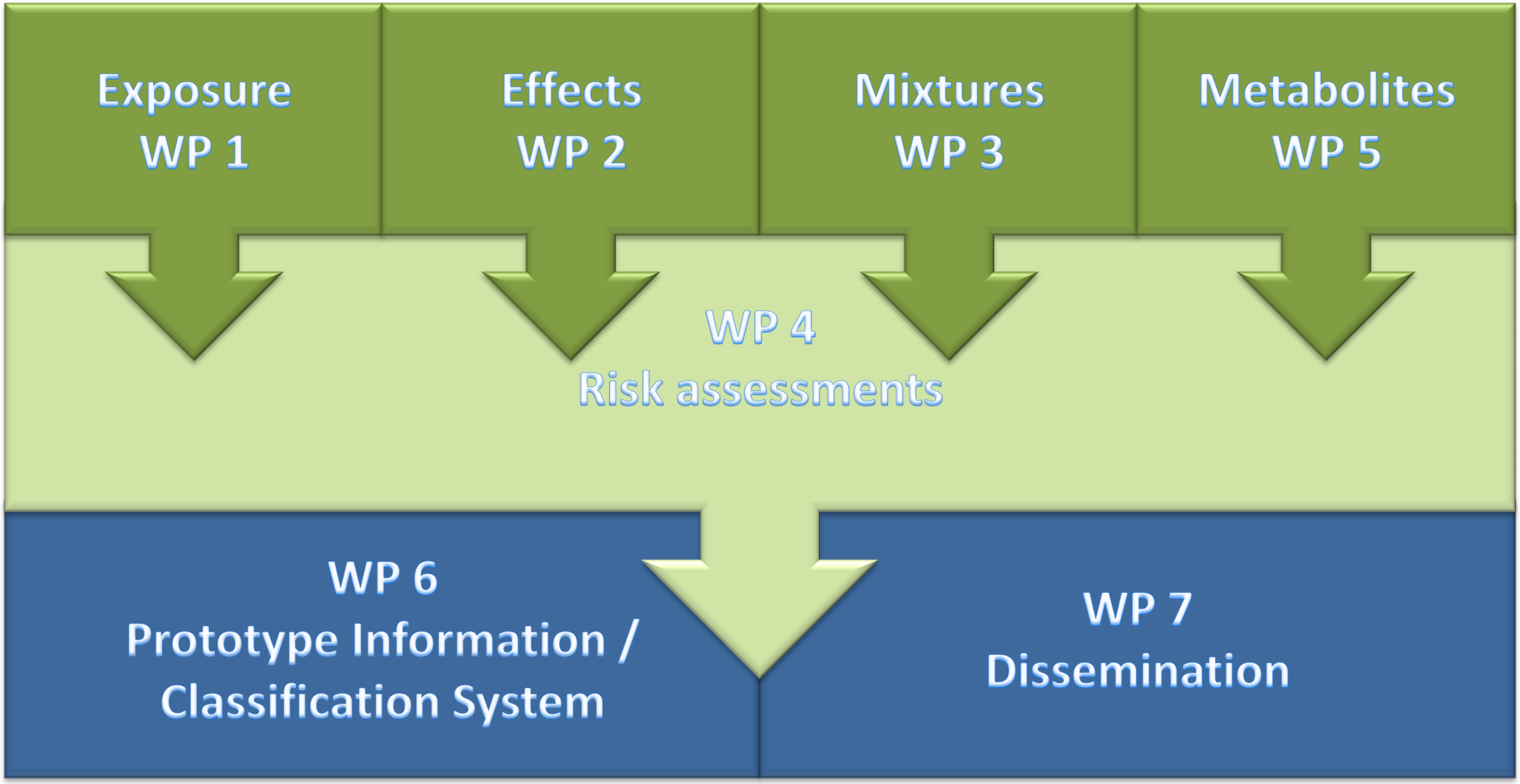
- determining **human and animal exposure** to target molecules
- producing **probabilistic estimates of risk** caused by exposure of wildlife and humans to the selected pharmaceuticals
- go beyond typical substance-by-substance risk assessments by **investigating toxicity of realistic mixtures**
- identifying stable **transformation products** and **investigate** their **concentrations and (eco)toxicology**

The PHARMAS project …

Social / behavioural science

… will develop a prototype for an information / classification system for PIE for Europe, by:

- exploring stakeholder needs and content requirements,
- evaluating scientific and socio-economic impact,
- develop a prototype for a web-based classification system (based on Swedish experience):
  - easily accessible DSS for practitioners (e.g. physicians, pharmacists)
  - providing straightforward action alternatives


Exposure
WP 1
Effects
WP 2
Mixtures
WP 3
Metabolites
WP 5
WP 4
Risk assessments
WP 6
Prototype Information /
Classification System
WP 7
Dissemination

Tests and Assays

WP2 - Effects

- OECD tests – exposing species to drugs
- Cytotoxic assays – e.g. Comet, micronucleus

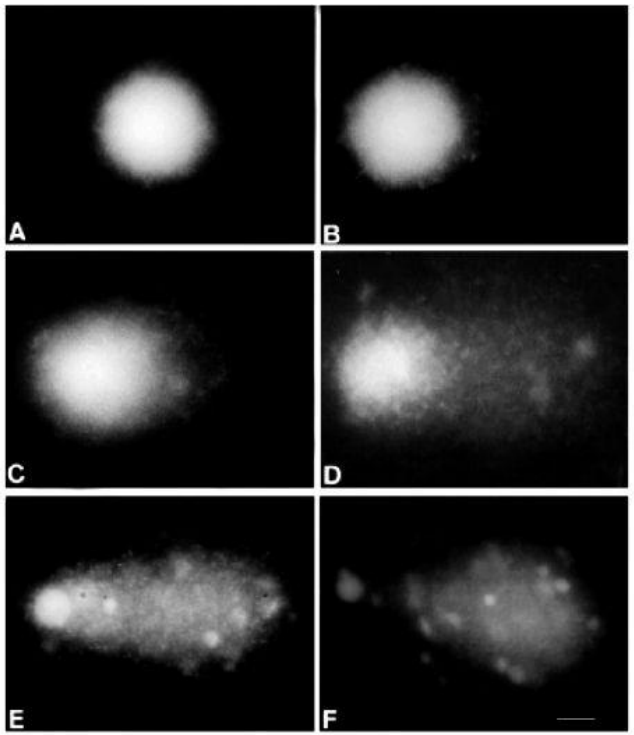
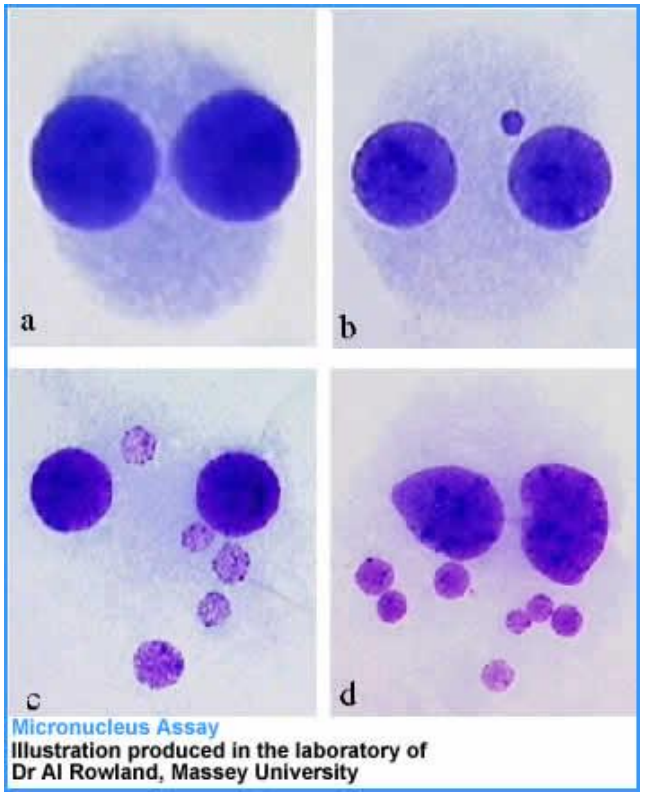


Figure 1 - Photomicrographs showing the classification of *Cnemonys torquatus* blood cells in the comet assay. **A**, Class 0, undamaged; **B**, class 1; **C**, class 2; **D**, class 3; **E**, class 4, maximum damage; **F**, apoptotic cell. Bar = 10 µm.



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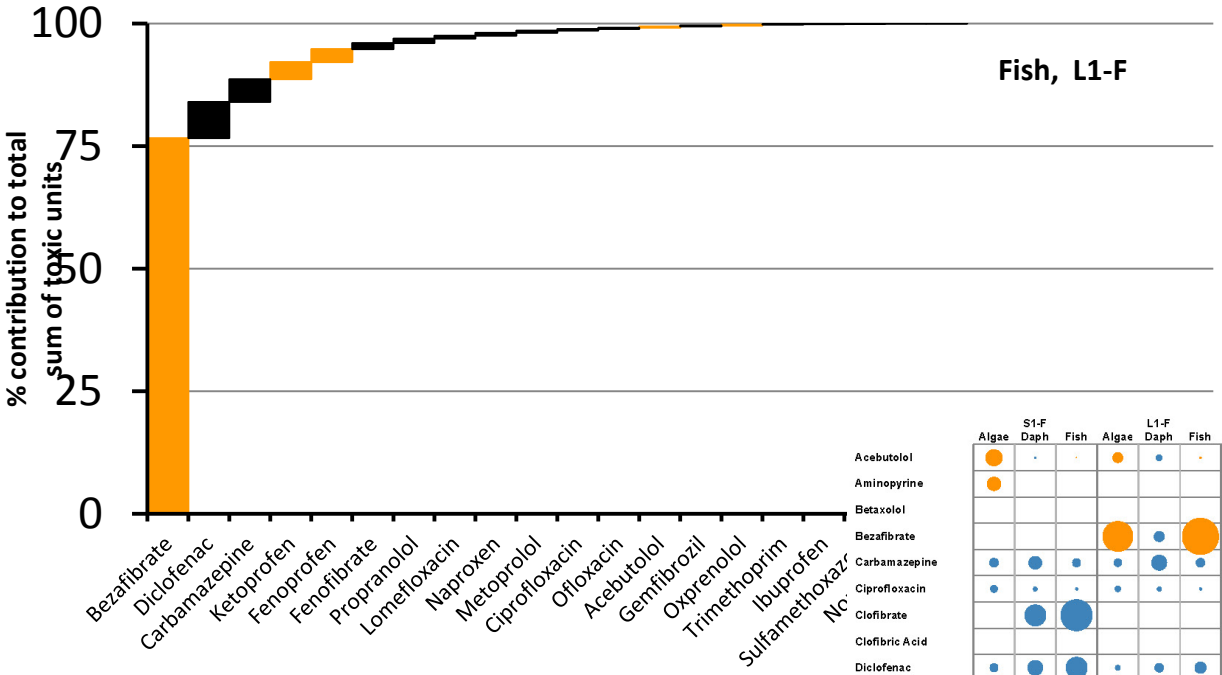
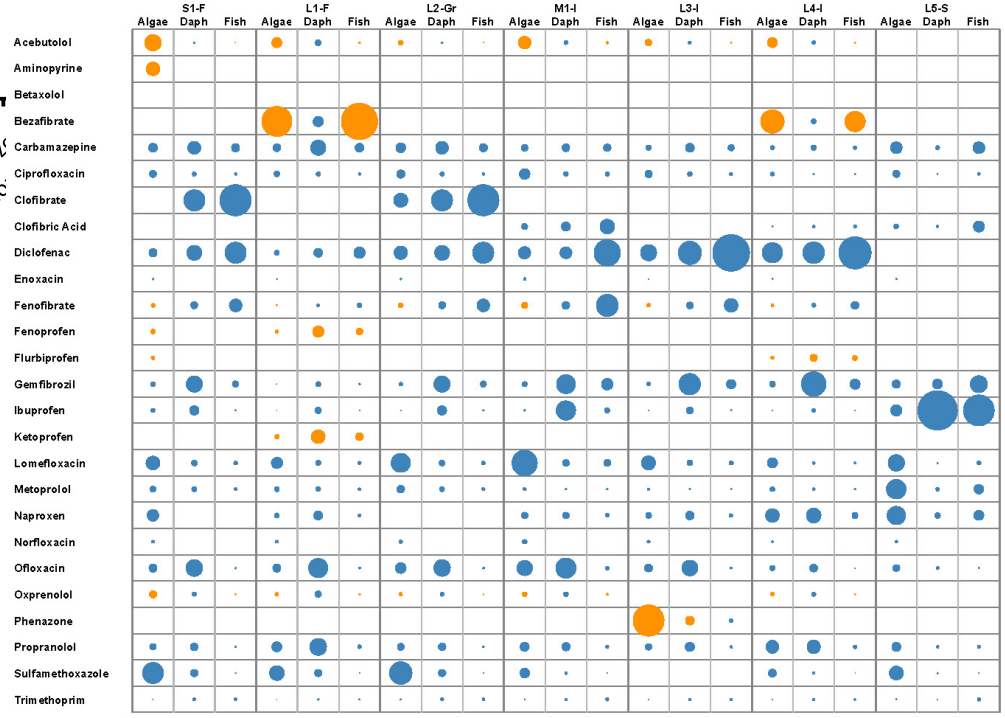
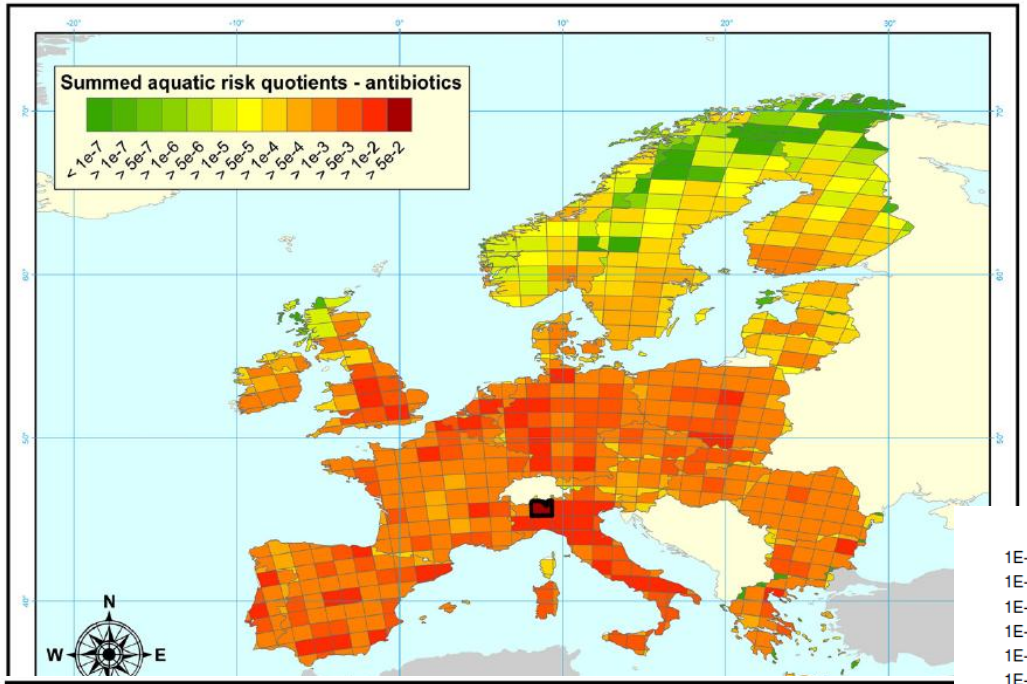
WP3 - Mixtures

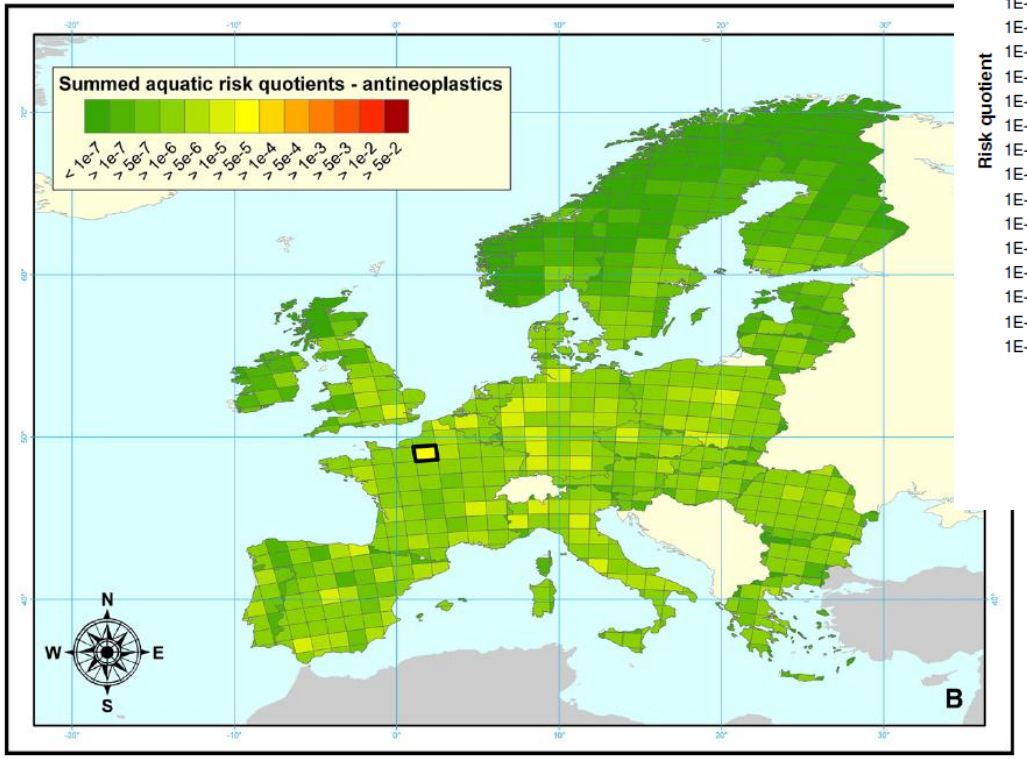
TU-Distribution (Algae, S1-F)

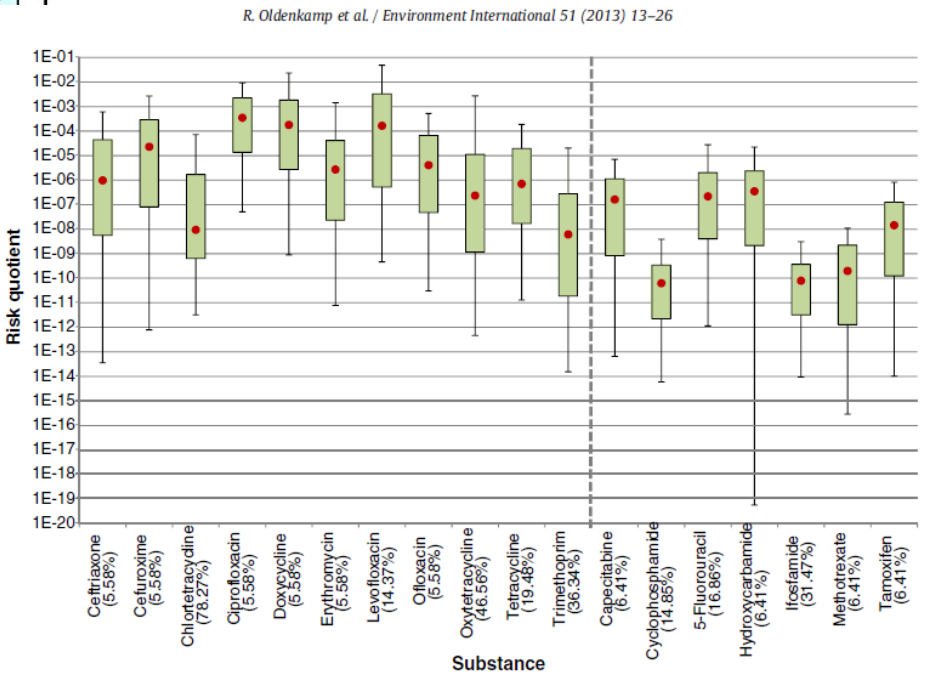




WP4 - Risk assesment







PHARMAS

Stakeholder requirements of an environmental information/ classification system for PIE

WP6 - Prototype information system

WP 6.1

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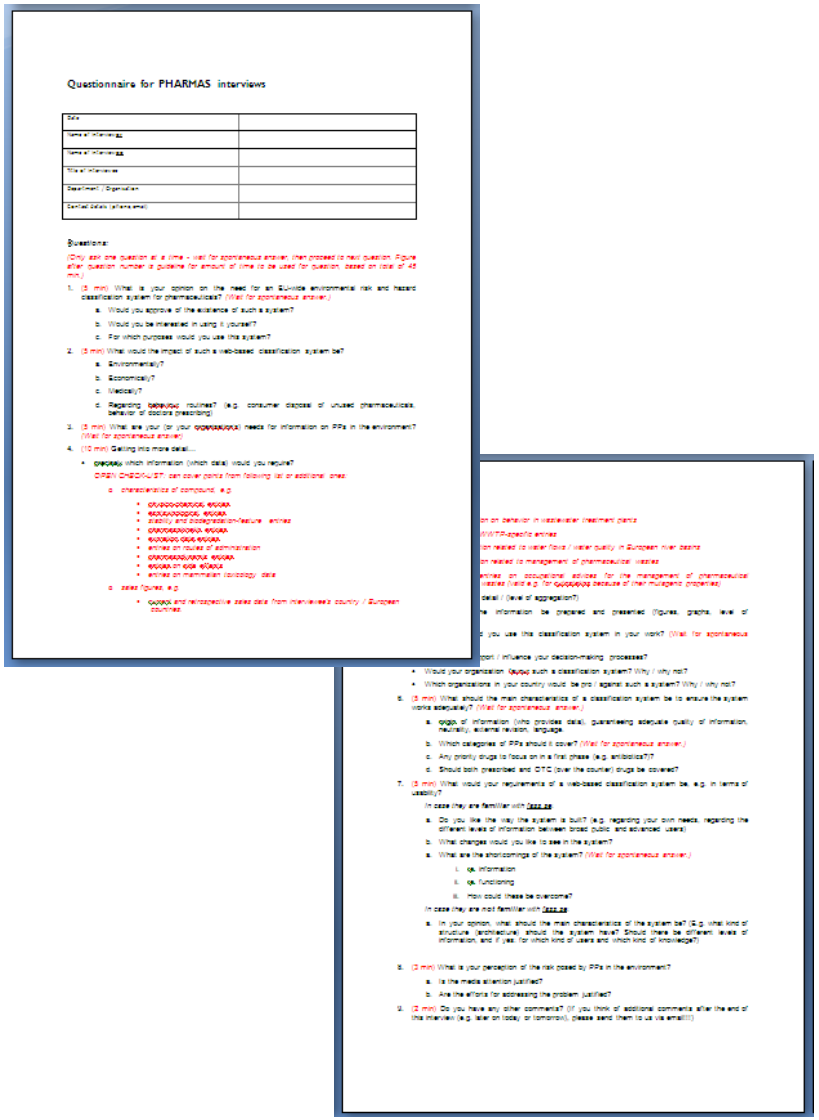
Ecologic Institute

SEVENTH FRAMEWORK PROGRAMME

Methodology

- *Qualitative, in-depth interviews (~ 60 minutes)*
- *Topics:*
  - *attitude towards system,*
  - *evaluation of use and impacts,*
  - *information requirements,*
  - *own use (e.g. decision-making),*
  - *characteristics and design,*
  - *risk perceptions.*
- ***Characteristics and functions of system left open***


Questionnaire for PHARMAS interviews

Date

Name of interviewer

Name of interviewee

Title of interviewee

Department / Organisation

Contact details (phone, email)

Questions:

(Only ask one question at a time - wait for spontaneous answer, then proceed to next question. Figure after question number is guideline for amount of time to be used for question, based on total of 45 min.)

1. (5 min) What is your opinion on the need for an EU-wide environmental risk and hazard classification system for pharmaceuticals? (Wait for spontaneous answer.)
   a. Would you approve of the existence of such a system?
   b. Would you be interested in using it yourself?
   c. For which purposes would you use this system?
2. (5 min) What would the impact of such a web-based classification system be?
   a. Environmentally?
   b. Economically?
   c. Medically?
   d. Regarding behaviour routines? (e.g. consumer disposal of unused pharmaceuticals, behavior of doctors prescribing)
3. (5 min) What are your (or your organisation's) needs for information on PPs in the environment? (Wait for spontaneous answer.)
4. (10 min) Getting into more detail...
   - precisely which information (which data) would you require?

     OPEN CHECK-LIST: can cover points from following list or additional ones:
     a. characteristics of compound, e.g.
        - physicochemical data
        - persistency
        - stability and biodegradation-feature entries
        - pharmacokinetics
        - exposure data
        - entries on routes of administration
        - pharmacodynamics
        - entries on acute effects
        - entries on mammalian toxicology data
     b. sales figures, e.g.
        - current and retrospective sales data from interviewee's country / European countries

on behavior in wastewater treatment plants

/ PBT-aspects entries

on related to water body / water quality in European river basins

on related to management of pharmaceutical wastes

entries on occupational advices for the management of pharmaceutical wastes (valid e.g. for cytostatics because of their mutagenic properties)

detail (level of aggregation?)

the information be prepared and presented (figures, graphs, level of

you use this classification system in your work? (Wait for spontaneous

tion / influence your decision-making processes?

- Would your organization support such a classification system? Why / why not?
- Which organizations in your country would be pro / against such a system? (Why / why not?

5. (5 min) What should the main characteristics of a classification system be to ensure the system works adequately? (Wait for spontaneous answer.)
   a. origin of information (who provides data), guaranteeing adequate quality of information, neutrality, external revision, language
   b. Which categories of PPs should it cover? (Wait for spontaneous answer.)
   c. Any priority drugs to focus on in a first phase (e.g. antibiotics?)?
   d. Should both prescribed and OTC (over the counter) drugs be covered?
7. (5 min) What would your requirements of a web-based classification system be, e.g. in terms of usability?

   In case they are familiar with [illegible]
   a. Do you like the way the system is built? (e.g. regarding your own needs, regarding the different levels of information between broad public and advanced users)
   b. What changes would you like to see in the system?
   c. What are the shortcomings of the system? (Wait for spontaneous answer.)
      i. re. information
      ii. re. functioning
      iii. How could these be overcome?

   In case they are not familiar with [illegible]
   a. In your opinion, what should the main characteristics of the system be? (E.g. what kind of structure (architecture) should the system have? Should there be different levels of information, and if yes, for which kind of users and which kind of knowledge?)

8. (3 min) What is your perception of the risk posed by PPs in the environment?
   a. Is the media attention justified?
   b. Are the efforts for addressing the problem justified?
9. (2 min) Do you have any other comments? (If you think of additional comments after the end of the interview (e.g. later on today or tomorrow), please send them to us via email!!!)

Methodology

12 stakeholder groups:

1.	*Env. authorities (including RBOs) / Chemical authorities*		**6**	**interviewees**
2.	*Pharmaceutical Industry*		**3**	"
3.	*Water industry*		**2**	"
4.	*Drinking Water authorities*		**2**	"
5.	*Research organizations (different disciplines)*		**5**	"
6.	*Medicines Authorities*		**3**	"
7.	*Medical associations*		**2**	"
8.	*Pharmacies / Pharmacy Associations*		**1**	"
9.	*Consumer NGOs*		**1**	"
10.	*Environmental NGOs*		**2**	"
11.	*Public Health authorities*		**1**	"
12.	*Pharmaceutical Waste/Recycling Companies*	+	**1**	"

Total : **29 interviewees**

Main findings

a) Attitudes and exp. impacts

- ***Approval all through:*** **100% approve system**
- ***Widespread potential uptake:*** **62% would use**
- ***Environ. impacts:*** **most opinions +**
- ***Economic impacts:*** **+ predominant (few opinions)**
- ***Behavioural impacts (doctors/public):*** **diverging opinions**

Main findings

b) Information requirements

- ***Strong and widespread** requirements through most groups for:*
  - *physico-chemical data*
  - *toxicity and ecotoxicity*
  - *behaviour in environment*
  - *behaviour in water TPs*
  - *sales and volumes data*
  - *environmental levels*

Main findings

b) Information requirements

- ***Strongest requirements:*** **water actors, research actors, env NGOs.**

Water actors

Research inst.

Env. NGOs

Staholder group / Information requirements	Environmental authorities						Pharmaceutical industry			Water Utilities Associations	Drinking Water Authorities		Research organisations					Medicinal products authorities		Medical associations		Pharma. Assoc.	Consumer NGOs	Environm. NGOs	Public Health systems	Pharma Waste Companies
SH number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18[1]	19	20	21	22	23	24	25	26	27	28	29
Physico-chemical	X		X	X				X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X		
Ecotoxicological	X		X	X	X[2]					X[3]	X	X	X	X	X	X	X	X[4]	X	X				X	X	X	X	X	
Stability and biodegradation -feature	X		X	X				X		X	X	X	X	X	X	X	X	X	X	X					X	X	X		
Pharmacokinetic			(X)								X	X	X	X	X	(X)	X			X							X		
Excretion data	X		X							X	X	X	X	X	X	X	X	X	X	X						X	X		
Routes of administration			X							X		X	X	X	X	X	X	X		X						X	X		
Pharmacodynamic			(X)								X	X	X	X	X	X	X			X							X		
Side effects			(X)										X	X	X		X	X		X						X	X		
Mammalian toxicology data	(X)		X								X		X	X	X		X	X		X					X	X	X		
Sales data	X[5]		X	X	X		6	X		X	X	X	X[7]	X	X	X[8]		X	9	X[10]						X	X[11]	(X)	
Behavior in drinking water and wastewater treatment	X		X	X			X	X		X	X	X	X[12]	X	X	X	X	X	(X)	X				X[13]	X	X	X	
Behavior in drinking TP				X	X					X	X	X	X	X	X	X	X	X	(X)	X					X	X	X	X	
Water flows / quality in EU river basins	X		X	X			X				X[15]	X	X	X	X	X[16]	X	X		X					X	X[16]	X	(X)	
Management of PP wastes	(X)[18]		X	19	X					X	X	(X)	X	X	X	X		X	(X)						X		X		

Main findings

b) Information requirements

- ***Strongest requirements:*** water actors, research actors, env NGOs.
- ***Less strong requirements:*** **environmental authorities**

Env. authorities

Staholder group / Information requirements			Pharmaceutical industry						Water Utilities and Associations	Drinking Water Authorities	Research institutions						Medicinal products authorities			Medical associat-ions	Phar-ma. Assoc.	Consu-mer NGOs	Environm-ental NGO		Public Health Sys-tems	Phar-ma Waste Comp-anies
SH number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18[1]	19	20	21	22	23	24	25	26	27	28	29
Physico-chemical	X		X	X				X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X		
Ecotoxicological	X		X	X	X[2]					X[3]	X	X	X	X	X	X	X	X[4]	X	X				X	X	X	X	X	
Stability and biodegradation -feature	X		X	X				X		X	X	X	X	X	X	X	X	X	X	X					X	X	X		
Pharmacokinetic			(X)								X	X	X	X	X	(X)	X			X							X		
Excretion data	X		X							X	X	X	X	X	X	X	X	X	X	X						X	X		
Routes of administration			X							X		X	X	X	X	X	X	X	X	X						X	X		
Pharmacodynamic			(X)								X	X	X	X															
Side effects			(X)										X	X	X		X	X		X						X	X		
Mammalian toxicology data	(X)		X								X		X	X	X		X	X		X					X	X	X		
Sales data	X[5]		X	X	X		6	X		X	X	X	X[7]	X	X	X[8]		X	9	X[10]						X	X[11]	(X)	
Behavior in drinking water and wastewater treatment	X		X	X			X	X		X	X	X	X[12]	X	X	X	X	X	(X)	X				X[13]	X	X	X	
Behavior in drinking TP				X	X					X	X	X	X	X	X	X	X	X	(X)	X					X	X	X	X	
Water flows / quality in EU river basins	X		X	X			X				X[15]	X	X	X	X	X[16]	X	X		X					X	X[16]	X	(X)	
Management of PP wastes	(X)[18]		X	19	X					X	X	(X)	X	X	X	X		X	(X)						X		X		

Gaps related to human effects / human toxicology

Main findings

b) Information requirements

- ***Strongest requirements:*** water actors, research actors, env NGOs.
- ***Less strong requirements:*** environmental authorities
- ***Some requirements:*** **pharmaceutical industry**

Pharma industry

Staholder group / Information requirements	Environmental authorities						Pharma industry			Water Utilities and Associations		Drinking Water Authorities		Research institutions					Medicinal products authorities			Medical associat-ions		Phar-ma. Assoc.	Consu-mer NGOs		Environm-ental NGO		Public Health Sys-tems	Phar-ma Waste Comp-anies
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Physico-chemical	X		X	X				X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X		
Ecotoxicological	X		X	X	X[2]					X[3]	X	X	X	X	X	X	X	X[4]	X	X				X	X	X	X	X	
Stability and biodegradation -feature	X		X	X				X		X	X	X	X	X	X	X	X	X	X	X					X	X	X		
Pharmacokinetic			(X)								X	X	X	X	X	(X)	X			X							X		
Excretion data	X		X							X	X	X	X	X	X	X	X	X	X	X						X	X		
Routes of administration			X							X		X	X	X	X	X	X	X		X						X	X		
Pharmacodynamic			(X)								X	X	X	X	X	X	X			X							X		
Side effects			(X)										X	X	X		X	X		X						X	X		
Mammalian toxicology data	(X)		X								X		X	X	X		X	X		X					X	X	X		
Sales data	X[5]		X	X	X		6	X		X	X	X	X[7]	X	X	X[8]		X	9	X[10]						X	X[11]	(X)	
Behavior in drinking water and wastewater treatment	X		X	X			X	X		X	X	X	X[12]	X	X	X	X	X	(X)	X				X[13]	X	X	X	
Behavior in drinking TP				X	X					X	X	X	X	X	X	X	X	X	(X)	X					X	X	X	X	
Water flows / quality in EU river basins	X		X	X			X				X[15]	X	X	X	X	X[16]	X	X		X					X	X[16]	X	(X)	
Management of PP wastes	(X)[18]		X	19	X					X	X	(X)	X	X	X	X		X	(X)						X		X		

Main findings

b) Information requirements

- ***Strongest requirements:*** water actors, research actors, env NGOs.
- ***Less strong requirements:*** environmental authorities
- ***Some requirements:*** pharmaceutical industry
- ***Minimal requirements:*** **doctors / pharmacists**

Doctors / pharmacists

Staholder group / Information requirements	Environmental authorities						Pharmaceutical industry			Water Utilities and Associations	Drinking Water Authorities	Research institutions						Medicinal products authorities		Pharma. associations		Pharma. Assoc.	Environmental NGOs		Public Health Systems	Pharma Waste Companies
SH number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18[1]	19	20	21	22	23	24	25	26	27	28	29
Physico-chemical	X		X	X				X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X		
Ecotoxicological	X		X	X	X[2]					X[3]	X	X	X	X	X	X	X	X[4]	X	X				X	X	X	X	X	
Stability and biodegradation -feature	X		X	X				X		X	X	X	X	X	X	X	X	X	X	X					X	X	X		
Pharmacokinetic			(X)								X	X	X	X	X	(X)	X			X							X		
Excretion data	X		X							X	X	X	X	X	X	X	X	X	X	X						X	X		
Routes of administration			X							X		X	X	X	X	X	X	X		X						X	X		
Pharmacodynamic			(X)								X	X	X	X	X	X	X			X							X		
Side effects			(X)										X	X	X		X	X		X						X	X		
Mammalian toxicology data	(X)		X								X		X	X	X		X	X		X					X	X	X		
Sales data	X[5]		X	X	X		6	X		X	X	X	X[7]	X	X	X[8]		X	9	X[10]						X	X[11]	(X)	
Behavior in drinking water and wastewater treatment	X		X	X			X	X		X	X	X	X[12]	X	X	X	X	X	(X)	X					X[13]	X	X	X	
Behavior in drinking TP				X	X					X	X	X	X	X	X	X	X	X	(X)	X					X	X	X	X	
Water flows / quality in EU river basins	X		X	X			X				X[15]	X	X	X	X	X[16]	X	X		X					X	X[16]	X	(X)	
Management of PP wastes	(X)[18]		X	19	X					X	X	(X)	X	X	X	X		X	(X)						X		X		

Main findings

c) Two approaches for IS on PIE

Two **(non-exclusive!!!)** concepts:

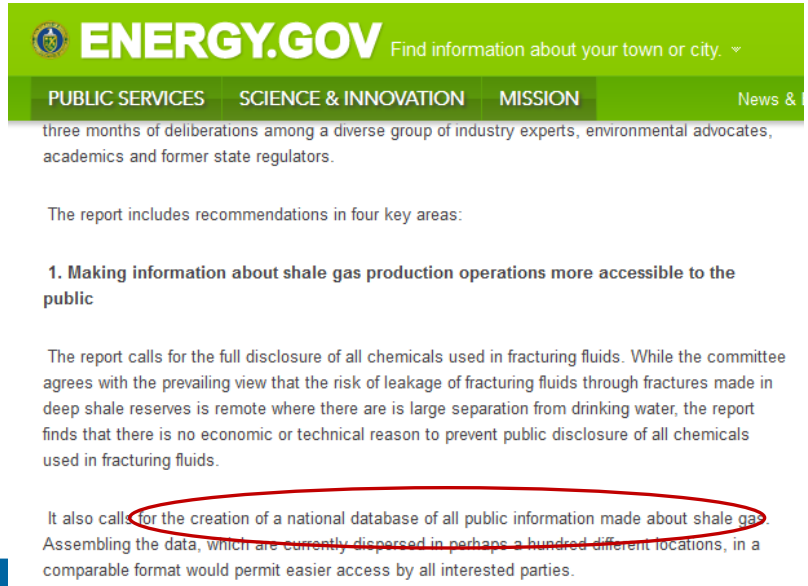
1) Knowledge-base approach

- Collects **wide array of information**, e.g.
  - *intrinsic properties, environmental behaviour*
  - *data on environmental occurrence,*
  - *further information (e.g. behaviour in WWTPs)*
- **Strong stakeholder support** (many affected by data gaps)
- **Basis** for **development of specific DSS** (e.g. WWTP processes).
- Used for **science and transparency** in emerging env. issues.

Main findings

c) Two approaches for IS on PIE

Some Knowledge Base examples:



Main findings

c) Two approaches for IS on PIE

2) DSS for doctors / pharmacists / patients

- Information on **environmental performance** of substances, i.e. limited to:

  a) intrinsic properties,

  b) substance's environmental risk / hazard.

- Aims to **influence behaviour routines** and **increase awareness**:
  - ***Possible criteria** when choosing **otherwise equivalent pharmaceuticals***
  - ***Improved disposal** of medicines.*
- Could **incentive companies** to develop products with **lower impact**.

Main findings

c) Two approaches for IS on PIE

Classification system for doctors / patients has widespread support, but….

Strong "pull" for more data, stakeholders affected by gaps

To ***increase impact***, system should ***go beyond needs of doctors / pharmacists***, and ***include elements of Knowledge-base approach***

- **Multiplier effects** (e.g. wastewater treatment)
- **More chances of uptake** and use / impact
- **Fass.se** already provides (some) additional data

Thank you for your attention.

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