European Commission

Science for Environment Policy

Guidelines for restoring ecosystems: when, where and how?

Chemical contamination impairs ecosystem function and reduces biodiversity. Restoration of contaminated ecosystems is important to re-establish the ecosystem services on which society depends. This study provides recommendations to maximise the success of restoration projects by considering when, where and how contaminated sites should be restored.

In 2013, the EU produced 322 million tonnes of chemicals, a significant proportion (over 40%) of which are harmful to the aquatic environment[1]. Chemicals that contaminate the environment have the potential to reduce biodiversity, leading to losses in the ecosystem services on which humans depend. There is therefore a growing movement to restore contaminated ecosystems. Several reports suggest that ecological restoration increases the provisioning of biodiversity and ecosystem services, and ecosystem services valuations indicate that its economic benefits outweigh its costs.

It has thus become a powerful tool for global environmental policy, with the Convention on Biological Diversity aiming to restore ecosystems that provide essential services, and the EU to restore ecosystems "so far as feasible"[2] in order to cease biodiversity loss. There are also national and international laws on chemical contamination, which often hold the responsible parties liable for restoration. For example, the EU Environmental Liability Directive establishes a 'polluter pays' framework for environmental damage.

Yet there is limited scientific guidance available on when, where and how to restore ecosystems degraded by contaminants. To remedy this, the authors of this review combined theoretical knowledge with field restoration activities to provide advice for practitioners and regulators. They analysed the literature on the mechanisms and strategies for restoring contaminated ecosystems, including economic and ecological theory, and approaches for translating knowledge to on-the-ground action.

The authors first discuss the merits of passive versus active restoration schemes. Passive restoration describes when the source of the contamination has been eliminated and the system is allowed to recover through natural processes. By contrast, active restoration describes when humans intervene to accelerate recovery, by mechanically planting trees for example. Deciding whether to utilise passive or active restoration partly depends whether the restoration is taking place in a country that requires compensatory restoration (when the polluter is required to compensate the public for the lost ecosystem services until restoration is complete). In these cases, passive restoration may be costlier for the polluter, because it tends to be slower than active restoration.

While active restoration can be more cost-effective, the authors say it is important to evaluate whether it is necessary before implementing a restoration plan – as it involves disturbing the natural environment and is in some cases more expensive.

So, once the method of restoration has been decided, when should it begin? The authors say restoration can be initiated for various reasons: a recent environmental event, newly available funding, or a change to regulation for example. Although the timing depends on the condition of the site (i.e. whether the contamination is still present), adequate funding and the political will to engage in what may be an expensive and long-term process are critical. At this stage, it is important to minimise disturbance and ensure sensitive areas are protected, which can increase the rate of recovery.

A critical part of any plan is what to restore. As the ultimate goal of any restoration project is to restore an ecosystem to a healthy state, establishing baseline conditions is key. Two approaches can be used to identify reference conditions at contaminated sites: historical (pre-contamination) conditions or using similar sites outside the area of contamination.

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Contact:
jasonrohr@gmail.com

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1. http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=ten00011
2. http://eu-un.europa.eu/articles/en/article_9571_en.htm

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As well as baseline conditions, it is important to have clear goals to measure the success of restoration. Yet consensus is lacking on which features should be restored, and often the default position is to restore only vegetative cover. The authors discuss some key characteristics of ecosystems that should be restored to provide ecosystem services, including genetic composition of selected populations, population abundance of species, species traits, community structure and composition, and ecosystem function. However, they warn that if the only endpoints are ecosystem functions or services, threatened or endangered species may be lost. Similarly, if the goal is species richness alone, important ecosystem services may be lost. The authors therefore recommend a combination of both structural and functional endpoints.

Although the question of where to restore may seem to have an obvious answer (the damaged site), there are in fact cases when improving ecosystem services somewhere other than the location of the contaminant (off-site restoration) can be beneficial, or even necessary. Examples include cases where the contamination cannot be removed without causing damage, or where soil is not healthy enough to support life.

To close, the authors provide three key recommendations. They say restoration should begin as soon as possible, with both structural (e.g. biodiversity) and functional (e.g. ecosystem services) endpoints. They also say practitioners should consider new ideas and approaches, such as microbial remediation or the payment for ecosystem services concept, which may overcome scientific and financial limitations.