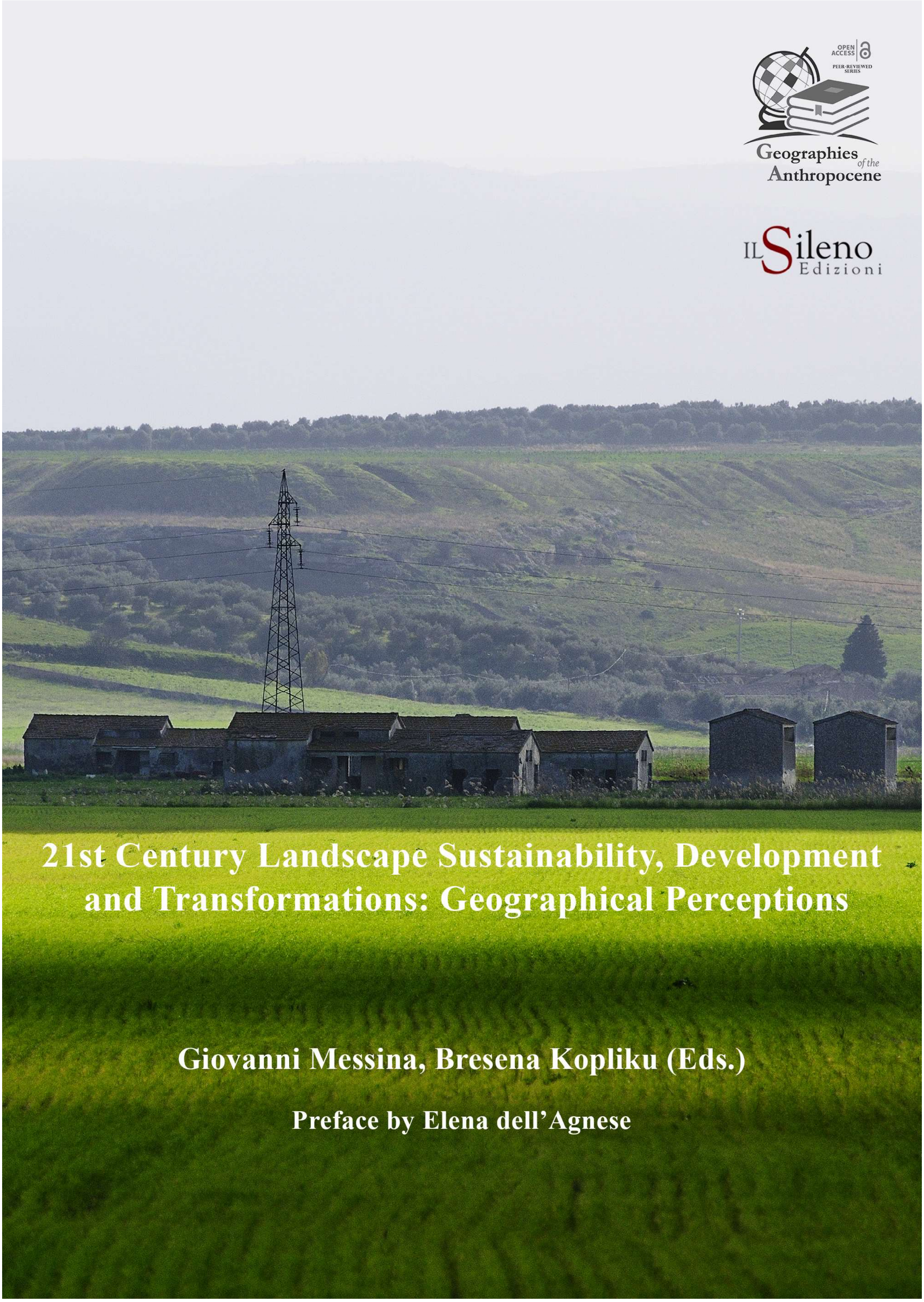

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Geographies of the Anthropocene

IL Sileno Edizioni

21st Century Landscape Sustainability, Development and Transformations: Geographical Perceptions

Giovanni Messina, Bresena Kopliku (Eds.)

Preface by Elena dell'Agnese

21st Century Landscape Sustainability, Development and Transformations: Geographical Perceptions

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The book series "Geographies of the Anthropocene" edited by the Scientific International Publisher "Il Sileno" (Il Sileno Edizioni) will discuss the new processes of the Anthropocene epoch through the various worldviews of geoscientists and humanists, intersecting disciplines of Geosciences, Geography, Geoethics, Philosophy, Socio-Anthropology, Sociology of Environment and Territory, Psychology, Economics, Environmental Humanities and cognate disciplines.

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Preface

Dealing with the sustainability of cultural landscapes seems to be a challenge today. Cultural landscapes, as Carl Sauer (1925) wrote, are nothing more than the phenomenologically observable expression of the relationship between humanity, understood as a social system, and the context in which it moves, lives, prospers, decays, and dies.

The examples of transformation are innumerable, and it is certainly not easy to account for them, as is attempted in this volume, which articulates its research questions in a series of spatial and transcalar perspectives. Thus, the book begins by considering landscape features as symptoms of decline and change, then moves on to talk about neighborhoods that need to be revalued and capitalized, then to consider regional spaces, and finally it broadens its gaze to global perspectives of contrasts and growth differentials that are in danger of being exacerbated, rather than mitigated, by technological change, which casts sometimes its negative fallout (its waste) on the poorest and most marginal spaces.

Within this articulated framework, the Mediterranean Fair (Palermo) becomes a visible symptom of the crisis in the economy that made it necessary, or at least useful, a crisis made even more explicit by the advent of the pandemic, and also of the end of "a Mediterranean productive dream," as the authors of the contribution write. A similar crisis of a system that wanted to focus on productive development at all costs is manifested in Taranto, again through a landscape of abandonment and ruins. Reinventing functions to the territory, which are expressed through the landscape, or recovering its history, therefore becomes essential. Beyond the urban landscape, which needs to be reinvented or heritagized, the rural landscape also presents significant challenges, which can be addressed, also in this case, by processes of patrimonialization, as it is happening in the rural spaces of the island of Salina, or in the Etna Nord wine "district".

If society changes, and consequently the territory and the landscape that are its expression change, the way of looking at the landscape, framing views of it, and examining and disseminating particular aspects of it can also change. A university degree can certainly play a role in changing your attitude towards changes, as demonstrated in the chapter about students enrolled in different courses a t the University of Turin and their attitude towards climate change. But even the way you look at the landscape can play a role. New media become a way to emphasize certain aspects of daily life (the bakeries), and a tool for "mediatizating" nature. Tourism landscapes may be enhanced by social media, be revitalized by a process of patrimonialization thanks to them, or simply be discovered/rediscovered (such as the cases of Magna Grecia Park, in Crotone, or of Sicilia Archeologica). Platforms can play a relevant role in changing the urban landscape, as in Tirana, as the digital transition, in general, can do, albeit with a different velocity in different contexts, with the risk of increasing, instead of bridging, geographical gaps (and of producing a big amount of E-waste, which difficult disposal is likely to fall precisely where the benefits of transition are least, and where development and transformation not always go hand in hand).

So, from the urban scale of a single urban item, albeit quite big, such as the Fiera del Mediterraneo in Palermo, we ended up reasoning about Africa, and of the consequences on the territory (and on the landscape) of the digital transition. Society changes, and its cultural landscape as well.

At all levels, and at all scales.

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Geographical analysis of WEEE (Waste Electrical and Electronic Equipment) dynamics

Alberto Corbino; Stefano De Falco

Geographical analysis of WEEE (Waste Electrical and Electronic Equipment) dynamics

Alberto Corbino; Stefano De Falco[1]

Abstract

WEEE (Waste Electrical and Electronic Equipment) is one of the global rising problems due to its increasing volume in association with health and environmental hazards occurring where the disposal happens. Most WEEE is currently generated by the Organization for Economic Cooperation and Development (OECD) countries; nevertheless, all the studies suggest that developing countries will be producing a double amount of WEEE than the developed ones within the next 6–8 years.
In this framework this paper explores and accounts the status-quo of WEEE generation and handling situation in different countries, analyzing their impact on public health and environment.

Keywords: ***WEEE, Green and Digital Transition, Circular Economy.***

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1. Introduction

The 'twin' green and digital transitions are at the top of the political agenda of the EU and other organizations of states, as, among the others, recalled by the African Union 2063 Agenda[2], in the ASEAN[3] Digital Masterplan 2025 and in the EU_LAC Digital Alliance[4].

The EU roadmap is increasingly cited as a virtuous example of dynamics to be pursued; yet at any geographical scale (Corbino et al., 2023) it can contribute to increasing, instead of bridging, geographical gaps, due to the positive impacts they often produce only in some areas and the negative impacts in others. This paradox concerns all the phases of the production process: the extraction of raw materials with significant negative socio-environmental impacts and external diseconomies in developing countries; higher energy consumption, largely due to energy-intensive processes related to ICTs[5]; lack or inefficiency of waste disposal procedures, that are still very distant from that virtuous model of circular economy often referred to in the above-mentioned inter-governmental programs.

Among the risks included in the development of the green and digital transition trajectories, the enormous volumes of electronic waste (WEEE or E-waste) that are being generated must be taken in serious consideration. This includes the waste of secondary raw materials contained within them, such as precious metals (PM) and rare earth metals (REM) (Olanrewaju et al., 2021). Up to 60 elements can be found in some EEE; materials such as plastics, precious metals (PMs) and rare earth metals (REEs) are commonly used to produce these products (ibidem). It is calculated that, in an efficient circular economy scenario, only in West Asia from 2020 to 2050, an estimated total of 130 t of gold, 5 t of rare earth metals, 17 Mt of iron and steel, 1.5 Mt of copper, and 2.6 Mt of aluminum could be recycled.

This is why the informal sector is more active in disposing E-waste

[2] It is recalled by the Goals n. 2 & 7 of AGENDA 2063, that is "Africa's blueprint and master, the continent's strategic framework that aims to deliver on its goal for inclusive and sustainable development and is a concrete manifestation of the pan-African drive for unity, self-determination, freedom, progress and collective prosperity". For further info: https://au.int/agenda2063/goals.

[3] ASEAN – The Association of South Asia Nations, include ten countries today.

[4] The European Union-Latin America and Caribbean Digital Alliance was launched in March 2023; it aims to foster the development of secure, resilient and human-centric digital infrastructures based on a values-based framework, ensuring a democratic and transparent enabling environment and putting a strong emphasis on privacy and digital rights.

[5] ICTS are currently responsible for 5-9% of the world's global electricity consumption (source: EU – JRC, 14/07/22 news announcement).

throughout the world: the workers involved (even children) perform crude activities without appropriate recycling facilities and are highly exposed to dangerous and unhealthy conditions (Dutta and Goel, 2021). The infamous e-waste 'recycling' sites in Agbogbloshie, Ghana and Guiyu, China are extreme examples of improper e-waste recycling that result in severe air, water, and soil pollution (Parajuly, 2019). The main health problems arising from WEEE are due to the presence of toxic substances and due to the non-biodegradability of these devices. If dispersed into the environment, certain components of WEEE can generate significant impacts on the environment and human health. In fact, these substances, if not carefully treated and disposed of, can generate acute and chronic effects on living organisms, often including irreversible damage. Health topic is currently more and more analyzed in the scientific debate. In fact, an analysis of the literature review through VosViewer software, using the keywords "WEEE" and "Health", generates a series of interconnected clusters, that shows a close relationship between the two themes (**Figure 1**).

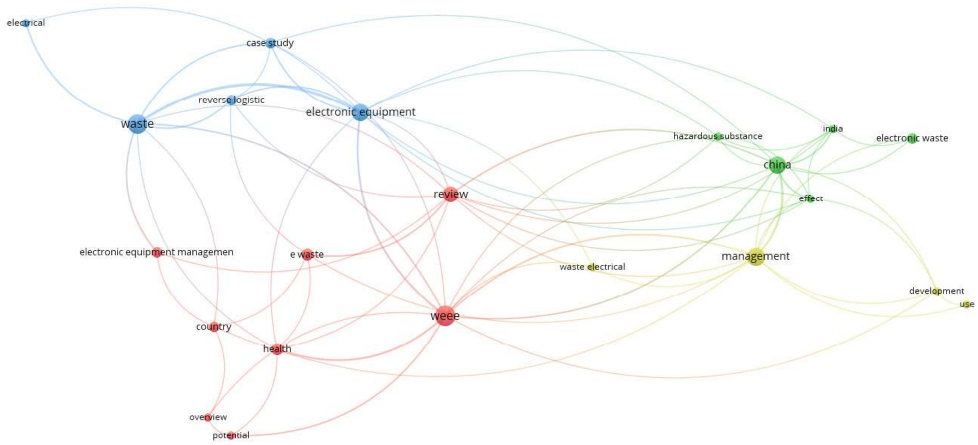

Fig. 1 Vos Viewer analysis. Source: authors' elaboration on Web of Science.

WEEE are defined by the Technical Guidelines of the "Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal[6]" as "electrical and electronic equipment that is waste,

[6] Adopted on 22 March 1989 and entered into force on 5 May 1992. It was adopted by decision III/1 of the Third meeting of the Conference of the Parties. The so called "Ban Amendment" provides for the prohibition by each Party included in the proposed new Annex VII to the

including all components, sub-assemblies and consumables that are part of the equipment at the time the equipment becomes waste". E-waste encompasses a wide variety of discarded products and in the European Union, according to the (WEEE) Directive 2012/19/EU[7], it's classified into six main categories: Temperature Exchange Equipment, Screens and Monitors, Lamps, Small Equipment, Large Equipment (incl. PV panels), Small IT and Telecommunication Equipment. For statistical purposes, however, WEEE is classified by similar function, comparable material composition, average weight, and similar end-of-life attributes; the UNUKEYs, the E-waste Statistics Guidelines on Classification Reporting and Indicators therefore divide EEE into 54 different product-centric categories (Forti *et al.*, 2018).

At a global scale, it is estimated that the amount of WEEE is approximately 18% of the world's total urban waste in 2020 with 3–5% increasing each year (Liu *et al.*, 2020).

A significant indicator of the growth of this worrying, yet little considered issue, is the extent of ICT's penetration into people's everyday lives. If we look, for instance, at the relationship between digital and finance in Sub-Saharan Africa (SSA), a region - in people's imagination – surely not among the most innovative, we find out that here the number of mobile money agent outlets has increased significantly, from almost zero in 2008 to more than 38.000 in 2018, on average in each country. Moreover, here the number of mobile money accounts now exceeds the number of traditional deposit accounts, with 21 percent of adults in the region having a mobile money account, and mobile-money transactions more than tripled from an average of 8 percent of GDP in 2014 to 25 percent in 2018, making SSA a leading region in the world (IMF, 2020).

In response to this ICT devices proliferation, some recycling targets have been set. For instance, article 7 of the abovementioned EU - WEEE Directive states that the minimum collection rate to be achieved annually by a member State shall be 65% of the average weight of electrical and electronic

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Convention (Parties and other States which are members of the OECD, EC, Liechtenstein) of: all transboundary movements to States not included in Annex VII of hazardous wastes covered by the Convention that are intended for final disposal, and; all transboundary movements to States not included in Annex VII of hazardous wastes covered by paragraph 1 (a) of Article 1 of the Convention that are destined for reuse, recycling or recovery operations. The text has been subject to various amendments since its adoption. A full text is available here: https://www.basel.int/TheConvention/Overview/TextoftheConvention/tabid/1275/Default.aspx

[7] Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE).

equipment (EEE) placed on the market (POM) in the three preceding years or, alternatively, 85% of WEEE generated on the territory of a member state. As we will show in this chapter, most EU countries are very far from this objective, although some of them constitute the benchmark at a world level.

As a confirmation of the complex scenario described above, the document produced by the European Commission regarding the warning on the risks connected to the EU objectives entitled "Strategic Forecast Report 2022: twinning the green and digital transitions in the new geopolitical context" can be really enlightening. In fact, it is stated that the greater progressive use of digital technologies could increase the volume of electronic E-waste produced up to 75MT by 2030, causing a larger environmental impact. In the EU, now, only 17,4% of WEEE is adequately treated and recycled, while the production of electronic waste is increasing every year by 2,5MT in the twenty-seven Member States.

The notion of a just transition, i.e. not unfair in the impacts it generates, despite being aimed at a sustainable technological/digital evolution, is becoming increasingly common among professionals. Nevertheless, however, WEEE disposal is still characterized by low efficiency especially in the transformation from waste to resource, thus leading to problems of accumulation and disposal of electronic waste. The solution to this drift is becoming, in the short term, that of exporting this waste to other destinations which, for a series of geopolitical reasons, are willing to accept WEEE flows within their borders. According to Ibitz (2012), several Asian countries have allowed e-waste imports, to obtain raw materials for their domestic production of electronic goods. The flows of materials from one country to another, in fact, are not only regulated by specific inter or intra-country agreements, but rather triggered by "market reasons" such as, for example, the generation of employment, the differences between income communities, etc. (Estrada-Ayub and Kahhat, 2014). Kusch and Hills (2017) examined the relationship between e-waste and GDP in countries in the pan-European region and found evidence of a strong linear relationship between economic development and e-waste generation. Lepawsky and McNabb (2010) who first investigated the dynamics related to e-waste trade flows, using exports and imports data at different time intervals, supported the hypothesis that rich countries are more likely to export rather than import E-waste, also reproducing vicious circles in North-South differentials for electronic waste. The main generators of electronic waste per inhabitant are North America and Europe, which export the largest percentage to developing countries. China, in absolute terms, is the second largest generator of e-waste after the United States. The enclave constituted by Taiwan, where the concentration of the electronics industry (especially microchips) is very high, generates very intense volumes of electronic waste, which for the most part is exported also and above all to China, where materials, classified as dangerous waste in Taiwan, are considered recyclable.

The practice of exporting electronic waste conflicts with the aforementioned Basel Convention which requires participating countries to dispose waste as quickly as possible and as close as possible to the source of production (Wirth, 1996). This ban is also proposed in the Bamako convention[8]. But, as Robinson (2009) argues, exporting countries often violate international treaties regarding the transportation of hazardous electronic waste. From the perspective of WEEE exporters, Tong (2004) examined the cross-border movement of e-waste and argued that it is driven by two forces: (i) disassembly of discarded electronic products is labor-intensive, and low-added-value and (ii) exporting countries' compliance with environmental regulations may increase the cost of disposal.

In figure 2 the distribution of the quantities of WEEE generated and recycled in OECD countries, and in figure 3 the histogram relating to the percentage distribution of the ratio between the two previous quantities are shown.

[8] The Bamako Convention is a treaty of African nations prohibiting the import into Africa of any hazardous (including radioactive) waste. It was negotiated in 1991 and it came into force in 1998.

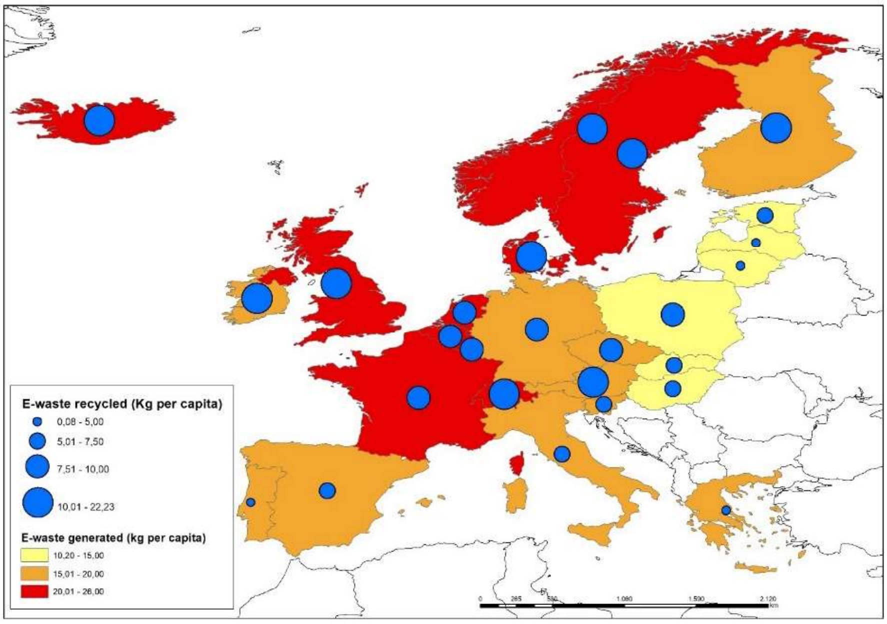

Fig. 2 E-waste generated, and E-waste recycled or reused in European OECD countries Source: authors' elaboration on Global E-waste Monitor 2022.

Switzerland stands as the champion (over 90%) of the so-called *urban mining*, that is the ability to "find" precious metals in urban waste. One of the reasons for this success is that an advance recycling fee paid by consumers finances the recycling procedure[9] (Kamasa, 2023).

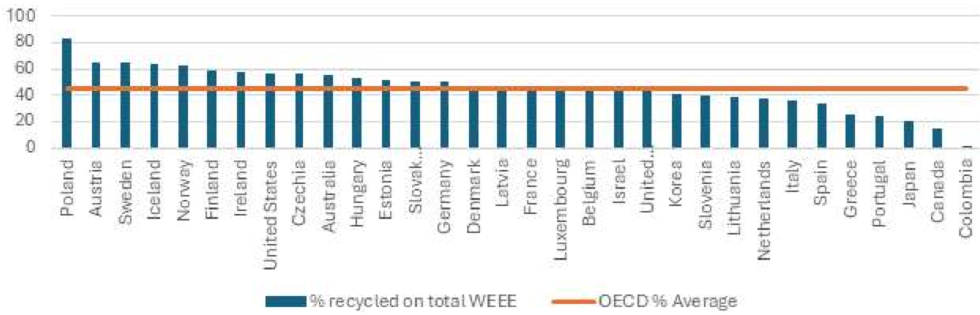

Fig. 3 % recycled on total WEEE for some OECD countries - 2019. Source: Authors' elaboration on Global E-waste Monitor 2022.

[9] In 1998, of the ORDEE - "Ordinance on the Return, Taking Back and Disposal of Electrical and Electronic Equipment", was introduced, imposing on consumers the so-called "advance recycling fee" on domestically bought electronics. In return, the consumers can bring back used electronics free of charge and manufacturers, importers, and retailers must take care of the disposal and recycling by regulation.

2. Geographic analysis of WEEE flows

The SCYCLE program of the United Nations Institute for Training and Research (UNITAR) has established a global WEEE monitoring system. The researchers collected all possible data from the Basel Convention, trade statistics and literature, compiling the first Global Transboundary E-waste Flows Monitor. The report is the first attempt to track cross-border flows of e-waste, to understand where it goes and what impact it has on communities and ecosystems.

WTO has calculated that nearly 13 million women and 18 million children work in e-waste processing informally, exposed to toxic chemicals. These include lead, mercury, nickel, brominated flame retardants and polycyclic aromatic hydrocarbons. Naturally, these impacts are concentrated in the global South, a veritable WEEE "landfill" of rich countries. Many countries lack both management infrastructure and workers rights implementation, making them attractive for cross-border trade. The new "atlas" of flows created by UNITAR estimates that around 5,1 million electronic waste (almost 10% of the total) is the subject of international trade. Only 1,8 million tons are shipped in a controlled manner. So, some 3,3 are uncontrolled, and they can become part of a legal trade, but also of an illegal trafficking of electronic waste to countries with lower treatment costs.

However, the report confirms that the movement of WEEE is mainly from north to south, from high-income countries to middle- and low-income countries. Only a very small part, between 2 and 17 thousand tons, are seized because they were illegally marketed by the European Union.

Already in 2014 Lepawsky (2014, p.10) stated that for over a decade the e-waste problem had been framed in terms of dumping of electronic discards by rich 'developed' nations in poor 'developing' ones; and although such trade was still occurring, a much more nuanced interpretation of the international trade in WEEE was needed.

Awasthi and Li (2017) argue that China and India are the two countries that mostly suffer from illegal imports of WEEE. One of the most frequent counterfeiting methodologies consists, as Huisman (2008) claims, in the transfer of volumes of used EEE in the form of electronic goods or as donations to institutions in the receiving countries (Puckett et al., 2002). Breivik et al. (2014) carried out a review of the literature to also understand different positions that positively affect the international trade of (W)EEE from developed to developing countries by justifying such flows as capable of reducing disparity in the adoption of technologies ICT.

According to this view, the export of used (W)EEE to less prosperous regions represents a reallocation of resources such as raw materials, spare parts, precious metals, etc., which can generate significant economic activity.

Efthymiou *et al*. (2016) studied the factors that influence the choice of countries where e-waste is transported illegally. They selected two types of factors: (i) macroeconomic, i.e. Gross Domestic Product (GDP) per capita and Open Market Index (OMI) and (ii) social, i.e. Human Development Index. With reference to GDP, Lepawsky and McNabb (2010) also argue that commercial transactions on e-waste tend to occur when the importer has a lower GDP per capita than the exporter.

An interesting point of view is that of Yu et al. (2010) according to which the dynamics of the flows appears to be a short-term issue since the digital development trajectory of developing countries will determine a strong increase in the production of their own waste, compared to which the import volumes they will be negligible or at least minor.

Rochman et al. (2017) sought to understand the roles of formal and informal actors in e-waste flows and identified three categories of factors responsible for illegal e-waste transports: (i) centrifugal push factors, forces capable of driving away illegal waste transports from their source, (ii) centripetal pull factors, i.e. forces capable of attracting illegal transports to their destination and (iii) facilitating factors, i.e. anything that makes illegal transports possible. They concluded that transport actors walk a fine line between legal and illegal practice, thus allowing illegal transport of e-waste to take place.

The figure 4 regards global import and export of regional WEEE flows and shows how these flows follow the same schizophrenic dynamics of international trade, in which the majority of countries are both, at the same time, importers and exporters of the same commodity.

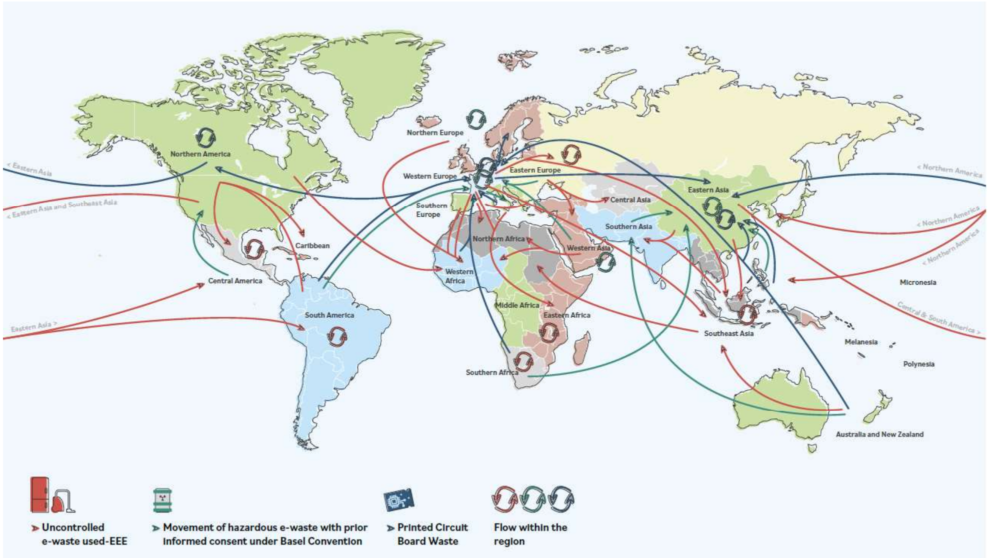

Fig. 4 Global Import and Export of Regional Flows. Source: Baldé et al., 2022

2.1 Regional scenarios

In this section we will briefly analyze the production, disposal, management and traffic dynamics of WEEE on a sub-continental basis. Given the geographic scale, very large differences between the different macro-region exist, due to a combination of several factors, including legal provisions, economic development, institutional efficiency and the complexity of the industrial chains. Furthermore, even within the same nation, therefore within the same legislative and institutional framework, notable differences can be identified, as, for example, it happens in Italy NUTS3 regions, as stated by the annual reports on this topic, published by the RAEE (WEEE) Coordination Center.

Table 1 reports some summary data about macro-regional differences in terms of E-waste production, sound management and import/export.

Region	*Data*	
	e-waste generated (kg/inh) *e-waste documented to be environmentally soundly managed (%)*	*e-waste % import/export*
Americas	13.1 Mt (13,3 kg/inh). 1.2 Mt (9%)	0.55 Mt (3%) imports. 0.39 Mt (2%) exports.
Europe	12 Mt (16,2 kg/inh) 5.1 Mt (42%)	1.2 Mt (10%) imports. 1.9 Mt (15%) exports.
Africa	2.9 Mt (2,5 kg/inh) 0.03 Mt (1%)	0.55 Mt (19%) imports. 0.13 Mt (5%) exports.
Asia	24.9 Mt (5,2 kg/inh.) 2.9 Mt (12%)	2.9 Mt (12%) imports. 2.8 Mt (10%) exports.
Oceania	0.7 Mt (16,1 kg/inh). 0.06 Mt (9%)	0 Mt (0%) imports. 0.021 Mt (3%) exports.

Tab. 1 Macro-regional Import and Export Hotspots. Source: authors' elaboration on Baldé et al., 2022

Americas

In the American continent, the production of WEEE is characterized by a non-homogeneous geographical distribution, especially along the North-South route. This lack of homogeneity can also be seen in relation to the different adoption from state to state of specific legislation on the topic. Furthermore, it is obvious that generation rates are very different depending on the number of people and the level of ICT penetration, since for example a city like New York generates more WEEE than many entire scarcely populated states in the nation.

In North America, Canada and the United States, WEEE production per capita is approximately 19-20 kg/person/year. Canada collects a wider range of products, but the recycling rate is only about 20% (Kumar and Holuszko, 2016). In South America, legislation related to WEEE is not widespread, although countries such as Argentina (2013) and

Brazil (2010) have drafted related legislation for the management of WEEE, whose production is increasing everywhere in the sub-continent.

Regarding the type of import/export of WEEE, North America imports printed circuit board waste, as several specialized recyclers are based in the region, while Central America and South America export this category of waste. As in many other cases, the lack of available information may hinder a better understanding and improvement of the e-waste problem in the Latin American region (Wagner *et al.*, 2022).

Europe

In European Union countries, sustainable development and the progressive adoption of circular economy models could prove to be distinctive factors in the ability to manage WEEE, however, according to the UNITAR SCYCLE programme, only 3 of the 27 EU member states (Croatia, Bulgaria and Poland) have reached the collection target of the WEEE directive. The rapid replacement rate of electronic devices also affects this dynamic[10].

As an example of the criticality of the E-waste issue with respect to negative data even in the presence of efficient dynamics, we can cite the Netherlands, where in 2018 366 kt of WEEE were generated, half of which was recorded as recycled in compliance with the NWR. It is estimated that around a quarter were recycled non-compliantly (27%) and around another quarter were disposed of in waste containers or exported for reuse, or could not be documented (UNITAR, 2020).

Africa

The use of EEE is still low in Africa compared to other areas in the world, but it is growing at a fast rate. In the last decade for instance, the penetration rate of personal computers has increased by a factor of 10, while the number of mobile phone subscribers has increased by a factor of 100, which a consequent price reduction and more affordable technology (Secretariat of the Basel Convention, 2021). In 2019 Africa was producing 2,9 MT of E-waste, in 2021 3 MT and an (under)estimated value for 2030 is 4 Mt, which accounts for a + 33% in less than 10 years-time (Massa and Archodoulaki, 2023).

It's calculated that today Africa locally generates between 50 and 85%

[10] In Europe, on average, smartphones are replaced every 2-3 years., as reported by "Science for Environment Policy": European Commission DG Environment News Alert Service, edited by the Science Communication Unit, The University of the West of England, Bristol.

of its total e-waste, the remaining originating from illegal transboundary imports from developed countries from the Americas, Europe, and China. About 2.9 Mt of e-waste was generated in Africa in 2019, with the highest e-waste generating countries (Egypt, South Africa and Nigeria) also being major population centers.

Even though monitoring the transboundary movement of e-waste into Africa is notoriously difficult, three African countries, two on the West coast, Ghana, and Nigeria, and one on the East coast, Tanzania, have been identified as recipients of e-waste from the EU/UK (Maes *et al.*, 2022).

As highlighted by Okwu et al. (2022), in Nigeria unprofessional WEEE burning and dismantling methods contribute significantly to the pollution of air, as some of the pollutants are able to travel over a long distance from the recycling sites. The soil, as well as the crops grown in the WEEE dumpsites, are exposed to a high concentration of metals.

Very little reporting of transboundary movement of e-waste exists within the African continent. This may be due to either low levels of reporting or to the import of used-EEE that become waste while already in the region.

<u>*Asia*</u>

Figures for the Asian continent rose to 24,9 Mt in 2019 (Forti *et al.*, 2020), and now make up almost 50% of WEEE generated globally, making Asia the largest generator of WEEE worldwide.

China ranked first in the world for the generation of e-waste in 2014, generating 8.53 million tons. This quantity is forecasted to be 15,6 and 28,4 million tons by 2020 and 2030, respectively, increasing dramatically by 25,7% each year (Wang *et al.*, 2016);

In Western Asia[11], the total absence of practices relating to the management of electronic waste suggests very negative estimates (UNITAR, 2023) for the future, with very significant increases in the quantities of POM EEE (7.5 Mt in 2050). Similarly, again according to estimates (UNITAR, 2023), correct management of activities related to e-waste could generate enormous demand for work, with 225,000 full-time equivalent jobs in 2050.

In Central Asia, particularly in Kazakhstan, very high growth trends in EEE consumption per capita can be recognized, and, therefore, here too the 250 forecasts estimate large increases in electronic waste (432 million kg in total, according to UNITAR, 2023)

[11] It includes Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, State of Palestine, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, and Yemen.

In India approximately 95% of E-waste is treated in the backyard without any expert personnel, equipment, technologies, and infrastructure (Arya *et al.,* 2021).

In Malaysia, as elsewhere, informal recyclers have flooded the WEEE recycling market, adopting "backward dismantling methods" to carry out operations, in pursuit of high profits, thus causing heavy environmental deterioration. In addition, due to the low-cost competition of informal recyclers, formal recyclers cannot obtain sufficient revenues to cover the operating costs and obtain reasonable profits. Therefore, WEEE recycling policies have been introduced and implemented (Krishnaswamy, 2019), and in China, already in 2011 government began to implement WEEE recycling management regulations to subsidize formal recyclers, as part of the solution policies (Liu *et al*, 2018).

Oceania

Australia and New Zealand are the largest producers of WEEE in this continent. While Australia has a product management program that has generated schemes for waste and recycling of WEEE, New Zealand has yet to develop a legal framework to support the management of WEEE, and it currently manages its e-waste via voluntary product stewardship schemes (Van Yken *et al.*, 2021)

Oceania exports printed circuit board waste mainly to Asia but has a low level of reporting on other kind of e-waste transboundary flows. As for other regions, the lack of information hinders a better understanding of the e-waste problem in the region.

3. Some possible positive foresight scenarios

The demand for, and production of EEE is expected to continue to rise in future. With technological advances and increased accessibility and penetration of electronics, WEEE generation is expected to rise substantially, with total volume generated expected to rise to 75 MT by 2030 (Forti *et al.*, 2020).

The increase in WEEE can be explained not only by a greater consumption of technology on a global level, but also by the reduced life cycle of the devices themselves - read planned obsolescence - and by consumers' low propensity to repair them. This explains why, although the weight of electronic devices decreases with technological evolution, the production of WEEE increases. In other terms, the subtractive dynamics of the electronic weight due to new technologies and more efficient production, is losing compared to the additive dynamics of the production of new devices due to the increase in demand.

The analysis of the current global state of disposal of e-waste has highlighted, as expected, a very different regulatory framework and very different management efficiency, ranging from over 90% in Switzerland to 0.1% in the West Asia. At the same time, everywhere, there is emerging awareness of a very needed change of scenario, necessary both to recover precious resources (urban mining) and to reduce damage to public health and the environment, deriving from mostly informal and therefore out of control disposal.

In fact, adequate regulation and application of the matter, supported by substantial public incentives to implement efficient recovery and recycling policies, will not only be able to block or decrease the flows of volumes of illegal electronic waste, but trigger virtuous circles within countries, in line with the much-vaunted principles of the circular economy. Furthermore, this would lead to both a reduction in the release of polluting substances into the environment - from mega landfills and from improvised small-scale dismantling laboratories - and obviously also in terms of employment it will lead to various advantages induced by a more regulated production chain of pre-treatment and waste recycling. It is, in fact, estimated that roughly 225.000 full-time equivalent jobs would be created for repair of used EEE and collection and pre-treatment of e-waste. In South Africa, for instance, there are currently an estimated 25 full-time equivalent recycling jobs per 1.000 t handled, and the sector has the potential to increase this number as more recycled e-waste is reintroduced back into the value chain (Lydall *et al*. 2017).

According to the current and forecasted data (Bagwan, 2024) of E-waste processing capacity and recycles it's possible to state that, the processing capacity of E-waste has been steadily increasing from 2014 to 2021. Looking ahead, the forecasted data from 2023 to 2030 suggests a continued upward trend in the number of recyclers, albeit with a more moderate rate of change. The projected rates of change range from 5,65% to 26,26% (ibid), indicating steady growth in the recycling capacity of E-waste over the forecasted period, from about 127 Mt to 199 Mt. These findings highlight the importance of promoting and supporting E-waste recycling initiatives.

Currently, fewer and fewer precious metals are employed in electronic devices, so the few metals that can be salvaged are sold for a very cheap price in international markets, making the process of recycling less convenient than exporting e-waste to countries with little-to-no regard for worker safety or environmental protections.

Instead, the African continent, where, among other things, a massive use of solar energy and therefore the installation of millions of solar panels is expected (WB, 2022), could become an international hub for legal and qualified disposal of E-waste, subverting its economic destiny from a destination for illegal waste trafficking to a hub of a virtuous global value chain.

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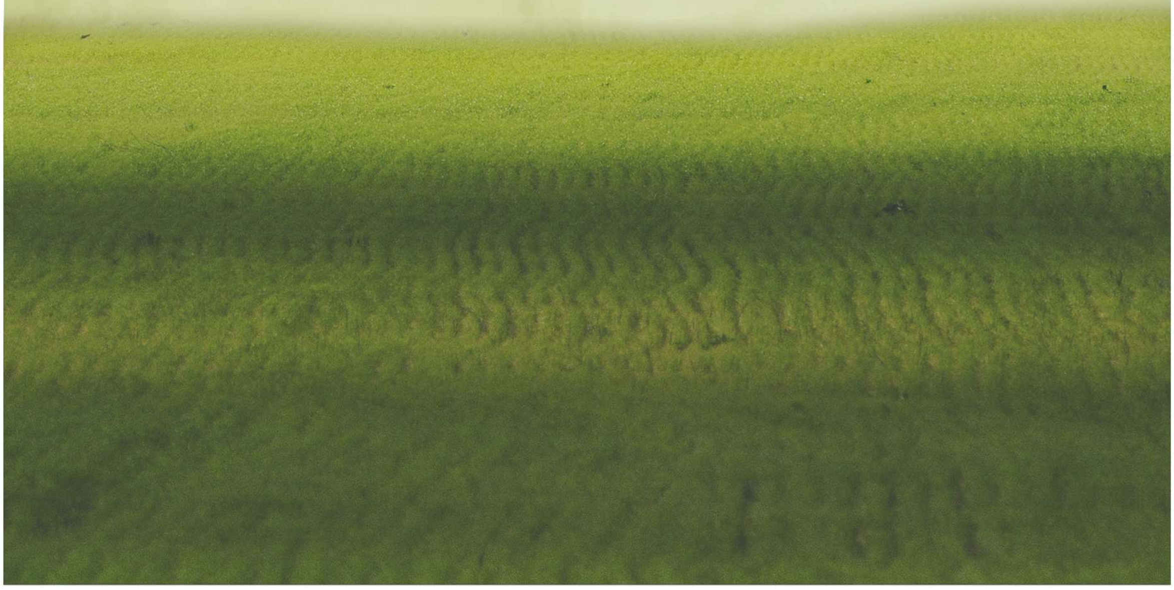

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