CRC CARE FACT SHEET 3

Remediation

Remediation means providing a remedy. Today it is generally used to mean the clean-up or making safe of a site or water body contaminated by toxic substances, whether they are natural or man-made.

Typically these are historical residues of industry, chemical spills, pesticide use, former sites of service stations and refineries, or heavy metals naturally present in the environment (see CRC CARE Fact Sheet 1 – Contamination)

Until recently it was common practice throughout the world to clean up these sites by excavating the contaminated material, removing and storing it where people were less likely to be exposed to it. Alternatively the site might be fenced off, sealed in and allowed to decline in toxicity through slow natural processes. However this often meant the land could not be used for residential, educational, work or recreational purposes or for food production.

These approaches mostly led to the contaminated material being stored in secure landfill sites or locations away from human settlement. Storage of contaminated material raises the possibility that, as cities expand, it will pose a risk to future generations and to the environment.

For this reason CRC CARE and leading scientists round the world advocate a proactive risk-based approach which involves first assessing the true extent of the risk (see CRC CARE Fact Sheet 2 – Risk Assessment), and then neutralising the toxic effect of contamination to make it as safe as possible without removing it from the site. This is known as know as risk-based land management and its advantage is that it is much less costly than removal. Remediation also includes using various technologies to either degrade contaminants or remove them via other biological or chemical means.

Types of remediation

Scientists have developed a wide range of innovative methods for cleaning up contamination in soils and water. These can now be used individually or together to precisely tailor the clean-up solution to contaminants and conditions in the polluted site. The following are among the choices now available to industry, environmental consultants and regulators for dealing with contamination:

Bioremediation

Bioremediation is any process that uses microbes, fungi, plants or their enzymes to make a contaminated site safe for human use or environmentally healthy. Examples of bioremediation include the familiar compost heap, in which plant waste is broken down into fertile soil, and the use of bacteria to break down oil or chemical spills. The microbes used can either be those naturally present in the soil encouraged by the use of fertilisers or oxygen, or specially developed ‘teams’ of microbes developed for treating particular types of chemicals.

The microbes break down the toxic chemicals by removing certain groups of atoms from their molecular structure – such as hydrocarbons, sulphates or nitrates - which the microbes require for their own metabolism. This process can make the contaminant harmless to other life forms. Progress can be monitored by measuring changes in the soil such as acidity, temperature, oxygen content or CO_2 production, which all point to microbial activity (see CRC CARE Fact Sheet 4 – Bioremediation).

The clean-up or making safe of a site or water body contaminated by toxic substances

‘Green chemistry’

‘Green chemistry’ is the treatment of any contaminated soil, water or air with a chemical substance which locks up, changes or breaks down the toxic compound into a safe form.

Remediation by oxidation involves the injection of oxidants such as hydrogen peroxide, ozone, potassium permanganate, persulfates, oxygen gas or plain air.

Another example of green chemistry is the use of absorbent clays which are mixed into contaminated soil to absorb pollutants, or incorporated into filters to cleanse water or air passing through them.

Phytoremediation

Phytoremediation is the use of special plants to clean up contaminated soil. These plants have particular abilities to selectively take up, break down or render harmless various metals, pesticides, solvents, explosives, oils and other contaminants. Phytoremediation is clean, generally efficient and inexpensive and the plants can afterwards be disposed of safely.

Examples of phytoremediators are the Chinese brake fern, which has a particular ability to remove arsenic from soils and store it in its leaves, Indian mustard which can remove lead and canna lilies which can break down industrial contaminants. Scientists have identified more than 200 plants which are “hyper accumulators” with the ability to store large amounts of pollutants.

Bioavailability reduction

Bioavailability reduction refers to various techniques like those outlined above for reducing the ability of contaminant(s) to reach humans via water, food, dust or other pathways. This can range from stimulating natural processes in soil and water to break them down or lock them up to actively treating soil and water so the risk of bioavailability is greatly diminished or eliminated.

Electrokinetic remediation

In this technique for treating soils contaminated with heavy metals a low electrical current is passed through the polluted site. Over time, and depending on soil type, this causes the heavy metal ions site to migrate to the electrodes, where they concentrate, allowing them to be dug up or treated and made safe.

Ultrasound

Ultrasonic heat shock is a relatively new technique used to treat organic pollutants in groundwater. ‘Firing’ ultrasound into the groundwater generates microscopic bubbles and locally intense heat which cause the pollutants to break down into harmless substances.

Active barriers

These are buried barriers made of adsorbent materials which are erected downstream from a contaminated site to intercept groundwater flowing from it and trap the pollutants before they can spread to sensitive areas or water sources. In some cases the “barriers” may consist of curtains of air bubbles, released underground to oxygenate the groundwater and stimulate natural microbes to attack the contaminant and break it down.

Pump-and-treat

Pumping up groundwater then treating it chemically or filtering it to remove pollutants, or using it to irrigate trees and plants which absorb them are among the options for cleansing heavily polluted water.

Our role

CRC CARE is at the forefront in developing new technologies and partnerships for risk assessment and remediation. For further details see CRC CARE Fact Sheet 2 – Risk Assessment.

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CRC CARE is a partnership of organisations providing research, technologies and knowledge in assessing, preventing and remediating contamination of soil, water and air.

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