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# SUITMAs as an archive of the human past: educational implications

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## Abstract

**Purpose** The relics of the industry are widely used for educational and touristic purposes. There are many examples of brownfield sites turned into tourist attractions. Interest in post-industrial areas concerns not only an infrastructure and ruins but also the soil cover. Soils in such areas should be also considered as important element of this type of landscape due to the artefacts' stored. This article aim is to present educational potential of post-industrial soils and artefacts to be found there on the example of the area of "Polchem".

**Methods and materials** This publication is based on the analysis of soils' artefacts in the non-reclaimed area of former chemical plant. Photographic material and literature studies focus on technogenic soils and its functions. The history of "Polchem", industrial tourism and industrial archaeology as well as verbal communication of people associated with the company were important components of this publication.

**Results and discussion** Soils play many ecological functions, one of them is archiving human history. In this approach, archaeology is combined with soil science serving as a tool in archaeological research. Such cooperation within two scientific fields leads often to valuable scientific achievements. Relatively young post-industrial areas are generally out of interest of archaeology. However, they can form the basis of soil education activities targeted at a larger number of recipients.

**Conclusions** Soils within cities are interesting due to recorded marks of human activity. Artefacts in soils can be used in various ways. One of them is an educational purpose. "Polchem" area is out of use now so it can be accessed by visitors (students and teachers). Artefact's diversity allows for quick finding and recognition of industrial history of the former plant. In this way, it could be present an important soil function—protecting cultural heritage.


**Keywords** Urban soils · Industrial soils · Technosols · Soil education · Artefacts · Ecosystem services

## 1 Introduction

Soils have a very important role in our life and in the management of the human environment because they are one of the most valuable elements of terrestrial ecosystems. Awareness of this role appeared in the 1970s when the first attempts were made to define the functions of soils, to classify them and to perform physicochemical tests on them. The European Soil Chapter, issued in 1972, was a prototype for documents confirming the important role of the soil environment. Contemporary research deals with the subject of soils and their significance for humans through the prism of the quality, functions and ecosystem services of soils, often using these different terms interchangeably. Soils perform many ecological functions (Morel et al. 2015; Foley et al. 2005; Vitousek et al. 1997). Soil cover can be a testimony of human activity in agricultural development, settlement or industry. Soils are a reservoir of artefacts—a historical trace of human existence and management. As such, they can function as a research material not only for naturalists but also for archaeologists, historians and anthropologists. Moreover, they can be successfully promoted and used as a feature of touristic and educational attraction.

Soil functions are understood to be the benefits that soils offer to organisms, including humans. There are many divisions of these functions, of which two can be distinguished as the most frequently quoted. The first is the concept of W.E.H. Blum (2005), modified many times by the author since 1988, and it is probably the most popular concept in the European environment. Soil functions, according to Blum (2005), can

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be divided into the ecological and the non-ecological. *Geological and cultural heritage* is one of them. In American publications, e.g. Doran and Parkin (1994), there is a scheme of soil functions corresponding to their quality. According to the American scientists, one of the most important functions is *to protect cultural heritage*. According to the FAO (http://www.fao.org), basic soil functions (among them *cultural heritage*) can be distinguished. Karczewska (2012) divides soil functions into three groups: one consists of the issues *cultural heritage*, *geological history* and *scientific and landscape values*.

The European Commission COM (2002) 179 adopted the basic assumptions of a soil protection strategy. Soil functions were divided into five groups, including *the cultural and material environment of human activity*.

According to Blum et al., soils represent and record a landscape's history using evidence of human activity as well as palaeontological evidence. It is essential of soils' *cultural function* (Blum et al. 2018).

Nowadays, there is a need to improve awareness of soil within cities as they are usually significantly altered by human activity. This can be achieved by a learning-by-doing strategy. Mobile Environmental Education Projects (MEEPs) are one example of promoting soil education (Siebe et al. 2017). Students can explore the soils of parks or schoolyards and its interaction with other environmental compartments using vehicles equipped with the materials they need. Using all their senses, such as touch, taste, smell, sight and hearing, young people can enhance their interest in soils (Siebe et al. 2017). In Europe, a number of soil awareness and education initiatives already exist from primary school education to informing decision makers and working with stakeholder groups (Towers et al. 2010). Soil science education is important for teaching knowledge and understanding of environmental systems and the value of environmental protection (Hallett and Caird 2017) but teaching ideas and practice are different around the world (Hartemink et al. 2014). A considerable part of this teaching is given to students from different disciplines (Hartemink et al. 2014) and from different stages of education (Prokof'eva 2018). Methods and forms of soil education should be adapted to the needs of recipients of a certain age and educational stage. According to Hartemink et al., these all require extra efforts to generate student interest and engagement in the subject and to find the educating soil scientists whose competence and creativity will also be balanced by a deep understanding of the applications of knowledge. This is a challenging task for all soil science educators (Hartemink et al. 2014).

The modern perspective on soil functions recognises the importance of understanding the soil environment as a food producer and gene reservoir, and as a record of the history of human activity via artefacts that can sometimes transform particular soils into a museum of sorts. Technogenic soils—those strongly transformed by human existence (other than agricultural activity)—are of just such formations (Charzyński and Hulisz 2013). Thus, these soils occur in urbanised and industrialised areas. Interest in technogenic soils has increased since the 1990s, when more studies of these soils began to appear. A soil research group was established for urban, industrial, transport, mining and military areas—SUITMA. In essence, understanding SUITMAs involves understanding the needs that cities express, and how soils can be designed to support ecosystem services (Morel et al. 2015).

The aim of this article is to present the soil cover of a post-industrial area of the former chemical plant "Polchem" in a snapshot of the factory's cultural soil functions, its 70-year history of production technologies, its industrial infrastructure and its role in factory workers' lives. In this context, the question arises whether the post-industrial soils can be interesting educational objects for scientists, students and tourists. The studied area does not look like a museum of industry. It could be seen, rather as a museum of industrial activity without buildings, technology lines, chimneys or railroad tracks, but full of traces of that activity. According to Field et al. (2017), places like that could be an appropriate basis for a future teaching–research–industry–learning soil science curriculum model that extends beyond traditional discipline-based teaching.

## 2 Methods and materials

This publication is based on the analysis of soil artefacts, photographic material and literature studies focusing on technogenic soils and their functions, history of the "Polchem" factory, industrial tourism and industrial archaeology, as well as the verbal communication of people associated with the company.

Soils within "Polchem" area have large number of human artefacts which play important role in analysing these soils and its further educational implications. The procedures consisted of several stages: selection of the study area, field study, interpretation soils and artefacts and creating a model of possible interpretations of artefacts within the former chemical plant area. Artefacts were collected during various fieldworks from 2013 to 2019. An initial selection of artefacts was made. During this process, artefacts in the best condition were selected as well as artefacts interesting in appearance and useful for potential interpretation. Artefacts were divided into specific groups according to FAO (2006) due to its diversity. Its potential interpretation in relation to the history of industrial plant was proposed.

The scope of this article covers post-industrial soils on premises of the "Polchem" the Toruń's "Company of Non-Organic Chemistry". The acronym "Polchem" is derived from the combination of the names Polish chemistry, defining the factory production profile. Toruń (53°01'N 18°36'E,) is a city in the Toruń Basin in Northern Poland, and covers an area of about 116 km$^2$. The main factor in terrain relief is the activity of the Vistula River, which is connected with the occurrence of many flood terraces with inland dunes. Human activity has continued uninterrupted since the founding of the city in the thirteenth century. The soil cover (Fig. 1) is typical of most cities.

"Polchem" is located on the western outskirts of the city (Fig. 1). Geologically, it is a fragment of the third terrace of the Vistula's ice-marginal valley. The surface layer consists of well-sorted river sands transformed by wind. Part of the area is covered by large numbers of dune fields. Brunic Arenosols were developed from those sands and loamy sands that are not very rich in clay fraction and with a high susceptibility to chemical degradation (Bednarek et al. 2015). Due to the development of the city and industry, the soils of this area are classified as SUITMAs, according to the WRB soil classification (IUSS Working Group WRB 2015) as Spolic Technosols (Fig. 1). After the demolition of "Polchem" (Fig. 2) in this area, a shopping mall, the "Motoarena" sports facility and a petrol station were built. These objects occupy only part of the site of the former plant. Other than these three examples, the area is not used and is unreclaimed, despite various investment attempts.

Technosols are common in urban areas. They have large number of human artefacts which play important role in analysis of technogenic soils. Artefacts were produced, modified or transported from their source, by human activity. Its importance in soils was noticed by many scientists. J. Howard (Howard 2017) presented common types of anthropogenic particles found in soils as well as description of artefacts and its diversity. Many examples of technogenic soils in Poland were presented by P. Charzyński, P. Hulisz and R. Bednarek (Charzyński et al. 2013). In this monograph, there are descriptions of various soils with artefacts related to human activities in urban, industrial, traffic, mining and military areas in Poland. Artefacts were described in Technosols of New York City (Shaw et al. 2010), Emilia Romagna Region in Italy (Antisari et al. 2014) as well as in mining areas of many countries (Echevarria and Morel 2015). In general, artefacts are described by many specialists according to their discipline. Nevertheless, the role of soils in storing and collecting traces of human activity is emphasised almost by every disciplines which are interested in humanly modified grounds (Edgeworth 2017).


**Fig. 2** Aerial view of "Polchem" after demolition (http://archiwum.mpu-Torun.pl/index.php?m=gal&id=13)

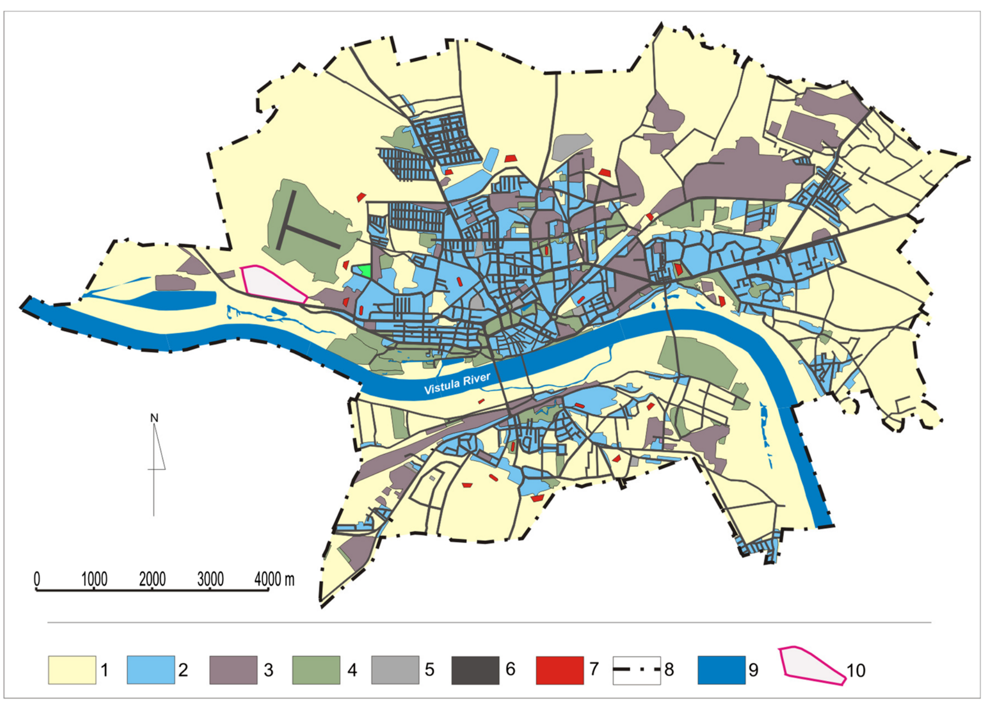


**Fig. 1** The soil map of Toruń (Bednarek et al. 2003; Charzyński et al. 2018; Charzyński and Hulisz 2017). Explanations: 1 Brunic Arenols and Fluvic Gleysols (undisturbed and weakly transformed soils), 2 Urbic Technosols, Eutric Arenosols (Technic), 3 Spolic Technosols, Dystric Arenosols (Technic), 4 Fluvic Hortic Pheozems (Siltic or Loamic), Haplic Pheozems (Arenic or Siltic), 5 Ekranic Technosols, Relocatic Pheozems, 6 Ekranic Technosols, 7 Isolatic Technosols, 8 city boundaries, 9 surface waters, 10 area of former chemical plant 'Polchem'

### 2.1 Polchem: historical background

The sulphuric acid company "Polchem" in Toruń was the second of three such facilities built in Poland in the interwar period (Kruszka and Wartalski 1995). The Polish-Belgian joint-stock company was set up in 1929. In 1933, the company led to the construction and commission of "Polchem", a new chemical plant in Toruń covering 60 ha. Initially, production included sulphuric acid of various concentrations, oleum (sulphur oxide), sodium and potassium sulphate (IV) and bisulphate (IV). The years 1970–1980 were not only a period of modernisation but also the beginning of environmental awareness. The negative impact on the environment was noted, and many various actions were taken to reduce it.

Until 1990, "Polchem" specialised in the production of several substances, such as simple dust superphosphate, technical and battery sulphuric acid, hydrochloric acid, chlorosulphonic acid, sodium sulphate, hydrosulphite, rongalite, zinc sulphate and reagent chemicals based on the technical chemicals it produced (Majchrzak et al. 2012).

The plant's final bankruptcy was declared by the court on 18.03.2003 (http://www.krs-online), but today, the plant website is still listing the available products on offer at the time it closed business. These are sodium hydrosulphide, sodium hydrosulphide for food purposes, sodium sulphate anhydrous technical and sodium sulphate (IV) heptahydrate (http://www.polchem.com.pl/produkty.html). All products are non-toxic and non-flammable but emit sulphur dioxide ($SO_2$) on being heated, and in addition to sulphate derivatives, most of them contain the heavy metals lead and arsenic, and some contain selenium (non-metal), cadmium, zinc and mercury. After 2003, the buildings were abandoned, workers were dismissed, and the entire infrastructure became post-industrial ruins (http://urbanqatsi.pl/Poland/polchem/Toruń-polchem.htm). It was decided to demolish the buildings, and the demolition material (debris) was sold for construction purposes.

## 3 SUITMAs in education: results and discussion

According to Siebe et al. (2017), three aspects must be considered to increase awareness about soils. In the human **mind**, there must be the need for "soil care". The participation of the **body** should be provided by experiences ("learning by doing"). Spiritual connections to soils create emotional links to them (by the **soul**). All three aspects can be perfectly fulfilled within the research area: the picture of soil disturbances can evoke a need for soil protection, field experience (with all precautions needed in polluted areas) and emotional engagement as a former industrial plant can be considered part of little homeland of Toruń citizens. Nowadays, people are interested in the local environment. They are concerned about redeveloping lands and creating new open areas within cities. On the other hand, soil ecosystem services in cities are far more difficult to evaluate because they are not at the centre of political or economic interest (Levin et al. 2017). However, the fact is that brownfield investments are trendy, smart and popular. There are many examples of brownfields that have been reclaimed in recent decades (e.g. the Ruhr area in Germany, the Silesian area in Poland), but many of them are still out of use. The "Polchem" area is awaiting proper use. An educational function could be a practical possibility these days. According to Levin (Levin et al. 2017), there are many examples of places around the world for integrating soil scientific research and cultural reflection.

There are many different ways to present the importance of soils using various educational tools. The Senckenberg Museum of Natural History in Görlitz developed an international touring exhibition with the title "The Thin Skin of the Earth – Our Soils" (Xylander and Zumkowski-Xylander 2018) where many forms of educational approaches were presented. All forms were necessary to maintain the visitors' concentration and achieve maximum awareness, e.g. high-quality models of soil organisms, digital and analogue hands-on-media, movies and VR. The exhibition was developed for a variety of target groups but has a special focus on families and school classes to change the visitor's attitude towards environmental issues following the concept of "from idea to action" (Xylander and Zumkowski-Xylander 2018).

To promote environmental awareness, environmental perception was utilised as the main tool to analyse public understanding of local environment (Santos et al. 2000). In São Paulo, a non-formal environmental education (EE) programme has been implemented in the natural conservation area through EE paradigms, which consider the objectives of education *about*, *in* and *for* the environment within cultural and natural perspectives. Various pedagogical tools were produced (Santos et al. 2000).

It should be noted that different groups of people are potential recipients so there is a need to introduce various educational methods. Bruce C. Ball shows the outcomes of selected methods of improved connections to soil issues for different groups (e.g. farmers, policy makers, scientists, children, adults (Ball et al. 2018). Both Prokof'eva (2018) and Świtoniak et al. (2018) present experiences of teaching soil science to students at different educational stages. It should be noted that this teaching requires special didactic materials, e.g. "Guidelines for soil description and classification" (Świtoniak et al. 2018).

"Digital natives"—students who are all "native speakers" of the digital language of computers, video games and the Internet (Prensky 2001)—need to adapt materials to their digital language. The Regional Environmental Center for Central and Eastern Europe (http://greenpack.rec.org/soil/index.

shtml) has an online soil lesson that goes into: why soil is important, basic soil functions, problems and threats to the soil, and impacts of war on soils, and finishes with "what people can do" to protect soil for the future (Harrison et al. 2010). The Field Museum (http://www.fieldmuseum.org) has lessons for children called "underground adventure" (Harrison et al. 2010) with exercises in soil texture, temperature, compaction and percolation, factors that affect soil use and soil biodiversity. In Russia (Buyvolova et al. 2018), it was proposed to introduce the student competition (soil judging contest) in describing soils, and the team wins whose description is closest to the description expert. This could be an interesting way for students who will take part in "Polchem" soils education.

Increasingly, students have a desire to learn about soils with an emphasis on environmentally oriented applications (Harrison et al. 2010) so "Polchem" soils, with their cultural functions, could be interesting enough for them.

The Tea Bag Experiment—an interesting example of international project—shows that students willingly take part in such of undertakings. TeaTime4Schools was funded by Sparkling Science, a research programme of the Federal Ministry of Science, Research and Economy. The Tea Bag Experiment (http://www.teatime4science.org) was associated with the Tea Bag Index—a simple method to study decomposition of plant materials in soil. Students buried tea and investigated the relation between decomposition and microbial activity of the soil. The objective of the TeaTime4Schools project was to achieve a better understanding the role of microorganism in the decomposition process.

There are many examples of soil campaigns that make the target group aware of the importance of soil. The campaigns are part of the "soilution"—solution for soil degradation (Bramel 2012).

Table 1 lists a selection of artefacts found within the "Polchem" area, and possible interpretations by visitors (students or other recipients) in light of the industrial history of this former plant. This is a way to involve all the senses (mind, body and soul) to learn the history of the place through the area's soil cover. "Polchem" was turned into a site of poorly cleared rubble, but it is full of traces of its former activity that can be called "post-industrial artefacts". "Post-Polchem" soils, like many other soils of post-industrial areas, are characterised by the clear dominance of the function they perform at the moment—cultural functions. They are a treasury of knowledge hidden in artefacts that are important to the learning of the history of the place and human activity in this area.

The artefacts might be fragments of concrete, bricks and reinforcement elements that are the direct result of demolition work, but also production waste, used containers, and, finally, sulphur accumulated in the soil. In the area of the plant not only can traces of industrial activity be found but also fragments of transport infrastructure. The quantity of these materials indicates the important role that "Polchem" played in history. Post-industrial soils are a kind of record of events connected not only with production but with all industrial activity (fragments of reinforcements, debris from buildings, elements of railway tracks) (Fig. 4).

According to Howard (2017), artefacts are objects of > 2.0 mm (whereas microartefacts are 0.25–2.0 mm) that were produced, modified or transported from their source by human activity. Howard (2017) classified them into five types on the basis of composition: (1) carbonaceous, (2) calcareous, (3) siliceous, (4) ferruginous and (5) other. Due to its diversity, artefacts are divided into groups according to FAO (2006): (1) artisanal natural material; (2) industrial dust; (3) slag; (4) concrete fragments; (5) pavements and paving stones; (6) bricks, pottery fragments, and tiles; (7) metal fragments; (8) mixed materials; (9) organic garbage; (10) synthetic liquids; (11) synthetic solids; (12) waste liquids; (13) charcoals; and (14) other.

Most of these types can be found in the discussed area; moreover, they are common there (Table 1, Fig. 3, Fig. 4). This area can be seen as a living SUITMA laboratory that has been influenced for many years by the production of sulphuric acid and artificial fertilisers. In the new Polish soil classification (Kabała et al. 2019, 2020), two types of soil artefacts have been distinguished—"normal" (e.g. concrete, stones) and "reactive" (e.g. ash, slag, tailings), to reflect their different reactivity and toxicity in soil environments. There is an abundance of reactive artefacts (sulphur) in the study area, and its toxic properties can be observed (extreme pH, spots completely devoid of vegetation) and shown to visitors (Fig. 5).

In view of the fact that the framework of cultural ecosystem services provides the opportunity to cooperate with other disciplines (Levin et al. 2017),"Polchem" can be considered also in the context of industrial archaeology—a field that has been developing since the mid-twentieth century and combining many disciplines (history of technology, archaeology, history of architecture, conservation of monuments, etc.). Soils can be an important storehouse of information and soil analysis can help archaeologists to date sites and get to know the major human activities (Vranova et al. 2015).

Industrial archaeology has become a basic tool for interpreting industrial heritage and technology (Labadi 2001; Januszewski 2010). The interest in industrial archaeology has led to the creation of museums in abandoned industrial facilities, as well as new forms of technical museums—ecomuseums, which can be museums of time, space and humanity, showing the relation between man, nature and technology. Soil scientists are encouraged to discover new links between ecosystem functions and the unique cultural histories in which cities have evolved (Levin et al. 2017). It is the way that the area of "Polchem" can be seen.

The technological revolution, together with increasing ecology awareness, caused the liquidation of companies that had the potential to continue production but that were replaced by others that used more efficient and environmentally

**Table 1** Possible interpretations of artefacts within the "Polchem" area, for educational purposes

| No. | Artefact | Example | Artefact group (by division) | What the visitor should/could deduce? | Reference to "Polchem" |
|---|---|---|---|---|---|
| 1. | Slag | Fig. 4a, 4i | Slag | It is an anthropogenic material; slag can be related to industry; slag changes the water and air characteristics of soil | Slag is a product of coal combustion in boiler rooms. *Boiler plant* rooms provided heating and hot water for "Polchem". It can also be a building material—"slag brick" |
| 2. | Sulphur | Fig. 4d, 4f, 4g, 4i | Industrial dust | It is a chemical and anthropogenic product; sulphur affects the chemical properties of soils; toxic to plants | "Polchem" produced sulphur acid, so sulphur was a raw material in production process |
| 3. | Synthetic solid | Fig. 4a | Synthetic solid | It is an anthropogenic material; synthetic solid can come from human activity other than industry | In the plant, there were many possible uses of synthetic solids (e.g. floor covering, insulation material, synthetic worktops) |
| 4. | Brick fragments | Figs. 3, 4h | Bricks, pottery fragments, tiles | Brick fragments could come from demolished buildings; they might be elements of industrial infrastructure | Bricks were a popular building material. "Polchem" was built from, among things, bricks, which are now a product of plant demolition |
| 5. | Chemical label | Fig. 4e, 4b | Mixed material | It is evidence of industrial activity related to the use of materials hazardous to people and the environment | Fluorosilicic acid ($H_2SiF_6$) was used in production of Sodium fluoride, Ammonium fluoride (acid), hydrofluoric acid and sodium fluorosilicate—important substances in the "Polchem" production structure. Many products were toxic, corrosive or irritant chemicals. |
| 6. | Plastic | Fig. 4a | Synthetic solid | It is an anthropogenic material; plastic could come from various sources | Plastic is a very common material. It was used in many different situations (as a building material; in office or lab equipment) |
| 7. | Metal fragments | Fig. 4b | Metal fragments | It is evidence of human activity; it could come from industry as well as from other sources | In the "Polchem" plant there were many metal constructions (sulphur furnaces, installation, railway infrastructure, etc.) |
| 8. | Concrete fragments with sulphur | Fig. 4d | Concrete fragments/industrial dust | Concrete fragments could come from demolished buildings, and sulphur demonstrates the chemical processes performed as the human activity. | Sulphur as sulphur acid—the main product of "Polchem"—is corrosive. Sulphur efflorescence is very common not only on the surface but also inside concrete fragments |
| 9. | Concrete fragments | Fig. 3 | Concrete fragments | Concrete fragments are evidence of demolished buildings and human activity | Concrete fragments come from the demolition of "Polchem". Concrete was used as a building material |
| 10. | Glass fragments | Fig. 4b, 4c, 4g | Other (glass) | This anthropogenic material could come from various human origins; it could be a type of rubbish | Glass is a fragment of the plant's windows and other constructions made of this material. Glass bottles were used for storing acid |
| 11. | Cable fragments | Fig. 4h | Synthetic solid/metal fragments | This anthropogenic material comes from various human activities; it is evidence of human and industrial waste | Metal elements were part of various industrial constructions (e.g. electrical cables) |

**Fig. 3** Soil profile with abundance of artefacts within the former "Polchem" area

friendly modern technologies. This process was often a cause of discontent among local communities (e.g. due to jobs losses). Nowadays, nostalgia for a plant where local people worked for decades could be another driving force in stimulating interest in the area and its SUITMAs and leading to growth of public awareness of soil degradation issues.

In 1978, the International Committee for the Preservation of Industrial Heritage (TICCIH) was established. In its name, the term "monuments" was replaced with "heritage", which was a stimulus for the development of industrial archaeology.

The premises of Toruń's plant is now a feature of the city's landscape and part of local memory. The soil cover is a 70-year-old record of the industrial activities. There are important links between industrial archaeology and contemporary

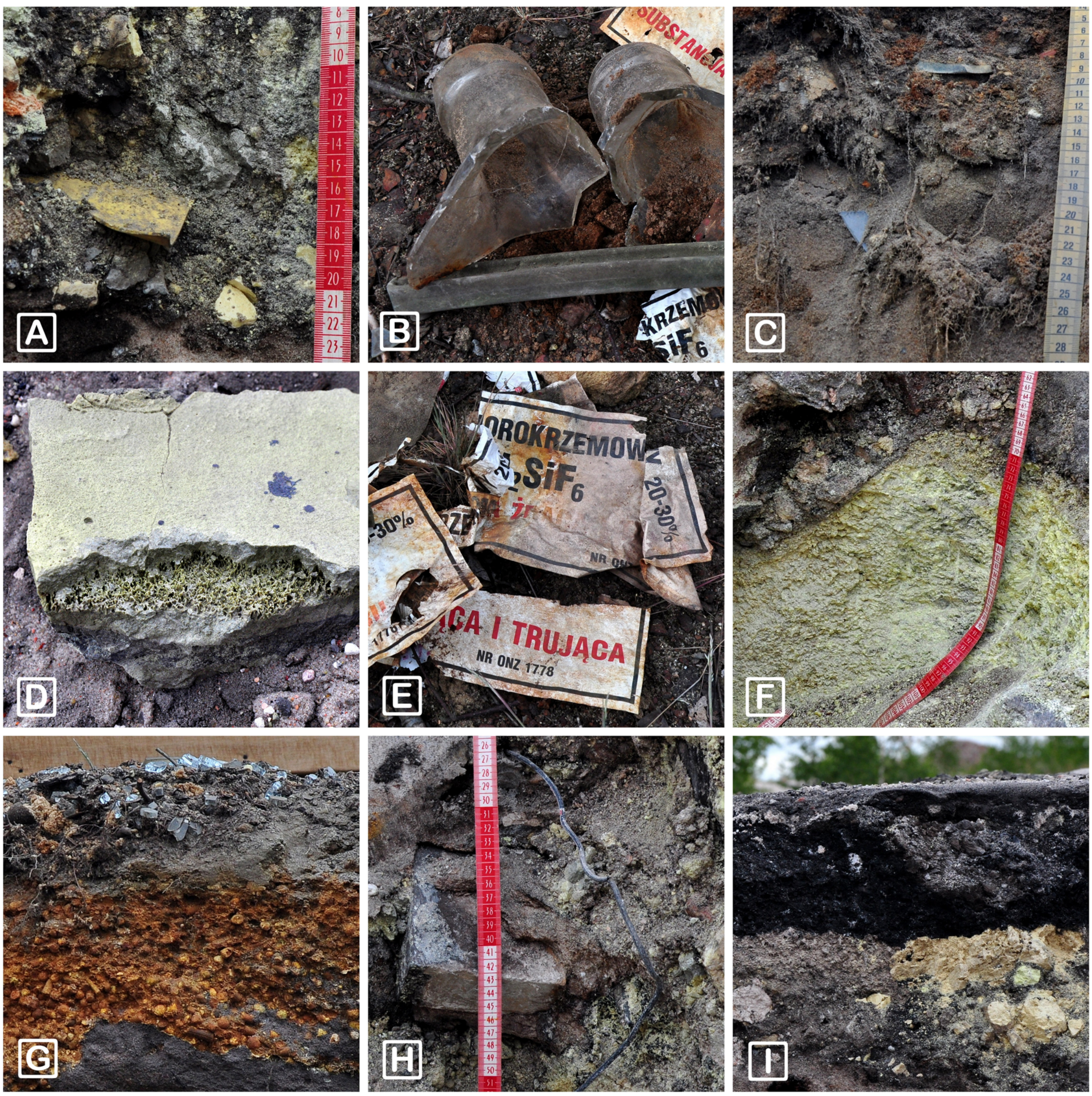


**Fig. 4** Artefacts found in soils within the former "Polchem" area: A Synthethic solid and slag; B Metal and glass fragments; C Glass fragments; D Concrete fragments with sulphur, industrial dust; E Chemicals labels; F Sulphur; G glass fragments and sulphur; H Cable fragments, bricks, pottery fragments, tiles; I Slag, Industrial dust

**Fig. 5** Extreme soil pH measured within the former "Polchem" area

society with its ideas, needs and plans for the development of post-industrial areas.

Industrial archaeology is an initiator and coordinator of research in the humanities and the technical, natural and economic sciences, and is seen as an interdisciplinary field in which specialist knowledge from many scientific fields is treated as a potential background for research. It certainly has a place for cultural studies into soil functions, as well as other branches of soil science. The soil cover of the "Polchem" site, and the artefacts and the history of this place, should be not only a subject of scientific research but could also be defined as cultural tourism with educational implications for post-industrial facilities. Industrial tourism and educational activities aim to provide knowledge about various elements of the industrial landscape. This kind of spaces includes not only buildings, installations and infrastructure but also the human factor—curiosity about the living conditions of the people who were "inside" the industrial centre in the past or are there in the present. Despite the fact that "Polchem" does not exist today, its history is written in the natural environment. The soils are features that perfectly preserve evidence of human activity. In connection with artefacts occurring in the soil, this could be a perfect reflection of the processes going on during industrial production. In such an environment, an educational and touristic approach can use the principles of *gamification* (Urbańska et al. 2019) to encourage engagement. Most modern students require interaction and competition because social media and virtual reality games have changed the way young people perceive the real world, and that also includes the education process, which should be supported by elements of gamification. It seems only natural to make use of such strong motivation in order to enhance the experience of field activities related to urban soil science.

According to Harrison et al. (2010) "education, whether formal or informal, is key to developing an understanding of any subject."

## 4 Conclusions

The "Polchem" soil cover has recorded the history of the plant. Nowadays, the world is being forced to solve many ecological problems. People are aware of the dangers of global warming and air pollution but they do not fully realise that soil resources and soil protection are equally important for humankind. The soil scientist community should paid much more attention to soil education to make people aware of the importance of soil, both in their surroundings and on a global scale. Soils are everywhere. Around the cities, there are unused brownfields, and these places could become a living laboratory for soil education. There are many possibilities in these areas to provide information about the process of soil evolution, destruction and protection, and other issues. The possibility to interest the recipient in artefacts that are often seen as ordinary waste is one of the options hidden in SUITMAs. The cultural functions of soils could, in combination with the artefacts found in former industrial areas, extend the tourist and educational offer of the city, in addition to being a place of scientific research addressed to different recipients.

## Declarations

**Informed consent** Informed consent was obtained from all individual participants included in the study.

**Conflict of interest** The authors declare that they have no conflict of interest.

**Human and animal rights** Research did not involve human participants and/or animals.



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