Mainstreaming Environment into Early Recovery: Industrial Facilities

Photo: S. van Dijk/UNDAC

Prepared by:

Martin Bjerregaard
Technical Advisor to UNDP CIT

Version 1.0

August 2015

GCER Global Cluster for Early Recovery
Smarter Response, Resilient Communities.

1. Introduction

This paper presents a proposed approach to minimizing negative environmental impacts from industrial facilities damaged by natural disasters and conflicts. The objective of the approaches included herein is to support Early Recovery practitioners in understanding key environmental concepts relating to damaged industrial facilities as well as provide a simple approach to cleaning contaminated residuals as part of Early Recovery programs.

Damaged industrial facilities can have a two-fold negative impact on recovery, namely:

1. Production at the damaged industrial facility will be reduced leading to reduced employment and livelihood opportunities as well as economic recovery being hindered. Furthermore, if the output of the industrial facility is related to reconstruction (for example bricks or other building material) then the costs for these products may rise due to lack of supply; and

2. The damaged industrial facility can be polluting the surrounding environment in turn impacting on human health through for example contaminating groundwater.

This paper proposes an approach to simple yet proven methods for reducing the negative environmental impacts of such damaged industrial facilities centered around use of reeds to clean oil contaminated residuals. There are numerous other simple and proven approaches to reducing negative environmental impacts from industrial facilities, i.e. improved performance of brick kilns, which could apply but have not been included herein – these can be further explored in subsequent phases of work relating to mainstreaming environmental issues in Early Recovery.

The paper is part of a suite of tools and guidance prepared for the UNDP Crisis Interface Team (Geneva) focused on mainstreaming environmental issues into Early Recovery. The two other papers concern debris management and disaster waste management with a focus on improving their environmental impact.

2. Reed Beds for Mechanical Workshops

Objective

The objective of the proposed approach to ensure minimal oil pollution from mechanical workshops is to provide a simple and proven method for cleaning the oil contamination resulting from the workshop operations. This approach provides for a solution that uses in-country resources, can provide a livelihood to those managing the reed beds and minimizes the environmental impact of the workshops handling humanitarian vehicles and trucks.

Mechanical Workshop contamination

Since workshops are used by the humanitarian agencies for their fleet of trucks and vehicles, then these workshops are often required to work at excess of capacity. In addition they will often have been damaged by the disaster or conflict and may have sustained damage to their operational systems including oil and fuel containers. Furthermore, certain workshops may not have been functioning optimally before the disaster/conflict when it comes to oil and fuel management.

Whilst operational, all mechanical workshops have the capacity to cause pollution through a number of operations and processes that have the potential to pollute the environment. These include storage, use and disposal of polluting liquids such as oils, fuels, solvents, antifreeze and other coolant additives and brake fluids. Unless the site drainage is correct and spillage control procedures are in place, environmental harm will occur. When a disaster occurs, the level of pollution can increase greatly if there is damage to the garage due to damaged storage containers leaking.

Mechanical workshops need to be repaired promptly and operational following a disaster and at this time the environmental impact of the pollution should be addressed. This is especially the case since the throughput of humanitarian vehicles and trucks will be in excess of their normal operational capacity.

As a minimum all mechanical workshops produce hydrocarbon contaminated waste water. In many countries interceptors are used to address this issue, however the use of interceptors is a costly and an environmentally unsustainable practice where the resulting water still contains hydrocarbon pollutants. *A simple, sustainable solution would be the instillation of a small reed bed system.* Operational and maintenance costs are minimal as reed bed systems are naturally regenerative.

Reed beds for oil decontamination

Reed bed technology is based upon the cleansing power of three main elements: soil dwelling microbes, the physical and chemical properties of the soil, sand or gravel, and finally the plants themselves. Of these, the microbial flora and fauna is the most important constituent.

Reed beds are an environmentally sustainable method for the treatment of contaminated water. As well as being beneficial for wildlife, they are often significantly cheaper than the equivalent mechanical systems and are easier to operate and maintain. Reed beds have been used across the world as treatment systems, including the treatment of:

- Hydrocarbon contaminated water from oil fields
- Service stations (oil interceptors, grey water and sewage)
- Sewage and grey water
- Mixed chemical industry contaminated water
- Agricultural washings
- Landfill leachates
- Groundwater remediation
- Pesticides
- Composting leachate
- Agricultural washings

Phragmites (reed) is one of the most widely distributed wetland plant genera worldwide. Reeds are readily available around the world and the World Checklist of Selected Plant Families, maintained by Kew Garden in London, accepts 4 species as of August 2013:

- Phragmites japonicus Japan, Korea, Ryukyu Islands, Russian Far East
- Phragmites karka - tropical Africa, southern Asia, Australia, some Pacific Islands
- Phragmites mauritianus - central + southern Africa, Madagascar, Mauritius
- Phragmites australis. - cosmopolitan

The species of reed used can be tailored to the area the reed bed is to inhabit. Endemic species can be selected to prevent the introduction of a non-native species with their associated potential invasive issues. In Nepal, for example, local reeds Phragmites Karka spp are utilised in waste water treatment.

The civil engineering surrounding a reed bed treatment zone is generally very simple, firstly an excavated void is lined to prevent seepage of wastewater to the environment, then this void is filled with appropriate gravel, soil or sand and the reeds are planted into this media. The water is delivered either over the surface of the system (vertical flow), or via a feeder trench at the front end of the system (horizontal flow).

Micro-organisms attach themselves to the outside of the gravel or soil particles and to the plants and plant roots. These organisms metabolise polluting chemicals, degrading and mineralising them. Commonly reed beds are used to degrade sewage, but with higher retention times even intractable compounds such as PAH, PCB, dyestuffs, amines and glycols can be treated. After the Gulf War for example, in the oil-polluted sands of the Kuwait desert, the first cleaning processes took place around the roots of annual plants, where oil-eating micro-organisms cleaned both the roots and the sand particles sticking to them (Nature, 1995).

The choice of bed media, gravel, soil or sand, is dependent upon the particular application requirements. Gravel is less active microbiologically, but allows a faster throughput of water. For this reason, gravel has commonly been used in secondary and tertiary sewage treatment applications and in mine waste water treatment where the plants help to keep the water oxygenated thus encouraging the deposition of insoluble metal ions precipitates. Soil has commonly been used for primary and secondary treatment of industrial effluents. Certain soil minerals actually encourage the deposition of metal ions, phosphate and sulphate. Soils can therefore be custom-engineered to treat particular effluent streams. In addition, the ability of clay particles and humic materials to entrap polluting chemicals means that the soil system can cope with shock loads.

The plants have three functions. Firstly, the very extensive root system creates channels for the water to pass through. Secondly, the roots introduce oxygen down into the body of soil and provide an environment where aerobic bacteria can thrive. These organisms are necessary for the breakdown of many types of compound, in particular in the oxidation of ammonia to nitrate, the first step in the biological breakdown of this compound. Thirdly, the plants themselves take up a certain amount of nutrient from the waste water. In the spring and summer, about 15% of the treatment capacity for sewage effluent occurs through this route. Most degradation of nutrients is, however, undertaken by the microbes. The plants are also capable of accumulating certain heavy metals, an area where there is currently a great deal of research.

The reed bed associated with treating waste water from a garage does not require a large amount of space and a company in the UK has developed Reeds in a Box (RIBs) to replace garage interceptors. The box is a specifically engineered container holding a miniature, yet fully developed, reed bed unit for smaller scale applications where space is a limiting factor.

Oceans ESU Ltd RIBs measure 3x3m, but can be connected to create a system of them if larger area is required. The boxes need a discharge point, which can be river, and set up takes only three to four days. They are fully operational within 6 months, but can start putting low volumes through from day one. They have been proven to function in temperature extremes with examples in China as low as -30C, and have also been used in Africa at high temperatures.

Livelihoods and Maintenance

The reed beds could provide viable livelihoods with people trained to install and maintain them. Maintenance would include replanting any area where reeds had died, harvesting reeds in the autumn or winter to promote healthy new reed growth, and propagating reeds for use in a nursery. Although the reeds from one small reed area would not provide much material, the harvest from several beds across various sites could provide a decent amount of material for use, such as a biomass energy source.

The improvements to the environment from installing these reed beds include reduction in contaminated land and contamination of water courses. The water released from the reed beds is suitable for irrigation, groundwater recharge, or release to natural watercourses. Reed beds also support local ecology with reeds being very important for wildlife and conservation, particularly in Europe and Asia, where several species of birds are strongly tied to Phragmites stands.

Construction of a small gravity fed reed bed system

To construct a horizontal flow reed bed a hole with a minimum size of three by three meters is dug to a minimum depth of 0.6 metres with a slope of approximately 1%. The hole needs to be lined with an impermeable membrane so ground water is not contaminated. At the shallowest end a perforated inlet pipe to distribute the contaminated water is installed, at the opposite (deepest) end an outlet pipe is positioned at the bottom of the bed. This can have a simple tap on it to control the water level in the bed and also the discharge of cleaned water. The soils and gravel is then put in and planted with Phragmites.

3. Assessing requirement for pollution control

The following simple approach can be adopted by the ERA or an Early Recovery practitioner for the determination of need for decontamination of effluent from mechanical workshops.

Identification of pollution checklist:

Barrels/storage containers visibly damaged/ leaking:	Yes or No
Oily sheen on water bodies:	Yes or No
Stained ground:	Yes or No
Chemical Odour :	Yes or No
Areas of plant die off or ground cover different from surrounding areas:	Yes or No

Guidelines for assessing suitability of site for a reed bed system

- Is there a large enough space? The reed bed needs at lease 3m X 3m.
- Is there either a discharge point such as a river, or room to construct a soakaway.
- Identify a local source of endemic reeds, the more mature the better as the system can be functional sooner.

4. Way Forward

A two-pronged approach is proposed:

1. A simple assessment form (as included in above section 3) is developed with photos to assist. This can then be used by the ERA or an Early Recovery practitioner to determine where decontamination of mechanical workshop effluent is required, especially focussing on those workshops which are being utilised by the humanitarian agencies; and,

2. Additional industrial facilities that are potential environmental polluters are identified, i.e. brick kilns, and similar schemes developed for these drawing on simple and proven solutions which can be locally built.

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