SURVEY OF ABANDONED INDUSTRIAL SITES IN THE PROVINCE OF CARINTHIA/AUSTRIA - METHODOLOGY AND RESULTS

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Abstract
The paper in hand mainly addresses the issue of abandoned industrial and commercial sites. The results of a survey form the central content and regards the method of investigation of this survey of abandoned sites in the province of Carinthia, including experiences and recommendations. The survey started with a number of more than 10,000 businesses. After the different steps of the survey (research phase, exploration phase, clarification phase and evaluation phase) 444 sites had to be attributed an increased potential for danger. After these steps followed an evaluation which concerned the priority in regard to the securing and/ or remediation of the abandoned sites. On the basis of certain gathered values, future surveys of abandoned industrial and commercial sites can be calculated fairly exactly.

Keywords: abandoned industrial sites; methods; registration; evaluation;

1. Introduction

Between mid-2004 and the end of 2006 the Institute of Geography and Regional Science was entrusted with the investigation of abandoned industrial sites in Carinthia. This investigation was initiated by the Office of the Carinthian Government in cooperation with the Federal Environmental Agency and was required according to art. 13 of the Inherited Waste Rehabilitation Act.

The objective of this project was the comprehensive investigation (except for the cities Klagenfurt and Villach) of businesses (factory sites which were in operation before 1989), i.e. of industrial plants and business establishments, in which environmentally hazardous substances were handled, as well as the classification and identification of these abandoned industrial sites in the Austrian province of Carinthia which has a land area of 9.282 square km, 8 districts (Feldkirchen, Hermagor, Klagenfurt-Land, St. Veit an der Glan, Spittal an der Drau, Villach-Land, Völkermarkt, and Wolfsberg) and 130 communities.

2. Definition and Legal Basis

According to art. 2 sect. 2 of the Inherited Waste Rehabilitation Act (BGBI. I 136/2004), abandoned industrial sites are defined in the glossary as sites of

businesses and factories in which environmentally hazardous substances were handled:
- Polluted and potentially contaminated areas may emanate from old waste deposits and abandoned industrial sites (of commercial and industrial nature), which must be classified as contaminated areas corresponding to the potential for danger and consequently have to be remediated as per state of technology and the future demands of use.

Article 13 of chapter III (Recording, Rating, and Evaluation of Polluted Areas) of the Inherited Waste Rehabilitation Act regulates the identification of abandoned industrial sites, according to which the investigation of abandoned industrial sites was to be conducted in Carinthia. The Governor is obliged to inform the responsible Governmental Department of potentially contaminated areas as per sect. 1. The inducement for this comes from the responsible Federal Minister of the Environment and must be coordinated with all other Governmental Departments concerned with this issue. The abandoned industrial sites are registered in the land register for contaminated areas. The areas which were assessed as in need of conservation and remediation according to the risk assessment must be identified as contaminated sites in an ordinance (atlas of contaminated areas) (http://www.umweltbundesamt.at/umweltschutz/altlasten/altlasteninfo/; 2.6.2008).

3. Initial Situation

The Federal Environmental Agency in Vienna issued an estimate in which the number of sites where environmentally hazardous substances were handled or where wastes were deposited was listed. According to that estimate the number totals approx. 80,000, of which 70,000 are abandoned sites of industrial or commercial businesses. The remaining 10,000 sites are closed-down landfills (old waste deposit sites). At the beginning of 2008 it must be assumed that a substantial part of the estimated 10,000 old waste deposit sites are recorded, whereas only one third of the 70,000 abandoned industrial sites are recorded (http://www.umweltbundesamt.at/umweltschutz/altlasten/problem/; 04.02.2008). The present results from this project already cover almost one fourth of the estimated number, which could possibly imply that the number of abandoned environmentally hazardous industrial and commercial sites will be considerably higher once the comprehensive investigation of all nine Austrian provinces is completed.

A high number of cases of damage (esp. contamination of ground water) in the last few decades have shown that there is an immediate need of action for knowing the location of the abandoned industrial sites as accurately as possible. The difficulty, however, is that, since the majority of sites were abandoned a long time ago, most

sites are no longer known today. Consequently, they can only be localized after extensive research and can then be evaluated concerning the potential for danger. The Federal Environmental Agency specifies the risk potential as follows: "Numerous cases of damage of ground water have shown that considerable hazards for the subjects of protection (water, soil, air) can emanate from industrial and commercial sites and abandoned landfills and thus can put people's health at risk" (Altlasten. In: http://umweltbundesamt.at/umweltschutz/altlasten/; 04.02.2008).

The following excerpt, which drastically depicts the general conditions, is provided to illustrate the current situation of the management of polluted areas:

> "By and large, the management of polluted areas in Austria works satisfactorily. Nonetheless, it is obvious that there are several further options for improvement", said Christian Holzer, one of the competent experts of the Department of the Environment, yesterday at the conference "The Future of Remediation of Polluted Sites in Austria" of the Austrian Water and Waste Trade Association (ÖWAV) in Vienna. Public authorities have invested approximately 770 million Euros in inherited waste remediation since the resolution of the first version of the Inherited Waste Rehabilitation Act (ALSAG) 17 years ago. Among others, Holzer identified the highly complex legal situation and the difficulty of holding the producers of inherited waste to account for the polluted sites as one of the challenges: "If they do not want to play along, they won't." This was confirmed by Bernhard Raschauer, well-known expert for environmental and constitutional law. In good humour, he asserted that the inherited waste remediation in Austria is working well and "that the Inherited Waste Rehabilitation Act does not really interfere." The difficulty is that the Inherited Waste Rehabilitation Act solely regulates the funding of remediation measures. However, what needs to be remediated in what manner is determined in the Riparian Rights Act, in the Waste Management Act, as well as in the Trade Law, which has time and again been a reason for legal uncertainties. Holzer therefore said it is a "miracle" that the systematic recording of 234 of the estimated 2,500 polluted areas and the remediation of 74 of those areas was successful. The remediation of another 109 abandoned sites is still in progress. However, there still remains a lot to be done (ÖWAV, 02.10.2007).

Taking into consideration all registered old waste deposits and abandoned sites, there is a ratio of 1 to 9 (Table 1), which can be attributed to unequally high potentials for danger. Approximately one third of the registered old waste deposits are transferred to the land register of potentially contaminated areas (Table 2). For abandoned sites the value is under 1%. In 2006, 41.989 areas were registered.

(www.bundesabfallwirtschaftsplan.at/article/archive/12504, 2.4.2008). In 2008 in sum already 51.081 sites have been registered. This shows the high dynamic of an intensive registration and evaluation process. In the fact the amount of 2.451 sites registered during the survey in hand has been increasing to 4 more in 2008. The survey of former old waste deposits and industrial sites will never end because it is more or less impossible to register all of them. The difference of 32 sites in 2007 and 2.455 in 2008 results from the data coming from the author´s survey.

Table 1. Development of registered waste deposits and abandoned industrial sites (Source: UBA, 2007 u. 2008).

	Old Waste Deposits		**Abandoned industrial sites**		**Sum**	
Province	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**
Burgenland	99	99	3.098	3.098	3.197	3.197
Carinthia	472	473	32	2.455	504	2.928
Lower Austria	1.168	1.169	2.355	2.358	3.523	3.527
Upper Austria	1.464	1.465	9.099	9.099	10.563	10.564
Salzburg	417	416	5.602	5.603	6.019	6.019
Styria	375	375	4.303	4.301	4.678	4.676
Tyrol	646	646	4.689	4.664	5.335	5.310
Vorarlberg	14	14	6	6	20	20
Vienna	341	341	14.498	14.499	14.839	14.840
Sum	**4.996**	**4.998**	**43.682**	**46.083**	**48.675**	**51.081**

Table 2 shows the most recent developments of the number of abandoned industrial and commercial sites, and old waste deposits which are registered after a first evaluation in the Austrian land register of potentially contaminated areas.

The total number varies due to the constant addition of newly registered old waste deposits and abandoned sites on the one hand, and the securing and remediation of such sites on the other. There are approx. 4 times as many old waste deposits as there are abandoned sites. Per anno 25 – 30 sites will be evaluated and classified (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW 2007).

In 2007 there were 160 contaminated areas after detailed investigations, the classification of which derived from old waste deposits as well as abandoned industrial and commercial sites. In 2008 there were 156 contaminated areas. Remediation was underway on 78 sites in 2008, 11 more than in 2007.

Table 2. Development of waste deposits and abandoned industrial sites in the inherited waste cadaster (Source: UBA 2007 u. 2008).

	Old Waste Deposits			Abandoned industrial sites			Sum		
Province	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Burgenland	38	36	38	2	2	2	40	40	40
Carinthia	35	35	35	12	12	12	47	47	47
Lower Austria	369	456	451	46	50	52	415	506	503
Upper Austria	850	840	641	123	116	115	973	956	756
Salzburg	124	124	124	15	15	174	139	139	298
Styria	223	222	211	14	15	15	237	237	226
Tyrol	104	99	99	5	5	5	109	104	104
Vorarlberg	12	12	9	3	3	3	15	15	12
Vienna	42	42	42	14	14	11	55	56	53
Sum	**1.796**	**1.868**	**1.650**	**234**	**232**	**389**	**2.030**	**2.100**	**2.039**

4. Methodology

The present investigation of abandoned industrial sites was divided into four phases:

- Research phase (steps 1-4)
- Exploration phase (step 5)
- Clarification phase (steps 6 and 7)
- Evaluation phase (step 8)

The following eight steps were applied:

1. Construction of a basic work database in Excel format.
2. Research and evaluation of written sources of information.
3. Cleaning of the data (double entries, overlaps).
4. Clarification of the sites by means of community surveys.
5. Inspection of sites which were recorded and registered as abandoned industrial and commercial sites or as, by now, undeveloped properties.
6. Classification of the collected data.
7. Statistic evaluation of the data, creation of a database with appropriate compatibilities, linking of data, photographical documentation, creation of maps.
8. Final classification.

4.1. Research phase

All industrial and commercial businesses where environmentally hazardous substances were handled were recorded. In order to secure a basis of data which is as accurate as possible the size of the businesses (number of employees), period of operation, utilization, etc. were surveyed.

In the first step the development of a clearly arranged basic work database with appropriate potential of compatibility (Excel charts) was made: Therein are columns with information about province, district, community, postal code, name of company, address, historical address, NACE – code, industrial sector (a list of sectors was provided by the Federal Environmental Agency in order to guarantee an identical procedure of classifying industrial sectors throughout Austria), type of business, category, and telephone number. In the process, the chart was constantly synchronized with a negative list, which contained criteria which were not relevant for the investigation, which lead to an initial filtering of the data. Thus, for example, a carpenter was not recorded as a person but only as a business (GeoK 2007, p.8).

The investigation of old waste deposits (cf. Fischer & Hlavinkova, 1999) and of abandoned industrial sites differed significantly. Whereas the spatial recording of abandoned industrial and commercial sites can only be accomplished by means of multitemporal aerial photography and map interpretation, written sources of information were surveyed as a first step in the investigation of abandoned industrial and commercial sites. Telephone books, office books, and address books were consulted as such written sources of information, which proved to be very beneficial. Thus, an adequately high degree of registration of over 85% could be reached in a second step.

Additionally, a so-called industry compass was utilized in which, however, primarily large companies are listed. For the years 1905 to 1990, 1,100 businesses could be recorded from this compass, all of which, except for 79 sites, were already known from the research of telephone books, office books, and address books. Furthermore, additional, if only sparse, information about the number of employees, the dates of establishment and closure of businesses, as well as the range of products and the operational activities could be obtained. In general, objective historical works can only be inspected in the archives of the State or National libraries.

During the initial collection of data various revisions need to be regarded. This can pertain to the location, the name as well as the address of a business. If, for example, a gas station was taken over by a different leaseholder, and a change of name ensued, the exact same location is listed twice due to the successive

leaseholders. This happens regularly in the case of gas stations. However, there usually is no change of address or telephone number, which indicates one and the same location. If the address and telephone number have changed, which, fortunately, happens infrequently, interviews are a good method of clarifying ambiguities.

Problems occur more frequently with telephone numbers, since, because of the increase of telephone extensions in the 1950s till the 1970s, double and triple digit numbers were extended by one digit so that then one and the same location were registered twice. The same applies to changes of address which were necessary because new street names and house numbers had to be introduced. After the expansion of housing development areas the common addresses: "town name plus house number" where not sufficient any longer.

Moreover, already existing information about chemical purification facilities, operating or already closed down gas stations, as well as already recorded potentially contaminated areas, which are available at the competent Department (Dept. 15) of the Office of the Styrian Government, were taken into account. Including the before mentioned possible overlaps, 10.850 potentially environmentally hazardous industrial and commercial businesses throughout Carinthia were recorded on the basis of this initial investigative measure. 5.686 relevant businesses remained (comp. fig. 2 in chapter 4) after the cleaning of the data (step 3).

Thus, the evaluation of all relevant lists was completed. As step 4 in phase I, community interviews could be commenced, yet with an initially underestimated and, therefore, unexpectedly high number of businesses as a starting basis. It has been proved feasible for large communities to examine and review the relevant businesses and sites in this community with former town representatives, after having secured an appointment by telephone. Preferably approached were employees of the construction division or road maintenance staff who had already been employed for many years at the beginning of the survey period or who had already are retired. Besides their knowledge concerning relevant former businesses their time budget is not as tight as that of those people in the community who are still working.

Thus, more businesses could be added to the database and questions concerning the potential environmental danger of businesses and factory sites could be clarified, especially in cases where several different businesses were successively operating on the same site.

In smaller communities in West-Carinthia communal, regional informative meetings were arranged in locations with appropriate infrastructure (e.g. municipal

offices). In these meetings representatives from various communities were interviewed in staggered intervals. In some cases interviews were conducted by telephone (GeoK 2007, S.15). Some communities distributed information in preparation for the interviews, which made the investigative work with the town representatives very efficient, both temporally and in regard to content. These communities stood out as very supportive and interested in the project.

In order to raise the survey's degree of efficiency, older town representatives and business employees should be involved in the process of investigation wherever possible. Long-term employees, retired employees of the construction department and of the road maintenance, as well as experienced employees of electricity suppliers proved to be exceedingly knowledgeable and therefore invaluable for the work at hand. Oftentimes, present employees do not know about the industrial or commercial activities of companies which may even have been terminated years or decades ago.

4.2. Exploration phase

Phase II was initiated by step 5 in which the localization of all locations, which have been identified in the previous steps, followed. Because of the large number of relevant businesses and industrial sites an efficient strategy for the investigation had to be developed. Accordingly, calling-in of town representatives or retired, former town representatives is advisable for the inspection of potential abandoned sites in large communities which were recorded during the pre-investigation. Also, a well thought-through routing, which allows for efficient work in terms of short distances and little expenditure of time, is necessary and advisable. In smaller communities it is usually sufficient to hold a short meeting concerning the localization of the sites in maps as well as on complementary photographs and aerial-photographs. The following sub-steps were taken (GeoK, 2007, S.18f):

- Time management based on the number of relevant sites in a single community.
- Estimation of the time needed for the inspection of abandoned sites in each community, with or without town representatives.
- Clarification, via telephone, of the soonest possible date for the inspection of the abandoned site with or without a town representative.
- Before the inspection, a meeting was held with the responsible town representatives in the municipal office.
- Briefing concerning the best possible route.
- Gathering of information before and during the drive to the respective site.
- Beginning the inspection with a town representative and appropriate documents (maps, plans, orthophotographs, etc.)

- In the course of the inspection other businesses and industrial sites could be added to the pre-investigation. Among these were small and micro-businesses, which were classified as environmentally hazardous in course of the inspection and on-site evaluation. These businesses had not appeared in any records until then and were referred to by abutters during the final inspection. Consequently, these businesses were included in the database as relevant abandoned industrial sites.
- Photographic documentation was not sufficient enough for businesses with wide-ranging premises for which reason orthophotographs were additionally drawn on.
- In a few cases, photos of the site could not be taken because vegetation has amply overgrown the sites which had been abandoned for a long time.
- Some sites could not be entered due to strict trespassing orders for which reason it was necessary to revert to orthophotographs in these cases.

In the course of the inspections the following experiences could be gained:

- It is absolutely indispensable to ensure in written form about vacation replacements of town representatives and their availabilities before beginning fieldwork. Otherwise, town representatives may not be available because of absences due to illness or sudden leaves, which complicate the coordination of fieldwork dates. Inspections, then, cannot be conducted as efficiently as planned, which, because of the great number of sites, leads to drastic delays in the project procedure.
- Because of pedestrian zones, many town centers are closed to traffic, permitting only more time-consuming inspections.
- Photographic documentation is especially difficult in narrow streets of houses where no ideal position for picture taking, which would allow for an ideal depiction of the site, can be found.
- In many cases, and especially in small communities, locating the sites was facilitated by the fact that business and industrial sites are concentrated in close vicinity of by- passes.
- Oftentimes, town representatives remembered relevant sites on location, which was recorded in the inspection protocols.

4.3.Clarification phase

In phase III (step 6) of the survey of abandoned industrial sites in Carinthia data which were gathered from the inspections in the previous phase had to be allocated exactly now. After this step a further reduction of the amount of potential sites which could be a danger for the environment was the result. In the following step number 7 a statistical analysis was made on the bases of a data bank with relevant compatibility. The data were also linked to a practicable set of data, a photo-

documentation and adequate maps were created. As a result of this phase number III 2.259 firms remained on 1.921 locations.

4.4 Evaluation phase

The next phase number IV (step 8) was the clarification of the remaining 2.451 sites by a model for evaluation, with which, based on three site classes, high, middle, and low potentials for danger can be identified. In the case of high and middle potential for danger, the potential for danger is determined incorporating the class of utilization (sensitive utilization), which leads to further, subordinate inspections (Fig. 1).

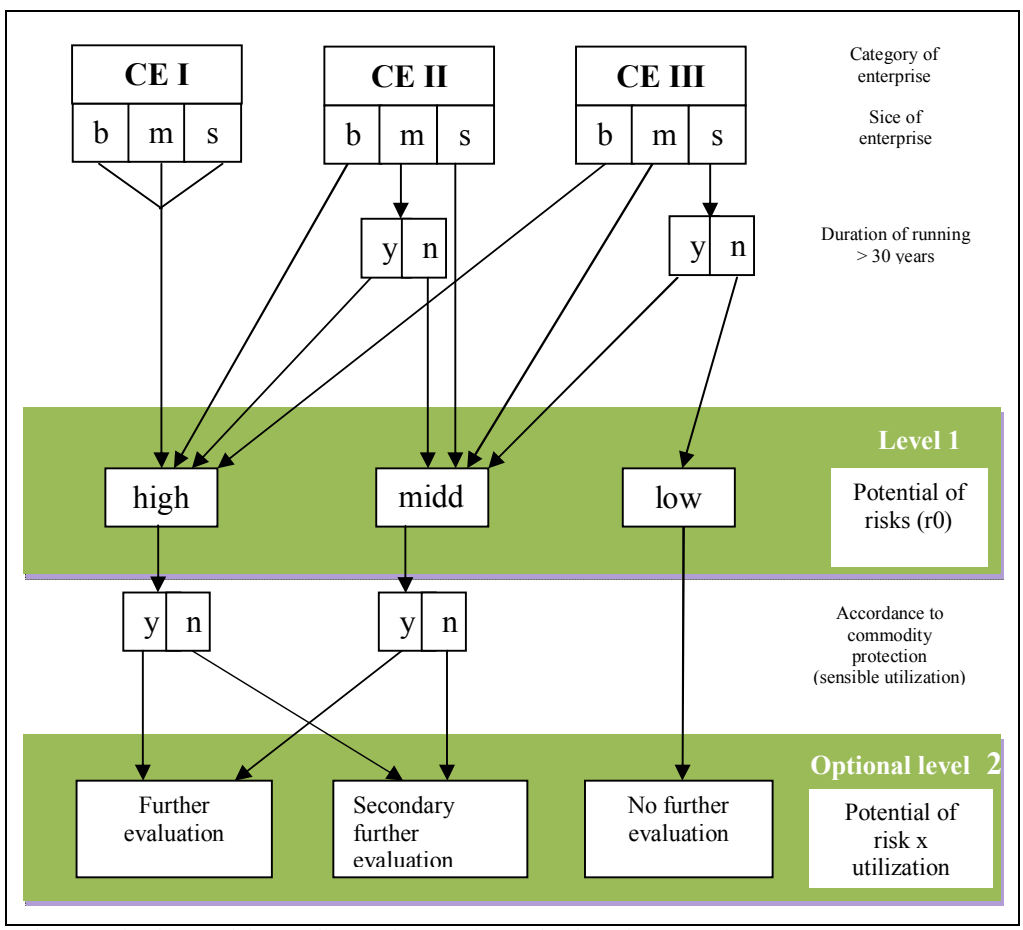

Fig.1. Evaluation model according to the Austrian Federal Environmental Agency (FEA) (Source: FEA, 2008).

The object of the classification is a primary evaluation of the particular businesses which are definitive of a site. Thereby, a division into the following three categories was made:

- Not relevant as potentially contaminated area (no further investigation required).
- Relevant as potentially contaminated area (lower ranging need for further investigation).
- Increased potential for danger (further investigation required).

In order to attain the classification according to the three categories it is inevitable to assign an industry code to each business, which, in turn, is assigned to a certain business format. Regarded as business formats are: services, production, and enterprises with large area. A further division was made concerning the size of the business (Table 3).

Table. 3. Classification of types of business incl. size of company acc. to the Austrian Federal Environmental Agency (FEA) (Source: GeoK, 2007, S. 32).

Type of site	Small firm	Medium firm	Big firm
Service	up to 5 employees	6-15 employees	>15 employees
Production	up to 10 employees	10-100 employees	>100 employees
Areal site	up to 1.000 m^2	1.000 - 10.000 m^2	> 10.000 m^2

The degree of the risk potential results from the industry-specific substances and materials used as well as the customary amount of the harmful substances used. The classification of all businesses in the three site classes is done on this basis, with site class I having the highest risk potential (Table 4).

Table. 4. Classification of sites according to the Austrian Federal Environmental Agency (FEA).

Class of site	Risk potential	Example for branches
I	high (further evaluations)	Dry-cleaning, coke oven plant, etc.
II	middle (relevance of suspected sites and secondary priority of further evaluations)	Carpentry, wood-impregnation, etc.
III	low (no relevance of suspected sites of contamination and no further evaluation)	Saw-mill, Automobile-garage, etc.

In case there were more businesses in close vicinity in one location, the industry with the highest risk potential was decisive. If there were several businesses of different industries, yet classified in the same category, the periods of operation were regarded in the evaluation. If the periods of operation were also identical, the industry mentioned first became the dominant industry.

5. Results

In this chapter the statistical analysis and the final results will be presented. For this purpose, the total number of potential businesses gathered from the literature research serves as the basis. This remarkable initial number amounted to n = 10,850. 5,686 businesses, which performed environmentally hazardous operations, remained after the cleaning of the data pool, which was necessary because of double entries and overlaps (Fig. 2). After the inspection of the abandoned industrial sites, the number of businesses could be reduced to n = 2.259.

Ordered according to business type this means that the number of production specific and enterprises with large areas for business could be reduced by 2/3. In contrast, the number of surveyed businesses of the type "service" was reduced by only 1/5 between the pre-investigation and the final results. This suggests a more precise recording from the beginning. In the final results all relevant businesses could be assigned to one of the three types.

Concerning the different industries it can be noted that the number of businesses, relevant as abandoned sites, could be reduced by 80% between the pre-investigation and the final results in the cases of "carpentry", "storages", "forwarding company", and "sawmill". This corresponds to a high degree of clarification.

Gas stations could be detected as by far the most common environmentally hazardous abandoned sites (approx. 25%), followed by automobile workshops (approx. 11%), dry cleaners (approx. 7%), as well as forwarding agencies and miscellaneous other automobile services (approx. 10% combined) (GeoK, 2007, S.31). On the whole, this means that almost half of all environmentally hazardous abandoned industrial sites are related to automobile facilities.

444 of a total of 2,451 evaluated sites appearing in the present research results have an increased risk potential, for which reason they need to be examined further. 1,506 sites are potentially contaminated areas and, therefore, also would have to be investigated further. 4 sites urgently need to be investigated further. Detailed investigations are already under way on 20 sites; the remaining sites are not relevant.

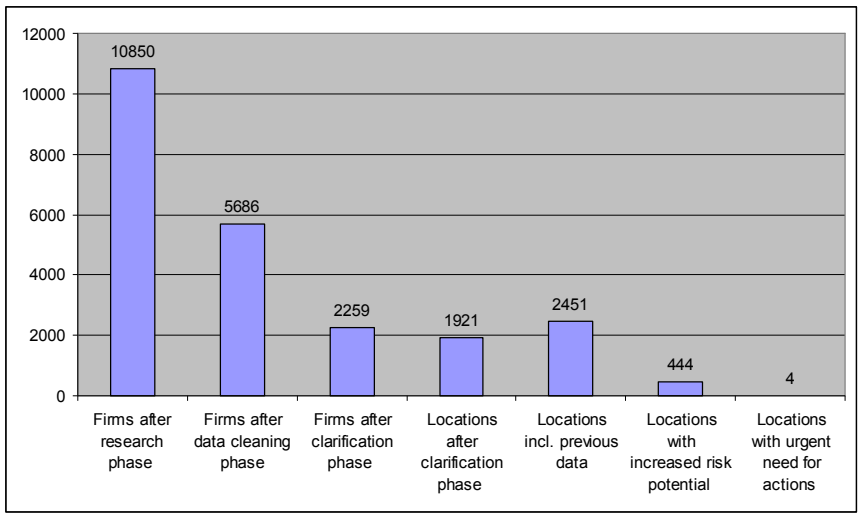

Fig. 2. Amount of businesses during the phases of survey of abandoned industrial sites in Carinthia.

For further surveys of abandoned industrial and commercial sites in the other Austrian provinces or in countries similar to Austria, the number of "businesses or sites per inhabitant" or "businesses or sites per km^2" of the extent according to chart 3 can be assumed in the planning phase for a survey of abandoned industrial or commercial sites (Table 5). This approximate benchmark should facilitate a realistic and accurate resource planning for the survey of abandoned industrial sites.

Table 5. Number of abandoned industrial sites in Carinthia according to inhabitants and area.

Category	**abandoned industrial site / inhabitant**	**abandoned industrial site / km^2**
Sites after research phase	1 / 40	1.2 / km² (1 / 0.8 km^2)
Sites after exploration phase	1 / 70	0.6 / km² (1 / 1.7 km^2)
Sites after clarification phase	1 / 210	0.2 / km^2 (1 / 5 km^2)
Sites with high risk potential	1 / 920	0.05 / km^2 (1 / 20 km^2)

6. Summary

This survey addresses the issue of abandoned industrial and commercial sites as well as the management of these sites in Austria, which includes the survey, inspection, and evaluation as well as the securing and remediation of abandoned sites. A report of the survey, which was conducted under contract, forms the central content. It regards the method of investigation of this survey of abandoned sites in the province of Carinthia, including experiences and recommendations.

The analysis of the available relevant documents resulted in a number of more than 10,000 businesses. After the cleaning of the data (removal of double entries and overlaps) this number could be reduced by approximately half. The subsequent inspections of the sites lead to further reduction of the relevant abandoned sites by, again more than half, so that approximately 2,250 businesses on 1,990 sites were left after this investigative measure. Together with the surveys previously conducted in the Villach and Klagenfurt area, approximately 2,500 sites could be recorded, 444 of which had to be attributed an increased potential for danger. According to abandoned site remediation management of the Federal Environmental Agency, these sites need to be investigated further. After this step followed an evaluation which concerned the priority in regard to the securing and/ or remediation of the abandoned sites.

The experience from this objective survey shows that, concerning the number of abandoned sites to be expected after the first investigative step, there is a ratio of approx. 1 abandoned site per 40 inhabitants and a ratio of 1 abandoned site per 920 inhabitants after the last investigative measure of the evaluation. On the basis of these values, future surveys of abandoned industrial and commercial sites can be calculated fairly exactly.

The choice of assistants for the inspections of the sites is of great importance. It is indispensable to draw on older, experienced and possibly retired community attendants. Furthermore, data entry forms available in the municipal offices should record the condition of abandoned sites in preparation for the inspections. In peripheral areas several communities should be invited to a common meeting. All in all, it must be guaranteed that the person responsible for the investigation is meticulous, diligent and reliable. Apart from that, a regular discussion of the intermediate results, which is equal to a continuous controlling during the project procedure, is necessary.

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