// DOSSIER: BIODIVERSITY AND POLLUTED SITES

USING BIOINDICATORS TO ADDRESS ENVIRONMENTAL CONCERNS IN LOCALISED AREAS

BROWNFIELDS: POTENTIAL TREASURE TROVES FOR THE ENVIRONMENT!

It is essential to make ecological restoration, biodiversity preservation and renewable energy production projects an integral part of today's land development strategy and sustainable land use management strategies. However, land to develop these types of projects is scarce in areas with a shortage of rental accommodation and where the need for havens of greenery is already the greatest.

For several years now, public policy has been turning its attention to brownfields. Once viewed as environmental black spots due to the polluted legacy of past activities, today they offer a new land resource, capable of providing solutions for the social and environmental issues dogging urban planners.

Often located in town centres, these sites offer a genuine opportunity for certain areas. More and more frequently, they undergo rehabilitation for re-use as spaces of urban agriculture, they encourage short food supply chains and promote social bonding or the production of renewable energy (photovoltaic, biofuel, etc.)

A key to the success of these highly valuable environmental projects is the efficient characterisation and management of any contamination and pollution present.

Tools are therefore required to characterise the mobility of the contaminants and the risks they represent for humans as well as for ecosystems (fauna, flora, etc.).

And yet, such tools have been around for many years even though professionals remain largely unaware of them: bioindicators of soil quality.

Whether used in situ or in the laboratory, bioindicator metrics will be used increasingly as a partner to characterisation studies of soil contaminants.

Depending which ones are used (bioindicators of effects or of accumulation), they will help project supervisors to evaluate the environmental risk of contaminants on a specific site, in conjunction with the quantitative health risk assessment.

Lastly, a research project conducted by INERIS[2] has developed an Ecological Index of Concern (EIoC) based on ecotoxicological reference values.

The EIoC allows a decision to be taken about the future ecological use of a site, by helping users to easily differentiate brownfields with pollution levels that give no cause for concern and which might be requalified for ecological use (as part of a green belt, or for recreation, etc.) from those whose environmental status raises concern and require a full, TRIAD-based ecosystem risk assessment before any decision about their future can be made.

A joint research project conducted by Tesora and Chrono-Environnement, founded by ADEME

Tesora and the Chrono-Environnement laboratory conducted an ecosystem risk assessment for metal contaminants in 16 plots on brownfields with various levels of metal and organic[3] contaminants located mainly in the Auvergne-Rhône-Alpes and in the Lorraine regions of France.

The ecosystem risk assessment (ERA) included a measurement of the bioavailability of metal contaminants using the "SET Index - snails tool[4]".

1 Measurements of transfer to an organism, family or community (plant or animal) that indicate the presence and/or effects of contaminants

2 INERIS. 2022. Identifying polluted brownfields that qualify for ecological upgrade: developing an Ecological Index of Concern, 89p.

3 For the purposes of this summarised article, only metal contamination was measured (after checking that there was no risk from organic contamination).

4 *Indice SET-escargot : bioindicateur d'accumulation destiné à quantifier les transferts réels entre le sol et les organismes du sol et donc la biodisponibilité des polluants*" (article in French): "SET Index - snails: bioindicator of accumulation for measuring real transfers between the soil and soil organisms, and therefore the bioavailability of pollutants" https://ssp-infoterre.brgm.fr/fr/fiches-techniques-innovantes/biodisponibilite-environnementale

The SET index measures the transfer excesses of metal pollutants in polluted soil to the snails' soft tissue compared to non-polluted soil.

Photo credit: B. Pauget / Chrono-Environnement

The combined results of the Ecological Index of Concern (EIoC) and the bioavailability of contaminants should demonstrate how, in certain cases, alternative management procedures (e.g. phytomanagement, creating ecological sanctuaries, etc.) can be used to avoid the need to cover contaminated soil with healthy soil.

The aim of these tools is to show that it is sometimes possible to preserve the ecological value of a contaminated site.

CHARACTERISING THE RISKS FOR ECOSYSTEMS

When an ecosystem risk assessment (ERA) is prescribed, studies using bioindicators of effects (Omega 3 and/or nematodes) and/or of accumulation (Bioaccumulation in soil fauna or bioaccumulation in plants) can be performed as a complement to the Ecological Index of Concern calculation.

The bioindicator chosen for this study was the SET index - snails. The combined use of the EIoC and the SET index can therefore guide the choice of management measures and follow-up actions, as shown in the flowchart below (Figure 1).

The methodology was used on 16 plots in order to characterise their risk for the ecosystems.

The Ecological Index of Concern revealed that the soil status on 4 sites gave cause for concern while 3 plots caused no concern for the ecosystems there.

The other 9 plots required more extensive analysis (a TRIAD-type supplementary investigation).

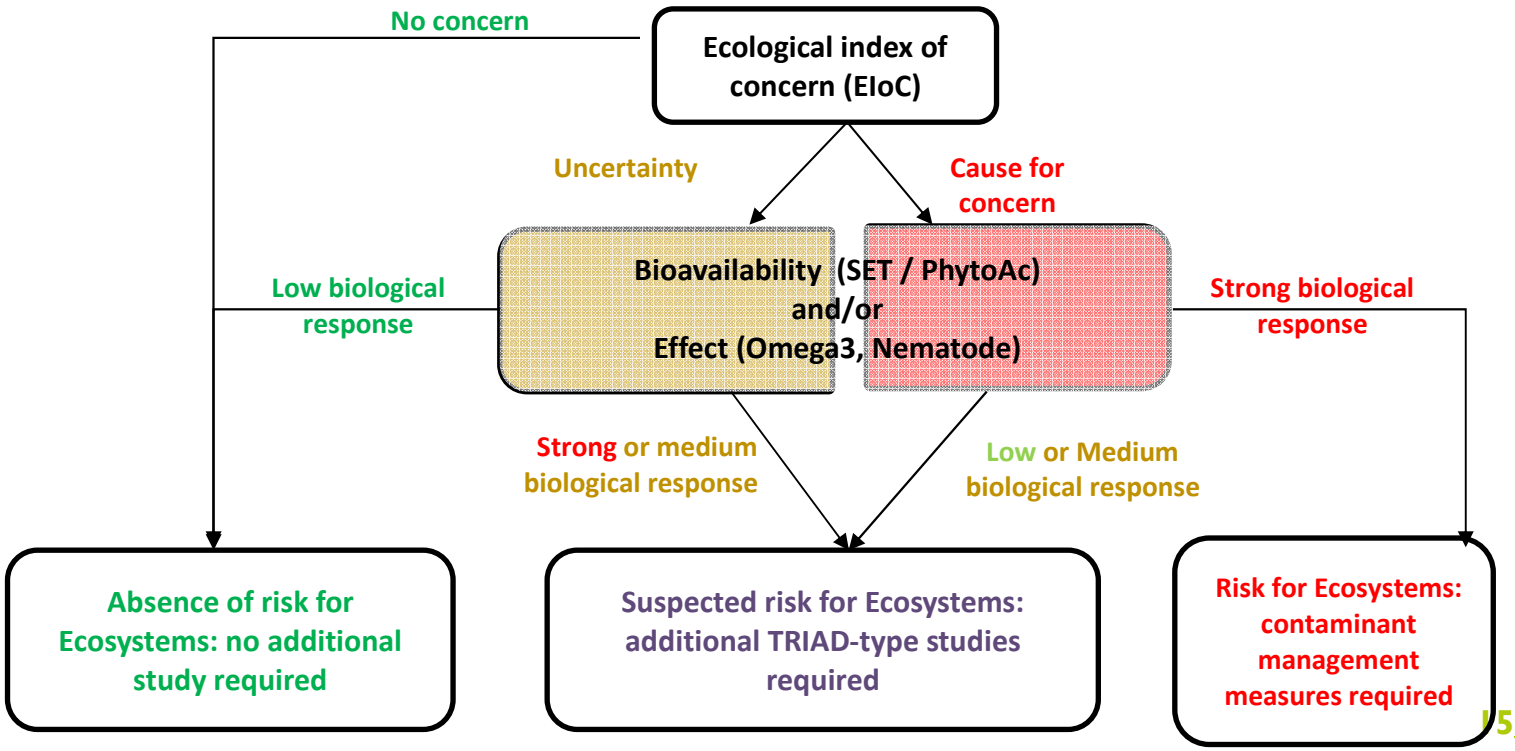
The SET-snail index indicated that, although the soils were contaminated, the low metal contaminant bioavailability demonstrated an absence of risk in 11 plots. Only one plot presented a confirmed risk.

The combination of the EIoC and the SET indices therefore allows us to determine the environmental risk of the plots and the steps needed to manage the pollution.

To summarise, of the 16 plots studied:

- Only plot No. 3 contained high levels of contamination and presented a confirmed risk for the ecosystems. Depollution operations must be carried out to manage the risks.
- The EIoC, confirmed by the SET index, demonstrated an absence of environmental risk in plots 12, 13 and 15. No additional analysis of these 3 plots will be needed.
- The EIoC returned a verdict of "uncertainty" in the case of 9 plots. The characterisation of low metal contaminant bioavailability shown by the SET index established that there was no risk for the ecosystems for 8 of them.

Figure 1: Flowchart for determining Risk for Ecosystems



• The uncertainty revealed by the SET index on plot 4 pointed to the need for a supplementary, TRIAD study. The same was the case for plots 1, 2 and 8 where the EIoC also showed a level of contamination that raised concern.

The methodology therefore allows us to establish that:

• 1 plot presents a risk for the ecosystems and management measures must be undertaken;

• 11 plots present no risk for the ecosystems;

• 4 plots require more in-depth, TRIAD-type environmental analyses before their environmental risk can be determined with certitude.

The absence of risk for the ecosystems identified in the 11 plots means that the pollution there is no reason why projects for ecological restoration/green belting/natural zones should not proceed.

Plot	IoC	SET	ERA
1	Cause for concern	Uncertainty	Uncertainty: TRIAD
2	Cause for concern	Uncertainty	Uncertainty: TRIAD
3	Cause for concern	Risk	Risk: Management action
4	Uncertainty	Uncertainty	Uncertainty: TRIAD
5	Uncertainty	No risk	Causes no concern
6	Uncertainty	No risk	Causes no concern
7	Uncertainty	No risk	Causes no concern
8	Cause for concern	Uncertainty	Uncertainty: TRIAD
9	Uncertainty	No risk	Causes no concern
10	Uncertainty	No risk	Causes no concern
11	Uncertainty	No risk	Causes no concern
12	Causes no concern	No risk	Causes no concern
13	Causes no concern	No risk	Causes no concern
14	Uncertainty	No risk	Causes no concern
15	Causes no concern	No risk	Causes no concern
16	Uncertainty	No risk	Causes no concern

Table 1: Ecosystem risk evaluation

Even though all plots contained at least 1 metal element concentration above the ordinary value ranges for French soils (the background values “ASPITET”), the characterisation of the risk for the ecosystems showed that the contaminants in the soils were not at all or not very bioavailable, and that the risk was low and under control.

When ecosystem risk assessments indicate the need for additional, TRIAD-type studies, the cost of these further studies and of any potential management measures were estimated independently of the risk characterisation results: either the TRIAD establishes an absence of any risk and the site can be declared suitable for ecological restoration, or a risk for the ecosystems is identified and the plot will undergo decontamination by removing the contaminated soil (TRIAD then Management).

It appears that, on the 4 plots where the EIoC indicated “uncertainty or moderate concern”, the cost of additional studies (TRIAD) are offset as soon as at least 1 plot is found to present no environmental risk, since the need to depollute the plot is obviated and environmental projects can go ahead.

OPTIMISED MANAGEMENT OF A LAND USE PORTFOLIO

Viewed in its wider context, when considered in the same way as human risk assessments, the information gained from an ecosystem risk assessment can help manage land use portfolios in a better way.

Current methods of managing polluted sites that use the total pollutant concentrations in soils for risk assessment in order to determine the compatibility of soil quality with the soil use seem restrictive when compared to the possibilities afforded by measuring bioavailability as part of an ecosystem risk assessment.

This study demonstrated the relevance of using ecosystem risk assessments (including bioavailability measurements) as early on as possible.

The assessments have proved their usefulness in enabling decisions to be taken about whether to keep the diffuse pollution in the soil in order to limit management costs.

In this way, projects to restore the brownfield to its natural state, to create biodiversity zones and to produce renewable energy can go ahead on environmentally secure sites.

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