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REGISTRATION OF CONTAMINATED SITES IN VIETNAM

PART 1: BASIC INFORMATION

Supported by:

Federal Ministry
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based on a decision of the German Bundestag

Registration of Contaminated Sites in Vietnam
Part 1: Basic Information

Imprint

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CONTENTS

LIST OF FIGURES AND PICTURES

ABBREVIATIONS

BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BBodSchG	Bundes-Bodenschutzgesetz
BTNMT	Decision or Circular of the Ministry of Natural Resources and Environment Vietnam
DONRE	Department of Natural Resources and Environment
GDLA	General Department of Land Administration
GIS	Geographic Information System
MONRE	Ministry of Natural Resources and Environment
ND-CP	National Degree of the Vietnamese Government
POP	Persistant Organic Pollutant
QCVN	Technical Standards in Vietnam
QD-BTNMT	Decision of the Minister of Natural Resources and Environment
QD-TTg	Decision of the Prime Minister
TCVN	Technical Standards in Vietnam
VEA	Vietnam Environment Agency
XRF	X-Ray Fluorescence

FOREWORD

Dioxins as long-lasting witnesses of the Vietnam War, heavy metals from handcrafts villages and industries, persistent organic pollutants from the extensive use of pesticides in agriculture – this are only some examples of pollutants found in Vietnamese soils. Contaminated soils are a widespread, complex and lasting environmental issue in Vietnam. However, data relating to the location and degree of contaminations are only sporadically available in many cases.

A proper registration, also called recording, of contaminated areas in a suitable data bank and cadaster is not only the first step towards the safeguarding and decontamination of contaminated sites – it is an essential tool to minimize risks by integrating information on soil contamination into (urban) planning and agricultural development processes.

The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports with the project CapaViet the transfer of technologies and experiences, as well as capacity building for national and regional experts for the development of soil contamination cadasters in Vietnam.

This manual is – in accordance with the regulations 30/2016/TT-BTNMT from the Vietnam Environmental Agency and 60/2015/TT-BTNMT from the General Department of Land Administration - a guideline to prepare and develop a soil cadaster that embraces necessary data and information to fulfill the provincial environmental agencies' administrative responsibilities.

Information in the cadaster and the associated data bank should also be used in the evaluation process of a site's environmental status before decisions on rural and urban planning are made. An example for the use of such synergies is defined in the regulation 60/2015/TT-BTNMT, which sees the mapping of soil contaminations as an integral part of the documentation and cadaster for the technical inspection and assessment of land, e.g. to define and plan uses for agriculture.

I am convinced that the manual provides you with the necessary information to successfully register soil contaminations in your province. This manual shall also motivate you, by giving an insight into the legal context, to share the gathered information and data with entities that make decisions on rural, urban and agricultural planning in Vietnam.

Andreas Bieber
German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)

1. INTRODUCTION

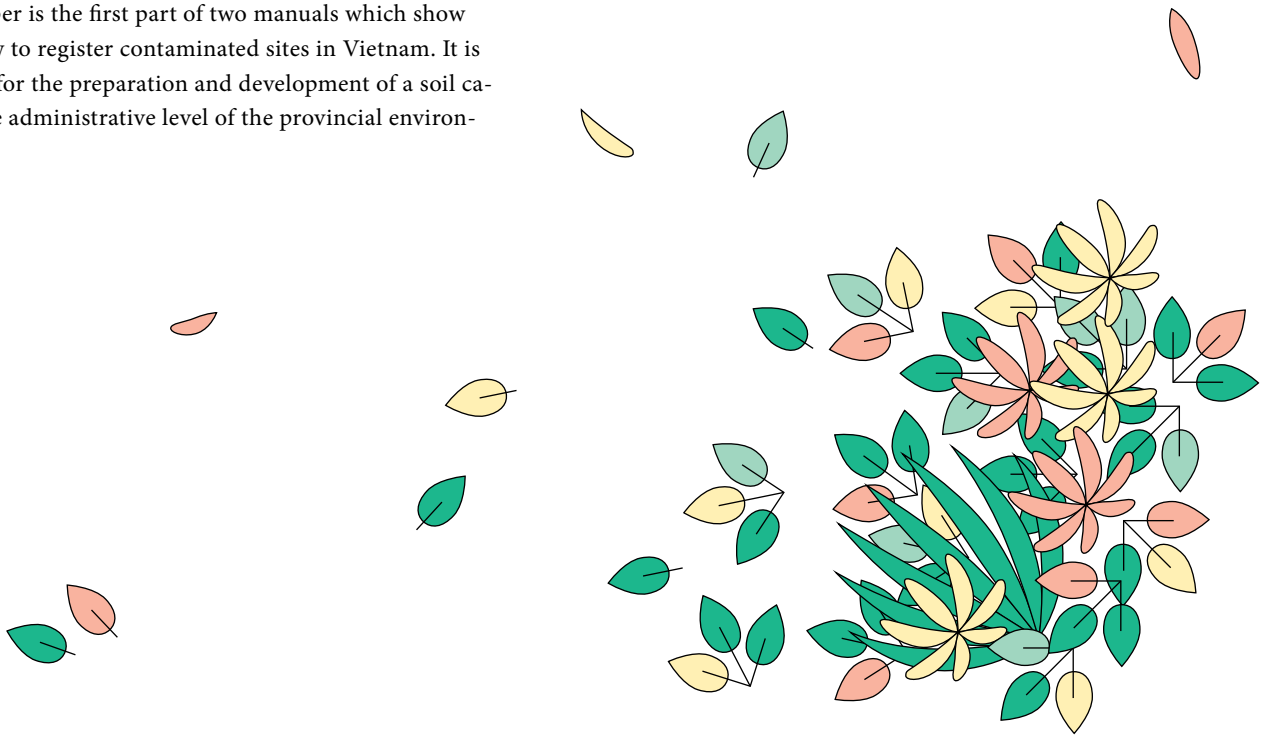
Contaminated sites in Vietnam are often results of previous industrial uses at the respective areas, as well as the incorrect use and storage of pesticides, recycling and reuse of heavy metals under inappropriate safeguards in craft villages and the use of toxic substances during the Vietnam War. In the last years, the government of Vietnam has made efforts to manage contaminated sites, but the lack of reliable data prohibits effective action.

A successful remediation of contaminated sites requires a systematic and gradual procedure - such as it has proved of value in Germany for many years. The first step of this process is the registration of (potentially) contaminated sites.

Registration of contaminated sites includes investigation in the sense of collecting information as well as various steps of assessment and documentation in maps and texts. The main subject of the scientific venture in Vietnam is to impart knowledge of procedure concerning the registration of contaminated sites.

This paper is the first part of two manuals which show the way how to register contaminated sites in Vietnam. It is a guideline for the preparation and development of a soil cadaster at the administrative level of the provincial environmental agencies (DONREs). This cadaster should be integrated as a layer on soil contamination into GDLA's cadaster for (agricultural) soil evaluation as defined in Article 6b of the regulation No. 60/2015/TT-BTNMT.

After the issue of soil contamination in Vietnam is presented and the legal background for the recording of soil contaminations it is briefly summarized in chapter 2, an overview over the five main steps in the management and treatment of contaminated sites is given in chapter 3. Then, chapter 4 and 5 outline in more depth the process of contaminated site registration. Chapter 5 comprises necessary background information for the choice of a suitable frame for recording, while chapter 6 presents, explains and evaluates different methods, tools and sources that can be used to investigate contaminated sites in Vietnam.



2. BACKGROUND INFORMATION

This chapter includes facts and explanations about the current situation regarding soil contamination in Vietnam (part 2.1), as well as information on the current legal background for the management of contaminated sites in Vietnam (part 2.2)

2.1. ENVIRONMENTAL PROBLEMS IN VIETNAM

Vietnam's environmental issues are closely linked with the country's special developments during the 20th century. The colonial rule of the French, which lasted from 1858 until 1954, established first large-scale enterprises, including a number of textile factories in Vietnam.[1]

Older and more traditional forms of manufacturing can be found in craft villages. Over 2000 of these villages with production lines focusing on metal manufacturing, paper manufacturing and paint works are currently located in Vietnam.[2,3] Due to the environmentally harmful nature of these production lines, the life expectancy of the population of craft villages was in 2008 around 10 years lower than average in Vietnam.[4] Additionally, waste waters of these craft villages are predominantly discharged unfiltered into draining ditches or ponds, what leads to the contamination of groundwater that is used as domestic water supply for more than half of the Vietnamese population.[5,6]

Mining is another significant source of contamination. Vietnam is rich in natural resources such as coal, ore, lead and rare earths, which are extracted by surface mining.[7] The land consumption of mining activities is enormous.

In 2006, more than 2900 hectares are affected by coal and ore mining activities in the Thai Nguyen province alone, with at least 1900 hectares of affected land listed in other provinces.[8] The waste water of mining activities and processing, partially discharged into hollow molds of mining areas, is often contaminated with heavy metals like iron, led, and arsenic.[9] As a result, the areas used for preparation and deposition of natural resources are polluted with heavy metals to a degree that makes agricultural use no longer possible. Another cause for environmental pollution is the Vietnam War (1955-1975). This is less due to the use of bombs and napalm, but rather due to poisonous chemicals such as "Agent Orange", which was used by the American armed forces for defoliation, and is still present in soils and sediments of water bodies in large areas of South and Central Vietnam.[10]

Vietnam is a country with strong economic growth, but environmental contaminations due to this untamed growth are becoming more and more apparent. To prevent that environmental factors influence economic growth, the Vietnamese Government is encouraged to take legal action. A suitable legislation for the management of contaminated sites as well as technical know-how and capabilities to carry out effective hazard prevention are recognized as essential components of an efficient environmental strategy. However, in practice they are developed in only a rudimentary manner.

One out of many constraints in solving the environmental problems is the lack of reliable data. Especially data that can be used to identify environmental threats and their severity is of outstanding importance for the further treatment of contaminated areas. The best way to gather and store this kind of data is the creation of a cadastral land register of potentially contaminated areas.

In Germany, the acquisition of potentially contaminated areas and the maintenance of cadastral land registers became to be regulated in some federal states in the late 1980s, while a nationally consistent management of contaminated soils was only regulated by law in 1998.[11] In the past years, the significance of cadastral land registers in land transactions grew.

In Vietnam, the legislation defining the registration and management of contaminated soils is still quite young, with first regulations passed in 2003.[12] The next chapter gives an overview over the current legal framework for the registration of contaminated areas in Vietnam.

2.2 LEGAL FRAMEWORK

In Vietnam there are different legal regulations which refer to the compilation of registers of contaminated sites.

Decree No. 64/2003/QD-TTg from 2003 was the first legal basis for the analysis and management of contaminated areas. The decree includes definitions of important terms regarding contaminated areas, as well as specifications about procedures, time frames and priorities for the management of contaminated soils. It also shows the determination of the government to gradually relocate "black-listed" industrial establishments out of residential areas. According to objectives set out in the decision, 51 establishments which most seriously pollute the environment had to be strictly managed by 2005, 388 establishments by 2007 and the remaining 3,856 establishments listed and all new ones by 2012. The regulation No. 1788/2013/QD-TTg from 2013 extended and prolonged the targets of the existing decree by defining the „comprehensive rehabilitation of establishments with severe environmental pollution until the year 2020".

In the last ten years, mechanisms and policies relating to subsidies have been issued and implemented in different forms both at central and local levels (see e.g. Prime Minister Decision 58/2008/QD-TTg on the financial endowment of projects for the rehabilitation of contaminated areas). In addition to supportive measures, the inspection and supervision of the implementation of the decision have also been enhanced, while regulation No. 117/2009/ND-CP specifies the management and rehabilitation of contaminated areas.[13]

The technical standards QCVN 45: 2012/BTNMT and QCVN 03: 2015/BTNMT define the permissible limits for dioxins and heavy metals in Vietnamese soils.

In October 2016, the regulation No. 30/2016/TT-BTNMT on the management, remediation and environmental regeneration of contaminated soils has been issued by the Vietnam Environmental Agency (VEA). It defines in more detail how to register, evaluate and to treat contaminated sites in Vietnam. The regulation also specifies how priorities are set for the remediation of contaminated sites.

The regulation No. 60/2015/TT-BTNMT on the technical inspection and assessment of land, issued in November 2015 by the General Department of Land Administration (GDLA) is preliminarily a regulation that defines the development of a databank and cadaster that provides and organizes data for evaluation of land and the classification of soil quality. This cadaster is developed with the aim to determine the potential for agricultural uses for Vietnamese soils and to establish a monitoring system to ensure food security. Data related to soil contaminations are crucial for such a soil quality assessment. Therefore, a brief check of local soil contaminations shall be included into this cadaster if potentially pollutive activities took place at the location to be evaluated.

The procedure to identify, assess and classify is thereby very similar to regulation No. 30/2016/TT-BTNMT. In contrast to it, the regulation from 2015 focuses only on registration and monitoring of contaminations and does not manage the prioritization and implementation of remediation measures.

The register of contaminated sites, which is matter of this manual, can be regarded as the basic requirement in order to implement the regulation No. 30/2016/TT-BTNMT.

The very same register shall also be an important feature of the databank and cadaster for the technical inspection and assessment of land, which is mandated and defined by regulation No. 60/2015/TT-BTNMT. Figure 1 gives an overview over the steps of registration of contaminated sites listed in the mentioned regulations.

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[1] *Mark (2012)*
[2] *Chu (2011)*
[4] *Government of the Republic of Korea, Korean Environment Institute, World Bank, (2005).*
[4] *MONRE (2008)*
[5] *Ibid.*
[6] *Asian Development Bank (2009)*
[7] *Fong-Sam (2014)*
[8] *Quy (2006)*
[9] *Förstner (2008)*
[10] *https://www.aspeninstitute.org/programs/agent-orange-in-vietnam-program/maps-of-heavily-sprayed-areas-and-dioxin-hotspots/ (11.06.2018)*
[11] *Schroers (2009)*
[12] *Decree No. 64/2003/QD-TTg*
[13] *Mark, Zschiesche, Stolpe (2015)*

REGULATION 30/2016/TT-BTNMT (VEA) (OCTOBER 2016)

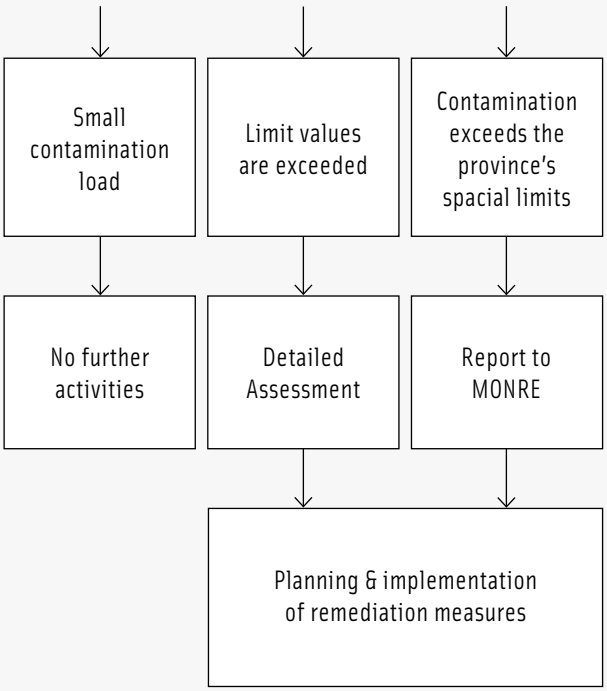
Site-related investigations at areas suspected to be contaminated with the aim to detect and manage contaminations

Assessment of soil contaminations through
- Documents about (former) uses and activities with pollution risks
- Interviews (owners, users, contemporary witnesses)
- Short on-spot inspection (collection of information on geographic conditions and possible sources, identification of contamination proliferation through five representative soil samples, photos)

Classification of contaminated soils by evaluating source and subject of contamination and its ability to dispense.

Results are outlined in a report and cadaster.

The regional people's comitee decides on **further management and remediation measures** by evaluating reports and collected data.



REGULATION 60/2015/TT-BTNMT (GDLA) (NOVEMBER 2015)

Area-wide investigations at many sites with the aim to build up a national cadaster to assess the quality of agricultural soils

Assessment of soil contaminations through
- Documents and maps about (former) uses and activities with pollution risks with their evaluation regarding accuracy, objectivity, topicality
- Short on-spot inspection based on data that is still missing (collection of information on geographic conditions and possible sources, identification of contamination proliferation through representative soil samples, photos)

Classification of contaminated soils oriented on official limit values and types of use defined in this and other regulations.

Results are outlined in a report and in layers within the cadaster for agricultural soil classification.

The responsible administrative organ has to be informed and shall decide on **further management and remediation measures**. Experts can make proposals for management measures.

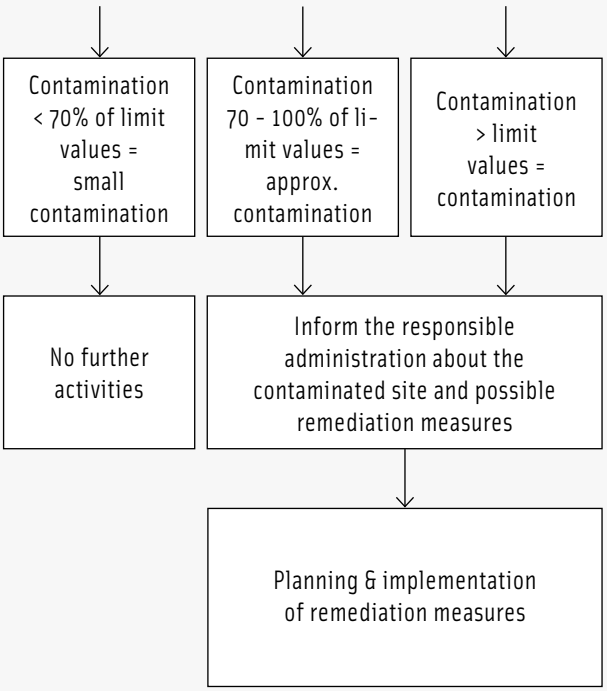


Fig. 1: Comparison of responsibilities and soil registration activities defined in the regulations 30/2016/TT-BTNMT and 60/2015/TT-BTNMT (OWN FIGURE).

3. TREATMENT OF CONTAMINATED SITES IN OUTLINE

In chapter 3.1 the term "contaminated sites" will be defined. Following this, chapter 3.2 will give a short overview over sources of pollution in soils and exposure pathways posing risks to human health.

3.1 DEFINITION OF CONTAMINATED SITES

Environmental impacts caused e.g. by the input of pollutants into industrial sites due to deficiencies in waste disposal and other causes in the past and also in present times prove to be a problem of great significance not only in Vietnam, but in all industrial countries.

Environmental policy derives, among others, from the requirement to manage these impacts. As a consequence, a field of reference of research and work concerning the handling of „contaminated sites" developed in many countries. The term "contaminated sites" points out that in contrast to preventive soil protection and waste disposal, the aim is to get subsequent control of environmental pollution caused in the past. In America the term "brownfields" is used analogously.

In Germany, the term "contaminated sites" means exclusively closed down plants and waste dumps whereas in Vietnam, the term has additionally been extended to plants still in operation.

Various regions of Vietnam, like the province of Bắc Ninh, contain areas of concentrated settlement and industry, which have been especially affected by the problem of "contaminated sites" owing to the change of industrial culture during the last few decades.

Fig. 2: Waste disposal site in Van Mon, Province of Bắc Ninh (MARK 2018)

Fig. 3: Industrial site (paper recycling) in Dương Ổ, Province of Bắc Ninh (MARK 2018)

Following the German Federal Soil Protection Act, it would be also appropriate to distinguish between waste disposal sites and industrial sites in practical recording work in Vietnam:

1. Waste disposal sites are waste disposal installations and other real properties on which waste has been treated, stored and landfilled (Fig. 2).

2. Industrial sites are real properties on which environmentally harmful substances have been handled (Fig. 3).

3.2 SOURCES OF CONTAMINATION AND PATHWAYS OF EXPOSURE

Similar to Germany, large parts of Vietnam have been moulded by a long industrial and mining history. Industry and trade, yet also military installations may have caused pollution of soil and/or groundwater.

Here, potential sources of contamination are:

— spilling of hazardous substances in storing, transporting or transfer into other containers
— accidents, leakage and damage
— inadequate waste disposal

Although environmental pollution of soil is not always consciously perceived, it may cause hazards and damage in various ways. Humans, animals and plants may take up pollutants from contaminated sites through soil, water, agricultural crops, animal feed or from air.[14] Gases may penetrate brickwork, accumulate in rooms and even reach explosive concentrations. Furthermore, contaminated sites may cause damage of buildings and reduce the value of the real properties affected.[15]

Pollutants from soil may be taken up on the direct way as follows:

— swallowing of contaminated soil and/or surface dust (oral intake)
— inhalation of volatile substances escaping from polluted soil and dust particles whirled up from the ground (inhalative intake)
— uptake of substances through skin in the event of an intensive contact with soil (percutaneous uptake)

Damage by a direct contact is possible notably then when the contaminated surface of the contaminated site is used in one of the following ways (sensible use):

— children's playground
— residential area (with garden)
— park and leisure facility, unsurfaced urban area
— large kitchen garden

[14] *Saxon State Agency for Environment, Agriculture and Geology (2008)*

[15] *Bavarian Environment Agency (2009)*

4. STEPS OF CONTAMINATED SITE MANAGEMENT

The systematic treatment of contaminated sites is, as a rule, a multi-stage process. As shown in Figure 4 it is subdivided into the stages recording, risk assessment, investigation and planning of remediation, remediation and aftercare.

Figure 5 shows the measures within the individual stages in more detail. Parallel to the individual stages or after completion of remediation, partly long-term monitoring measures may be required.

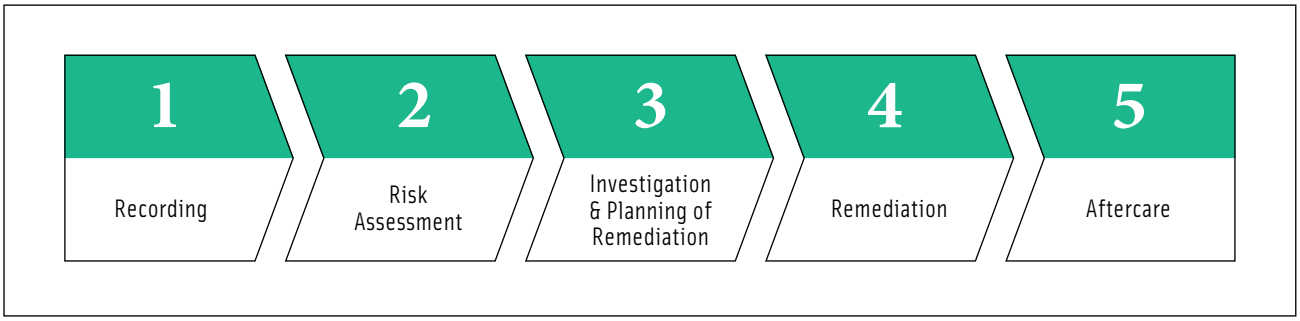


Fig. 4: Steps of systematic treatment of contaminated sites (OWN FIGURE)

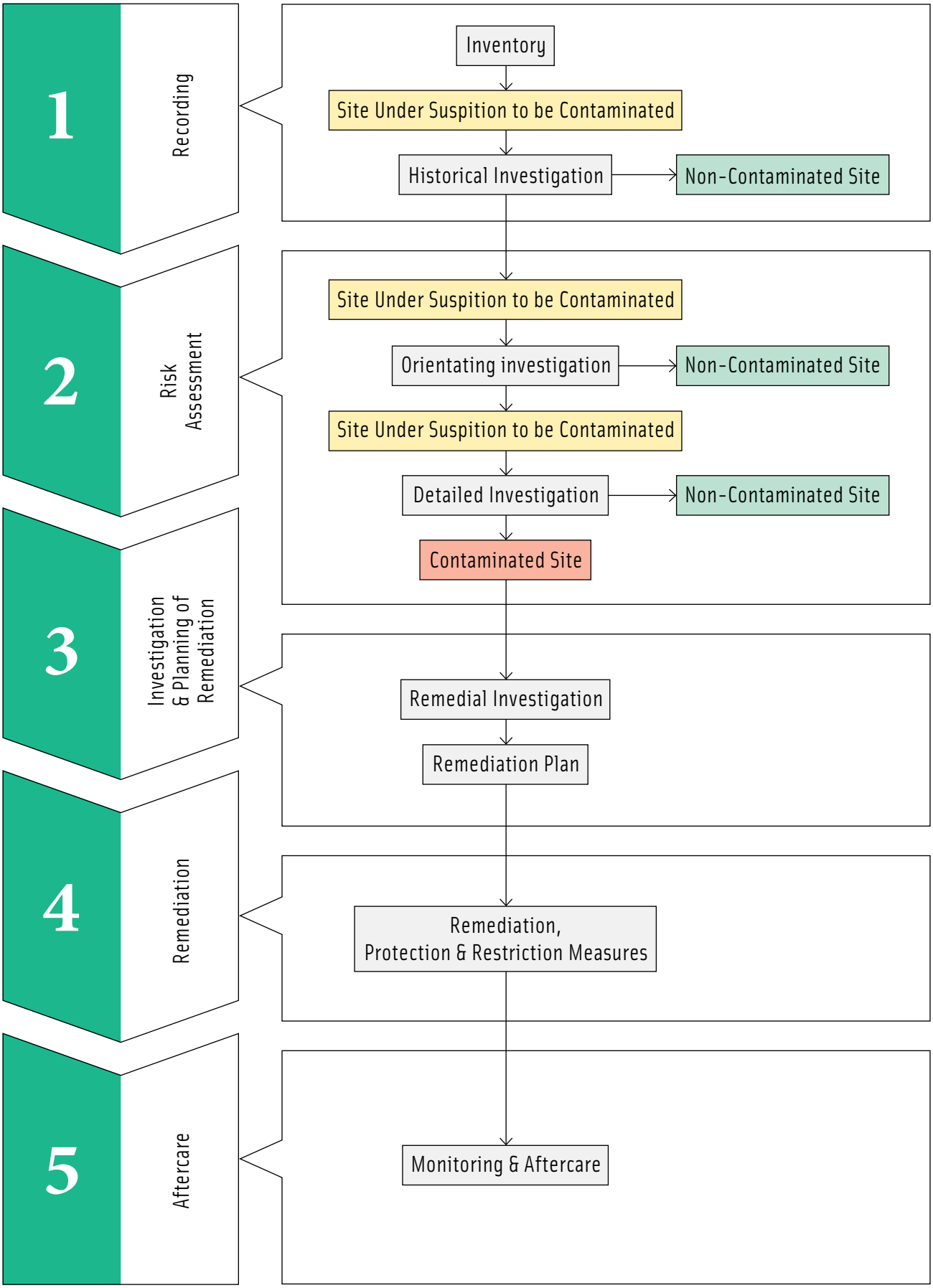
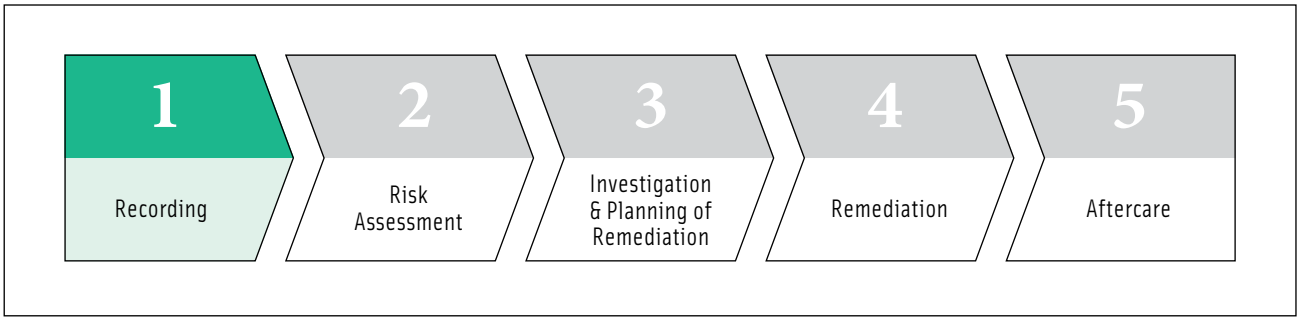


Fig. 5: Treatment of contaminated sites as a multi-stage process (OWN FIGURE, based on BLUME, 2011)



4.1 RECORDING OF (POTENTIALLY) CONTAMINATED SITES

Recording is the first, basic stage of treatment of contaminated sites. Recording involves investigation in the sense of collection of information, various stages of assessment and documentation of the findings in the form of maps and texts. Basically, a distinction is made between **area-wide** and **site-related** investigations (see chapter 5.2).

The objectives of the recording stage are:

— conducting area-wide investigations of industrial and waste disposal sites and their compilation in a list;
— the assessment of the industrial and waste disposal sites investigated with regard to the identification of sites suspected of being contaminated;
— conducting extensive site-related investigations;
— an assessment of the results of investigations in the sense of a first risk assessment and further measures resulting from it.

Content and target of the investigations are:

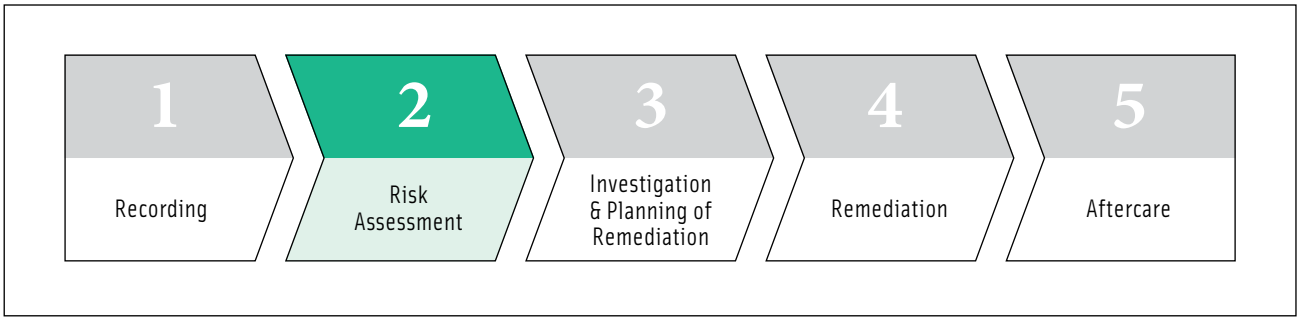
— classification of specific case groups of industrial and waste disposal sites or individual cases of areas suspected of being contaminated,
— determination of the position and spatial extension of the potentially contaminated areas and
— collection and processing of all further information relevant to environment on the individual areas.

Investigations do, as a rule, not involve local investigations exceeding a potential site inspection. Drilling, sounding, chemical-physical investigations etc. are basically left to the subsequent stages. The data and findings collected are filed in registers, updated by the competent authorities and displayed on maps.

The investigations made by the authorities follow two aims:

— the detection and localizing of possibly all industrial sites and waste disposal sites situated in the area of responsibility of an authority (area-wide investigations).
— the compilation of all detailed information required for the individual treatment (site-related investigations).

In practice a strict distinction between are-wide and site-related investigations may not always be made. In area-wide investigations basically an information level is to be striven which allows a substantiated fixing of priorities for the subsequent work.



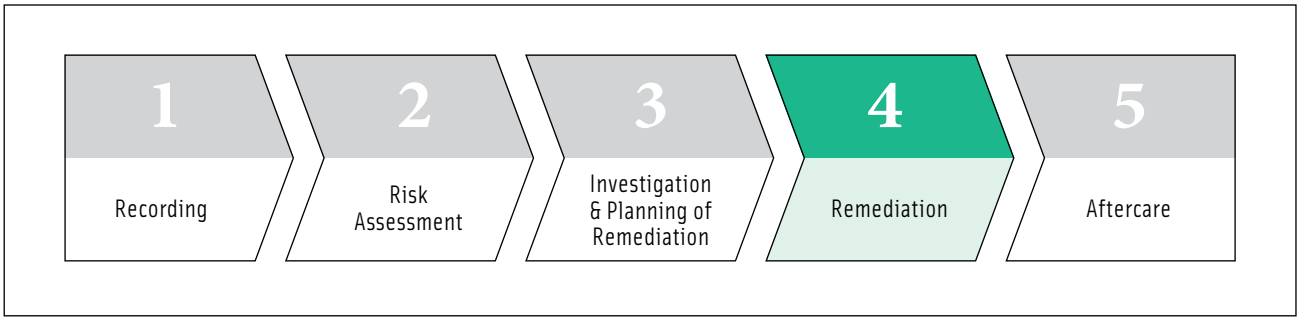
4.2 RISK ASSESSMENT: SAMPLING AND ANALYSING

An essential prerequisite to appropriate and efficient investigations are thus extensive site-related investigations (historical research). The first risk assessment based on the results of recording, the „assessment of recording", shall be systematically assigned to the "recording" stage. It is the basis for making a decision on the need, type and extent of specific investigations.

As to their type and quantity, the investigations required for assessing hazards have to be adapted to the pollutant potential of an area suspected of being contaminated. In addition, spreading of the relevant pollutants from the area as a source of hazards up to their effects on the subjects of protection concerned and the effects possibly resulting from it have to be recorded in the individual case as exactly as possible. Thus, the determination of the type and concentration of pollutants, the investigation of their mobility or mobilizability and recording of the exposition of the subjects of protection concerned form part of the investigation of an area suspected of being contaminated.

The mobility or mobilizability of pollutants depends on their chemical bonding, on companion substances affecting solubility, entering of water and soil properties at the respective site (e.g. pH, clay content or content of organic substance). Considering the effective pathways „soil-human" and „soil-plant", notably the way and intensity of soil use is of importance to human exposition. On the other hand, primarily the geological and hydrogeological conditions have to be determined with regard to the effective pathway "soil-groundwater".

In Germany, the results of the investigations are also assessed, in particular by means of trigger and measure values under the circumstances of the individual case. In Vietnam there are different acts and decrees concerning critical values of contaminants, e.g. the technical standards TCVN 7209: 2002 on soil quality - maximum allowable limits of heavy metals in the soil, TCVN 5300:2009 on soil quality – classification of soil polluted by chemicals and also 30/2016/TT-BTNMT on the management, treatment and environmental restoration of contaminated soils. Currently, the new regulation 30/2016/TT-BTNMT shows the way how to assess contaminated sites in Vietnam.



4.3 REMEDIATION: DECONTAMINATION AND SECURING

Remediation measures require thorough planning. During the preparation and implementation of remediation measures, an engineering supervision of the works and an expert monitoring will be required.

When carrying out remediation measures occupational and ambient safety (immission control and protection of the residents) will play an important part as contaminated materials will be handled. Measures relating to occupational and ambient safety have to be planned and supervised.

For the elimination and limitation of pollutants, the German law distinguishes in § 2 (7) and (8) BBodSchG between remediation measures on the one hand and protective and restrictive measures on the other hand. Remediation measures include measures to remove contaminants (decontamination), measures to prevent the spread of pollutants (securing measures) and other measures to eliminate and reduce other harmful changes to the soil.

The scientific-technical distinction between decontamination and securing measures is that:

— **Decontamination measures** eliminate or reduce pollutants durably.
— **Securing measures** prevent or reduce the spread of pollutants in the long term without eliminating the pollutants. As all engineering structures have a limited life and thus also their securing effect, these structures will have to be possibly restored after respective periods of time.

Therefore, in addition to measures for decontamination of a site, securing measures may be taken to prevent pollutants from spreading.

DECONTAMINATION MEASURES

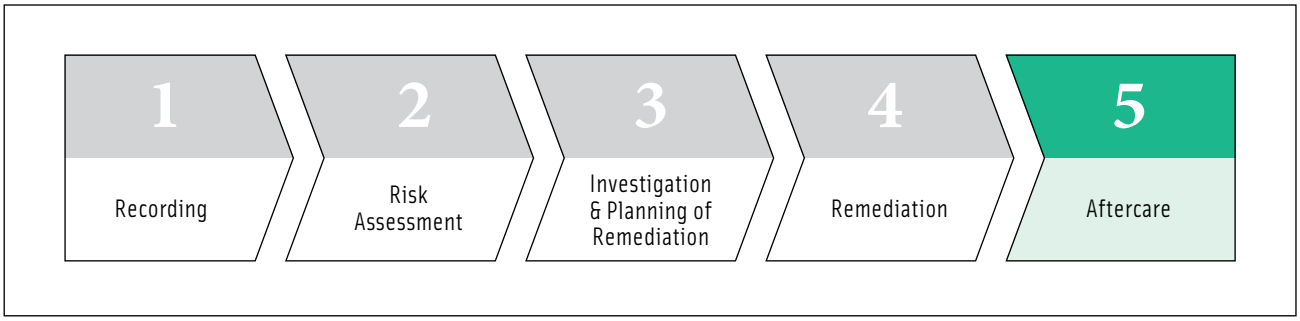
In the case of decontamination measures the following remediation measures have to be distinguished according to the place where the method will be applied:

— "on site remediation": a remediation measure where the polluted soil or the polluted groundwater or the polluted soil air are taken off and treated in situ;
— "off site remediation": a remediation measure where the polluted soil is excavated and treated in an external plant;
— "in situ remediation": a remediation measure where soil masses are not moved and pollutants are removed or reduced directly in the subsoil. Examples of in situ remediation are:
  — the excitation of the microbial degradation of mineral oil contamination by the supply of air or oxygen or
  — electro-kinetic methods for the purification of soil polluted by heavy metals.

Altogether, various methods are available for decontamination: thermal methods (evaporation of pollutants by the action of heat, oxidation of pollutants), microbiological methods (microbiological degradation of pollutants) and various other methods (e.g. suction of polluted soil air or expulsion of easily volatile substances from groundwater). Also the removal of polluted soil with its subsequent placing on a waste dump or in a secured area within the contaminated site is called decontamination.

SECURING MEASURES

Securing measures are:
— constructional encapsulation and enclosing measures. Examples are:
  — surface covering of contaminated sites by non-polluted soil to avoid a direct contact with the polluted material or
  — surface covering of contaminated sites by a sealing system to prevent forming of seepage water or
  — erection of vertical sealing walls to prevent groundwater from entering laterally.
— hydraulic and pneumatic securing measures: An example of pneumatic securing measures is the installation of gas windows in former waste disposal sites.
— measures restricting the mobility of pollutants (immobilisation): an example of immobilisation measures is the consolidation of polluted soils with the aid of cement.



4.4 AFTERCARE

After remediation measures took place, the achieved residual polluted levels, as well as the harmless elimination of added active substances and materials must be recorded. Based on this, the current situation of the site is evaluated.
The observation objects of the monitoring depend on the nature of the former soil contamination as well as on the type of process chosen for remediation.

In case of landfills, monitoring in the after-care period according to German Law includes periodical audit of the hydrological balance (to detect leakage), the quality of the leachate and the landfill gas, determination of the settling behavior of the landfill body and the ground water quality in the groundwater in- and outflow. The completion of the after-care phase must be determined by law.

5. REGISTRATION OF CONTAMINATED SITES

After the previous chapter gave a short summary of the various steps towards the successful management of contaminated sites, this chapter gives more details on the registration process of contaminated sites, including a discussion of different scales and objectives of site recording. It also presents methods and sources for the recording of contaminated sites, such as research in archives and the evaluation of documents and records, the analysis of maps and aerial photos as well as site inspections and the tool of interviews.

5.1 OBJECTIVE AND SCOPE OF RECORDING

Before suitable methods of site assessment can be chosen, it is vital to define the scope and objective of the planned investigation. By presenting different scopes of investigations as well as objects of the investigation of (possibly) contaminated soils, this chapter guides you to choose the right method of recording.

5.2 AREA-WIDE AND SITE-RELATED INVESTIGATIONS

Area-wide investigations are carried out to systematically determine the industrial and waste disposal sites situated in the area of responsibility of an authority as well as to create the information basis required for a complete identification of sites suspected of being contaminated.

Investigations aim to achieve a sufficient level or density of information in order to obtain indications on the presence of a contaminated site (position, former use of industrial sites, hazard potential/risk resulting from it, area size, type of the material deposited in the case of former waste disposal sites etc.).

As a rule, already available, yet mostly scattered information is collected and evaluated for implementing further measures. In this phase of treating contaminated sites, soil samples are not taken. Area-wide investigation is mainly rather based on historical sources which originally served for other purposes than the recording of contaminated sites (e.g. directories, trade registers, maps and aerial photos).

A site-related investigation should, as far as possible, collect and display all information that is appropriate for reconstructing the site's history and investigating the associated contamination-related uses and events. Here, the method of investigation aims at gradually condensing information by evaluating various information sources independent of each other.

5.3 CATEGORIES OF USE RELEVANT FOR INVESTIGATION

In the light of investigations to record and document uses and/or events which may play a (restrictive) part in planning a follow-up use, the areas with the following categories of use have to be investigated:

Industrial sites
Abandoned and industrial sites in operation, that are suspiciously contaminated as for their typical kind of usage. (A list of relevant industrial sectors will be presented in manual 2)

Craft villages
Craft villages with a high potential of soil and groundwater contamination should be registered by concentrating equal or similar units of usage. Examples will be given in part 2 of the manual.

Waste disposal sites
Sites where waste material (industrial waste, commercial waste, medical waste, domestic waste etc.) has been deposited must be determined. Waste disposal sites have to be recorded and, if necessary, categorized as follows:

— Deposits
  By deposits all waste disposal sites are summed up where material is deposited onto the top of natural ground. This may, on the one hand, be done by a systematic, planned activity, e.g. for ground levelling and preparation of building ground (base deposit) and for the erection of dumps, dams or dikes. On the other hand, an "indiscriminate" way can be chosen for so-called "uncontrolled" dumps, disposal sites of buildings, demolition rubbish and other temporary, mostly small-area material deposits.

— Backfills
  This concerns natural or artificial hollow shapes such as e.g. pools, pits, trenches, basins etc. backfilled with material.

Storage areas
Storage areas will be recorded as a further object category. They are defined as areas where piece goods or bulk material (partly not to be specified in a more detailed way) have been stored. Article 22 of regulation No. 60/2015/TT-BTNMT pays special attention to pesticide storage facilities.

Areas with extensive use of organic fertilizers and pesticides (incl. aquaculture production sites)
Additional to the pesticide storage facilities, there are other areas where an extensive amount of organic fertilizers took place. Also aquaculture sites should be considered due to possible uses of drugs and chemicals, as well as their waste water and the resulting contamination of the soil.[16,17,18]

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[16] *Weston, D.P. (2000)*
[17] *FAO (2015)*
[18] *Lupi, Carlo (2015)*

6. METHODS AND SOURCES FOR RECORDING CONTAMINATED SITES IN VIETNAM

Basically, only few data sources, if any, are **directly** available that give further information on
— the partial areas of a site which are possibly contaminated,
— the contamination concerned,
— the time or time span in which potential damage was inflicted.

For practical site-related investigation, this means that only in exceptional cases, areas on a non-active site suspected of being contaminated can be directly spatially localized and classified chronologically as well as by type of contamination.

As a rule, these areas have to be localized and classified **indirectly**, namely through detecting all potentially polluting uses and activities. According to article 22 of regulation No. 60/2015/TT-BTNMT these potentially polluting uses and activities can be found at:

— industrial areas and craft villages, areas of ore production and processing,
— waste disposal sites (industrial waste, commercial waste, medical waste, domestic waste etc.) and backfills,
— areas of planting and breeding of water products,
— areas with intensive use of organic fertilizers and pesticides,
— storage facilities for pesticides,

Accidents or other cases of damage as well as areas of military actions are not listed in article 22 of regulation No. 60/2015/TT-BTNMT, but should also be taken into account.

In practical site-related investigation, four methods have proved to be especially efficient:

1. **Archive research** with evaluating the unprinted and printed documents obtained in public archives and company archives and in official (old) registries,
2. **Multi-temporal mapping**, i.e. the evaluation of maps and aerial photos of various subjects and times of origin, especially
   — the evaluation of first editions and continuation of official topographic **maps** of a scale of 1:25,000 and larger and
   — the interpretation of **aerial photos** available from aerial, route and other navigation,
3. **Interviews** with contemporary witnesses like e.g. site owners and as well as former and current users
4. **Site inspection** to understand the current situation.

In general, it is not sufficient to apply only one of the methods mentioned. In appendix 2 of regulation 30/2016/TT- BTNMT, according to article 6 these methods are listed in detail with the exception of multi-temporal mapping.

In German practice a combination of the first and second method has proven most successful. Interviews with contemporary witnesses are only recommended if detailed information cannot be obtained from archive research, evaluation of documents and records or multi-temporal mapping. In Vietnam, however, interviews will certainly be a more important tool due to restricted documentation, maps and aerial photos.

If possible, the findings of recording should be supplemented by a **site inspection**. Site inspection can also be one of the basic methods for registering contaminated sites. Experiences in Vietnam show that the first two methods (archive research and multi-temporal mapping) cannot be applied in each

region because of a lack of information. Site inspections in combination with interviews are therefore the most promising methods in many regions of Vietnam, although it is advisable to apply archive research and multi-temporal mapping wherever it is possible.

6.1 ARCHIVE RESEARCH AND EVALUATION OF DOCUMENTS AND RECORDS

During the usage history, documents and records with directly or indirectly usable information relevant to the environment have been compiled. These data sources are - depending on the specific site - more or less comprehensive.

As typical examples of such documents and records can be mentioned:

— operating licences,
— applications for permissions for the construction and reconstruction of buildings and plants,
— respective layouts and plant layouts at specific times of industrial site development,
— production and other plant reports and
— damage information and reports relating to accidents including war damage.

The evaluation of this documentation – frequently compiled over decades – usually provides important information on

— the historical building and plant stocks and their functions,
— potential accidents/leakage and other singular events such as military actions,
— manufacturing methods (relevant to contaminated sites) and other industrial procedures and sequences of work
— ownership systems (and their change).

To find documents and records efficiently, it is recommended to adopt an approach deriving from the official regulations related to the transmission of documents and records about site utilization and ownership. Document stocks considered to be worth archiving are usually arranged and stored according to the **provenance and site principle**, i.e. according to sites where they have been compiled.

Accordingly, it has to be first of all reconstructed which operations are of relevance to contaminated sites (mostly) without being indicated by the titles of the records. Subsequently, it has to be determined which authorities or company departments have dealt with processes possibly relevant to contaminated sites.

Then the archives or information offices competent for storing the records of the sites concerned will have to be found.

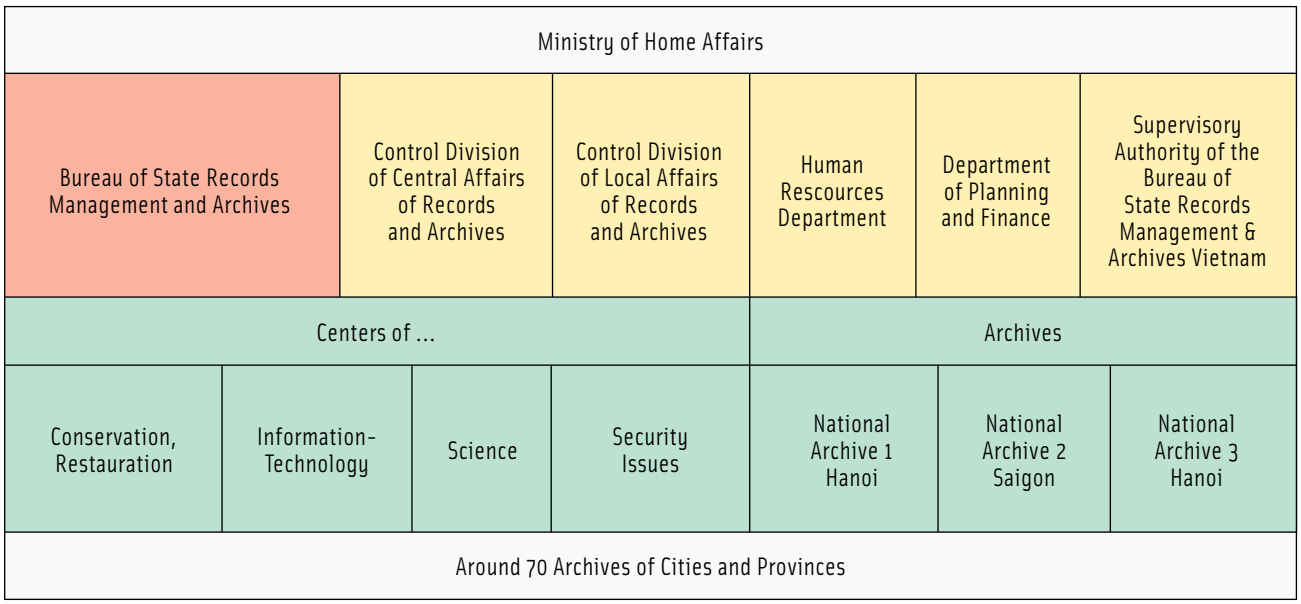


Fig. 6: Structure of archives in Vietnam (OWN FIGURE)

Using this approach, attention shall be paid to the fact that administrative competences on the decision-making level and in the regional subordination (may) have changed over time, e.g. through administrative reforms. Furthermore, documents with information relevant to contaminated sites may not only be available on one level but, in case of former parallel transmission of specific records and documents, in archives in different administrative levels.

Site-related investigations usually start by detecting relevant records on the **local level**. Which archive or official (old) registry shall be preferably consulted is scarcely generally binding and should be decided only depending on the case-specific basic conditions. If a company archive exists for the site under investigation and access to it is provided, the research should start in any case at this level.

If research at the local level shows that there are obvious gaps in the documentation of the respective site, further research in competent archives on **regional** or **national** levels must be considered.

Categories of investigation to be considered are:

— site localization; including position and extension,
— legal conditions; including ownership and other users,
— stock of plans and buildings in spatial and temporal development,
— industrial processes,
— amount of materials handled, produced or processed,
— accidents including war damage,
— site-internal dumps and backfills.

6.2 MULTI-TEMPORAL EVALUATION OF MAPS AND AERIAL PHOTOS

Multi-temporal mapping involves a combined analysis of maps (in particular official topographic, yet also other maps) and aerial photos over the course of several periods of time. With the evaluation of these area reproducing information carriers - taking place not only on one time level but – **multi-temporally** – origins, dates, locations and dimensions of soil contaminations can be investigated.

The information value of **topographical maps** is due to generalization distinctly lower than that of aerial photos. The larger the scale, the more suitable is the map for recording. Most suitable is the scale 1: 5,000, followed by the scales 1: 10,000 and 1:25,000.

Aerial photos are essentially more accurate than maps. They document a site with all details without generalizing the condition and appearance at the time of taking the photo (see Fig. 7).

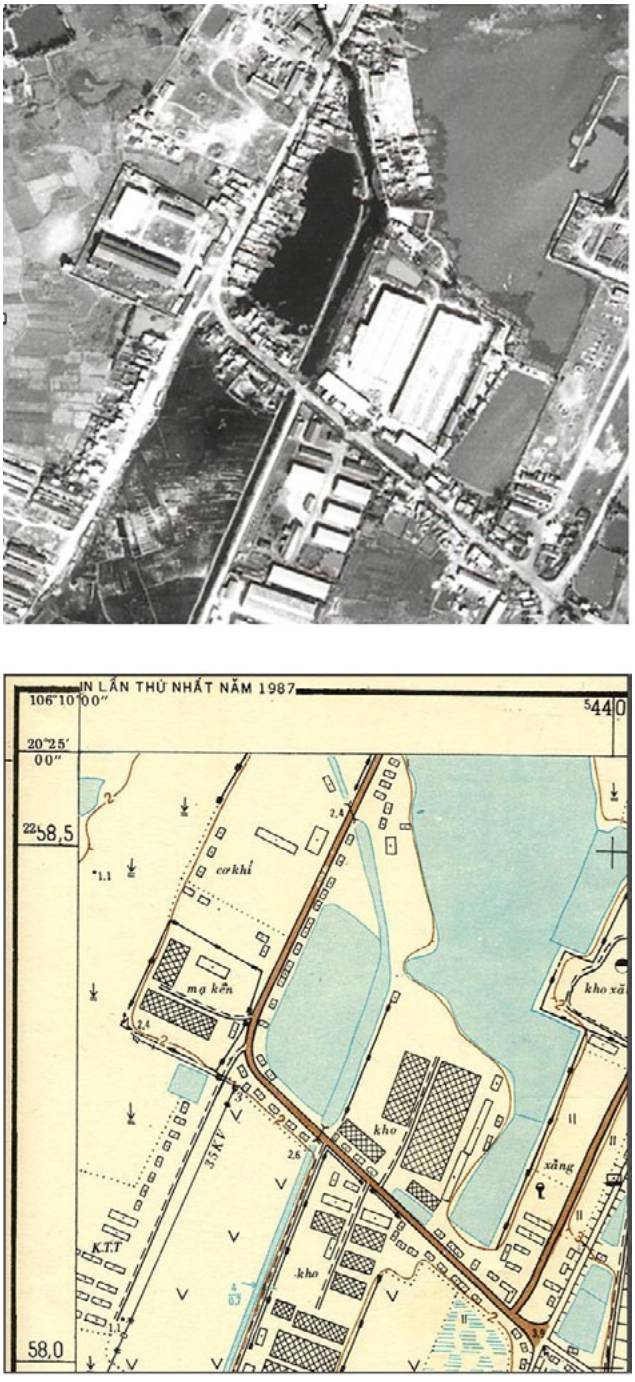


Fig. 7: Detail of an aerial photo on an approximate scale of 1: 15000 (left), which corresponds to the extract of a topographical map (right) (GERMAN-VIETNAMESE PROJECT SCIENTIFIC BASICS FOR THE DEVELOPMENT OF A CATASTER OF CONTAMINATED SITES IN VIETNAM).

Aerial photos are central-perspective pictures, thus not reflecting in each case the terrain section photographed, but more or less strong **distortions** of the layout presentation. They depend on height relations at the terrain but depend also on the inclination of the photo axis of the camera. Also the scale of one and the same aerial photo is not uniform. It is bigger in higher-laying areas and smaller in low-laying parts. In addition, the standard value of the scale is never consistent representing actual values. That is why scale data shall be understood as average and rounded approximate values.

On the one hand, the **visibility** of buildings, plants and other objects on the aerial photo depends on the **scale**, the **photographic quality** of the photographic material (sensitivity to light and selectivity) and the **condition of the atmosphere** at the time of photographing.

On the other hand, the visibility depends on the **type of the aerial photo**. Aerial photos taken with the aid of a so-called photo-grammatic camera with nearly vertical photographic axes (vertical photos) - as in the case of navigation for surveying purposes – and overlapping individual photos in flight direction (so-called end lap) are especially suited. With the aid of special software (e.g. Stereo Photo Maker, which is free of charge) they may be viewed as three-dimensional spatial models and can be quantitatively evaluated.

The most important identification feature of waste disposal sites is their **three-dimensional representation**. It is sometimes caused by dark shadows in the photos. For the evaluation of aerial photos, shadow formation is basically not desired. Aerial survey flights in the framework of aerial survey navigation are therefore mostly carried out at midday, so that shadows are frequently only minimally developed. That is why former waste disposal sites of an insignificant thickness only scarcely cast shadows, what makes them an identification feature with only low importance and reliability in practice.

6.3 INTERVIEWS

If interviews shall bring useful results, it has to be ensured that the persons questioned have special and also respective knowledge about the site. In addition, they should have a sufficiently reliable memory and, not last, they should be ready to give unreservedly information about processes and facts relevant to the environment.

Though, in actual cases, it is in general not very difficult to find contemporary witnesses meeting largely this required profile, it is proved to be a problem to find suitable interview partners having knowledge about facts from a longer distant past while meeting the described profile.

Before carrying out interviews with contemporary witnesses, the content of the questionnaire for individual cases should be fixed. Here it is appropriate to distinguish between:

1. **Key questions:** They refer purposefully to site-specific facts about which no information or only incomplete, contradictory or unclear information was available before questioning

2. **Control questions:** They refer to findings already known and serve as a basis to assess and evaluate the special knowledge and the memory of the person interviewed.

3. **Person-related background questions:** Supplementary to control questions, this type of questions serves to evaluate if the interviewed person is familiar with the respective site and how he or she was involved with it.

After the contents of the interviews have been fixed, a suitable **interview form** has to be chosen.

Written interviews with a fixed sequence, pre-formulated questions and mostly standard answers are, especially regarding needs of time and costs, a comparatively favourable alternative. Yet, this standardized interview form is scarcely suited to collect lacking individual information and for the elimination of contradictions or uncertainties in the data material. It serves to confirm or disprove facts, but does not serve to gain new and additional information.

That is why questioning of contemporary witnesses in site-related investigations should not be standardized, but be carried out as "**open questioning**" in the form of so-called recorded **intensive interviews**. In this type of interview the persons are encouraged to react flexible according to their specific knowledge, experience and individual memories. Therefore, more differentiated and well-founded results will be reached as in standardized questioning.

Nevertheless, the results of questioning contemporary witnesses – even if prepared and carried out in a professional way – shall be always assessed **critically**. In fact, interviews may impart absolutely new, relevant information and thus contribute to supplement the data stock of a site-related investigation. This however applies predominantly to more recent uses and events.

6.4 SITE INSPECTION

To finalize of a site-related investigation, a detailed inspection of the site under investigation is recommended. Such a site inspection serves for the documentation of the current and actual state of the respective site (a. o. by photos) and **supplements the findings of research** if the following measures are considered part of the site inspection:

— **mapping of perceptible contamination** to investigate and assess soil pollution. The use of a folding spade may be useful. However, it should be checked in advance whether a ground photo will be required (protective measures, waste disposal etc.);
— **subsequent investigation of relevant units of a plant** (separator etc.) to be neither recognized on the aerial photo nor indicated in plant layouts;
— **assessment and classification of waste disposal sites still visible** with regard to their material composition;
— **clarification of building and plant functions** which are still uncertain.

In addition, the type and state of sealing and further parameters relevant to the assessment may be collected depending on the individual case. Ideally, the site inspection is carried out accompanied by a person who knows the site and, if necessary, in combination with questioning of contemporary witnesses.

While the advantages of a site inspection to supplement research findings and to document the current state is undisputed, its importance to site-related investigations is often overestimated. It does not need to be further commented that site inspections may, as a rule, only supply information on a very small part of the site's history of use, namely on the condition of the terrain after the plant or former site utilizations have been closed down.

Changes of the building and plant stock, overgrown waste disposal sites and backfills are only a few exemplary categories that cannot be investigated by site inspections. What can be assessed at site inspections are **industrial safety measures**, to which shall always be paid attention.

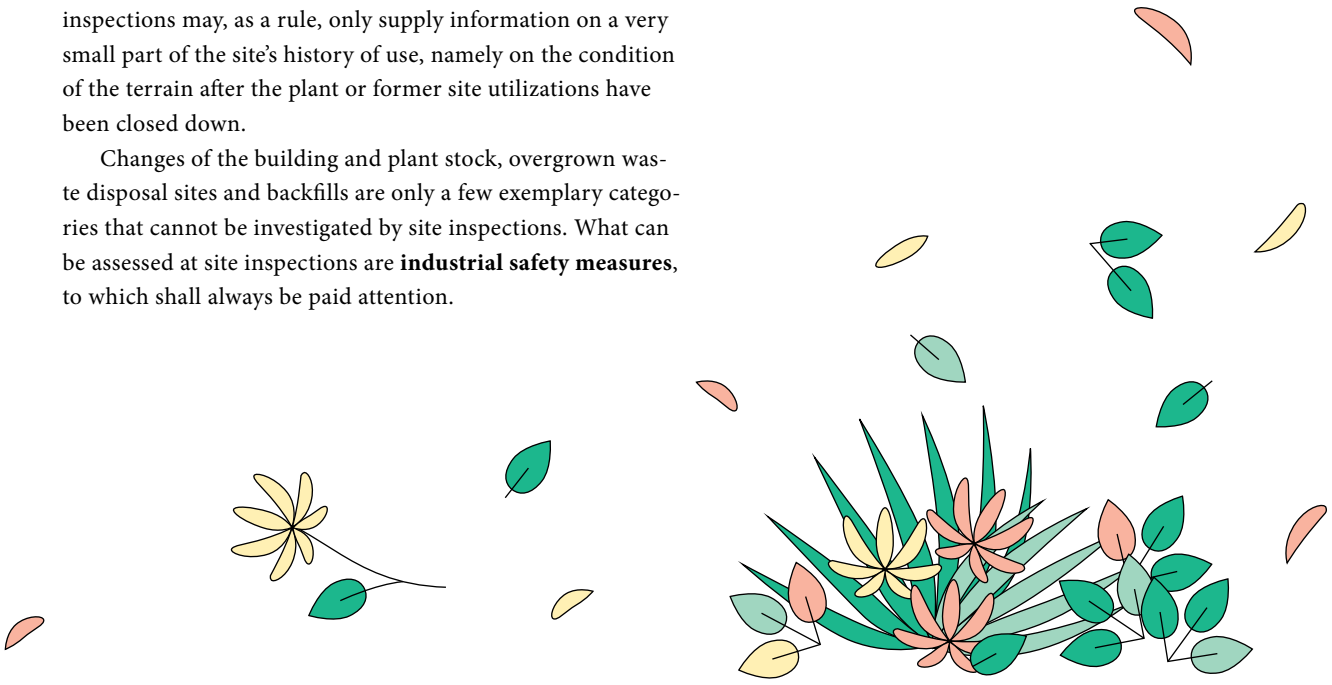
The site inspection can and shall, according to the regulation 30/2016/TT- BTNMT, also be used to take a small number of soil samples at locations where a contamination is likely. If accessible, a mobile XRF-spectrometer can be used before the samples are taken to localise points where contaminations are most likely and soil samples may be most informative.

6.5 CONCLUSIONS TO METHODS OF CONTAMINATED SITE RECORDING

While experience shows that in Vietnam, direct data sources on soil contaminations are only available in individual cases, most areas suspected to be contaminated must be localized **indirectly**. Among the indirect assessment methods, archive research, interviews with contemporary witnesses, multi-temporal mapping through the evaluation of topographic maps and aerial photos and site inspections are the most efficient. However, these methods shall always be used in combination.

Archive research jointly with multi-temporal mapping are in Germany the most successful tools to detect possible contaminations. In Vietnam, those two methods cannot be applied in each region because often, the necessary data and information are missing. This is also the reason why interviews with temporary witnesses may play a more prominent role in Vietnam.

It can therefore be concluded that **the methods of site inspections in combination with interviews of temporary witnesses** are in many regions of Vietnam the most promising tools to get a comprehensible overview over possible contaminated sites.



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THIS MANUAL WAS DEVELOPED WITHIN THE GERMAN-VIETNAMESE PROJECT CAPAVIET

The cooperative project **"CapaViet – Capacity and infrastructure development for the establishment of a soil contamination cadaster in Vietnam by the example of Bắc Ninh Province"** wants to strengthen Vietnamese authorities at the provincial level in the independent registration and assessment of contaminated sites.

Together with **MSP - Dr. Mark, Dr. Schewe & Partner GmbH** and the regional environmental agency (DONRE), a cadaster of contaminated sites will be developed in Bắc Ninh Province. Potentially polluted locations will be recorded in a data bank and in GIS by German and Vietnamese experts. Like this, the involved employees of **DONRE Bắc Ninh** will learn in practice the necessary know-how for the development of a cadaster of contaminated soils. As flagship project, the cadaster for Bắc Ninh can serve as a transferable example for other provinces in Vietnam.

Training courses in cadaster development and in the use of mobile analytical methods for the assessment of heavy metals in soils strengthens the employees of Vietnamese authorities at the provincial and national level.

To support the autonomous development of soil contamination cadasters, experts in Vietnam will be provided with technical tools for the mobile analysis of heavy metals and cadaster development, which will be drafted and disseminated during the project. UfU will further develop a draft for a legal regulation defining the registration of soil contaminations.

As follow-up project of AnaViet, CapaViet is financed by Exportinitiative Umwelttechnologien of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

Fig. 8: Photos: KOVAC