A.5. Waste

Classification of obsolete pesticides for prioritising the need and urgency of measures

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Objective

Stocks of obsolete pesticides can be found in many countries. It is estimated that quantities of obsolete pesticides can range up to several hundred thousand tonnes. In many cases these pesticides are stored under poor conditions. Consequently they lack the basic provisions to deal adequately with leakage or other types of accidents. This can affect occupational health of workers at the site, and it will lead to contamination of groundwater or soil. The latter can cause potential public and environmental health risks (Tauw, 1999a; Theelen, 1999).

It is generally accepted that the stocks of hazardous obsolete pesticides are to be removed. Such actions however can be very costly. As a consequence many sites are abandoned and not remedied at all. Because of the limited available fundings needed for remedial activities of sites with obsolete pesticides it is useful to rank the urgency of clean-up of the different sites. In this way the sites with the highest priority can be addressed first. This can be achieved using a risk evaluation approach of the sites, in which the various types of environmental risks of these pesticides are assessed. Based on such an evaluation the urgency of remedial action can be set. Besides an assessment can show how objects might get exposed to the pesticides. This information can be very useful for temporary measures and actions to be taken to reduce the potential risk down to an acceptable level. The latter can save costs.

Within our company we have developed an approach how to define the urgency of remedial actions, based on various types of potential risks of stocks of obsolete pesticides. Input needed in this system is the name of the pesticide and general information about the site and soil use of the surroundings. The system is based on a classification of the well-known pesticides, on the basis of their toxicological and physiochemical properties, as these properties relate to the fate of the chemicals in the environment and their associated potential exposure risks of humans. With the information effective measures can be proposed, and costs of the remediation of each site can be estimated on forehand. In this way sites can be ranked for the urgency, types of measures, and the costs of actions (Tauw, 1999a; Tauw, 2000).

Approach

A method was formulated for identifying groups of pesticides. It is based on potential health risks for humans. It classifies pesticides into different groups due to their potential impact on human health. Simple objective criteria were defined to classify a pesticide in a small number of groups, for the various types of impact. The aspects and criteria are:

Acute toxicity for humans

Pesticides with a high degree of acute toxicity may pose a hazard for human health, if people are in direct contact with the chemicals. Therefore this aspect is considered for the health assessment of obsolete pesticides.

The classification of the impact of pesticides to human health due to its acute toxicity is based on the LD_{50}. Therefore the existing WHO classification was chosen. Based on their LD_{50} the individual pesticides were classified as highly, moderately, and slightly acute hazardous for human health.

Long-term toxicity for humans

Another aspect is the long-term toxicity for humans. Such chemicals may pose a health risk for the general population if long term might occur, for example through exposure from contaminated drinking water wells.

The classification of the impact of pesticides to human health due to its long-term toxicity is based on the ADI (Acceptable Daily Intake). This value is derived for pesticides by international organisations to protect the general population for possible adverse effects after life time exposure. Based on the ADI the individual pesticides were classified as highly chronic toxic, moderately toxic, and not toxic for human health, using boundary values of 1 mg and 1 mg per kg bodyweight per day.

Persistence

Most chemical compounds are broken down in the environment by biological organisms or physiochemical processes. Some compounds however are resistant for degradation. These persistent pesticides might cause potential health problems for public health on a larger scale due to their accumulation in the human food chain.

This aspect can be classified on the basis of the half-life (DT_{50}) of a pesticide in soil. A half-life of 80 days leads to a degradation of 90 to 95% of the initial quantity within one year. Therefore a value of 80 days was used to set a class of high and low persistency.

Mobility

Finally the pesticides were classified on the basis of their mobility via groundwater. The mobility of a pesticide via groundwater is related to its retardation; with this the rate of spreading via groundwater can be calculated.

The pesticide sorption to soil that can be described by its Koc value can be used to classify the mobility. For a coarse sandy soil with an average amount of organic matter a logKoc value of 3 equals to a rate of spreading of 0.1 m per year. Therefore the pesticides were classified as mobile for chemicals with a logKoc up to 3, and not mobile with a logKoc greater than 3.

Data collection

For the classification about 40 pesticides were selected that are considered relevant according to the FAO (Tauw, 1999a). From these pesticides data was collected about the formulations, its use, the mobility and degradation, rate of volatilisation and bioaccumulation, and its phytotoxicity from various sources such as Worthing and Hance (1991) and Verschueren (1996). Additionally the toxicological information was gathered from sources such as Vermeire et al. (1991) and the IRIS database (www.epa.gov/iris).

Measures

The need and urgency of measures can be established for each group of pesticides on the basis of their classification. For example: the acute toxic pesticides need for direct protective measures, whereas chronic toxic compounds soil may not need for urgent action. And, areas that are contaminated with persistent pesticides should be not used for crop cultivation and pasture grounds, or they should be remediated on forehand. Mobile compounds may spread through the groundwater, leading to potential health risks elsewhere if people use groundwater for drinking water. Besides spreading may lead to a contaminated agricultural or residential site in the surroundings. Consequently, spreading of mobile pesticides should be monitored and controlled by adequate measures.

To ensure the appropriate actions to be taken decision trees were developed for the assessment of toxic, mobile, and persistent pesticides. In these schemes various endpoints were defined, and for each endpoint remedial activities are given. As an example the evaluation of mobile pesticides is presented in Figure 1.

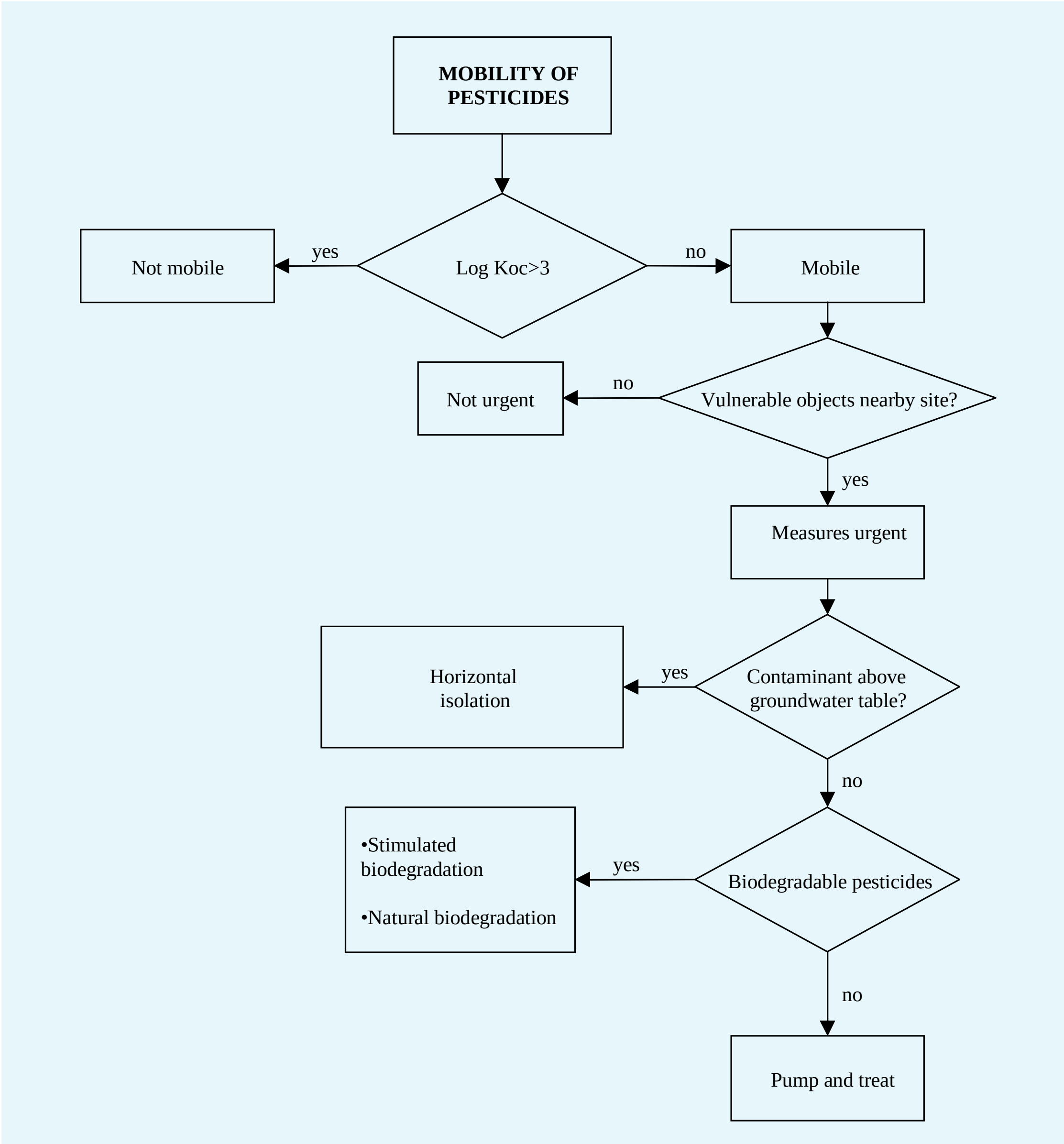

Figure 1. Decision tree for the evaluation of mobile pesticides, to define the urgency of a remediation, and its appropriate measures (Tauw, 2000)

A case study

A soil investigation was done at a site with obsolete pesticides in Yemen.

Site

The site concerns the Surdud Farm that was established between 1964 and 1967 by the Russian government. The total area counts about 1,200 ha. In 1983 the Russians stopped their activities and a private American company took over the site. In that year, the Americans buried most of the obsolete pesticides that were found at the farm in a pit. These pesticides came from Russia and various other donor countries, and had been shipped to Yemen during the time the Russian Governmental ownership. The depth of the pit is estimated 3.5 m below surface, and the bottom of the pit was not covered by foil or textiles. Other pesticides were mixed with cement and put in a concrete slab or stored in barrels. The concrete slab and three of such drums of 200 l are still at the site. In 1985 the Farm was taken over by Yemeni staff. In 1996 the pit was opened and some material was removed and shipped to the UK. Then the pit was closed again. A soil site assessment was then carried out in 1998 by the Plant Protection Department of Yemen, in collaboration with Ghayt Aquatech of Yemen and Tauw bv, The Netherlands.

The disposal site is an area of about 200 m², enclosed by a fence. It is directly surrounded by agricultural land that belongs to the farm. At present the farm produces fruits like mango and bananas; vegetable like tomatoes and onions, and cereal crops like maize and sesame. An overview is presented in Figure 2. The site is situated near mountains and close to the river Wadi Surdud. The river is usually almost dry but peak floods will occur in the raining season.

Pesticides in soil and groundwater

A record of the obsolete pesticides stored at the site was not available. In the soil survey the pesticides DDT, lindane, and endrin were detected from the topsoil down to a depth of about three meters. Besides DDD and DDE were found. No pesticides were found in the groundwater (Tauw, 1999b).

Classification

DDT According to the classification is DDT moderately acute and moderately chronic toxic, not mobile, but very persistent. DDD and DDE are its degradation products.

Lindane According to the classification is lindane moderately acute and moderately chronic toxic, not mobile, but very persistent.

Endrin According to the classification is endrin both acute and chronic highly toxic, not mobile, and very persistent.

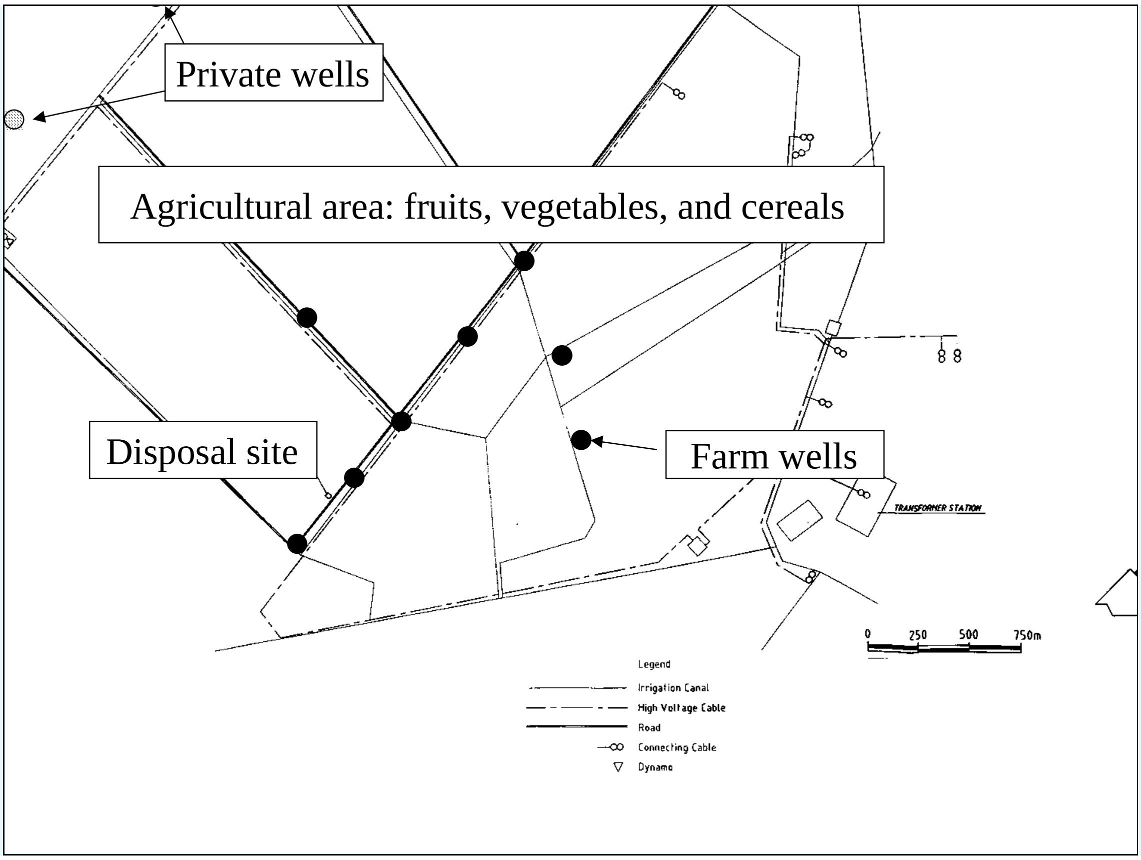

Figure 2. Map of the Surdud Farm

Risk evaluation

The risks of these obsolete pesticides are determined by their persistency, and the acute and chronic toxicity of endrin. The pesticide residues are not detected in the groundwater, thus proving the conclusions about the low rate of mobility of these compounds.

On the basis of the acute toxicity, endrin poses a health risk when humans are in direct contact with the pesticides. Besides a potential health risk exists for people in the surroundings due to the persistency if accumulation in the food chain can occur. The latter cannot be excluded as at present the surroundings of the site are used for agricultural activities, including growing cereals that can be used as animal feed. As however these pesticides are not mobile in groundwater, a transport of residues of DDT, lindane, and endrin into the surroundings is only likely by erosion of the topsoil and transport by the wind.

In this Yemen case the urgency of a remediation is to be based on the acute toxicity first. According to the site description the site is enclosed by a fence, thus humans are not likely exposed by direct contact. Consequently remedial activities are only urgently needed if spreading of contaminated topsoil by wind is taking place. This can be shown by an additional study to the pesticides in the topsoil of the surroundings, or to concentrations of the pesticides in the crops.

Conclusions

The case study demonstrates that the persistent obsolete pesticides have been found in the soil, and not in the groundwater. These findings are consistent with the predicted fate of these chemicals on the basis of their classification.

Besides it is shown that the urgency of remedial actions can be defined on the basis of information of the site and its surroundings.

Consequently it can be concluded that the approach to classify stocks of obsolete pesticides on their health impact offers an appropriate way to decide about the urgency of measures and the types of measures for different locations.

Literature

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