Lobby of the Shenyang Industrial Museum, by Juan Manuel Cano Sanchiz.

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THE ECOLOGICAL TURN OF INDUSTRIAL MUSEUMS. A COMPARATIVE ANALYSIS BRITAIN-CHINA*

EL GIRO ECOLÓGICO DE LOS MUSEOS INDUSTRIALES. UN ANÁLISIS COMPARATIVO REINO UNIDO-CHINA

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Abstract
Museums are undergoing an ecological turn aligned with current global strategies for sustainable development. This shift is also occurring in the industrial museum/heritage sector, notably in Britain and other Western countries, where new environmental concerns and actions are reshaping the way in which the industrial past is represented and used. In this paper, we analyse how this approach is developing in China. To do so, we take the British experience as a model and combine quantitative and qualitative analyses to study five British and four Chinese case studies. We claim that industrial museums have the responsibility to contribute to the healing of some of the wounds of industrialisation (in this case, climate and ecological damage), which can be achieved through sustainable planning and environmental education.

Keywords
Industrial Museums, Sustainability, Environmental Education, Climate Change, Ecological Civilization.

Resumen
Los museos están experimentando un giro ecológico en consonancia con las actuales estrategias globales de desarrollo sostenible. Este giro puede detectarse también en el sector del patrimonio y los museos industriales, sobre todo en Gran Bretaña y otros países occidentales, donde nuevas preocupaciones y acciones medioambientales están reconfigurando la forma de representar y utilizar el pasado industrial. En este artículo analizamos cómo este enfoque diferente se está desarrollando en China. Para ello, tomamos como modelo la experiencia británica y combinamos análisis cuantitativos y cualitativos para estudiar cinco casos británicos y cuatro chinos. Defendemos que los museos industriales tienen la responsabilidad de contribuir a solucionar algunos de los problemas derivados de la industrialización (en este caso, daños climáticos y ecológicos), lo que puede materializarse con una planificación sostenible y educación ambiental.

Palabras clave
Museos industriales, sostenibilidad, educación ambiental, cambio climático, Civilización Ecológica.

INTRODUCTION

We are under environmental alert. According to the World Meteorological Organization (WMO, 2023), in 2021, greenhouse gas emissions reached record values –carbon dioxide (CO_2) was 149% of pre-industrial levels (before the mid-19th century), methane was 262%, and nitrous oxide was 124%. In 2022, the planet was 1.15 ± 0.13 ºC warmer than the average before industrialisation, the ocean continued to warm and the ice sheets and glaciers kept melting (WMO, 2023). As a consequence, sea levels are still rising at c. 3.4 ± 0.3 mm per year (WMO, 2023). In July 2023, we witnessed the highest global temperature since we began to keep records (NASA, 2023) and in the following months, a world-wide increase of extreme weather events. Our current reality makes it difficult to achieve the 2030 Sustainable Development Goals (SDGs) adopted by the United Nations in 2015.

The museum sector worldwide is not alien to the problem and is currently transforming to meet the SDGs, although with different levels of commitment and results depending on the country. Still, the topic has gained such traction in the last years that fostering sustainability was explicitly included in the new museum definition of the ICOM.[1] We describe this transformation as an ecological turn, and we argue that these concerns should be particularly addressed by industrial museums because industrialisation has been one of the principal causes of the environmental crisis, as the comparison of greenhouse gas figures before and after the industrial period demonstrate. Thus, we argue that industrial museums must be platforms that critically examine and help solve present problems that are rooted in the industrial past, in this case, environmental and ecological damage.

In this article, we define industrial museums as institutions that display narratives and collections about the industrial period or, more broadly, about people using technology to work through time. More specifically, we explore the ecological turn of industrial museums in Britain and China. Our study and conclusions are partial and limited, as we consider five cases from the former and four from the latter –although our previous work with industrial museums lets us observe these cases within a wider context (Cano-Sanchiz, Zhang, Lei 2020; Long, Cano-Sanchiz, 2022). Additionally, our analysis of these two countries is uneven in terms of sources, methods, and data. Rather than a symmetrical comparative analysis, we use the British cases as models to evaluate how Chinese industrial museums are performing the ecological turn and to define some Chinese characteristics in doing so: particularly, the role of the Ecological Civilization (EC) paradigm (see below) and the closer connection to developing industries and technologies. Britain is chosen as a model due to its long tradition in industrial museology and especially to the significant number of environmental actions carried out in its industrial heritage and museum sector in recent years (see below). China was selected as a more detailed case study because internationally, it is perceived as a polluting country and, at the same time, as «an emerging environmental leader» (Weins *et al.*, 2023: 15). China's efforts to tackle climate change (see *China's Policies*

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1   «A museum is a not-for-profit, permanent institution in the service of society that researches, collects, conserves, interprets and exhibits tangible and intangible heritage. Open to the public, accessible and inclusive, museums foster diversity and sustainability. They operate and communicate ethically, professionally and with the participation of communities, offering varied experiences for education, enjoyment, reflection and knowledge sharing» (ICOM, 2022).

and Actions to Deal with Climate Change)[2] are embedded in the country's major plan for transitioning from an Industrial Civilization to an Ecological Civilization (see Wei *et al.*, 2021), which includes the achievement of the SDGs as well (Sun *et al.*, 2018). We are interested in examining the role of industrial museums in this challenge because in China industrial museums are growing dramatically and are assigned relevant roles as soft-power devices.

The roles that museums can play in fighting climate change have been recently discussed (Rees, 2017; McDowall, 2019; Davis, 2020; Merriman 2024). Even though this ecological turn is developing relatively fast in the industrial heritage and museum field (see below), little academic literature has been produced about the potential contribution of this sector. There is, however, recent related research to consider. Some researchers have shown interest in the ecological side of industrialisation (Magalhães, 2021; Soares, Cordeiro, 2023). Archaeologists have explored the agency and heritage value of industrial waste and pollution (Quivick, 2022; Stewart, 2022), while landscape students have coined the term «industrial nature» in an attempt to reassess the impacts of industrialisation on the environment, which were not always negative (Stuart, 2010; Tempel, 2012). Closer to the standpoint of this article, architects and industrial heritage scholars have published about adaptive reuse as a means to promote sustainable development and reduce carbon emissions by recycling architecture and its embodied energy (Watson, 2012; Svetoslavova, Walczak, 2023). In this context, the remediation and restoration plans of the Ruhr region constitute a popular model to follow (Berger, 2019: 48-49).

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2   https://www.mee.gov.cn/zcwj/gwywj/202110/t20211027_958030.shtml [Accessed 01/08/2023]

Although some researchers have recently opened a line of discussion on how industrial heritage can be aligned with the SDGs (Cordeiro, Silva, 2023), very little has been published in the academic literature regarding the potential contribution of industrial museums in pursuing a more ecological future grounded on the experience of the industrial past. Ruud and Thorstensen (2022) have analysed the exhibition *Climate for Change* hosted in the Norwegian Petroleum Museum and criticised the idea that, rather than promoting real transformations, it perpetuates traditional discourses of progress and change. But this kind of analysis is rare, among other reasons because monographic exhibitions on climate change are still uncommon in industrial museums, at least when compared to broader presentations of environmental history (Jiang, Hu, 2018). Finally, while environmental education is not alien to museums in general (Hao, 2011), its existence in the narrower realm of the industrial ones is still scarce both internationally and in China, with very few studies on the subject (Zhu, 2021).

MATERIALS AND METHODS

This research uses two groups of materials, whose collection and analysis are based on different methods.

First, information about ecological experiences from five British industrial museums: Amberley Museum, Brunel Museum, Science + Industry Museum, National Coal Mining Museum for England, and Big Pit National Coal Museum of Wales (Table 1). Data in this group were mostly collected through the museums' official websites, social media, general news, and communication with staff.

Name	Location	Administration	Inauguration	Sector	Website
Amberley Museum	West Sussex	Charity	1979	General industry	https://www.amberleymuseum.co.uk
	Main environmental actions: environmental policy, ecological and environmental contents in exhibitions and narratives, environmental education, green team, World Environment Day events, community activities, production and use of renewable energies (solar panels), substitution of fossil-fuel vehicles by tricycles, reduction of plastic disposables, increase of recycled materials, discounts for visitors coming by train, adaptive reuse, carbon literacy training				
Brunel Museum	London	Charity	1961	Building engineering	https://thebrunelmuseum.com
	Main environmental actions: environmental plan, decarbonisation, ecological networks, environmental discourses, sustainable development, adaptive reuse				
Science + Industry Museum	Manchester	Charity	1983	General industry	https://www. scienceandindustrymuseum.org.uk
	Main environmental actions: environmental plan, lectures and discussions on climate change, decarbonisation scheme, carbon literacy, energy efficiency, adaptive reuse, environmental discourses (green industrial revolution), use of renewable energy and resources, production of the exhibition film *Electricity: The Spark of Life*, blog posts on biomaterials, sustainable food, etc.				
National Coal Mining Museum for England	Wakefield	Charity	1988 (national since 1995)	Coal mining	https://www.ncm.org.uk
	Main environmental actions: monographic exhibitions, production and consumption of renewable energy (solar panels), substitution of fossil fuels by biomass, energy efficiency plan, waste reduction policy (use of renewable or biodegradable materials), research, environmental discourses, water treatment plan (to clean the water pumped out from the mines), adaptive reuse				
Big Pit National Coal Museum of Wales	Blaenavon	Charity	1983	Coal mining	https://museum.wales/bigpit/
	Main environmental actions: adaptive reuse, online lectures (marine animals and the environment, building sustainability), natural science research, blog posts on soil materials, natural history, etc.				

Table 1. British case studies. Source: authors.

Second, more detailed information on our four case studies in China: Shenyang Industrial Museum (SIM), Chongqing Industrial Museum (CIM), Beijing Auto Museum (BAM), and Chemical Industry Museum of China (CIMC) (Table 2). This selection was based on these museums' capacity to represent the industrialisation of China (both Shenyang and Chongqing were major industrial centres and their industrial museums are among the largest and most comprehensive in the country) and the closer relationship to environmental issues of the automobile and chemical industries. Data in this group were collected through fieldwork (including a three-month study in CIM), analysis of the museums' websites and visitors' reviews on social media, interviews with curators and members of the staff, and questionnaires (see supplementary materials). 145 questionnaires were delivered among visitors: 42 for SIM, 60 for CIM, 40 for BAM, and 3 for CIMC.[3] Data were analysed by combining quantitative and qualitative analyses and statistics aided by IBM's SPSS software (CIMC's questionnaires were excluded from the statistical analysis due to their insufficient number). The SPSS analyses aim to empirically measure the perception of the visitors. To do so, their answers were translated into numerical values. Some of these results are included in Tables 3 and 4 and the pie charts on page 35. In this article, the SPSS analyses focus on environmental issues and do not consider questions such as demographics. All the data is available in the supplementary materials to test other interpretations. The research also included an experimental analysis of the impact of CIM on the remediation of the area, which was developed with ArcGIS Pro and remote sensing data.

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3   The low number of questionnaires for CIMC is because the museum has limited opening times and visits are only possible under appointment.

Name	Location	Administration	Inauguration	Sector	Area (m²)	Collection (items)	Website
Shenyang Industrial Museum (SIM)	Shenyang (Liaoning Province)	Public	2012	General industry	53,076	13,126	Under construction
Chongqing Industrial Museum (CIM)	Chongqing	Private	2019	General industry	63,333	c. 16,000	http://www.2019cqim.com
Chemical Industry Museum of China (CIMC)	Beijing	Mixed (public company)	2010	Chemical industry	2,540	6,392	http://www.chemmuseum.com
Beijing Auto Museum (BAM)	Beijing	Public	2011	Automotive industry	c. 50,000	c. 6,000	http://www.automuseum.org.cn

Table 2. Chinese case studies. Source: authors.

THE ECOLOGICAL TURN IN INDUSTRIAL MUSEUMS OF BRITAIN

Britain is setting up a model to follow in the ecological turn of the industrial heritage and museum sector. Environmental initiatives have grown significantly in the last few years within the frame of wider programmes such as the Carbon Literacy Project, the Climate Change Strategy of Historic England or the UK Museum COP. For example, the use of alternative fuels (instead of coal) in Claymills Victorian Pumping Station (Burton Upon Trent) or Crofton Beam Engines, the repurpose of UNESCO World Heritage Cromford mills to produce hydroelectric power, or projects to use water from disused coal mines to heat homes and other places. These actions have been accompanied by several training activities, such as the Scottish Transport & Industry Collections Knowledge Network's online spring 2021 event «Burning Issues: The Future of Fossil Fuels in Heritage», the Association of British Transport & Engineering Museums' 2023 annual seminar «Sustainable Steam and Sustainable Communities», or the «Industrial Heritage & Climate Change» seminar hosted in 2023 by Dr Michael Nevell from the Ironbridge

Gorge Museum Trust. It is not the aim of this section to analyse these initiatives. Rather than that, we identify eight common actions based on the experiences of five British industrial museums (see Table 1). These eight actions are used to scrutinise how industrial museums in China are executing the ecological turn.

A1) Environmental plans and policies. Documents elaborated by the museums to guide their sustainable development. Example: the *Brunel Museum Sustainability Statement* of 2021, which establishes a general plan to decarbonise the museum, work with partners with similar ecological commitment, use the museum to raise awareness of the climate crisis and find inspiration in the past to create solutions in the present, and promote the sustainability of the institution.[4]

A2) Exhibitions design and museum discourses. Ecological and environmental content in the permanent/temporary exhibitions and narratives of the museums. Examples: the «Nature Trails» of the Amberley

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4 https://thebrunelmuseum.com/about/sustainability-at-the-brunel-museum/?_gl=1*1koxzbn*_ga*MTAxNTUxNTM0OS4xNjkzMjc2NjI5*_ga_YEY236B4R4*MTY5MzI3NjYyOC4xLjEuMTY5MzI3Njc5OC4wLjAuMA [Accessed 24/10/2023]

Interpretation panels from the «Nature Trails» (left) and views of the exhibition «Powering a Nation» (right). Source: courtesy of Amberley Museum (left) and of National Coal Mining Museum for England (right).

Museum.[5] As informed by its learning and engagement manager Louisa Jones (personal communication, 9 July 2022), the «Nature Trails» place the lime kilns preserved in the museum into its environmental context and relate the industrial landscape to climate change and biodiversity loss. The museum has incorporated global warming, the use of pesticides or the carbon cycle in its narratives, while visitors are encouraged to reduce consumption and increase recycling. Also, the temporary exhibition «Powering a Nation» hosted in the National Coal Museum for England in 2022, addressed issues such as the future of fossil fuels and renewable energies considering its economic, technological and environmental impacts.[6] The exhibition reviewed the history of coal consumption in the

long term and its shifting ecological critiques, as commented by curator Mark Carlyle (personal communication, 15 September 2022).

A3) Eco-friendly construction. Measures taken by the museums to reduce their carbon footprint, resource consumption, and waste production. We include here cutting down coal burning (traditionally common in those museums displaying steam engines in operation), renaturation or reforestation plans, recycling in several forms, and other actions to revert the ecological damage produced by industrial activities. Example: the National Coal Mining Museum for England counts on solar panels to produce electricity, uses biomass for heating, and has a plan for energy efficiency and consumption of biodegradable materials (personal communication with Mark Carlyle, 15 September 2022). Also, the Science + Industry Museum counts on

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a decarbonisation scheme.[7] This kind of measure is now common in the museums of Britain.

A4) Green Teams. Training of human resources to implement the environmental measures of the museums and promote ecological awareness. Example: the Amberley Museum's green team of staff and volunteers (personal communication with Louisa Jones, 9 July 2022).

A5) Educational activities. Science popularisation and didactic programmes and resources to enhance the ecological and environmental literacy of society. Example: Science + Industry Museum's «Climate Talks», a series of online lectures and conversations involving leaders, researchers and activists.[8] Some of the talks of this series may fit into A6 too, but we include them here because they are addressed to the general public.

A6) Academic activities. Research-oriented activities to produce advances in knowledge in environmental science, climate change, and related topics. Example: the project on geothermal heat pumps developed by the National Coal Mining Museum for England together with some partners, which resulted in the publication of a monograph (Faull, 2011).

A7) Community activities. Community-led or community-addressed activities to promote sustainability, ecological consciousness or environmental crisis awareness, such as ecological markets, recycling workshops, food waste prevention campaigns, etc. Examples: annual World Environment Day events in Amberley Museum.[9]

A8) Adaptive reuse. Physical reutilisation of former constructions to host the museum and their related facilities, especially when they are industrial. Example: most British industrial museums are partially or totally located in former industrial spaces, but we highlight the Big Pit National Coal Museum of Wales because its transformation from an operative coal mine into a museum has been the topic of a temporary exhibition in 2022-2023.[10]

Chinese Case Studies

Shenyang Industrial Museum (sim)

sim occupies the repurposed Shenyang steelworks from 1956 and some new constructions (A8). The current permanent exhibition, which was first installed in May 2012, is divided into five halls: General History, Machine Tool, Foundry, Automobile and Tiexi (the name of the district where the museum is located, once one of the heaviest industrialised areas in ne China), although this distribution will change with the ongoing renovation plans developed by sim in partnership with the University of Science and Technology Beijing. The museum counts on high qualifications (National Grade ii Museum, aaaa National Tourist Attraction) and holds several titles, among others being a National Science Popularisation Education Base.
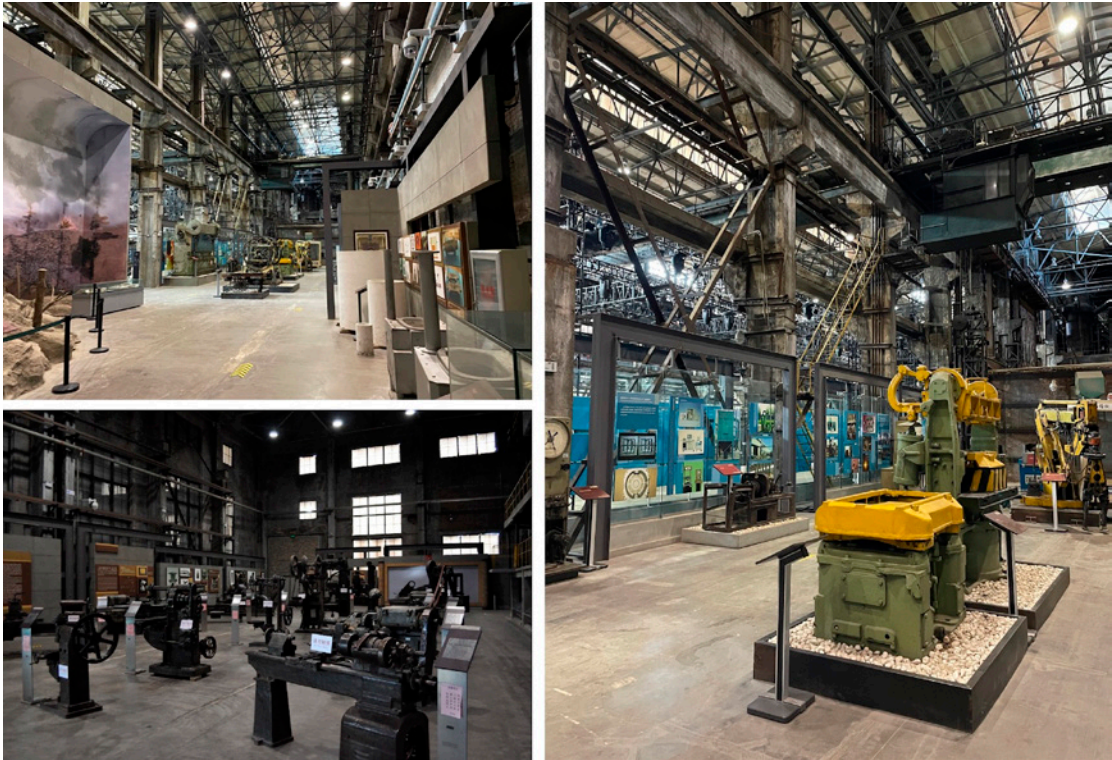
There are some contents related to environmental concerns and sustainable plans in almost every section of the permanent exhibition (A2), although they are more prominent in sections such as «Looking to the Future» of the Machine Tool Hall. At present, these narratives weigh little in the overall discourses, but they are planned to be further developed in the reform of the museum. sim organises community activities

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7 https://www.scienceandindustrymuseum.org.uk/about-us/we-are-changing/decarbonisation. [Accessed 24/10/2023]

8 https://www.scienceandindustrymuseum.org.uk/climate-talks. [Accessed 24/10/2023]

9 https://www.amberleymuseum.co.uk/whats-on/amberley-environment-day/. [Accessed 24/10/2023]

10 https://museum.wales/bigpit/whatson/10228/From-Mine-to-Museum-Exhibition/. [Accessed 24/10/2023]

Recycled industrial spaces in SIM. Source: authors.

Environmental narratives (A: «The Green Engine»), displays (B: «Future of the Small Town») and lecture (C: «Museums, Sustainability and Wellbeing») in SIM. Source: authors (A-B) and courtesy of Shenyang Industrial Museum (C).

Question	Score range	SIM score	CIM score	BAM score
Q7: Are you concerned about ecological and environmental issues?	1-3	1.74±0.627	1.18±0.390	1.83±0.594
Q9: How much do you know about industrial culture?	1-3	2.00±0.541	2.27±0.578	2.10±0.591
Q10: What is your general opinion of industry?	1-3	1.45±0.739	1.42±0.696	1.53±0.816
Q11: What do you think about the connection between industrial museums and the ecological environment?	1-3	1.48±0.671	1.28±0.555	1.40±0.591
Q13: Do you think environmental issues are sufficiently explained in this museum?	1-3	1.69±0.780	1.60±0.718	1.80±0.853

Table 3. Partial statistical results from visitor questionnaires. The score range corresponds to the minimum and maximum possible values. The score (which includes a margin of error) is the average value for all the answers. The lower the score, the more positive the answer. Source: authors.
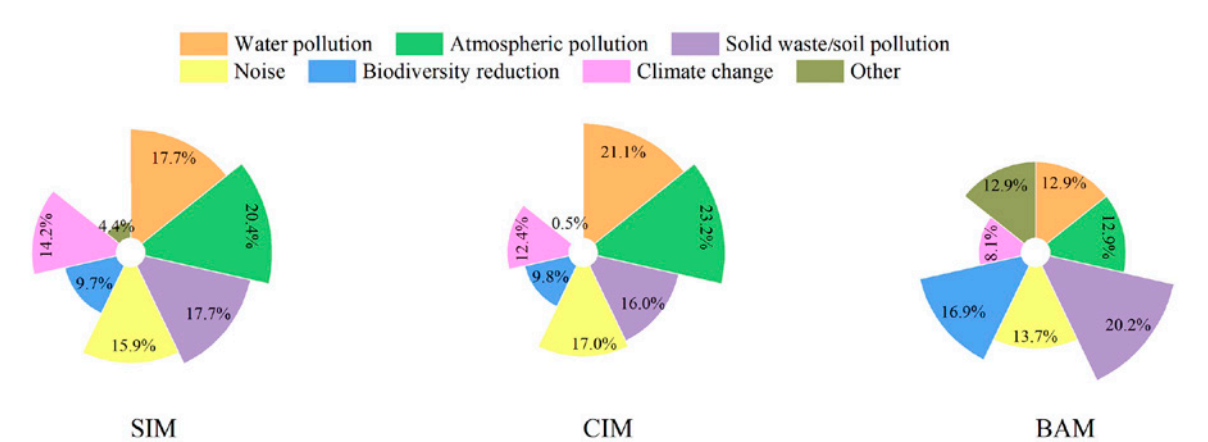
Main environmental problems addressed by sim, cim and bam, in the opinion of their visitors. Source: authors.

related to ecology and the environment to commemorate World Environment Day (A7), although this kind of action is not common. For the first time in 2023, a lecture on environmental education and the potential role of the museum in fighting climate change was offered to the general public in the framework of the International Museum Day, which was focused on «Museums, Sustainability and Wellbeing» (A5). Finally, in the aforementioned reform of the museum, it is planned to raise public funding to use renewable sources of energy with the installation of solar panels (A3).

sim's visitors are generally concerned about ecological and environmental issues, have an average knowledge of industrial culture, and show a positive perception of industry. Most

think that industrial museums should address environmental questions, and believe that sim does just that, especially regarding air, water, and soil pollution and solid waste (Table 3).

Chongqing Industrial Museum (cim)

cim is part of the wider Chongqing Industrial Culture Expo Park, whose construction started in 2015, but has not yet been completed. The museum is located in the former facilities of the Chongqing Iron & Steel (Group) Co Ltd (A8), which are surrounded by mountains and in front of the Yangtze River (see Liu, Yang, 2014). The museum includes an Industrial Heritage Park, a main exhibition, and an exhibition entitled Soul of Steel. As sim, cim is

Environmental displays and narratives (above) and integration of industry and nature (below) in CIM. Source: authors.
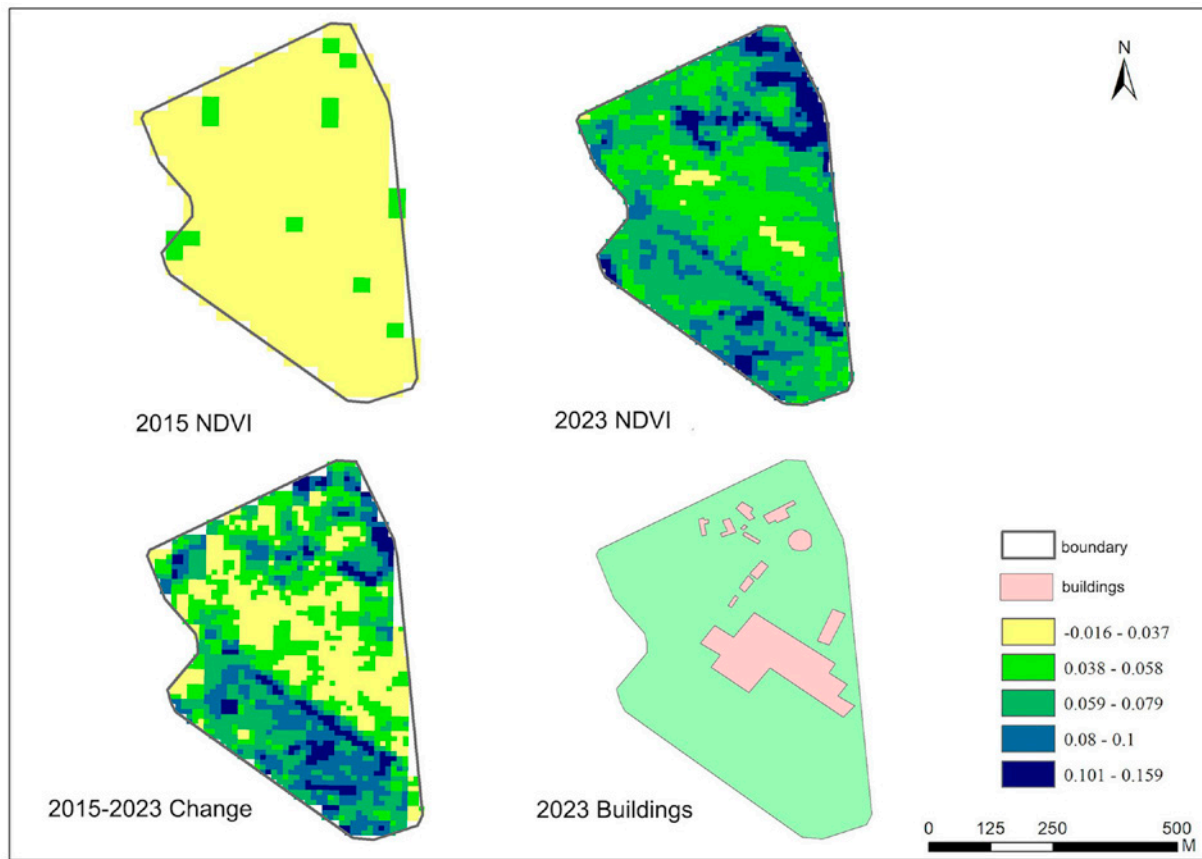
Renaturation (based on NDVI) of Chongqing Industrial Culture Expo Park. Source: authors, with data from Sentinel-2A.

a AAAA National Tourist Attraction and holds titles such as National Science Popularisation Education Base and Creative Industry Base.

CIM includes environmental narratives, materials and multimedia resources in its main exhibition, namely in the «Future – Emerging Industries» section (A2). The «New Industry» section covers topics such as energy saving and environmental protection industry, new sources of energy, and the intelligent automobile industry, among others, mostly focusing on the achievements accomplished in Chongqing municipality. On the other hand, we performed a Normalised Difference Vegetation Index (NDVI) analysis of the Chongqing Industrial Culture Expo Park, which revealed that the area has experienced significant reforestation since the development of the park and the museum, beginning in 2015 (A3).

As revealed by our questionnaires, CIM's visitors are very concerned about ecological and environmental issues, have a poor knowledge of industrial culture, and have a very positive perception of industry. The majority of them think that industrial museums should address environmental questions, and consider that CIM does it, especially regarding air, water and noise pollution.

Chemical Industry Museum of China (CIMC)

CIMC belongs to the China National Chemical Corporation Ltd (Sinochem, a leading state-owned enterprise in the sector) and is located within its headquarters. CIMC plans to renovate the museum's construction with environmentally-friendly materials (A3) and an environmental plan per conversations with museum staff on 3 March 2023 (A1). Yet this renewal project is still in the fundraising phase (according to personal communication

with the museum's staff on 1 November 2023). CIMC aims to preserve, study and exhibit the history and achievements of the Chinese chemical industry and promote chemistry literacy. The museum combines important efforts in science popularisation with the more market-oriented discourses characteristic of company museums (Gao, Liu, 2023). The main exhibition of CIMC is articulated into five halls: Ancient History, Modern History, Contemporary History, Chemical Industry, and Chemical Life Science.

Environmental and ecological contents are relatively common in the displays and discourses of the museum (A2), especially in the Contemporary History Hall (section «Pioneering the Future»), the Chemical Industry Hall (sections «Opening-up the Future» and «Future Development of Chemical Industry»), and the and Chemical Life Science Hall. For example, the museum provides information on recycling, air emissions, polluted water treatments, soil remediation, or energy saving and new sources of energy (e.g. batteries for electric vehicles) to promote a more sustainable chemical sector. The museum also explains via exhibitions international treaties on climate change such as the Montreal Protocol (1987) and the Kyoto Protocol (1997) making use of text from the treaties and supporting images. CIMC counts on a Health and Safety of the Environment Department (A4), which may explain why its environmental-related contents are much more prominent than in other industrial museums in China. The mission of this department is to contribute to the development of EC through environmental education. To do so, the museum works with primary and secondary schools (A5), for whom it offers several courses/workshops within two general programmes: «Plastics Make a New World» (focused on plastic consumption and disposal)

Environmental displays and discourses in CIMC. Source: authors.

and «Battling Water Pollution» (see Zhao and Liu, 2023).[11]

Beijing Auto Museum (BAM)

BAM occupies a brand-new building whose construction followed energy efficiency and other sustainable measures (A3). The building has the shape of an eye to symbolise the museum's spirit of «viewing the world and facing the future», as can be read on its website. The museum covers the history of the car industry in China and abroad from every possible angle, including industrial, technological, social, cultural, and ecological aspects. Its main narrative is chronologically arranged into the Halls of Innovation, Development, and Future, and is complemented by other exhibits. BAM is

an AAAA National Tourist Attraction and holds several titles, such as being a National Excellent Base for Popular Science Education and an Environmental Education Base.

Some environmental contents can be found in the Hall of the Future, namely in the section «Resource & Environment», which delves into energy consumption, polluting emissions, car scrapping and traffic congestion. Also included in this hall is the collection «Future Prospect» which explores subjects such as intelligent transportation, automotive recycling and reuse, and new energies in transportation (A2). BAM is often engaged with community activities around ecological and environmental themes (A7), such as the «Holding Hands with the Blue Sky, You and I Go Together» environmental photo contest or other related activities for Earth Day or World Environment Day. The museum also counts on a programme for environmental education oriented to primary and secondary schools (A5) (Hu, Gu, 2017).

11 http://www.chemmuseum.com/s/23631-66363-266985. html. [Accessed 24/10/2023]
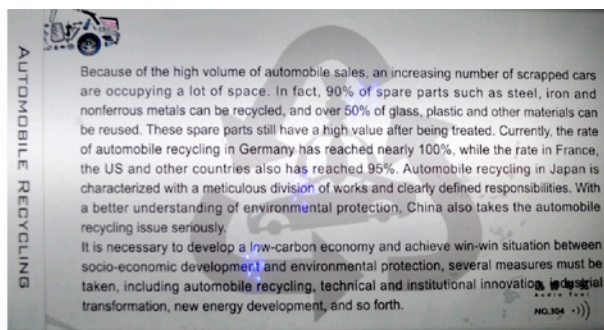
BAM and its Hall of Future. Source: authors.

BAM's visitors are not particularly concerned about ecological and environmental issues and have limited knowledge of industrial culture, and a rather positive perception of industry. While most of them think that industrial museums should address environmental questions, not all of them think BAM is doing enough. In their opinion, the more prominent environmental issues discussed in BAM are solid waste and soil pollution, biodiversity loss and noise pollution. While the latter sounds natural for a car museum, it is surprising that air pollution (12.9%) and climate change (8.1%) are not among the main issues identified by the visitors. All of this data reveals that the museum faces some problems in delivering its ecological discourses, in which air pollution and climate change play important roles. In our opinion, this is, in part, because a significant segment of the visitors is integrated by car fans or families with children who come mostly for leisure, as shown by our questionnaires and by the reviews posted on TripAdvisor[12] and Mafengwo[13] (a popular Chinese travel review platform).

FINDINGS AND DISCUSSION

In this section, we summarise the findings of our analyses and, together with the experience from our previous work (Cano-Sanchiz, Zhang, Lei, 2020; Long, Cano-Sanchiz, 2022), formulate some overarching generalisations. After that, we define the particularities of the Chinese industrial museums' environmental discourses, which we frame into the EC scheme. Finally, we highlight the value of environmental education while defending the potential contribution of industrial museums to fighting climate change.

12 https://www.tripadvisor.com/Attraction_Review-g294212-d4097173-Reviews-Beijing_Automobile_Museum-Beijing.html. [Accessed 24/10/2023]
13 https://www.mafengwo.cn/poi/22071.html.   [Accessed 24/10/2023]

The findings of this research conclude that industrial museums in China are undergoing an ecological turn. Most of the environmental actions identified in the British industrial museums can be found in their Chinese counterparts (Table 4). Environmental content is present in all the museums' exhibitions and discourses (A2), usually reproducing EC narratives. The second strongest action among the case studies is eco-friendly construction (A3). In our opinion, this is at least in part because all of them were constructed in the 2010s and thus designed in a context of growing concerns about the environment in the construction sector. In relation to this, the recycling of architecture (A8) is performed when appropriate facilities are available. Even though only half of the case studies reused former industrial facilities, this is relatively common in the industrial museums in China– e.g. China Railway Museum in Beijing, Jingdezhen Ceramic Industry Heritage Museum, Hubei Cement Site Museum in Huangshi, Tsingtao Beer Museum in Qingdao, etc. Other actions have already appeared in the Chinese industrial museums, but they need to be further developed. Among them are environmental education (A5), which is often concentrated on young audiences, especially school groups; and more general activities addressed to the wider public (A7), which are not available in CIM and CIMC. Finally, this research has found some weak points in the ecological turn of the Chinese industrial museums when compared to the British model. The existence of green teams (A4) and environmental plans and policies (A1) are rare, while research-oriented academic activities (A6) about ecological or environmental issues have not been developed in the case studies yet. Our findings show that the museums analysed in this article are performing the ecological turn at a moderate rate, with CIM lagging slightly behind SIM, CIMC and BAM.

The results of the visitor survey show that, even though the industrial culture literacy of the average visitor is not particularly high, most of them (especially in Beijing) believe that the impacts of industry on people's lives are more positive than detrimental. From our perspective, and within the museum context, this is a result of the narratives of progress and development often displayed in Chinese industrial museums. Still, the reception of environmental narratives by visitors is relatively high, with only 13.91% of them ignoring them,

Environmental action	SIM	CIM	CIMC	BAM	%
A1: Environmental plans and policies	0	0	1	0	12,5
A2: Exhibitions design and museum discourses	2	2	2	2	100
A3: Eco-friendly construction	1	2	1	2	75
A4: Green Teams	0	0	2	0	25
A5: Educational activities	1	0	2	2	62,5
A6: Academic activities	0	0	0	0	0
A7: Community activities	2	0	0	2	50
A8: Adaptive reuse	2	2	0	0	50
Average score (%)	50	37	50	50	-

Table 4. Environmental actions in Chinese industrial museums. Key: 0 = no action; 1 = planned action; 2 = executed action. In the percentages, executed actions weigh double than planned actions. Source: authors.

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while 62.61% of visitors think that industrial museums paid proper attention to addressing environmental problems and displaying information about how to solve them.

The qualitative analysis qualifies some of these interpretations, which we shall discuss within the wider framework of the EC project (see Wang, Cui, 2011; Hansen, Li, Svarverud, 2018; Wei *et al.*, 2021; and Weins *et al.*, 2023 for further analysis and discussion on the subject) to define some differences in the Chinese industrial museums' ecological turn. The concept of EC is not exclusive to China (Gare, 2016; Clayton, Schwartz, 2019), but in the 21st century, it has acquired new dimensions there. In 2007, EC (*shēngtài wénmíng* 生态文明) was mentioned by President Hu Jintao as a long-term strategy to balance economic development and environmental protection. Later, and fostered by President Xi Jinping, EC went deeper into Chinese institutions and policies, entering the Constitution in 2018 as one of the five major pillars for the development and modernisation of the country (Wei *et al.*, 2021; Weins *et al.*, 2023: 8). Today, EC is a holistic scheme that envisions a shared global future for all living beings (Hansen, Li, Svarverud, 2018). For Weins *et al.* (2023: 6), the EC scheme reveals distinct Chinese characteristics and some nuances when compared to the SDGs and Western environmental paradigms, but China's EC project is understood as an international, collaborative task (Wang, Cui, 2011). Besides, in the Chinese context, the SDGs are framed within the wider EC. All in all, EC's final goal is «neither to control nor conquer nature, but rather to adhere to its rules and rhythms in order to realise shared prosperity» (Weins *et al.*, 2023: 9).

Environmental materials in Chinese industrial museums are often related to EC discourses, even though EC is not always explicitly mentioned. This sets an important difference in regards to the British (and Western) model, which is generally driven by SDGs. The EC approach influences the nature and roles of the environmental contents in the Chinese industrial museums. They are usually integrated into the last chapter of their narratives due to, among other reasons, that these contents are very future-oriented and Chinese industrial museums typically offer chronologically arranged discourses. In such narratives, the EC is presented as transformative and modernising, but also as a continuation into the future of a millenary Chinese civilization that has gone through three major stages: the Agricultural Civilization, the Industrial Civilization and the Ecological Civilization (Weins, 2023: 10). In this framework, environmental contents are related to present or future industrial developments rather than to a critique of the environmental consequences of past industries. Explanations on new materials and sources of energy, recycling technologies, residue processing plants and so on are used to support the presentation of the country's ongoing projects and its major environmental goals, such as achieving carbon neutrality before 2060 (Mallapaty, 2020).

Finally, we claim that industrial museums must be assigned the responsibility of contributing to fighting climate change. The current climate crisis is, to a great extent, a result of industrialisation and cannot be ignored in industrial museums' exhibitions and narratives. The museums' contribution can be materialised through the environmental actions identified in this article, which can be

categorised into two main groups: sustainable development and environmental education. Here we focus on the latter.

Environmental education has received enough academic attention since the *Tbilisi Declaration* was issued during the first intergovernmental conference on the subject organised by UNESCO in 1977 (Reid, Dillon, 2005; Stevenson *et al.*, 2013; Ardoin, Bowers, Gaillard, 2020). In China, it is generally understood as a process that disseminates basic knowledge of the environment to improve society's ecological literacy, promotes sustainable development in the long term, and builds awareness of the EC (Cui, 2007). Our survey reveals that some visitors are not fully aware of the seriousness of the climate crisis and its close ties with industrialisation, especially in southern China. There are several reasons to explain this fact, but here we focus on the museum context. First, even though most industrial museums include some environmental content, this is still a minor topic when compared to the museums' main narratives on national history and progress and development. As a consequence, the museums usually grant more space to celebrate the benefits of industrialisation than to explore its negative sides. Second, environmental content is habitually presented through graphics, text, photos and models, while real artefacts and multimedia or interactive resources are less used. Even though our visitor survey points out that most of them react to the ecological narratives of the museums, we consider that the medium used to display these narratives, and the fact that they are often encountered at the end of the visit, reduce the capacity of the museums to deliver environmental messages, especially considering that young audiences are prominent. Wider explanations

of environmental and ecological issues backed by more diverse media and real artefacts might be more effective in engaging the public in fighting climate change and pursuing sustainability.

We think industrial museums in China are well-positioned to develop this different task because their educational function is particularly strong (see Long, 2023), with 75% of our case studies entrusted as official national educational bases. Still, environmental education needs to gain traction. Compared to other topics, such as science popularisation and patriotic education, environmental education has little weight in industrial museums, although there are exceptions (CIMC or BAM, for example). As institutions displaying official discourses, we believe that industrial museums can be platforms to inform visitors about the negative consequences of industrialisation, raise awareness of the dimension of the problem, fight misinformation, and provide society with knowledge and tools to fulfil its share in tackling the climate crisis. Involving the public in environmental policies in other contexts has produced good results in China, for example in improving solid waste sorting (Wang *et al.*, 2022) and reducing air pollution (Nature Geoscience, 2019; Feng *et al.*, 2023). Thus, we believe that industrial museums can play a significant role in achieving sustainable development and fulfilling the EC goals if they help to educate society to do so.

CONCLUSION

This research reveals that industrial museums in China are developing an ecological turn aligned with the global transformation of the museum sector in the pursuit of sustainability.

We maintain that Britain constitutes a model to follow in this regard. Compared to the British case, we conclude that the ecological turn of industrial museums in China is developing at a moderate rate. While some positive changes can be observed, some actions need to be strengthened, such as the inclusion of green teams in the museums or more academic, educational and community activities and contents delving into ecological and environmental themes. Our study has also revealed that the Chinese ecological turn has some particularities. The most prominent one is that the ecological turn of the Chinese industrial museum is modelled by the EC paradigm (although such a paradigm integrates the SDGS), which combines global cooperation and Chinese characteristics. Beyond regional differences, we argue that the current climate crisis is inseparable from modern industrialisation and as such, industrial museums must adopt a responsible position about it. We champion the ecological turn of the industrial museums, which can become models to follow in sustainable planning and development, and relevant educational centres to improve the environmental literacy of society and engage it in building a more ecological and sustainable world.

References

ARDOIN, Nicole; BOWERS, Alison & Estelle GAILLARD (2020) «Environmental education outcomes for conservation: a systematic review», *Biological Conservation*, 241: 108224. https://doi.org/10.1016/j.biocon.2019.108224

BERGER, Stefan (2019) «Industrial heritage and the ambiguities of nostalgia for an industrial past in the Ruhr Valley, Germany», *Labor*, 16.1: 36-64. https://doi.org/10.1215/15476715-7269314

CANO-SANCHIZ, Juan Manuel; ZHANG, Ruijie & Lifang LEI (2020) «The Image of Railways in China: Museums, Technology and Narratives of Progress», *The Historic Environment: Policy & Practice*, 11.2-3: 258-281. https://doi.org/10.1080/17567505.2020.1737312

CLAYTON, Philip & Andrew SCHWARTZ (2019) *What is Ecological Civilization?: Crisis, hope, and the future of the planet*, Anoka: Process Century Press.

CORDEIRO, José Manuel Lopes & Ronaldo André Rodrigues da SILVA (2023) «Nizhny Tagil y la Agenda 2030, el pasado material y el futuro sostenible: una propuesta para alineación de acciones y objetivos» en ÁLVAREZ ARECES, Miguel Ángel (ed.) (2023) *Un futuro para nuestro pasado*, Gijón: CICEES.

CUI, Jianxia (2007) «Environmental education: origin, content and purpose», *Journal of Shandong University (Philosophy and Social Science edition)*, 4: 147-153. (In Chinese)

DAVIS, Joy (2020) «Museums and climate action: a special issue of Museum Management and Curatorship», *Museum Management and Curatorship*, 35.6: 584-586. https://doi.org/10.1080/09647775.2020.1842235

FAULL, Margaret (ed.) (2011) *Heat-pump technology using minewater*, Wakefield: National Coal Mining Museum for England.

FENG, Yueyi *et al.* (2022) «Developing China's roadmap for air quality improvement: a review on technology development and future prospects», *Journal of Environmental Sciences*, 123: 510-521. https://doi.org/10.1016/j.jes.2022.10.028

GAO, Xingtang & Zitang LIU (2023) «Push the wall into the market, innovation and integration embracing the future. A little thought on the future market-oriented operation of China National Chemical Museum», *Cultural Relics World*, 379.01: 86-88. (In Chinese)

GARE, Arran (2016) *The philosophical foundations of Ecological Civilization: a manifesto for the future*, London: Routledge.

HANSEN, Mette Halskov; LI, Hongtao & Rune SVARVERUD (2018) «Ecological Civilization: interpreting the Chinese past, projecting global future», *Global Environmental Change*, 53.7: 195-203. https://doi.org/10.1016/j.gloenvcha.2018.09.014

HAO, Juan (2011) «Museums and Environmental Education», *Hakka Literature Museum*, 1: 51-57. (In Chinese)

HU, Keyi & Zhanfeng GU (2017) «Holding hands with the blue sky. You and me together. Environmental photography ceremony in Beijing Automobile Museum», in *Sohu*. Available at https://www.sohu.com/a/147221191_386897 [Accessed 15/11/2023] (In Chinese)

ICOM (2022) «Museum definition», in *International Council of Museums*. Available at https://icom.museum/en/resources/standards-guidelines/museum-definition/ [Accessed 21/08/2023]

JIANG, Shan & Aiguo HU (2018) «The research value of environmental history in industrial museums. The industrial museum of Westphalia, Germany as an Example», *Poyang Lake Journal*, 55.4: 119-124+128. (In Chinese)

LIU, Boying & Boyin YANG (2014) «Conceptual planning and architectural design of Chongqing Industrial Museum», *Industrial Construction*, 44.9: 1-6. (In Chinese). https://doi.org/10.13204/j.gyjz201409001

LONG, Lan (2023) *The educational role of the Chinese industrial museums. Evaluations and recommendations based on the case of Beijing*, master's thesis, Beijing: University of Science and Technology Beijing. (In Chinese)

LONG, Lan & Juan Manuel CANO-SANCHIZ (2022) «Industrial Museums with Chinese Characteristics: Theories and Practices», *Museum Management and Curatorship*, 39.2: 149-168. https://doi.org/10.1080/09647775.2022.2158912

MAGALHÃES, Gildo (2012) «Usinas hidroelétricas como patrimônio histórico e ambiental», in OLIVEIRA, Eduardo Romero; MENEGUELLO, Cristina e Silvio OKSMAN (orgs.) (2012) *Patrimônio industrial na atualidade. Algumas questões*, São Paulo: Cultura Acadêmica, 69-88.

MALLAPATY, Smirti (2020) «How China could be carbon neutral by mid-century», *Nature*, 586: 482-483. https://doi.org/10.1038/d41586-020-02927-9

McDOWALL, Georgina (2019) *From information to imagination: the role of museums in tackling climate change*, master's thesis, Amsterdam: University of Amsterdam.

MERRIMAN, Nick (ed.) (2024) *Museums and the climate crisis*, Abingdon and New York: Routledge.

NATURE GEOSCIENCE (2019) «Cleaner air for China», *Nature Geoscience*, 12: 497. https://doi.org/10.1038/s41561-019-0406-7

NASA (2023) «NASA Confirms July 2023 is Warmest Month on Record», in *NASA's Goddard Space Flight Centre*. Available at https://svs.gsfc.nasa.gov/14396#section_credits [Accessed 15/01/2024]

QUIVIK, Fredric (2022) «Butte and Anaconda, Montana. Industrial waste as industrial heritage», in CASELLA, Eleanor; NEVELL, Michael & H. STEYNE (eds.) (2022) *The Oxford Handbook of Industrial Archaeology*, Oxford: Oxford University Press, 341-356.

REID, Alan & Justin DILLON (eds.) (2005) *Environmental education*, London: Routledge.

RUUD, Lise & Erik THORSTENSEN (2022) «"We must all be ready for major changes": visiting *climate for change* at the Norwegian Petroleum Museum», *Journal of Educational Media, Memory and Society*, 14.1: 55-75. https://doi.org/10.3167/jemms.2022.140104

TEMPEL, Norbert (2012) «Post-industrial landscapes», in DOUET, James (ed.) (2012) *Industrial heritage re-tooled*, Lancaster: Routledge, 142-148.

REES, Morien (2017) «Museums as catalysts for change», *Nature Climate Change*, 7: 166-167. https://doi.org/10.1038/nclimate3237

STEVENSON, Robert *et al.* (eds.) (2013) *International handbook of research on environmental education*, London: Routledge.

SVETOSLAVOVA, Mirela & Bartosz WALCZAK (2023) «The revitalization of brownfields for shaping the urban identity and fighting climate change», *Builder*, 8.313: 48-52. https://doi.org/10.5604/01.3001.0053.7585

SOARES, José & José Manuel Lopes CORDEIRO (2023) «Bad smell for business? Industrial pollution and environmental consequences in River Ave (1892-1974)». Paper presented at the *48th Economic and Business History Society Conference*, Porto, Portugal, May 2023.

SUN, Xiufeng *et al.* (2018) «China's progress towards sustainable land development and Ecological Civilization», *Landscape Ecology*, 33: 1647-1653. https://doi.org/10.1007/s10980-018-0706-0

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Stewart, Haeden (2022) «The ecological life of industrial waste», *Archaeological Papers of the American Anthropological Association*, 33: 91-105. https://doi.org/10.1111/apaa.12159

Stuart, Iain (2010) «Industrial nature and the green heritage of mining at Broken Hill, Australia», *Industrial Patrimony*, 23: 53-62.

Wang, Shuming & Lu Cui (2011) «Opportunities for moving from Industrial Civilisation to Ecological Civilisation. Philosophical reflections on the climate crisis», *Studies in Dialectics of Nature*, 27.5: 96-101. (In Chinese) https://doi.org/10.19484/j.cnki.1000-8934.2011.05.018

Wang, Yao *et al.* (2021) «Implementation effect of municipal solid waste mandatory sorting policy in Shanghai», *Journal of Environmental Management*, 298: 113512. https://doi.org/10.1016/j.jenvman.2021.113512

Watson, Mark (2012) «Adaptive re-use and embodied energy», in Douet, James (ed.) (2012) *Industrial heritage re-tooled*, Lancaster: Routledge, 136-141.

Wei, Fuwen *et al.* (2021) «Ecological Civilization: China's effort to build a shared future for all life on Earth», *National Science Review*, 8.7: nwaa279. https://doi.org/10.1093/nsr/nwaa279

Weins, Niklas *et al.* (2023) «Ecological Civilization in the making: the 'construction' of China's climate-forestry nexus», *Environmental Sociology*, 9.1: 6-10. https://doi.org/10.1080/23251042.2022.2124623

wmo (2023) *State of the global climate 2022* (wmo-No1 1316), Geneva: World Meteorological Organisation.

Zhao, Li & Zhirou Liu (2023) «Exploring the design of science education activities for primary and secondary schools using museum resources. The narrative of science education activities of the China National Chemical Industry Museum as an example», *Cultural Relics World*, 3791: 77-82. (In Chinese)

Zhu, Yan (2021) «Ecological environmental education for youth based on the cooperation between museums and schools. The case of Shanghai Wusong Industrial Zone Exhibition Hall», *Science Education and Museums*, 7.2: 149-152. (In Chinese) https://doi.org/10.16703/j.cnki.31-2111/n.2021.02.013

Data Availability Statement

The authors confirm that the data supporting the findings of this study is available within the article and its supplementary materials at https://zenodo.org/doi/10.5281/zenodo.10129277 . Personal communication with curators and museum staff is not shared for privacy reasons, but additional information can be provided upon reasonable request.