Mixtures in the soil environment (seen in the context of any EU soil directive)

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Perhaps not such a mythical beast

It is real

It is in (slow) progress

COUNCIL OF
THE EUROPEAN UNION

Brussels, 4 March 2010

Interinstitutional File:
2006/0086 (COD)

6124/1/10
REV 1

LIMITE

ENV 64
AGRI 35
DEVGEN 42
FORETS 19
FSTR 5
RECH 40
REGIO 5
TRANS 27
CODEC 89

REVISED NOTE

from :	General Secretariat
to :	Committee of the Permanent Representatives
No. prev. doc. :	5772/10 ENV 44 AGRI 28 DEVGEN 37 FORETS 15 FSTR 2 RECH 23 REGIO 2 TRANS 18 CODEC 61
No. Cion prop. :	13388/06 ENV 495 AGRI 305 DEVGEN 232 FORETS 32 FSTR 64 RECH 242 REGIO 53 TRANS 246 CODEC 1012 - COM(2006) 232 final
Subject :	**PREPARATION OF THE COUNCIL (ENVIRONMENT) MEETING ON 15 MARCH 2010** Proposal for a Directive of the European Parliament and of the Council establishing a framework for the **protection of soil** - Progress report

I. **INTRODUCTION**

1. The Commission submitted its proposals for a Thematic Strategy for soil protection and a Proposal for a Directive establishing a framework for the protection of soil to the Council on 25 September 2006. The proposal for a Directive is based on Article 192(1) of the Treaty on the Functioning of the European Union.

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DEFINING SOIL ECOSYSTEM SERVICES

- food and other biomass production
- storing, filtering and transforming nutrients, substances and water
- basis for life and biodiversity, such as habitats, species and genes
- physical and cultural environment
- source of raw materials and products
- acting as carbon reservoir
- archive of geological and archaeological heritage

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- nd products
. eservoir
geological and archaeological heritage

Soil is really pretty important stuff

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THREATS TO SOIL SERVICES

Soil Degradation

- erosion by water or wind
- organic matter decline
- compaction
- salinisation
- landslides
- acidification

Contamination (treated as a separate issue)

SFD AND CONTAMINATED SITES

Article 10 : Identification and inventory of contaminated sites

A flexible procedure for identification of contaminated sites

- through identifying potentially soil-contaminating activities
- by following a Member States prioritisation procedure
- states can set a deadline for finalisation of the contaminated sites inventory

Strong concerns in relation to the provisions on the risk assessment methodology for identifying contaminated sites – SFD states this can be left to Member States to determine.

SFD AND MIXTURES

BRGM (Bureau de Recherches Géologiques et Minières) advice :

"Mixtures is considered as a technical issues, and not policy one." and therefore is not covered in the current SFD proposal.

Member states could suggest the inclusion of Mixtures in national legal & technical frameworks, but such details would be likely to become problematic for any harmonization at European level (e.g. how to define acceptable risks for mixtures? Which mixtures?)

Summary of current policy position

Better to have a framework directive on soil (as is available now for water) instead of nothing

COUNTRY SPECIFIC POLICIES

Many countries have policies and guidance

- human health
- ecological risk assessment
- integrated approaches (ecosystem services)

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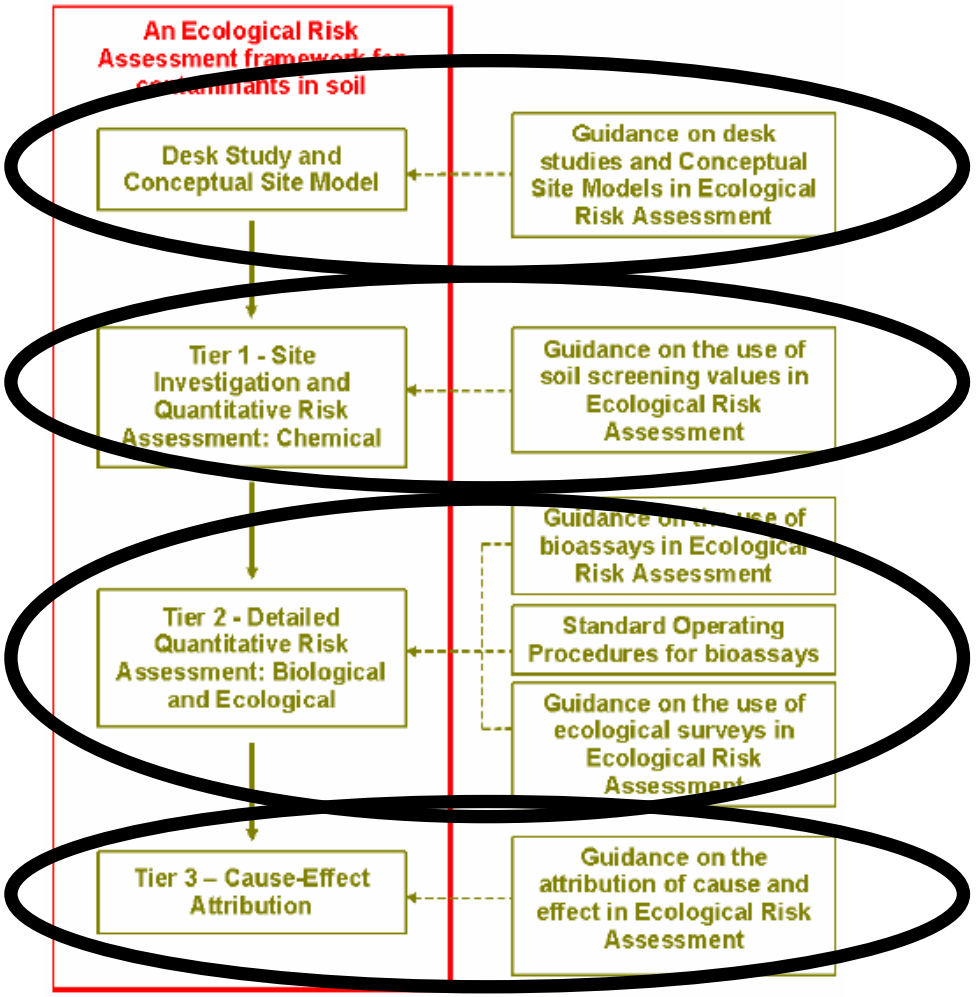
TYPICAL RISK ASSESSMENT STRUCTURE



Conceptual model

EQS

Biological investigations

Integrated risk analysis

Figure 1.1 Position of this document within the overall ERA framework

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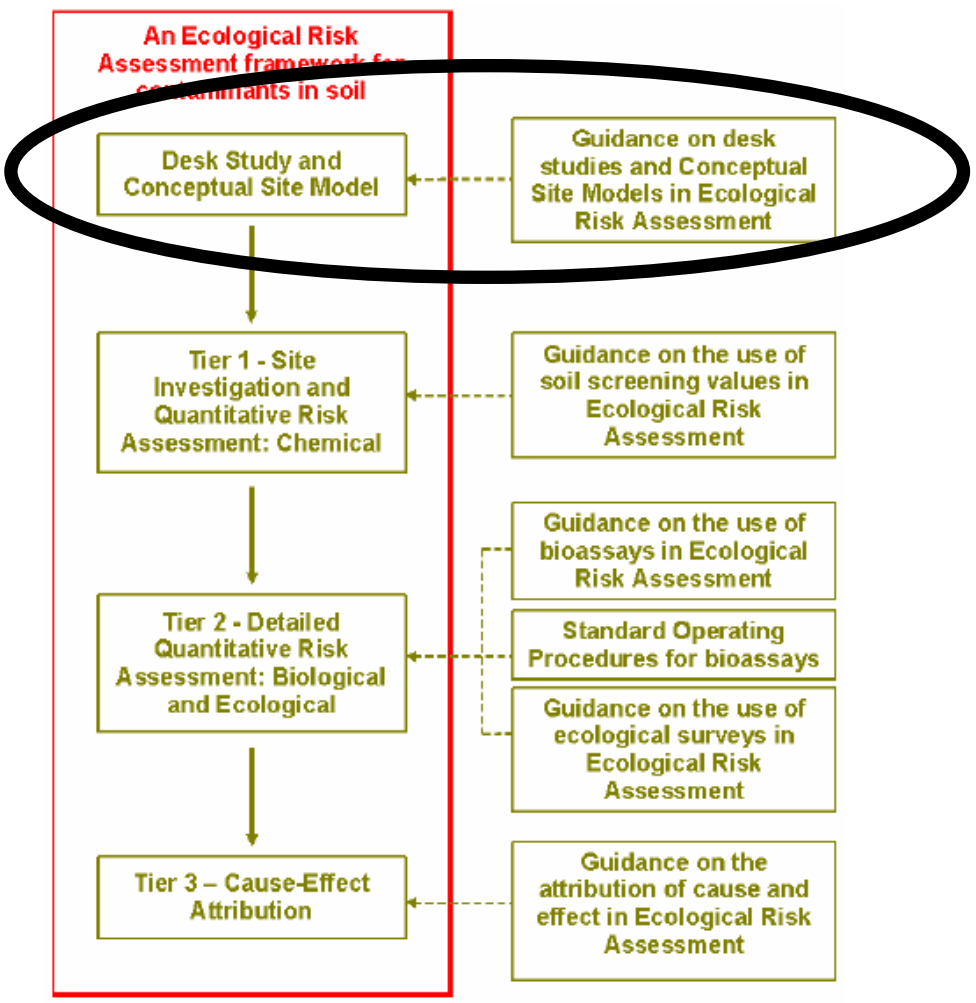
TYPICAL RISK ASSESSMENT STRUCTURE



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Conceptual framework

ESTABLISH SOURCES

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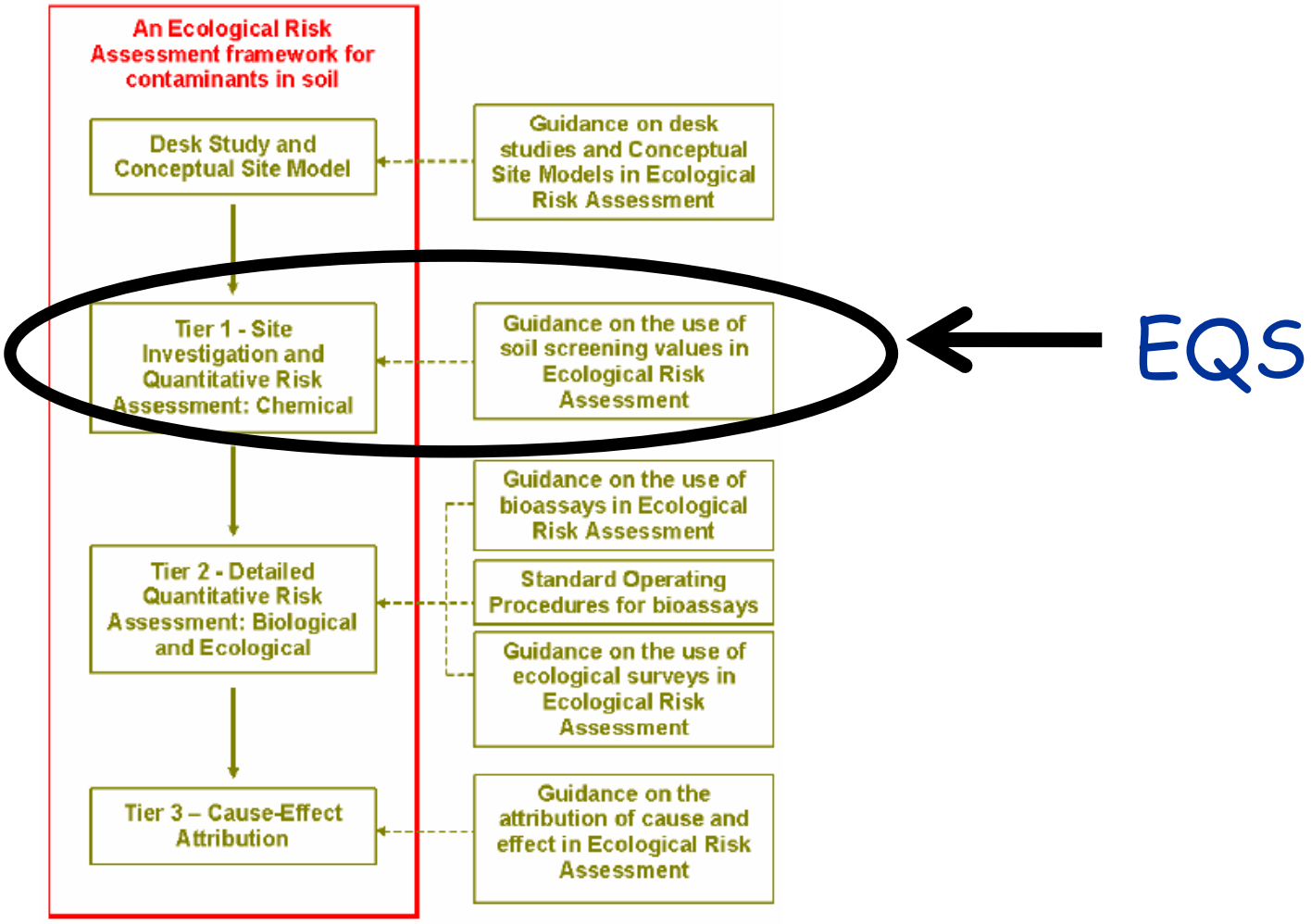
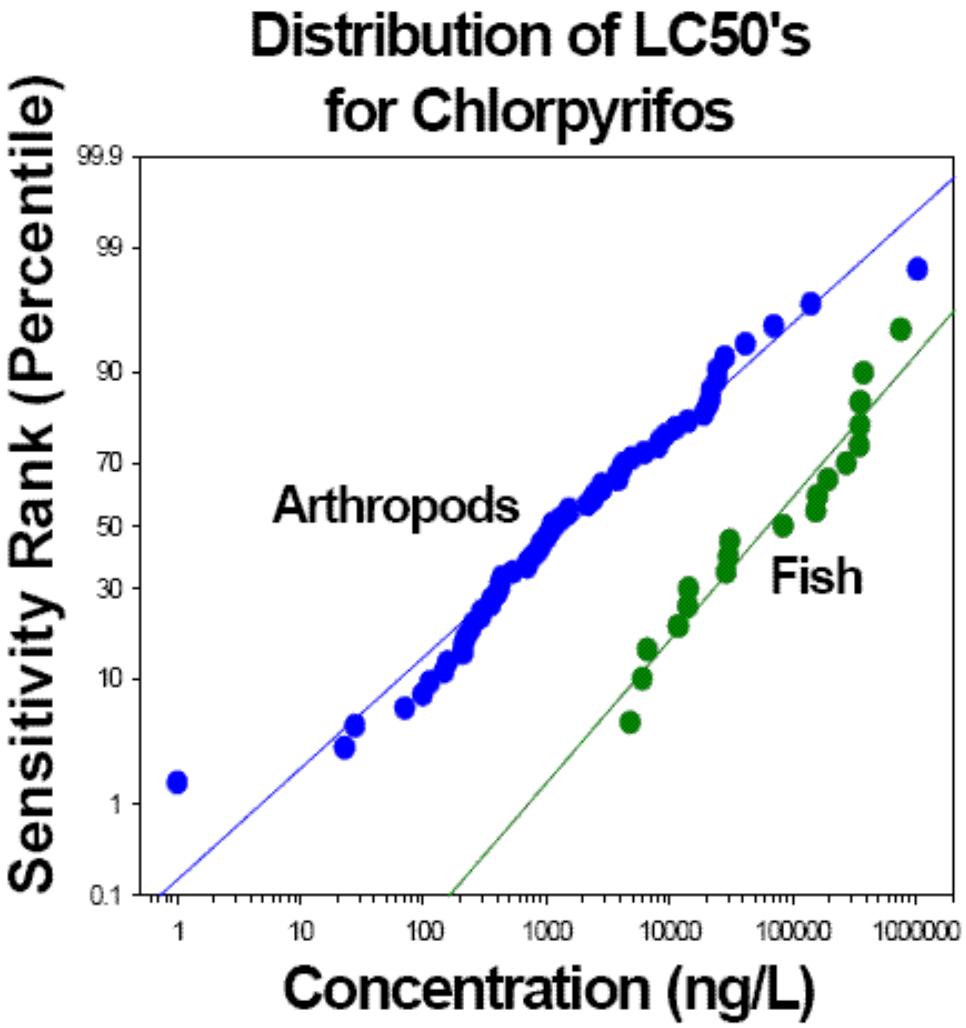


Figure 1.1 Position of this document within the overall ERA framework

DERIVING EQS VALUES

By species sensitivity distribution



- Order species by sensitivity to chemical
- Use of define level that would protect a certain percentage of species (e.g. 95%)
- Use as a protection value in policy

PRIORITY CONTAMINANTS

Focus on the "usual suspects"

- metal processing
- oil and coal gas processing
- legacy pesticides and POPs
- chlorinated solvents

Metals	Arsenic	Polycyclic aromatic hydrocarbons (PAHs)	Polycyclic aromatic hydrocarbons (PAHs)
	Beryllium		Benzo(a)pyrene
	Cadmium		Anthracene
	Copper		Naphthalene
	Lead	Chlorinated hydrocarbons	1,2,4-trichlorobenzene
	Mercury		Tetrachlorobenzene
	Nickel		Pentachlorobenzene
	Selenium		1,2-Dichloroethane
	Zinc		1,1,1,-Trichloroethane
Organometals	Organolead compounds		Trichloroethene
	Organotin compounds, e.g. tributyltin		Tetrachloroethene
Inorganics	Cyanides		Pentachlorophenol
Aromatics	Total petroleum hydrocarbons (TPH)		Chlorotoluenes
	Benzene		Vinyl chloride
	Toluene		Chloroform
	Ethylbenzene		Hexachlorobuta-1,3-diene
	Xylene(s)		Polychlorinated biphenyls (total)
	Phenol		Dioxins and furans
Pesticides	Dieldrin		
	DDT (total)		
	HCH (total)		

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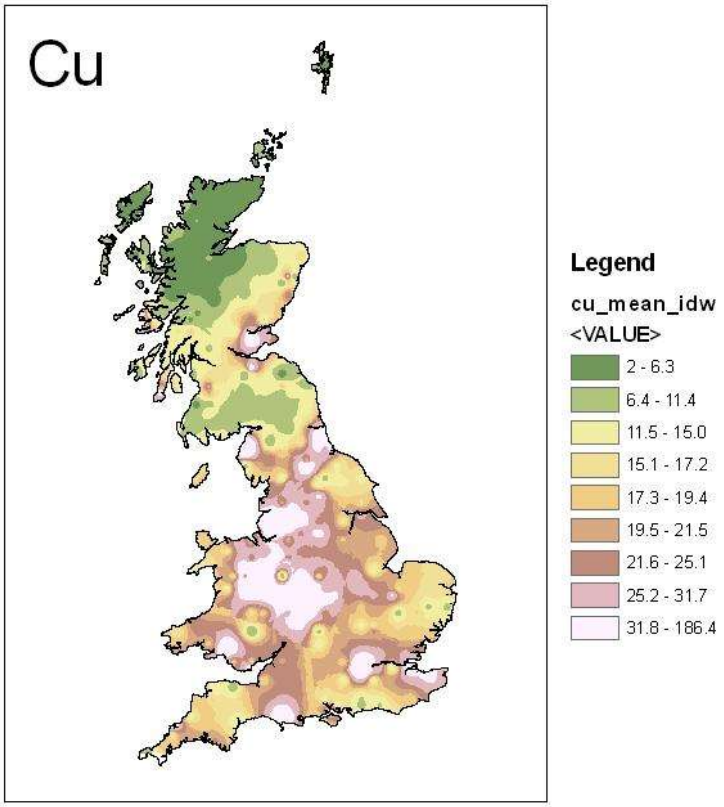
MIXTURES

Universal (near) truth - Pollutants do not occur in isolation



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Spurgeon et al (2008). Environ. Pollut.

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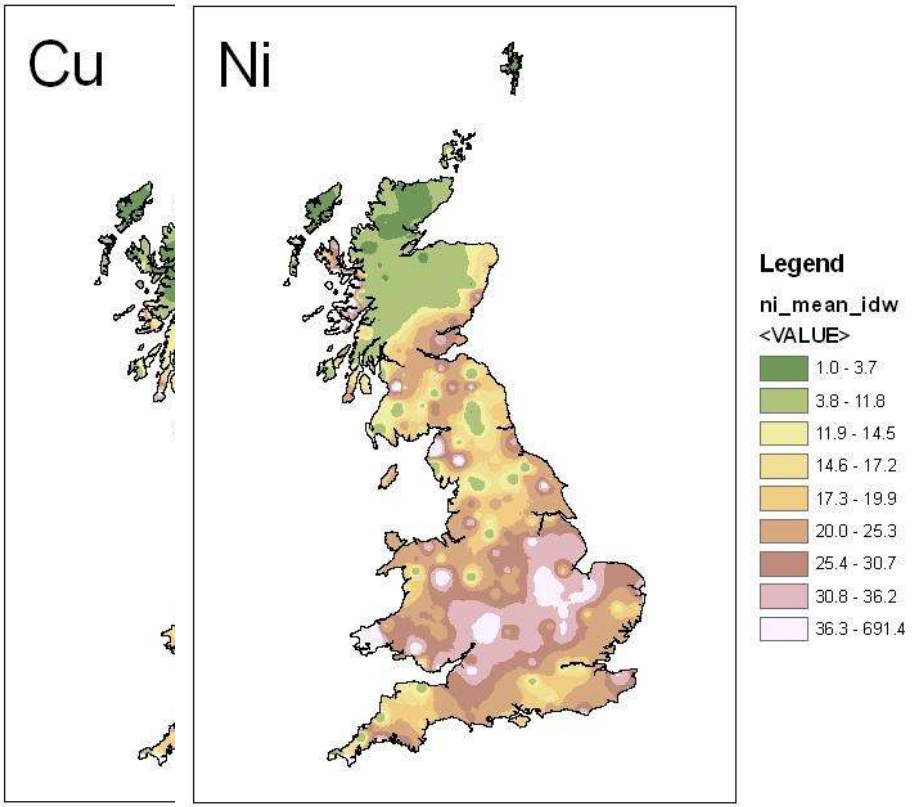

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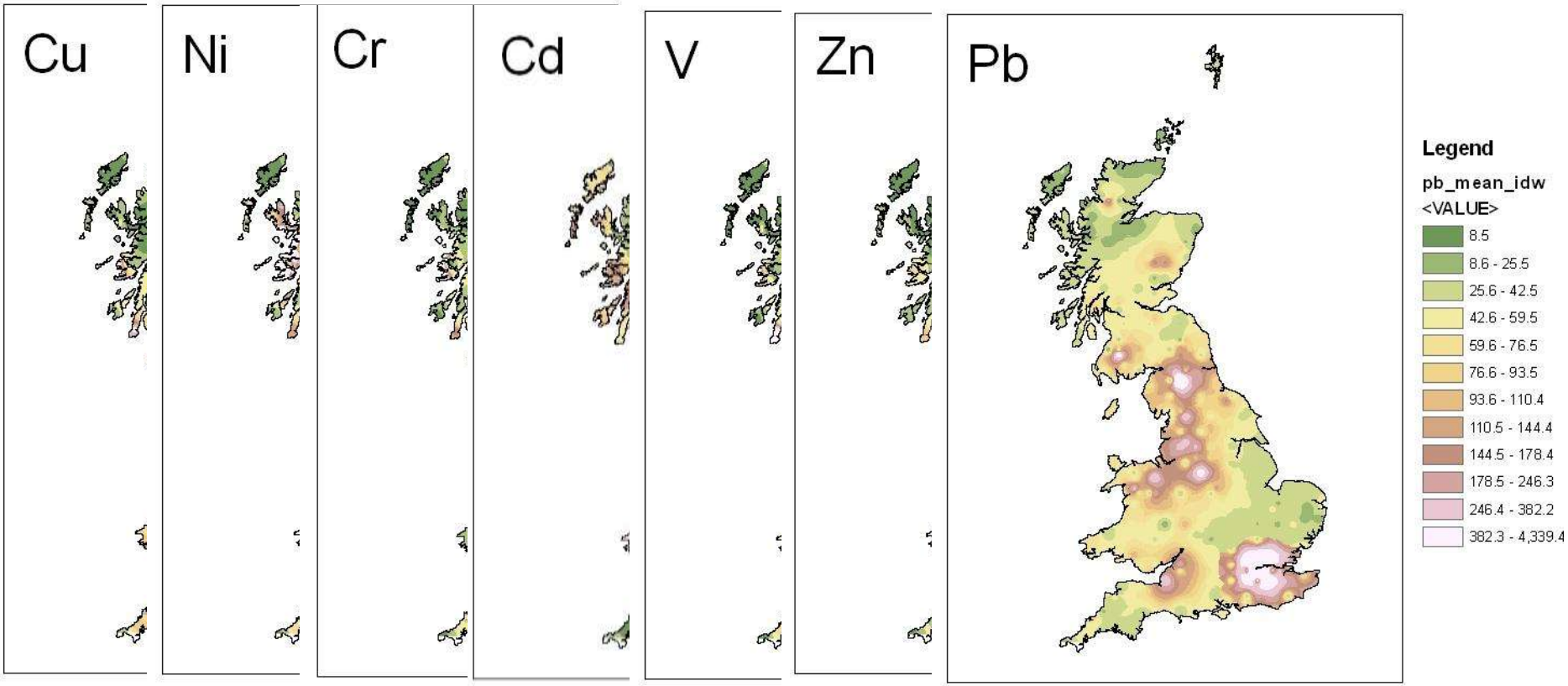

Current risk assessment practice does not recognise this

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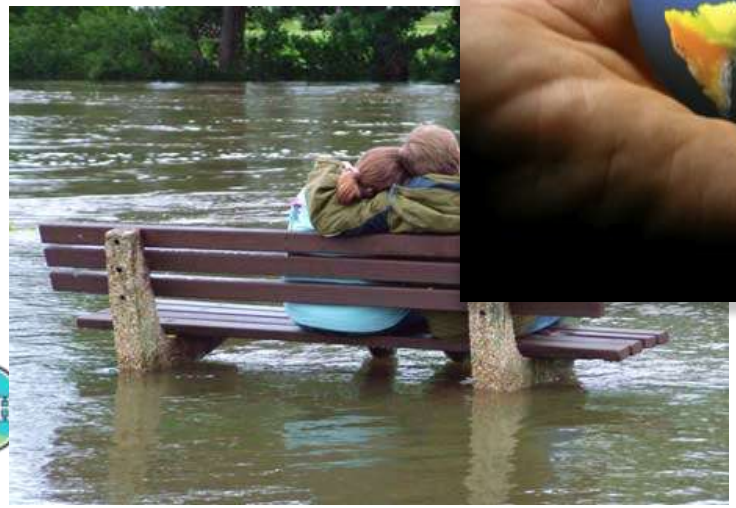
Spurgeon et al (2008). Environ. Pollut.

MULTIPLE STRESSORS

Chemicals not in isolation of other stressors



TYPICAL RISK ASSESSMENT STRUCTURE

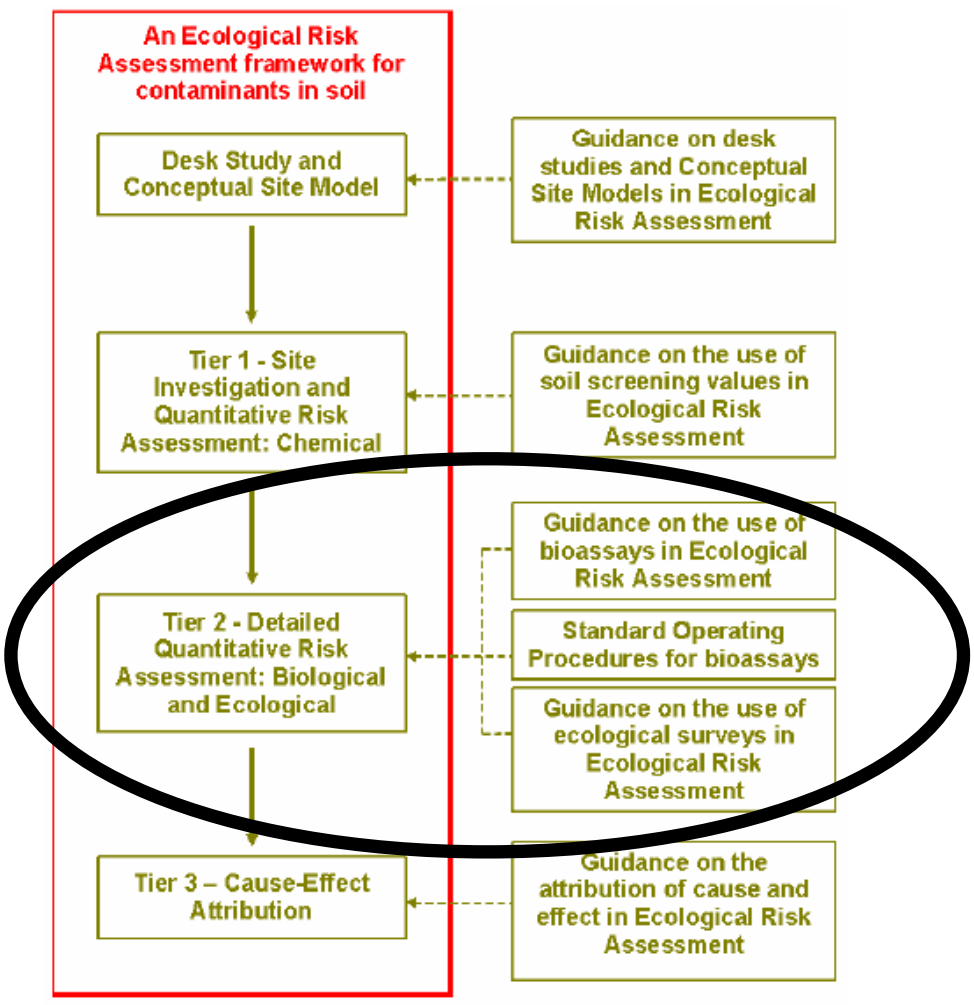


Figure 1.1 Position of this document within the overall ERA framework

Biological investigations

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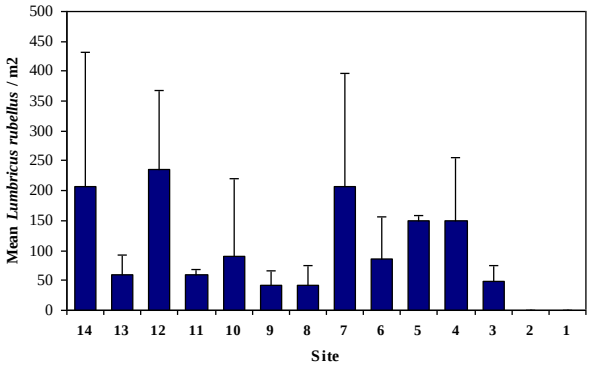
ECO-SURVEY OR BIOASSAY

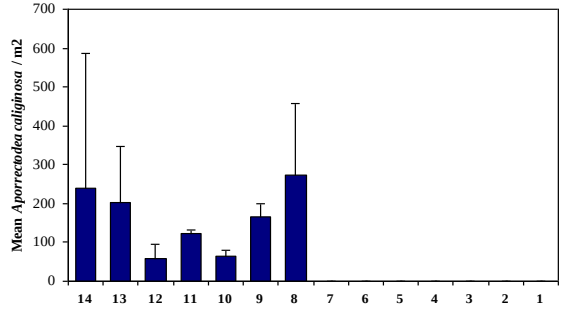
Earthworms

Species abundance

Lumbricus rubellus



Aporrectodea caliginosa



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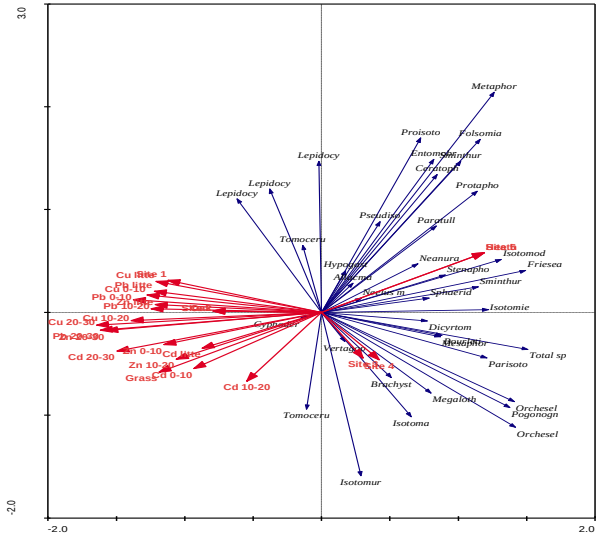
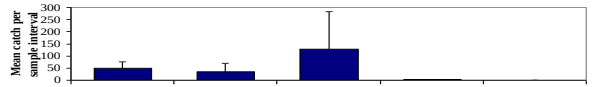
Springtails

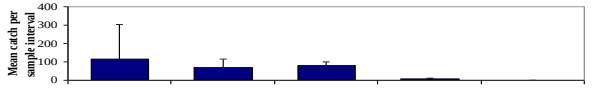
Community composition



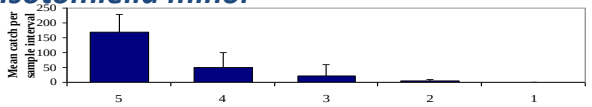
Orchesella cincta



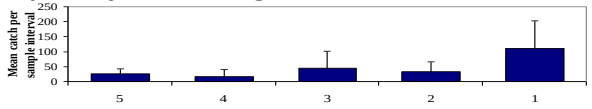
Orchesella villosa



Isotomiella minor



Lepidocyrtus lanuginosus



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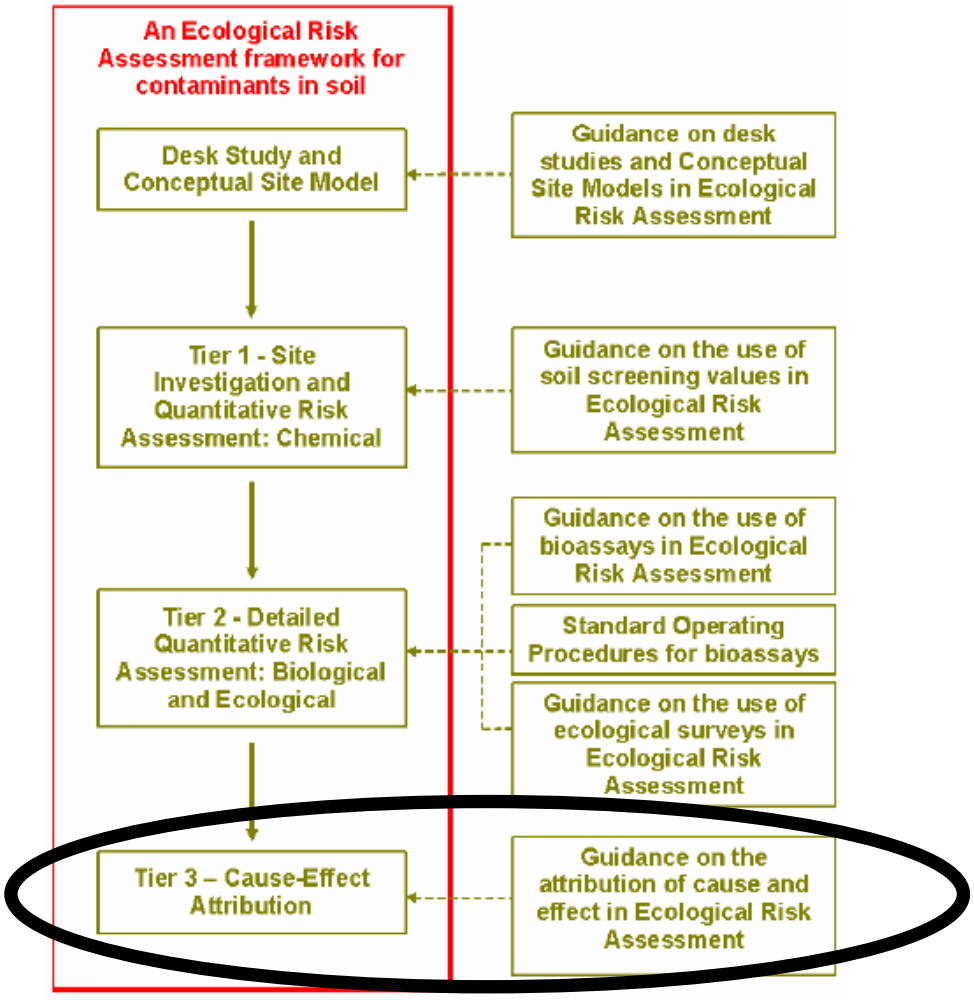

Integrated risk analysis

Figure 1.1 Position of this document within the overall ERA framework

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FRAMEWORKS AND MIXTURES

Linking exposure and effects in mixtures risk assessment still remain a research question

SO WHAT DOES SOME OF THE RESEARCH SAY?

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MIXTURE THEORY: THE BASICS

The 4 classes of joint effect	No interaction (additive)	Interaction (non-additive)
Similar action	Simple similar action	Complex similar action
Dissimilar action	Independent action	Dependent action

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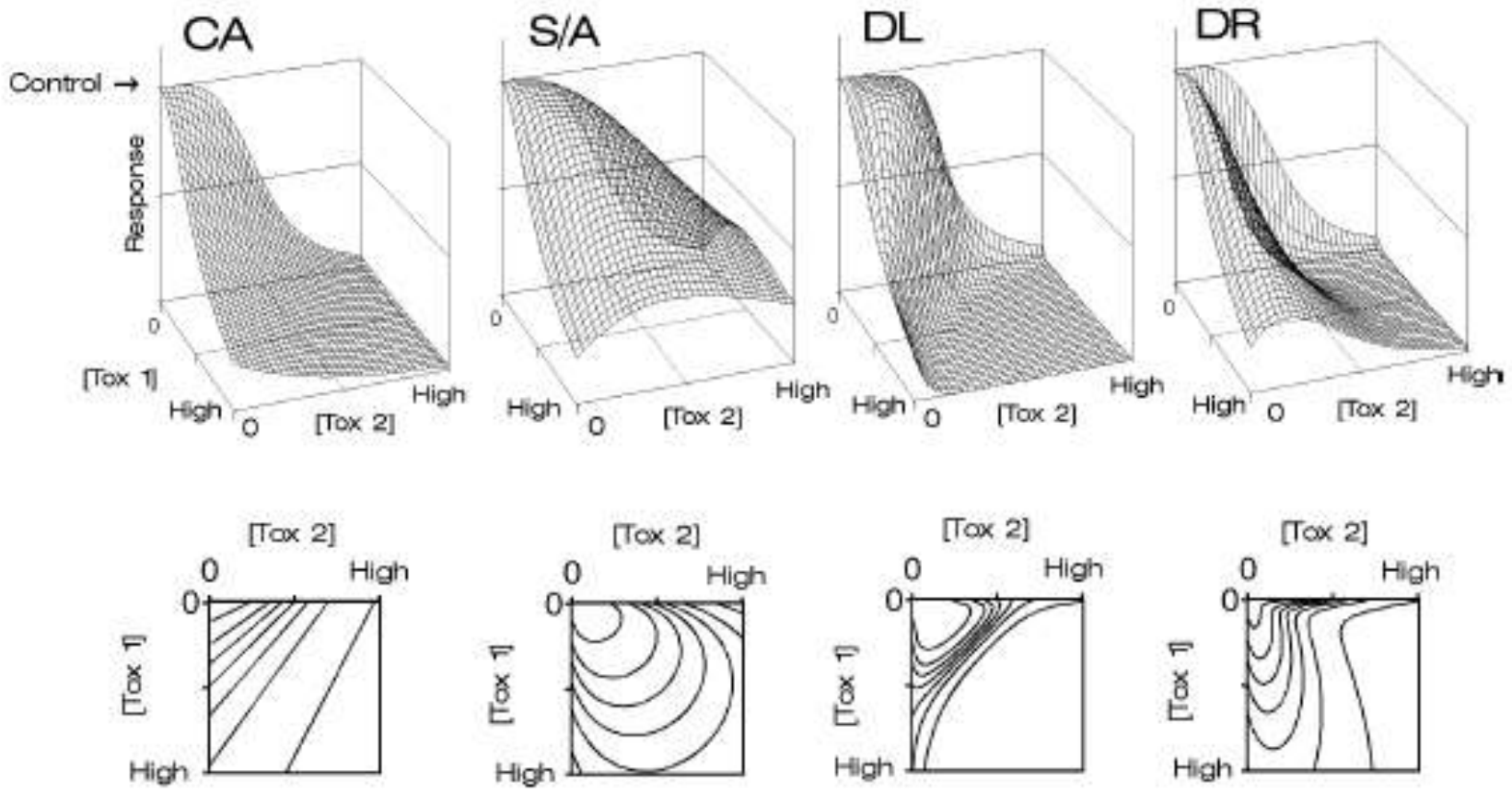
(Hewlett and Plackett, 1959)

MIXTURE ANALYSIS IN DETAIL

Add parameter "a" Add parameter "b"

1) CA & IA → 2) S/A → 3A) DL or 3B) DR



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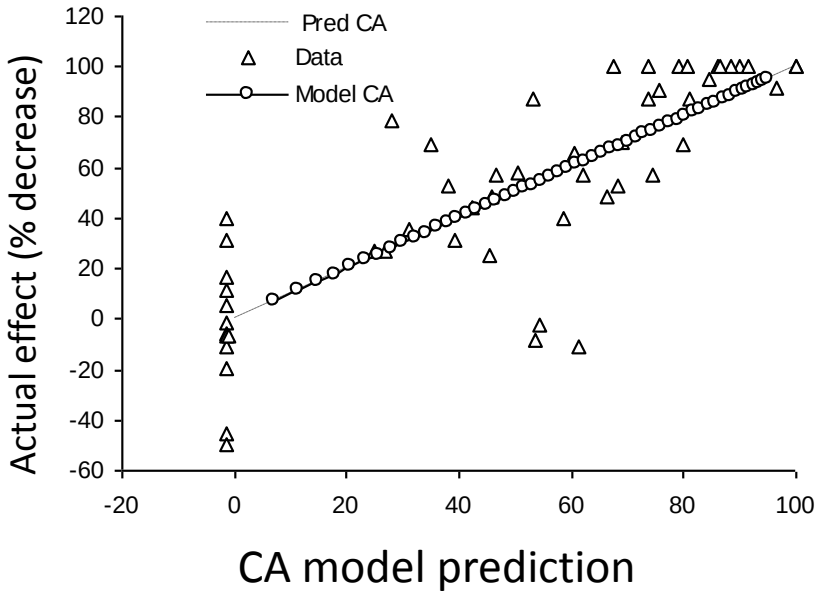
(Jonker et al (2005). ET&C.

Fig. 3

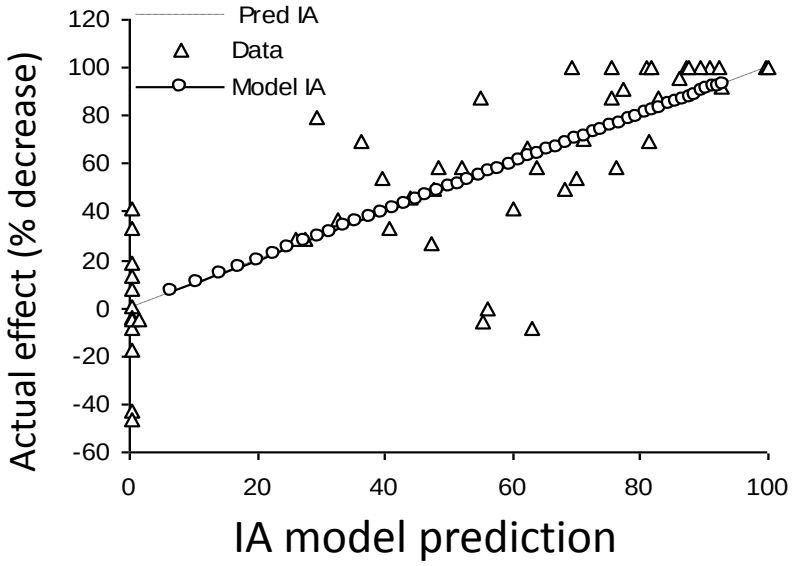
MIXTURES PRACTICE

- Exposed *L. rubellus* to the pesticide chlorpyrifos and metal nickel
- Exposure 28 day in natural soil
- Measured effect on cocoon production

a



b



Conclusion – This stressor mixture is additive (can't tell how)

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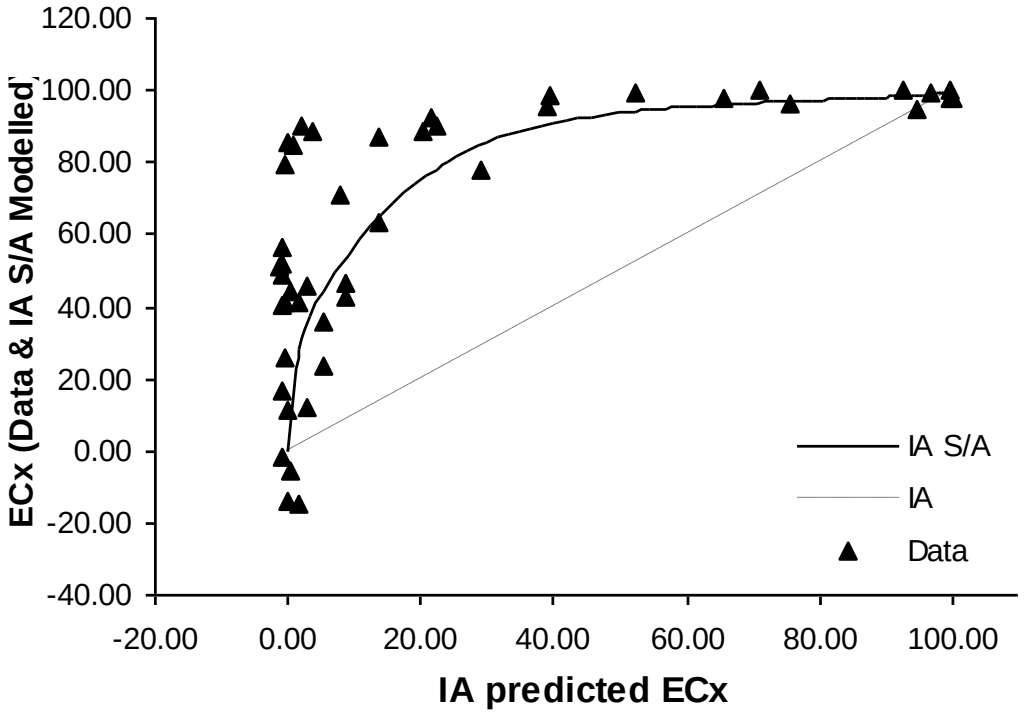
Lister et al (in press). Env Int

MIXTURES PRACTICE

An example: Cd + diuron in *C. elegans*

Predict ECx values by IA and S/A models and compare to data



Conclusion - This binary mixture is synergistic

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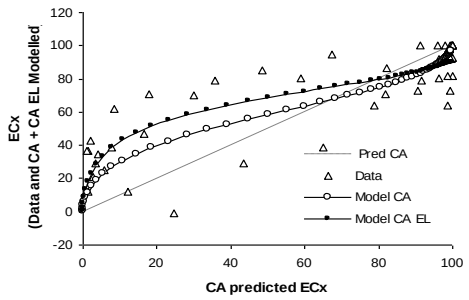
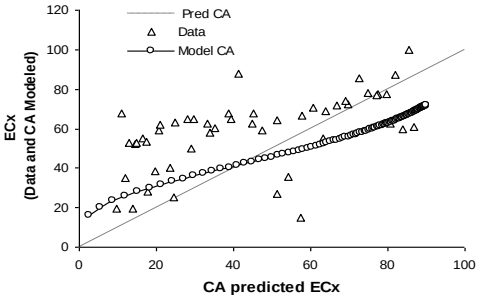
MIXTURES – A SURVEY

Mixtures of pesticides (Organophosphates (Chlp, Diaz), pyrtehroidfs (Perm) and neonicotinoids (Imid, Thia).

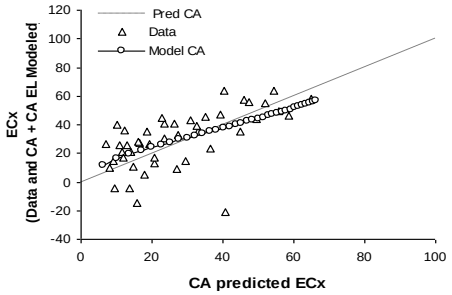
A Clp x Diaz



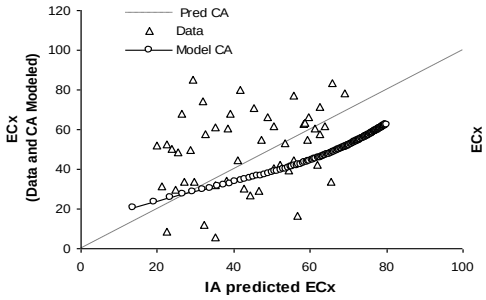
B – Imid x Thia



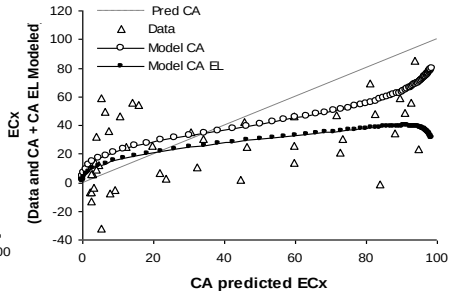
C – Perm x Imid



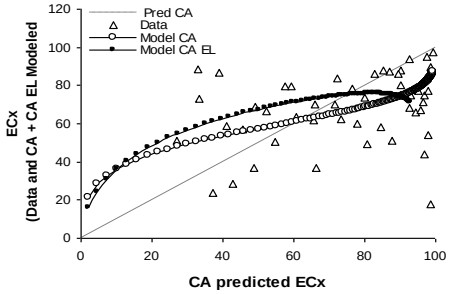
D – Perm x Thia



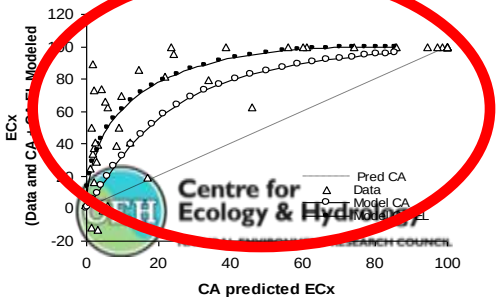
E – Perm - Clp



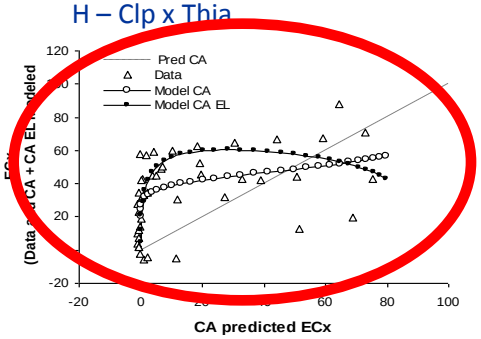
F – Perm - Diaz



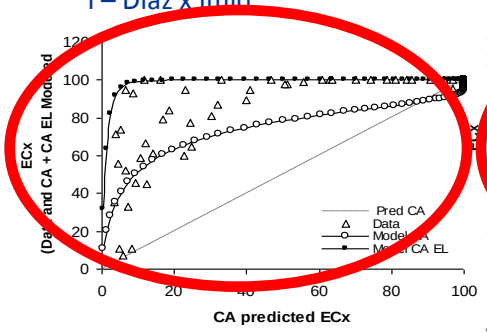
G – Clp x Imid



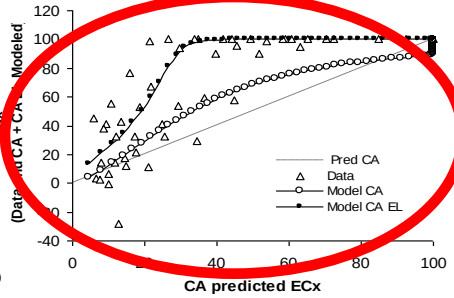
H – Clp x Thia



I – Diaz x Imid



J Diaz x Thia



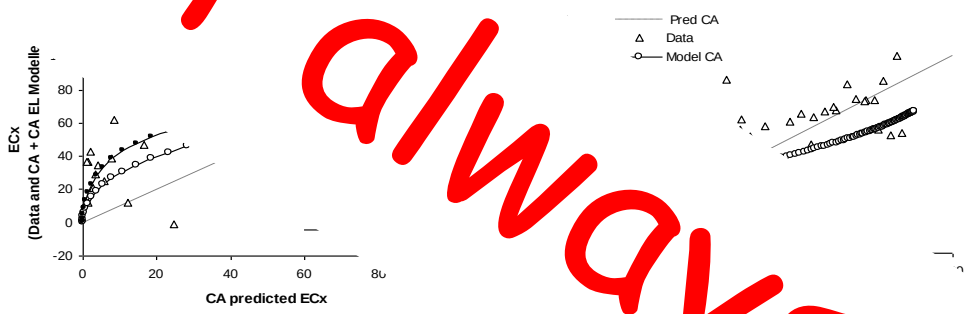
Svendsen et al (2010). ET&C

MIXTURES – A SURVEY

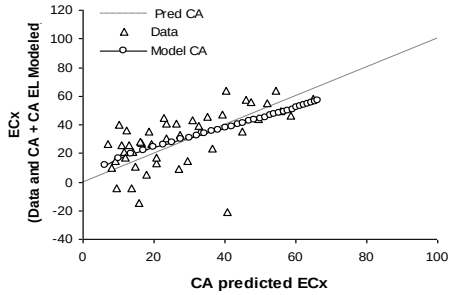
...f pesticides (Organophosphates (Chlp, Diaz),
... (Perm) and neonicotinoids (Imid, Thia).

Not always additive

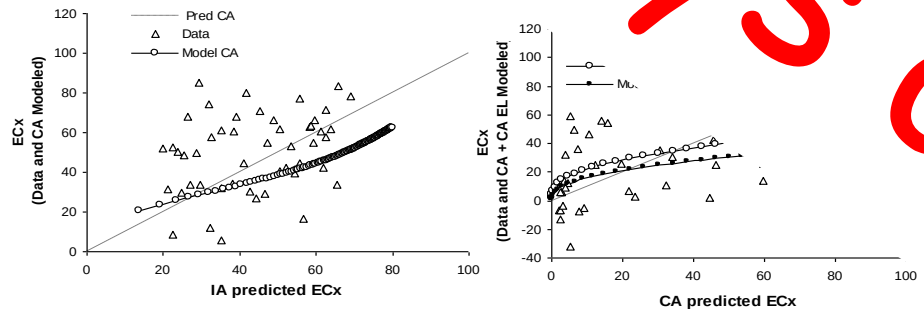
B – Imid x Thia



C – Perm x Imid

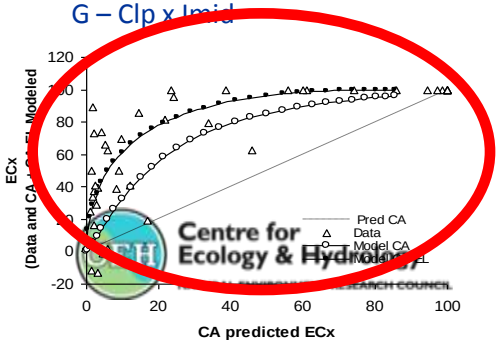


D – Perm x Thia

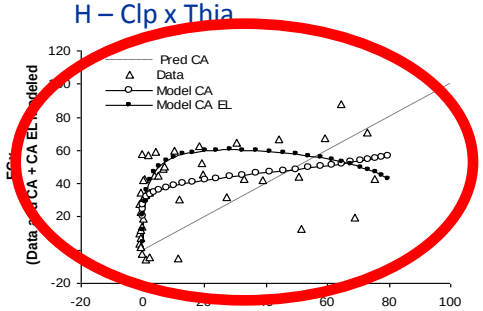


F – Perm - Diaz

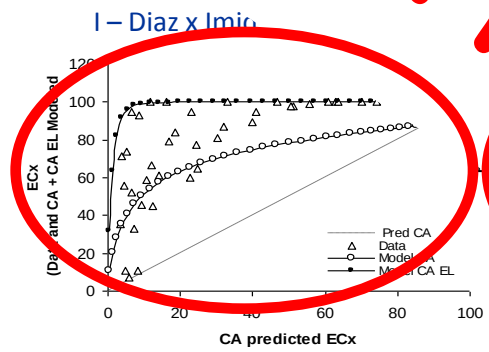
G – Clp x Imid

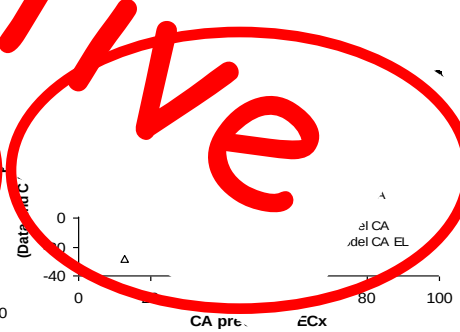


H – Clp x Thia



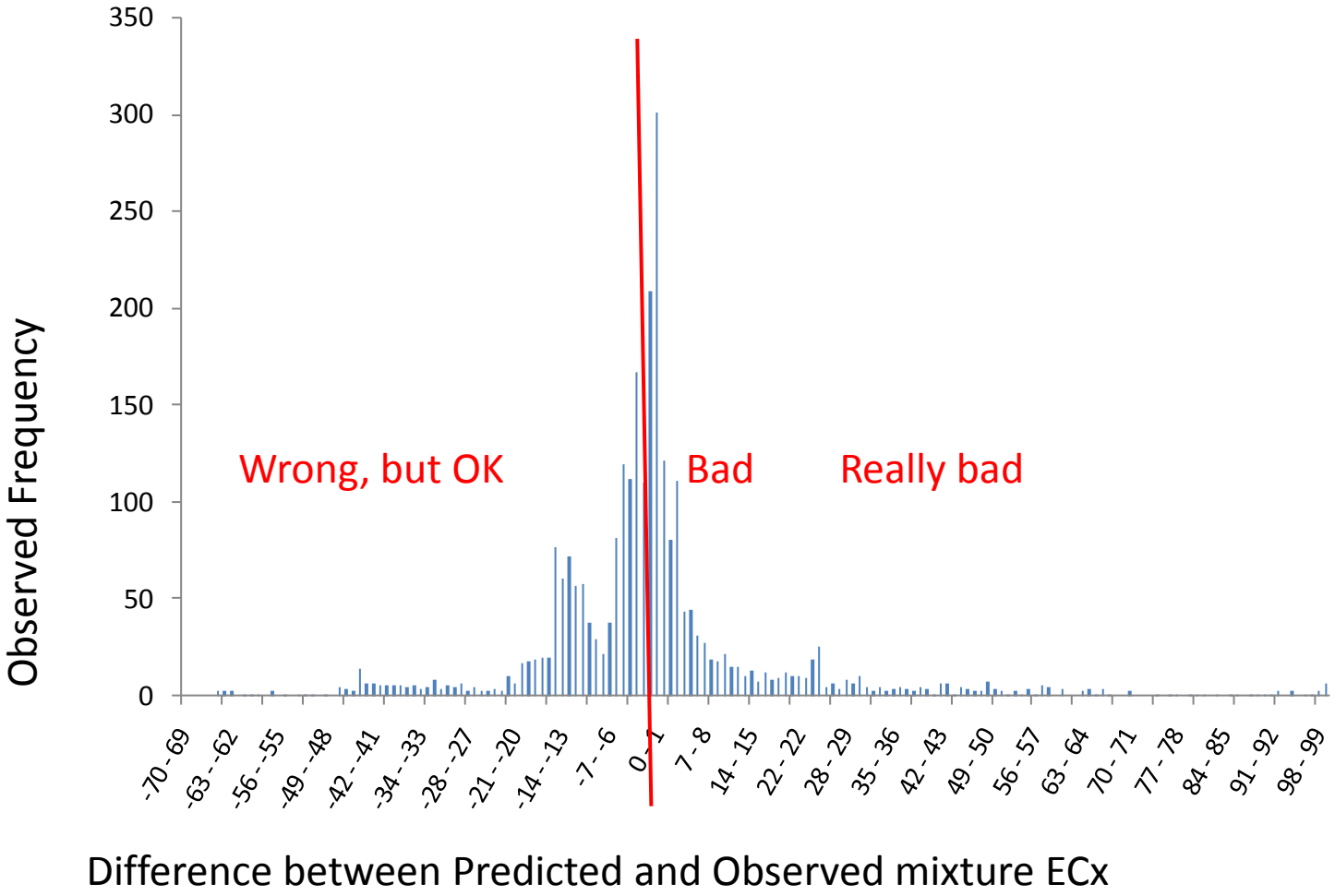
I – Diaz x Imid





Svendsen et al (2010). ET&C

PATTERNS OF OBSERVED EFFECTS



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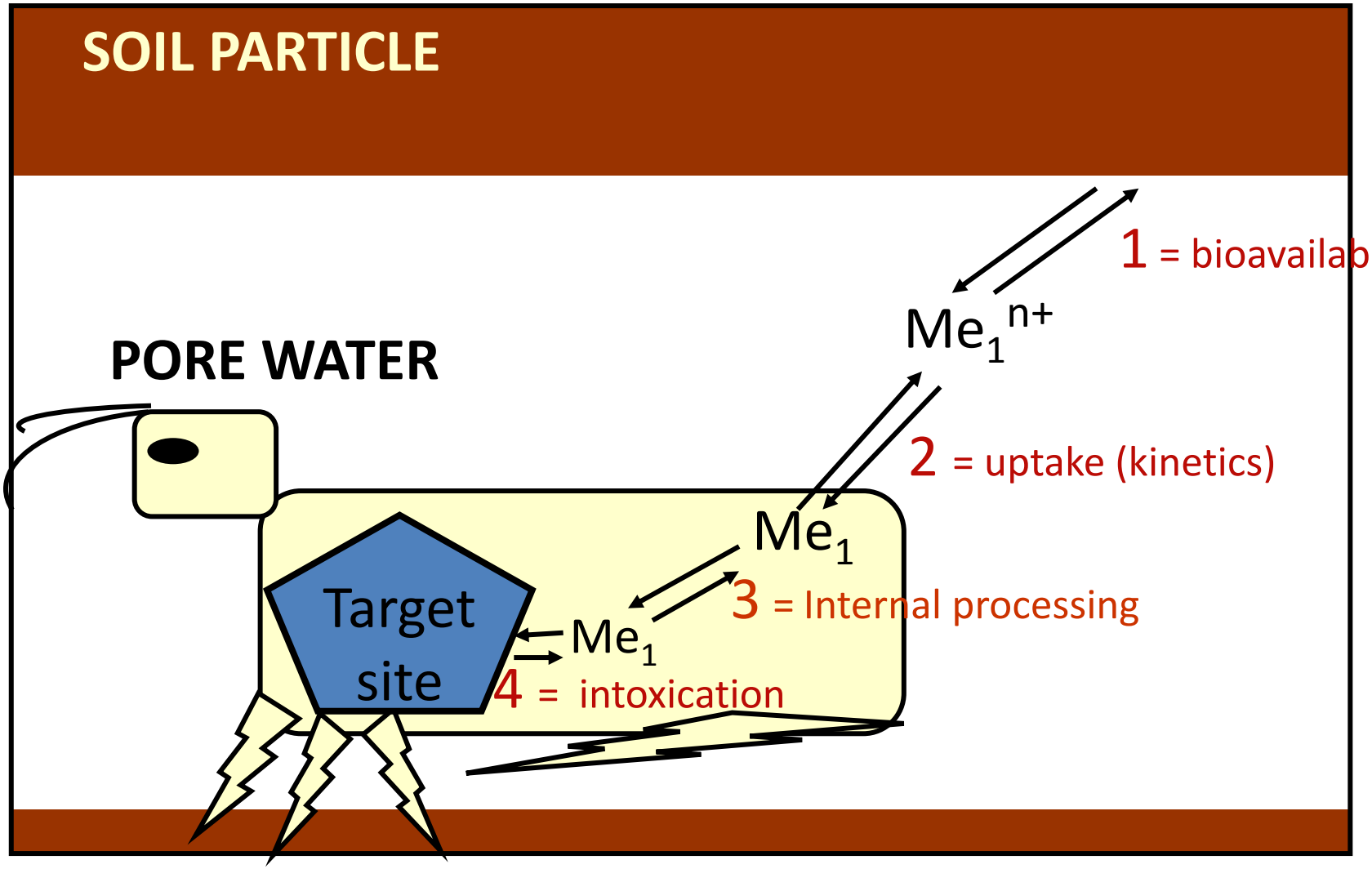
STEPS IN UPTAKE AND INTOXICATION



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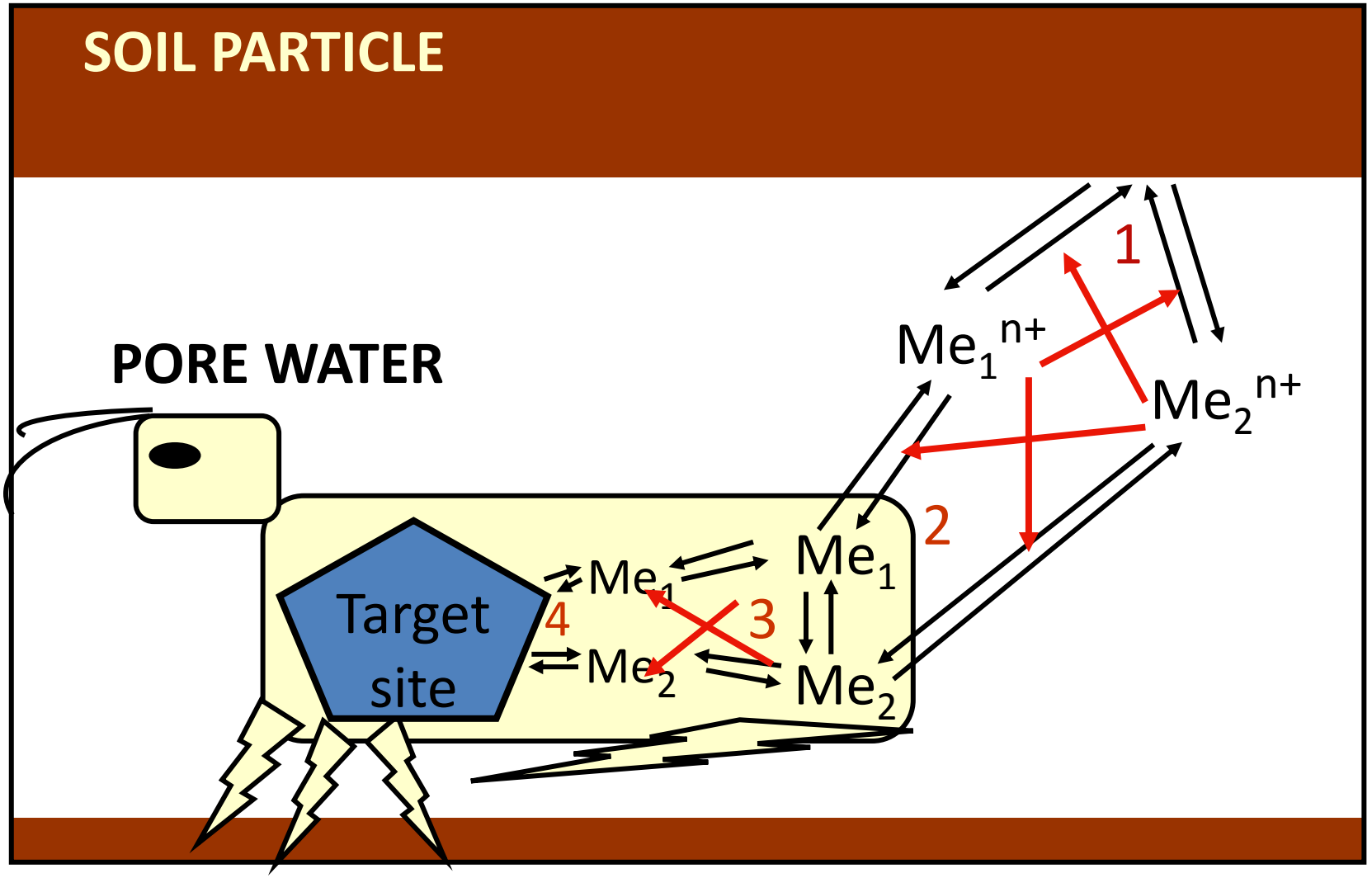
For one metal

STEPS IN UPTAKE AND INTOXICATION



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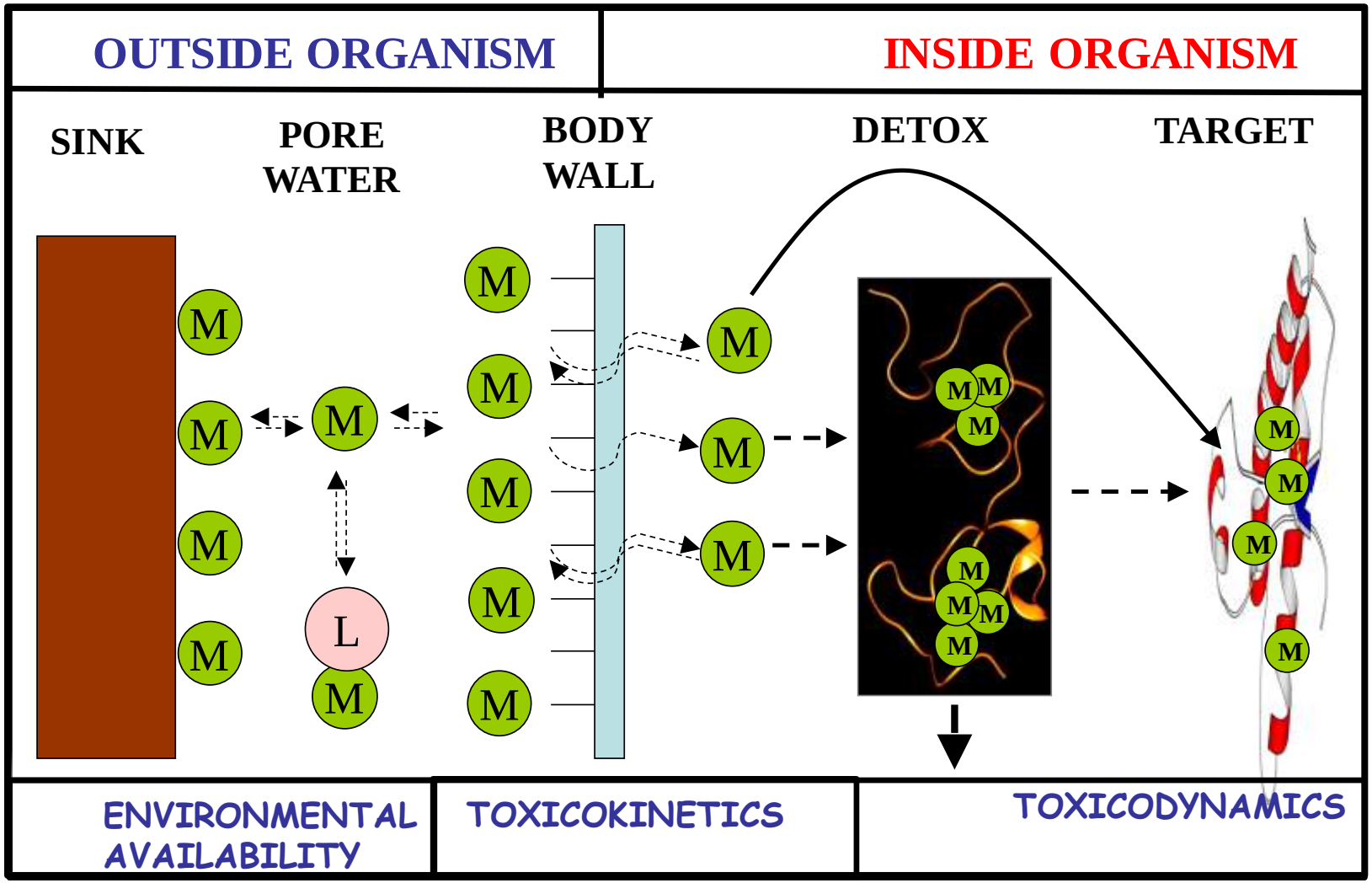
For more than one metal

A CONCEPTUAL MODEL OF INTERACTION



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Spurgeon et al. (2010)

FOUR TYPES OF INTERACTIONS

1. Chemical and physico-chemical interactions
   → affecting exposure and bioavailability

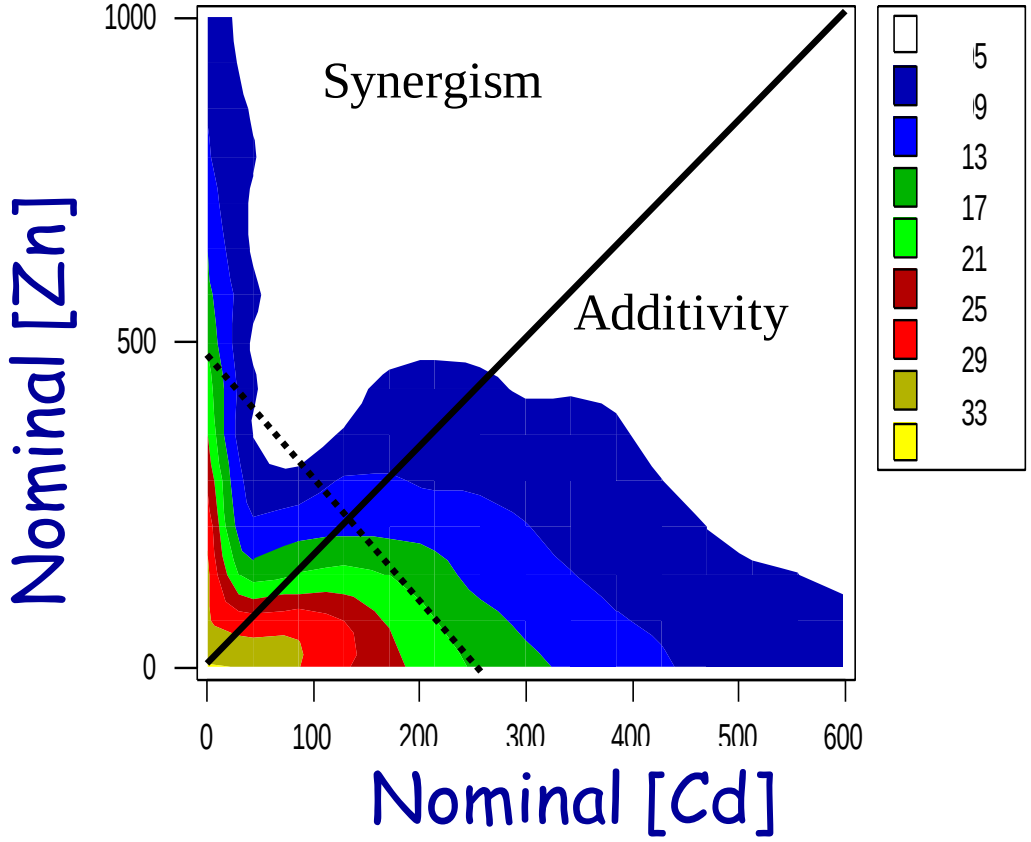
2. Physiological interactions at uptake sites
   → quantity taken up by organisms

3. Physiological/biochemical interactions
   internal processing → amount available at target

4. Interactions at target site(s)
   → intoxication processes

EXAMPLE – ENVIRONMENTAL AVAILABILITY

- Exposed *E. andrei* to Cd and Zn mixture for 28 day
- Partial factorial design (different levels and ratios)
- Measured effect on cocoon production



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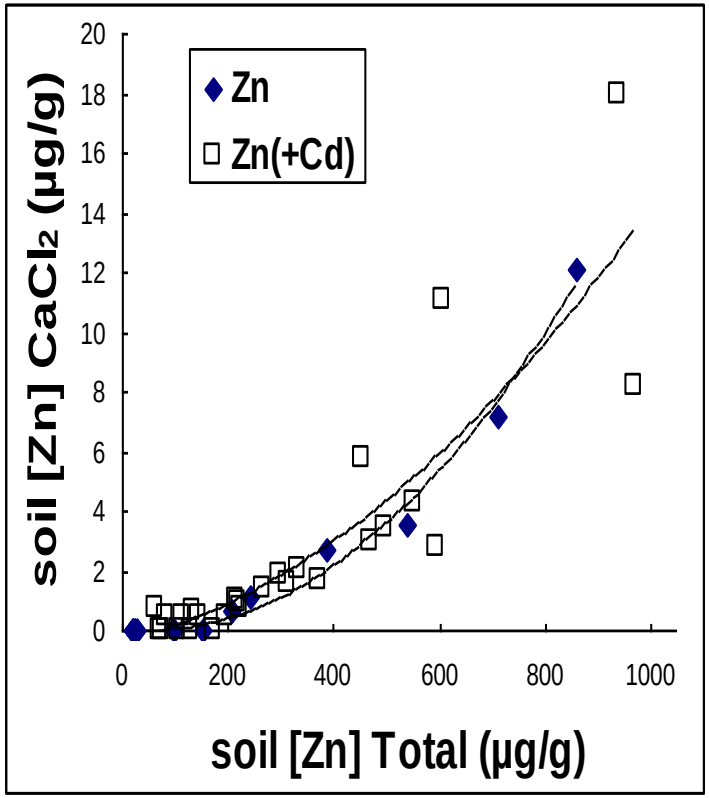
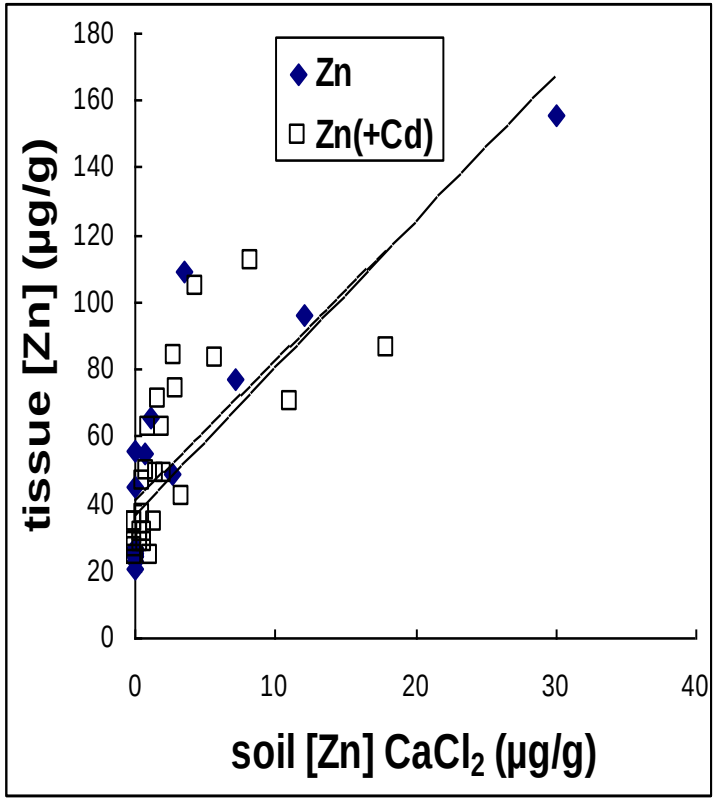
Unpublished data

EXAMPLE – ENVIRONMENTAL AVAILABILITY

ZN SORPTION & ZN UPTAKE



No significant effects



No significant effects

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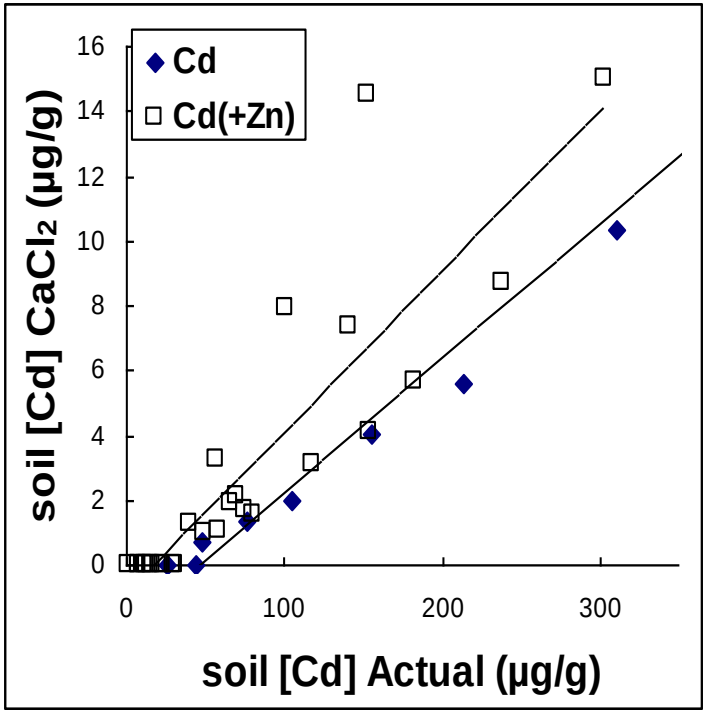
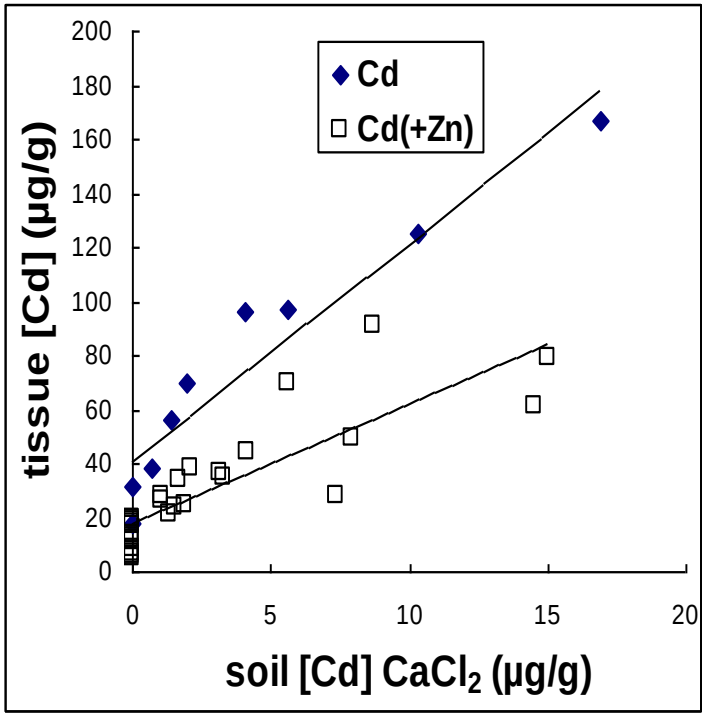
EXAMPLE – ENVIRONMENTAL AVAILABILITY

CD SORPTION & CD UPTAKE



Significant effect
(Zn makes Cd more available)



Significant effect
(Zn lowers uptake of available Cd)

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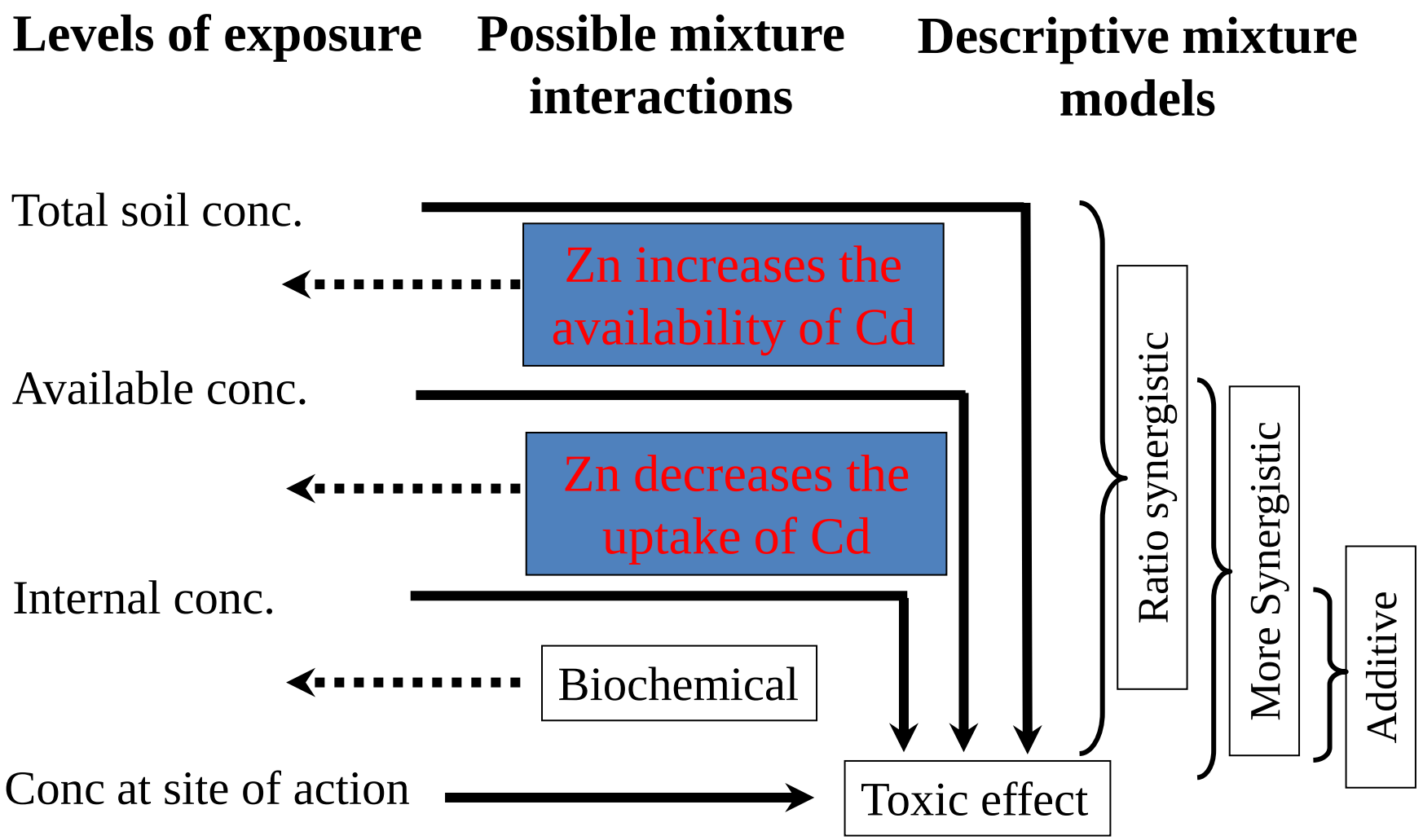
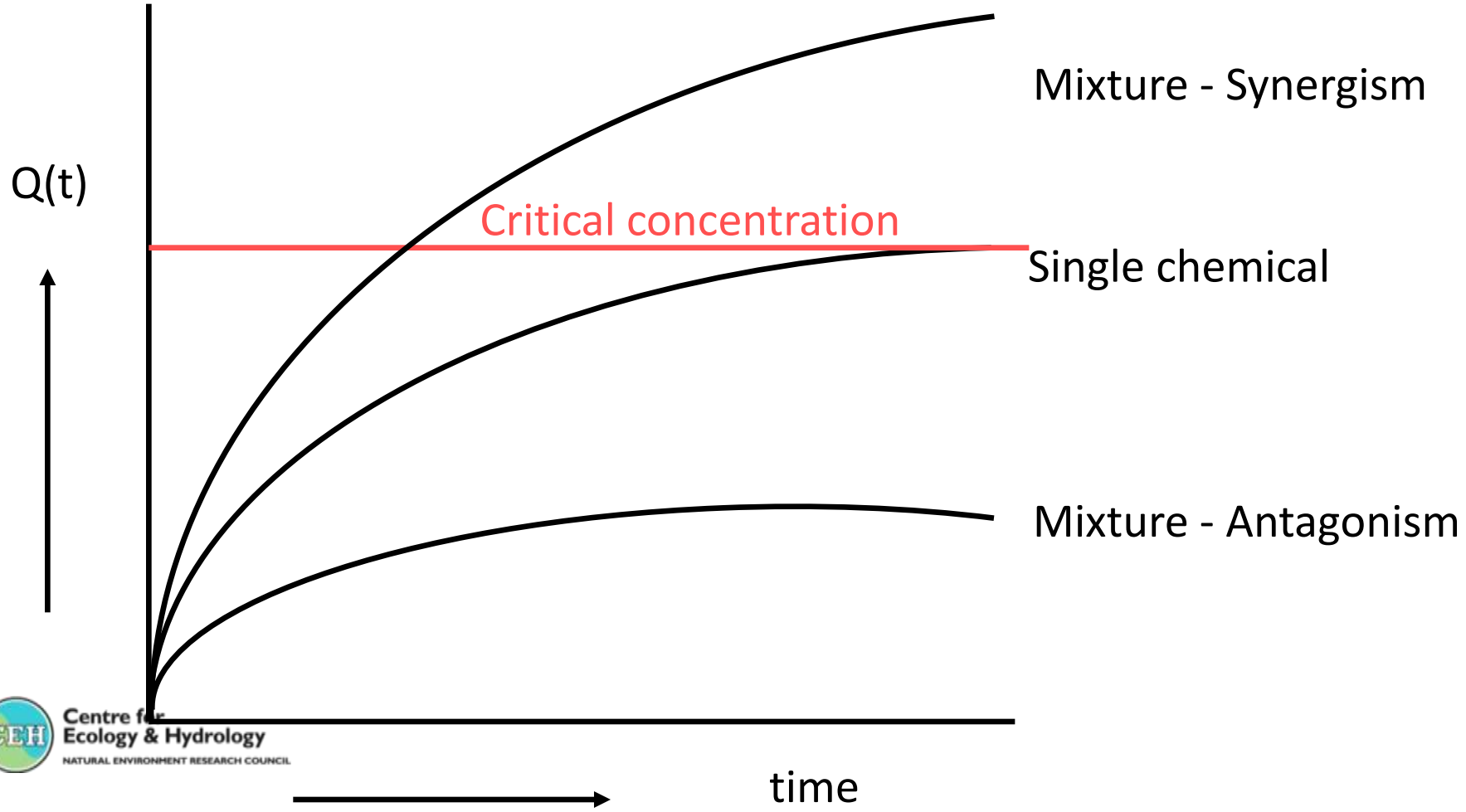
THE TOTALITY OF INTERACTIONS



EXAMPLE - TOXICOKINETICS

Toxicokinetics: Conceptual model



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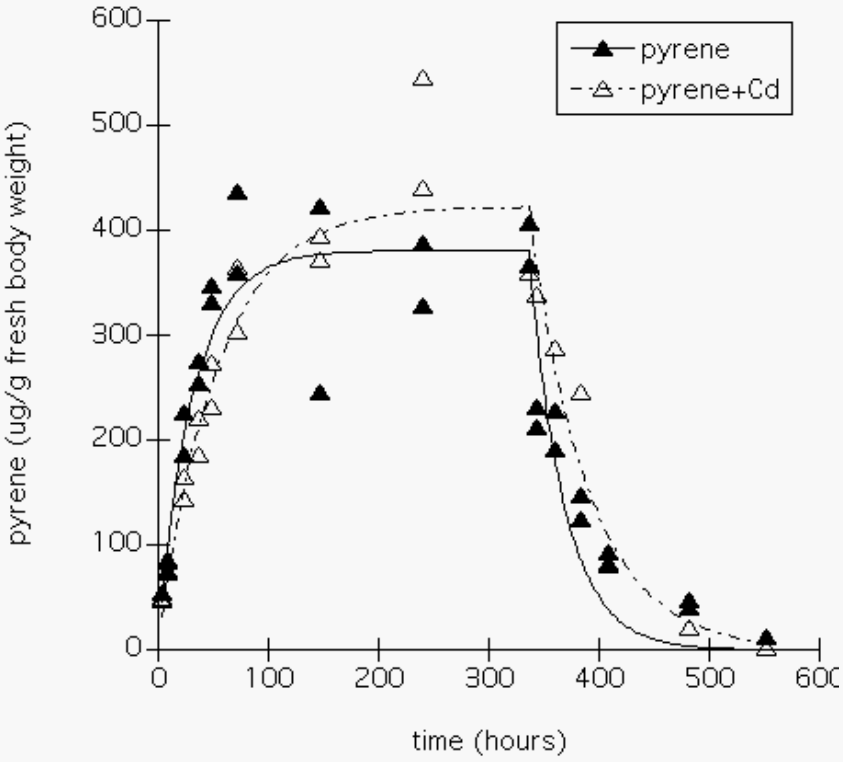
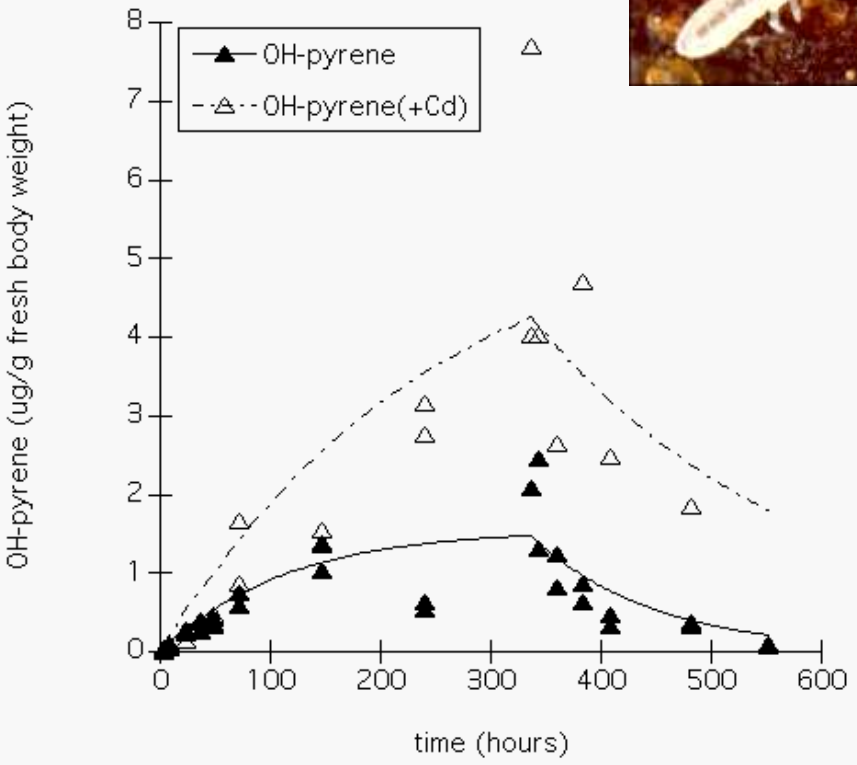
EXAMPLE - TOXICOKINETICS

PYRENE METABOLISM IN *F. CANDIDA* AFFECTED BY CADMIUM





→In Cd exposed animals, pyrene metabolism inhibited – potential for synergism

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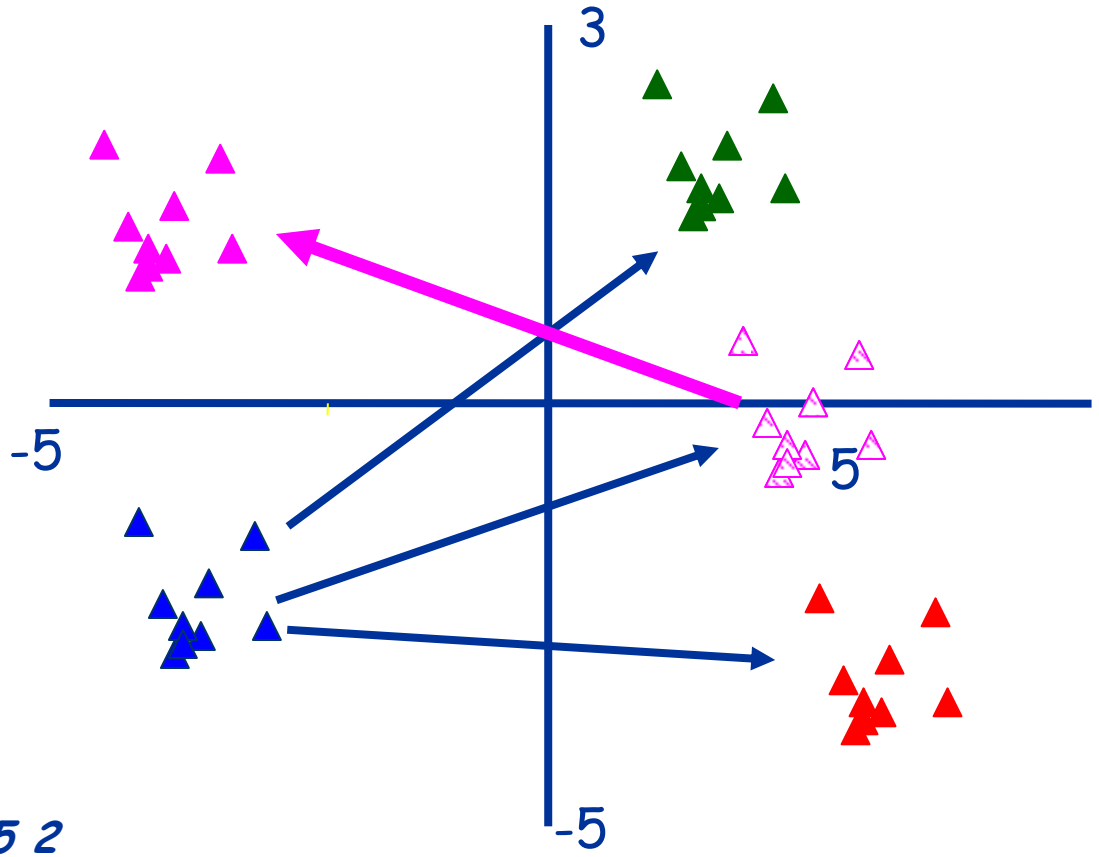
Broerse et al. (in prep)

EXAMPLE - TOXICODYNAMICS

Toxicodynamics: Conceptual model



- *Control*
- *EC50 Chem 1*
- *EC50 Chem 2*
- *EC25 1 + EC25 2*

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Dorne et al (2007). Bioanal Chem

EXAMPLE - TOXICODYNAMICS

BIOMARKERS OF MULTIPLE PESTICIDE EXPOSURE VIA FOOD

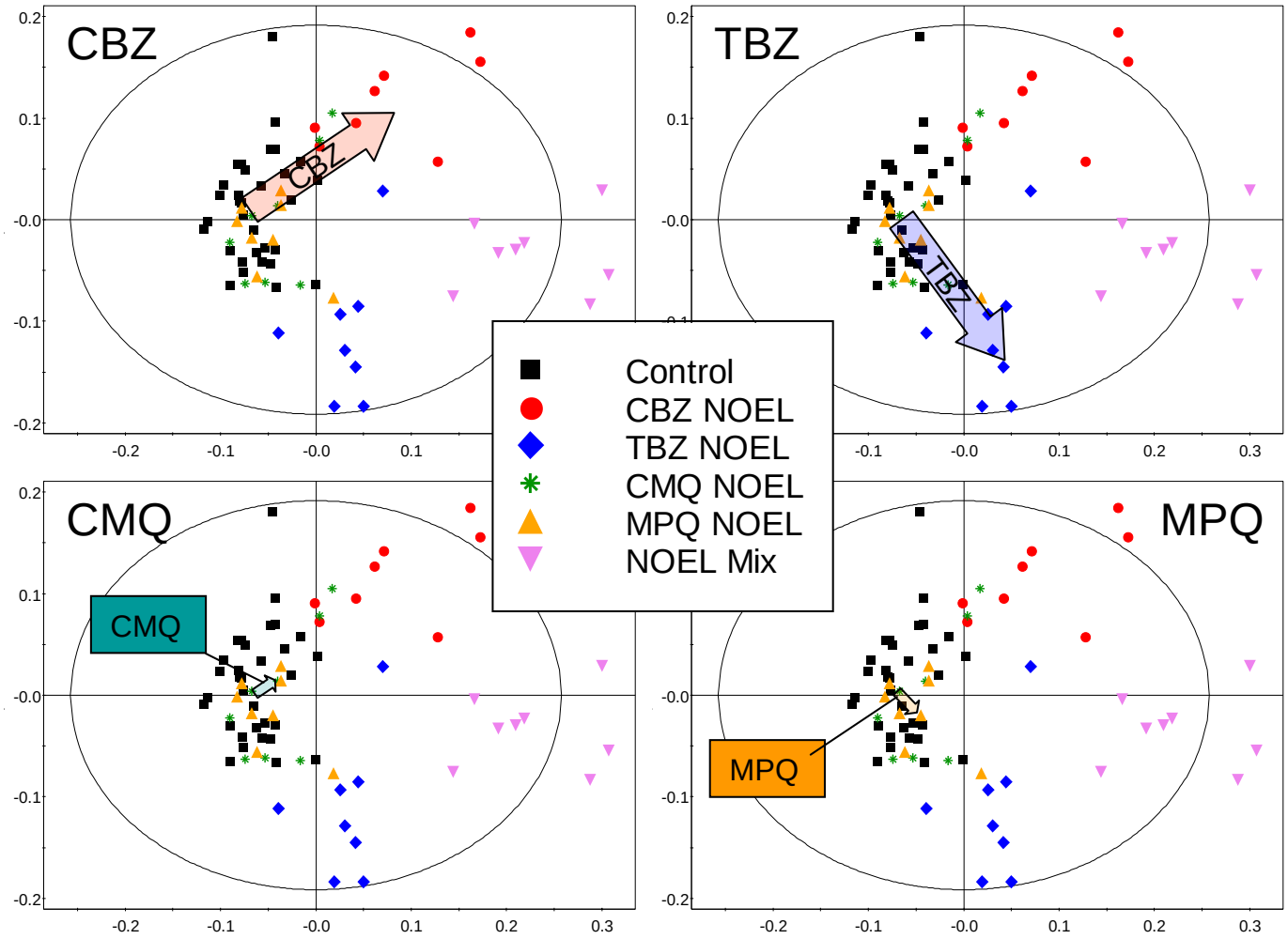
- Used pesticides that occur in food
- Four pesticides – related pairs from two groups

- Benzimidazole fungicides
  - Carbendazim (CBZ) and Thiabendazole (TBZ) (found on fruit).
- Bipyridylium herbicides
  - Chlormequat (CMQ) and Mepiquat (MPQ) (found on cereals).

EXAMPLE - TOXICODYNAMICS

Similar or different response?

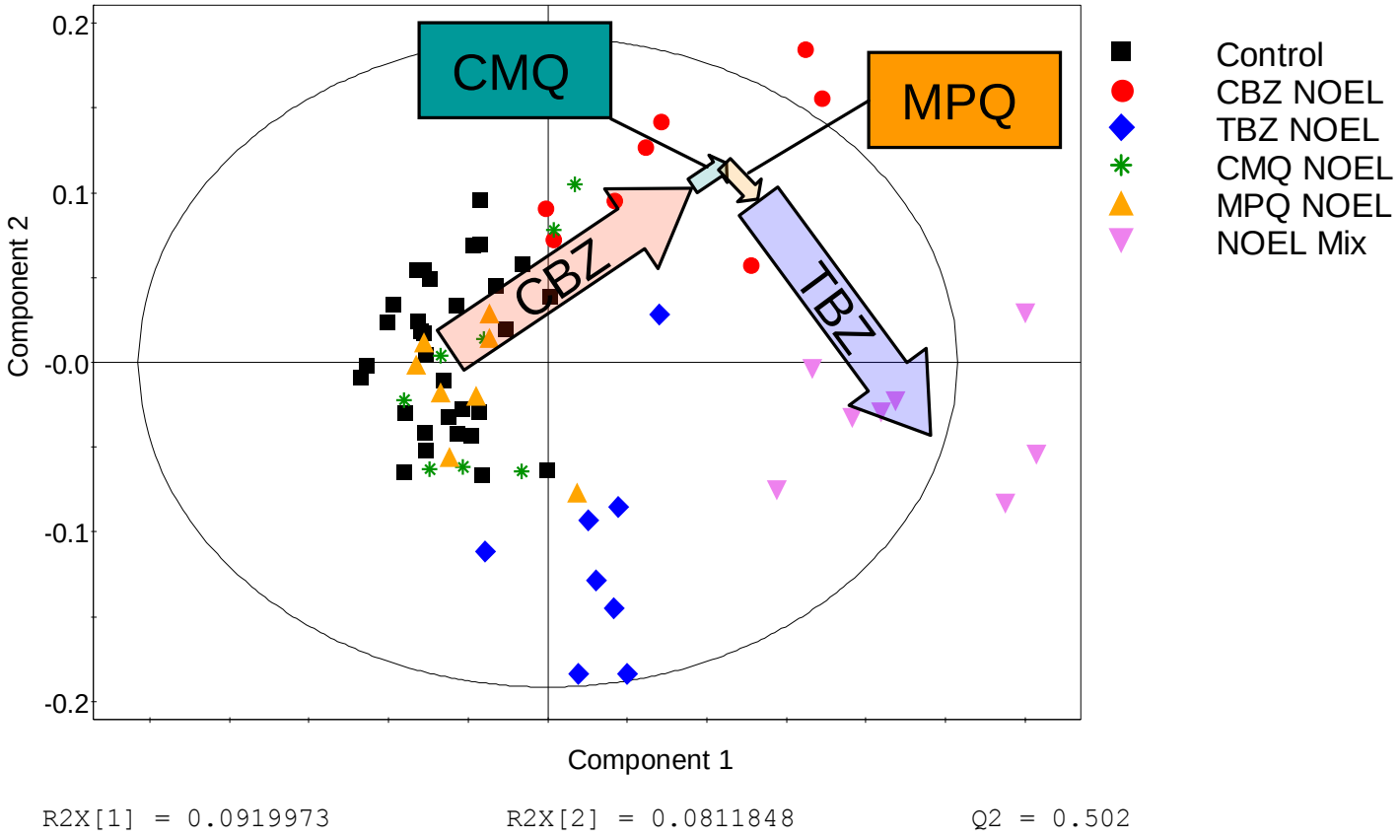
1st class strong effects and 2nd class weak effect – all diff. directions



Svendsen and Spurgeon (unpublished data)

EXAMPLE - TOXICODYNAMICS

What about the mixture effect?



– Mixture effect is sum of individual effects (somehow)

MIXTURE EFFECTS

ADDITIVITY

+

UNCERTAINTY

=

REALITY

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It's Over