HAZRUNOFF PROJECT

Practical exercise on HNS behaviour SEBC understanding

CEDRE

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Contents

- Explosivity and flammability
- Toxicological threshold values
- Environmental limits
- Example of environmental programme

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Why do we need thresholds limits?

- Cartography: according to modelling forecasts of chemicals dispersal
- Evaluation: giving information to response teams
- Emergency measures: population evacuation, fishing exclusion zone…

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What is a toxicological threshold value?

- Definition: the minimum concentration of a substance that causes a negative effect, that may be of varying severity, on a human population for a given exposure time

- Determining: extrapolation to humans of data obtained from experiments on animals

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What do we need toxicological threshold value?

- To know if intervention is possible

- To evaluate if population need to be confined or evacuated

Which are the limits of this values?

- No globally harmonized system
- Each type of value has its own definition and was developed in specific purposes

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Immediately Dangerous to Life or Health (IDLH)

1994 Maximal concentration in the air until which one worker can escape without risking to die or to feel irreversible effects on the health following severe respiratory or eye irritation and other noxious effects (disorientation or lack of coordination)

1987 Maximal concentration in the air until which a person exposed for at most 30 minutes can run away without risk of irreversible effects for the health.

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AEGL values

Concentration of a substance in the air over which…

3 …the potentially mortal effects or the deaths could arise within the population.

2 …the irreversible effects, the severe harmful effects or long-term opposite effects could be observed within the population.

1 …the population could present signs of notable discomfort and irritation or other signs that are non-sensory and asymptomatic. These effects are non-invalidating and reversible after exposure cessation.

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EPRG values

Maximal atmospheric concentration below which…

3 …It is likely that almost all the individuals could be exposed during more than one hour without feeling or developing of effect threatening their life.

2 …it is likely that almost all the individuals could be exposed during more than one hour without feeling or developing irreversible or incapacitating effects.

1 …it is likely that almost all individuals could be exposed more than one hour without feeling more than light passing effects or detecting a smell.

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TEEL values

Concentration limit below which…

3 … it is likely that almost all the individuals could be exposed without feeling or developing effect threatening their life.

2 … it is likely that almost all the individuals could be exposed without feeling or developing irreversible or incapacitating effects.

1 … it is likely that almost all the individuals could be exposed without feeling more than light passing effects or detecting a smell.

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To summarize

Death — AEGL 3 | EPRG 3 | TEEL 3 | IDLH

Irreversible severe effects — AEGL 2 | EPRG 2 | TEEL 2 | IDLH

Reversible moderate effects — AEGL 1 | EPRG 1 | TEEL 1

No effects

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To summarize

Value	Target population	Publishing agency	Time of exposure	Values published
IDLH	Workers	National Institute for Occupational Safety and Health (NIOSH)	30’	390
AEGL	General population, including sensitive individuals	National Academy of Sciences	10’, 30’, 1h, 4h, 8h	70
EPRG	General population	American Industrial Hygiene Association (AIHA)	1h	145
TEEL	General population, including sensitive individuals	US Department of Energy	1h	> 3,000

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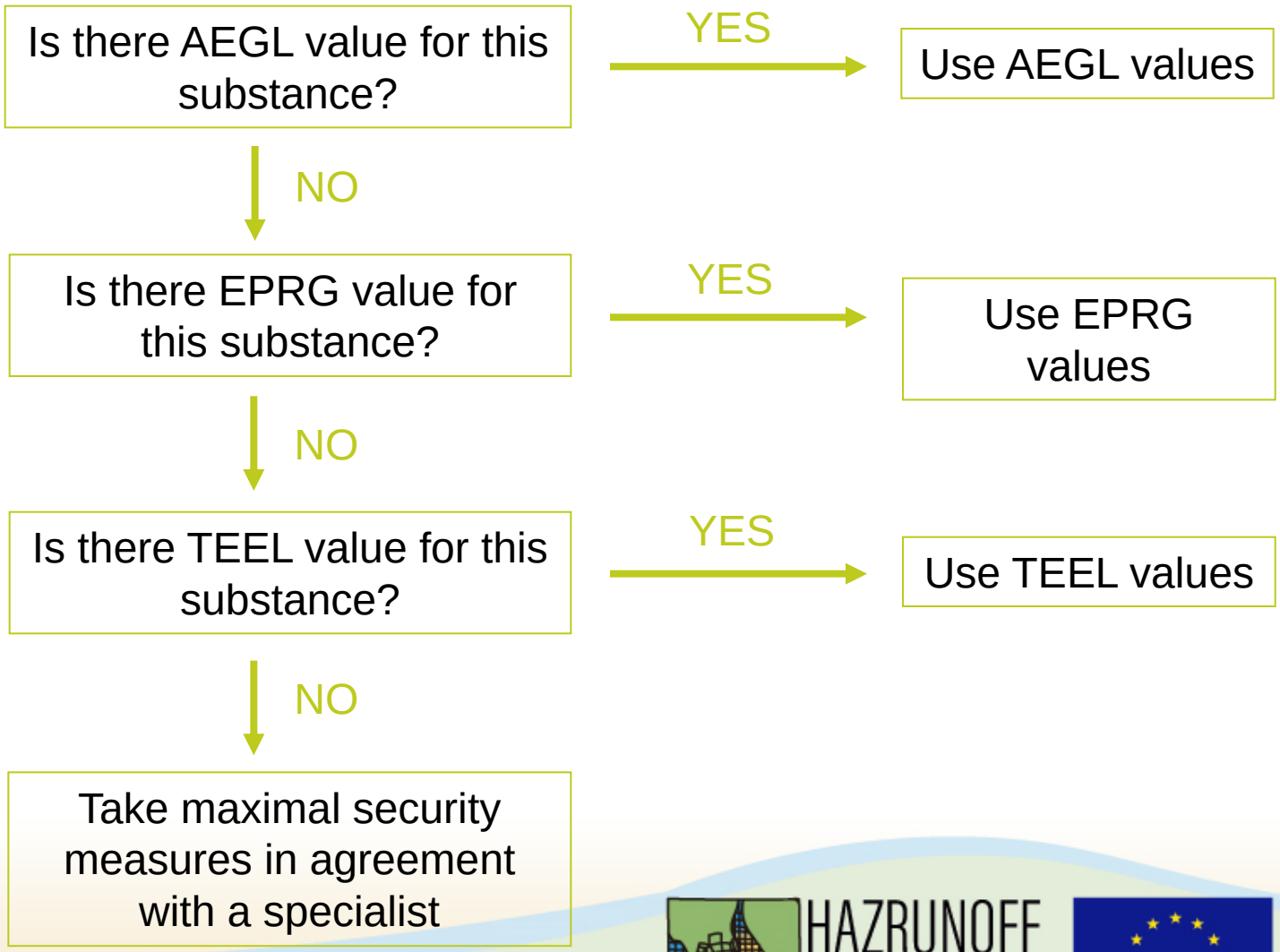
Choosing the right value in case of an incident



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Examples – 1 h exposure

Chemicals	AEGL 3	EPRG 3	TEEL 3
Ammonia	1,100 ppm	750 ppm	n/a
Carbone monoxide	330 ppm	500 ppm	n/a
Chlorine	20 ppm	20 ppm	n/a
Hydrogen bromide	120 ppm	n/a	n/a
Nitrous oxide	n/a	n/a	20,000 ppm

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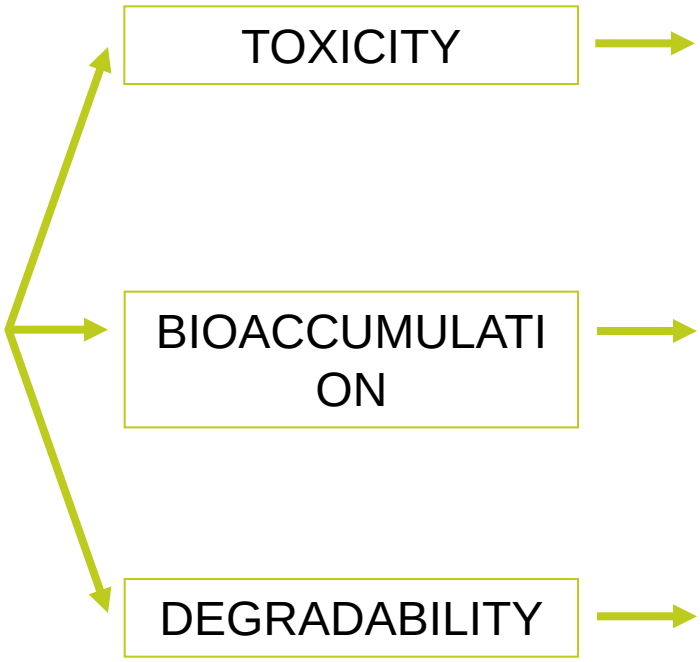
Why do we need environmental limits?

To asses…



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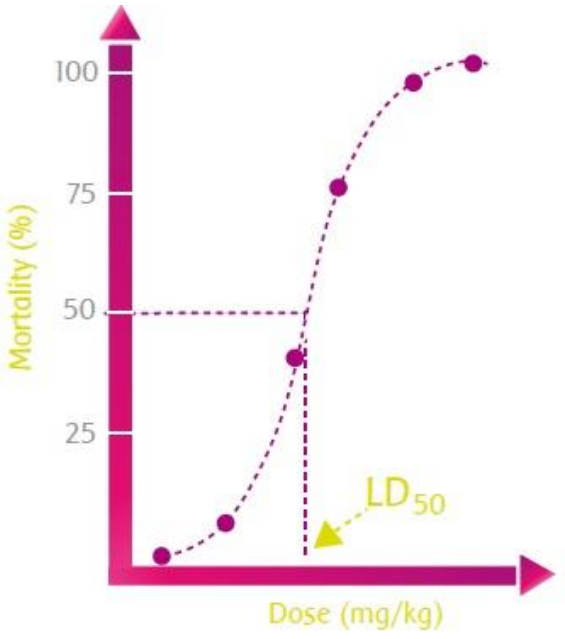
LD_{50} and LC_{50}

LD_{50}:

The dose of a substance that will kill 50% of a given population in specific experimental conditions. It is expressed in milligrams of a substance per kilogram of animal body mass (mg/kg).



LC_{50}:

In the case of a gas or liquid, the median lethal concentration (LC_{50}) is calculated and expressed in milligrams per litre (mg/L) or parts per million (ppm).

DDT (rainbow trout)	3 to 6 µg/L
Lindane (rainbow trout)	20 to 36 µg/L
TEPP (rainbow trout)	500 to 980 µg/L

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PEC/PNEC

1 >

PEC

Predicted Environmental Concentration

PNEC

Predicted No Effect Concentration

> 1

Concentration below which exposure to a substance is not expected to cause adverse effects.

Chromium	0.6 µg/L
Benzene	8 µg/L
Chloroform	146 µg/L
Methanol	154 mg/L

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BCF (Bioconcentration factor)

$$\frac{\text{[substance] in organism}}{\text{[substance] in water}}$$

BCF > 4,000	4,000 > BCF > 500	BCF < 500
Very bioaccumulable	Bioaccumulable	Little bioaccumulable

Vinyl chloride	10 to 40 L/kg
Xylene	72 to 106 L/kg
Mercury	5,000 to 9,000 L/kg

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Kow and Log Kow

$$Kow = \frac{[\text{substance}] \text{ in octanol}}{[\text{substance}] \text{ in water}}$$

Kow defines the ability for a substance to be lipid soluble, so its ability to bioconcentrate in the tissues.

Non accumulable  1 < Log Kow > 7  Highly accumulable

Vinyl chloride	1.58
Chloroform	2.13
DDT	6.4

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Half life

Time in the course of which a fraction representing 50 % of the initial quantity is degraded.

Abiotic degradation:

Hydrolyse

Photodegradation

Styrene (air)	7 to 16 h

Biodegradation:

Water

Sediment

Glyphosate (seawater)	47 to 315 d

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Example of a biomonitoring:

Assessing the environmental impact of the *COSTA CONCORDIA wreck through an integrated, multidisciplinary weight of evidence approach*

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Example of a biomonitoring

Marine Environmental Research 96 (2014) 92–104

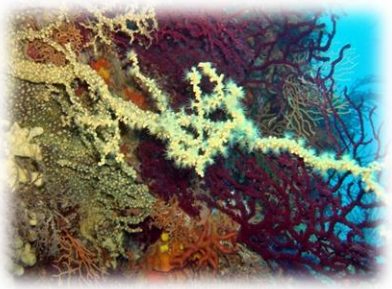
Contents lists available at ScienceDirect

Marine Environmental Research

journal homepage: www.elsevier.com/locate/marenvrev

A multidisciplinary weight of evidence approach for environmental risk assessment at the Costa Concordia wreck: Integrative indices from Mussel Watch

Francesco Regoli [a,*], David Pellegrini [b], Anna Maria Cicero [c], Marco Nigro [d], Maura Benedetti [a], Stefania Gorbi [a], Daniele Fattorini [a], Giuseppe D'Errico [a], Marta Di Carlo [a], Alessandro Nardi [a], Andrea Gaion [b], Alice Scuderi [b], Silvia Giuliani [b], Giulia Romanelli [c], Daniela Berto [e], Benedetta Trabucco [c], Patrizia Guidi [d], Margherita Bernardeschi [d], Vittoria Scarcelli [d], Giada Frenzilli [d]



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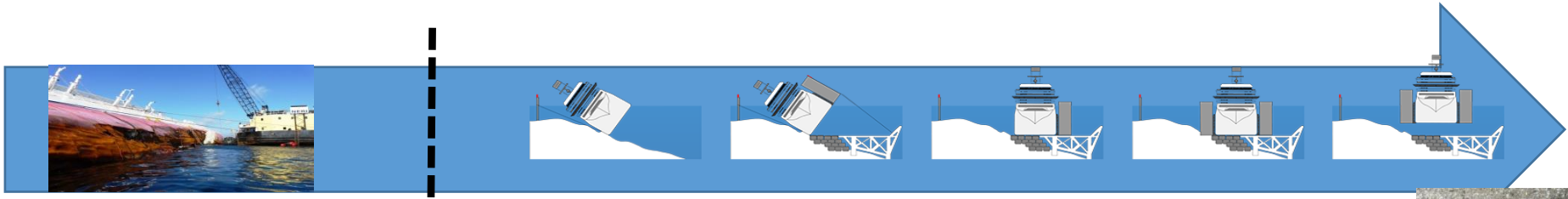
Treatment of the Costa Concordia wreck



EMERGENCY PHASE ***PARBUCKLING PROJECT***

Implementation of an environmental biomonitoring programme

Sampling dates

I Campaign Jan 2012 — II Campaign Mar 2012 — III Campaign Apr 2012 — IV Campaign May 2012 — V Campaign Jun 2012 — VI Campaign Jul 2012 — VII Campaign Oct 2012 — VIII Campaign Dec 2012 — IX Campaign Jan 2013 — X Campaign Apr 2013

To look for which pollutants

Bioavailability
- Trace metals
- Polycyclic Aromatic Hydrocarbons PAHs
- Volatile hydrocarbons C6-C10
- Aliphatic hydrocarbons C10-C40

- Halogenated pesticides
- Polychlorinated byphenyls PCBs
- Organotin compounds
- Flame retardants (PBDE)
- Anionic surfactants

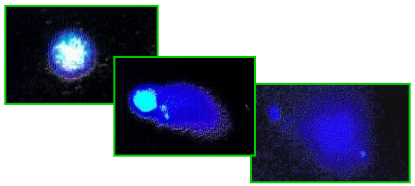
By biomarkers measurements

Detoxification-Exposure biomarkers
- Metallothioneins
- Peroxisomal proliferation
- Cytochrome P450 and bile metabolites
- Acetylcholinesterase

Oxidative stress
- Antioxidants and antioxidant enzymes
- Total antioxidant capacity

Cellular damage
- Lysosomal stability
- Lipofuscin and neutral lipids
- Lipid peroxidation

Genotoxic effects
- DNA integrity
- Micronuclei and nuclear alterations



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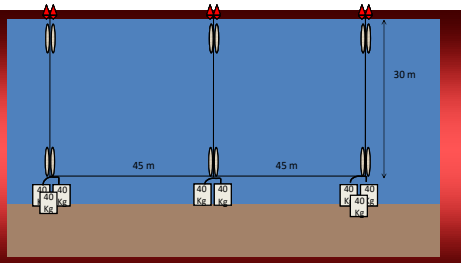
Implementation of the environmental monitoring

Active Mussel Watch
Short term chemical spill and impact
3 sites, 2 depths



Bioavailability and long term effects in native fish
Species of different trophic levels

- Scorpion fish (*Scorpaena* sp.)
- Red mullet (*Mullus barbatus*)
- Forkbeard (*Phycis blennoides*)
- Stargaze (*Uranoscopus scaber*)

Rocky shore invertebrates, algae:
different exposure route and chemical persistence on rocks.
- *Thais haemastoma*
- *Patella* sp.
- *Codium bursa*

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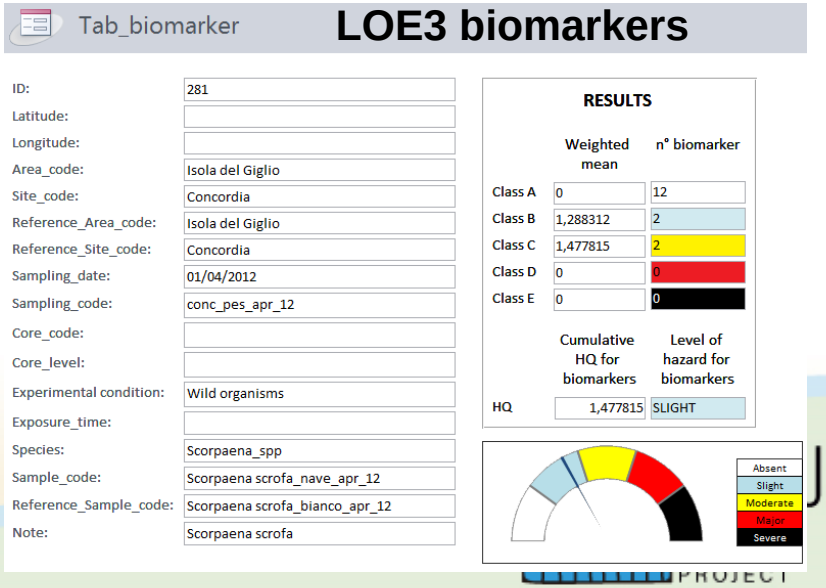
How to expose the results

Need to express the results in an understandable way…

and not –only- in a purely scientific way!

Methodology followed

- Calculation for each biomarker of the variation compared to Threshold, corrected for statistical significance and importance of biomarker (score)
- Assignment of each biomarker response to 1 of 5 classes of effect
- Calculation and Classification of cumulative HQ in a level of hazard according to % distribution of biomarkers in the 5 classes



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Biomonitoring results

- Bioavailability data exclude serious contamination events from the wreck or a consistent increase of environmental pollutants
- Nonetheless, **moderate or episodic spills with reversible effects have been detected**, differing between the emergency phase and the operations for removal
- The more evident bioaccumulation trend in *T. haemastoma* suggests different exposure dynamics on rocky shores due to a re-washing effect
- Consistently with bioaccumulation, biomarkers did not reveal major effects on the health condition of both transplanted or native organisms, still allowing a very sensitive detection of early biological disturbance
- The Weight of Evidence approach and the presented model were confirmed useful to summarize large datasets of different typologies of data, for characterizing environmental quality and risk assessment in a comprehensive process of “site-oriented” management decisions

http://www.disva.univpm.it/content/ecotoxicology-and-environmental-chemistry?language=en

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Key points

- Substance hazard
- Ecotoxicology data
- Response of relevant biomarkers
- Impact at the population and/or community levels
- Need to mix different tools

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