Research Article

Irene Bavuso*, Guido Furlan, Emanuele E. Intagliata, Julia Steding

Circular Economy in the Roman Period and the Early Middle Ages – Methods of Analysis for a Future Agenda

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Abstract: In recent years, studies on reuse practices in premodern societies have multiplied. Nonetheless, a linear model (production – usage – discard) is still widely employed for describing past economic systems. Integrating it with a circular model, instead of assuming that products were discarded after their usage, would greatly benefit our knowledge of ancient and medieval economies. In this work, we present a model of circular economy and define the terms used in this context. Thereafter, a possible agenda on how to study circularity both through archaeological material and written sources is traced. This covers archaeological fieldwork methods, as well as the process of interpretation and the re-evaluation of old data. It also proposes new strategies to use and read written sources to explore reuse practices. If different theoretical and methodological approaches are combined, a more holistic and vivid picture of premodern economies can be gained and help our understanding of how past societies used the resources available to them.

Keywords: circular economy, reuse, urban archaeology, Roman period, medieval period

1 Introduction

The circular economy (CE) concept advocates the need for economic systems that aim at reducing waste through recycling, reusing, and repairing products. This is generally regarded as beneficial to create more stable supplies of raw material for production lines and an environmentally sustainable future. CE stands in contrast with the more traditional linear economy model, in which resources are exploited to produce commodities that would later be turned into waste and not reintroduced into societies (Kirchherr, Reike, & Hekker, 2017; Korhonen, Honkasalo, & Seppälä, 2018; Murray, Skene, & Haynes, 2017).

The concept has seen a surge of interest in the academic world and beyond in recent years, thanks to more proactive and environmentally driven political agendas at the governmental, intergovernmental, and non-governmental levels (e.g. Ellen MacArthur Foundation, 2014; European Parliamentary Research Service, 2022; Yong, 2007). Recent publications have often focused on showcasing contemporary case studies or providing literature reviews on the numerous definitions of CE. Much effort has also been put into defining what CE is. Although the blurry conceptual boundaries of this term are open to a wide array of interpretations, the scholarly community

* **Corresponding author: Irene Bavuso,** Department of History and Art History, Utrecht University, Utrecht, The Netherlands, e-mail: i.bavuso@uu.nl
Guido Furlan: School of Culture and Society, Centre for Urban Network Evolutions, Aarhus University, Aarhus, Denmark, e-mail: g.furlan@cas.au.dk
Emanuele E. Intagliata: Department of Cultural Heritage and Environment, Università degli Studi di Milano, Milan, Italy, e-mail: emanuele.intagliata@unimi.it
Julia Steding: School of Culture and Society, Centre for Urban Network Evolutions, Aarhus University, Aarhus, Denmark, e-mail: j.steding@cas.au.dk

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generally perceives CE as a convenient umbrella definition that encompasses regenerative or preservative processes such as reduce, reuse, and recycling (the so-called 3 Rs, see the abovementioned literature).

If one moves the focus from contemporary history to the study of past societies, it is possible to note several substantial differences in the way CE has been approached. Until recently, studies have looked at ancient societies primarily through the linear economy lens. It is only in the past couple of decades that scholars have begun to realise that this traditional model is insufficient for understanding these economies, and it could be effectively integrated (certainly not replaced) by the circular one; as a consequence, studies on the 3 Rs – reduce, reuse, recycle – have multiplied (e.g. Andrade & Raja, 2023; Duckworth & Wilson, 2020b; Peña, 2007; https://projects.au.dk/circulareconomy). However, this increased interest in the topic is still fragmentary, with studies usually dedicated to single circular economic aspects (e.g. recycle and reuse) and materials (e.g. glass, metal, and stone), but rarely addressing CE as a whole (for an exception, see Romanowska et al., 2021a).

Examining how CE is currently dealt with gives the opportunity to rethink the scope and mode of this research approach. In contemporary societies, processes of economic circularity are heterogeneous in quantity and quality. Waste treatment processes vary greatly across countries, for waste quantity and the capability of states to treat them are proportionate to an increase in wealth (The Organisation for Economic Co-operation and Development, 2020). In addition, if metal, glass, and paper have generally been subjected to systemic recycling, other materials (such as, for e.g. textiles) still fall considerably short in this sense (Ellen MacArthur Foundation, 2020). Variety also exists among reuse processes. Planned obsolescence strategies have considerably reduced the ability to repair old products – particularly electronic appliances – and only in 2022 did the European Commission establish the "right to repair" as a way to reduce waste and promote a more sustainable economic model (European Parliamentary Research Service, 2022). By contrast, recycling has a much longer normative history. The reasons behind this state-of-the-art, which has recently inspired a better-concerted effort to reduce waste through a CE action plan by the European Community members (The European Commission, 2020), can vary. These range from the development of technologies relevant to CE processes to more subjective choices at the individual level based on, among other things, economic or cultural reasoning.

One must assume that CEs in the past were similarly heterogeneous in scale and modes and that the study of a single CE process for distinctive materials (e.g. glass recycling) can only provide us with an incomplete picture of the entire phenomenon. Therefore, in principle, the absence of a single CE process does not necessarily indicate an overall tendency towards a more linear type of economy. To avoid such bias, research would need to go beyond sectorialisation and promote a better-integrated approach to regenerative and conservative processes. This would include the study of a wide array of materials and, ideally, an interdisciplinary approach that also includes analytical techniques applied to archaeology.

The scholarly community has been slowly but steadily moving in this direction in the past couple of decades. For example, J. Theodore Peña has attempted to highlight all the possible ways in which pottery in the Roman world may have been reintroduced into the economic system by circular processes as seen through the integrated study of written sources and archaeological evidence (Peña, 2007). More recently, the edited volume by Chloë N. Duckworth and Andrew Wilson has collected a wide array of cases to demonstrate the high degree of circularity embedded in the Roman economy, therefore undermining the still prevalent idea that reuse only belonged to Late Antiquity and the Middle Ages (Duckworth & Wilson, 2020b). In 2021, a study by Christina T. Halperin looked at the *longue durée* of circularity in Ucanal, Guatemala, using as proxies the recycling of ground stone and pottery, and the secondary use of building material (Halperin, 2021). In so doing, the author effectively promoted a more holistic way of exploring CE at site-level through full quantification and an autoptic approach.

Despite all this, a deeper theoretically informed and concerted effort is certainly needed. Long-term perspectives are still very often marginalised to the benefit of narrowly dated case studies on single classes of artifacts or material. Moreover, the study of CE processes has generally received uneven treatment. Reuse of architecture and sculpture, for instance, is a topic that has often attracted scholarly attention – particularly for Late Antiquity and the medieval period (e.g. Barker, 2020). By contrast, repair (which is often more difficult to discern in the archaeological record) has received less consideration (Jervis & Kyle, 2012). Finally, a stronger effort could also be put into integrating archaeological analyses with the study of written sources (e.g. Freestone, 2015).

Far from being exhaustive, this contribution advocates the need for a better-integrated and less fragmented study of conservative and regenerative processes to enhance understanding of ancient CEs. It also

aims to provide a preliminary theoretical framework, which will necessarily need to be refined in the future. In so doing, this article also explores the terminology associated with circularity and sketches a theoretical model in which past circularity is explained and codified. Finally, it examines what is still needed to fully reach a CE-mindset in research.

2 What is Circular Economy? A New Model for the Roman Period and the Middle Ages

CE should be understood as an integral part of pre-modern economies, and Figure 1 shows how circular dynamics can be integrated into a linear model of primary use – which proceeds from raw materials to

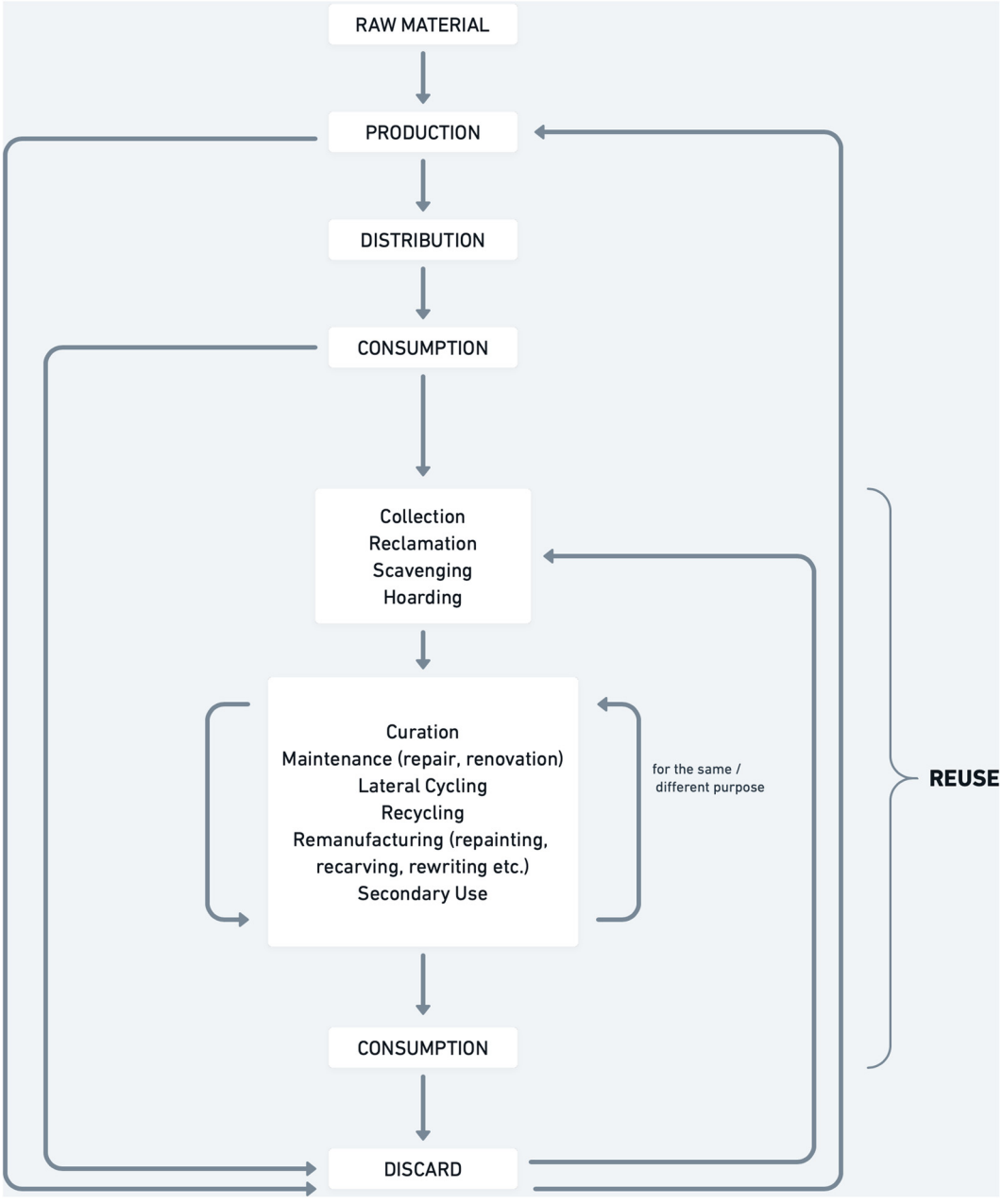

Figure 1: Model of a CE (© The authors).

production, distribution, consumption, and finally discard (Peña, 2007, pp. 8, 39; Schiffer, 1972, p. 158). In 2020, Duckworth and Wilson presented a comprehensive model of circularity in the Roman period, which acknowledged the life cycle of different objects and the role of diverse actors and processes. We build on that model and extend its timespan to include also the early medieval period. Moreover, we understand reuse as an umbrella term that includes a variety of different processes; these, in turn, can interact with one another fundamentally complicating the circular dynamics.

Since different definitions are often applied to the terminology of circularity, it is important to redefine these terms. In a circular dynamic, after the first consumption, the materials are collected again through more or less organised practices, the most important of which are reclamation, scavenging, and hoarding. These may or may not be performed after a phase of temporary discard. Through the act of reclamation, the object is removed from its original context and used again with or without a change in use. Reclaimed objects may have a high value, and may be curated or rediscovered; or they may be reclaimed for practical uses (Sainsbury, 2019; Swift, 2012). A significant act of reclamation, sometimes with important symbolic functions, is spoliation, describing the reuse of stone elements in a modified or unmodified form (Dumser, 2018, with extensive bibliography). The activity of reclamation was linked to that of scavenging, that is to say, the recovery of items and materials from waste from a large variety of sites (Downs & Medina, 2000). During the early post-Roman period, in areas of western Europe which experience a stronger disintegration of the Roman economic structure, scavenging has been proposed as the most common way of obtaining materials for which there was a shortage, such as metals (Fleming, 2012, 2021). Hoarding instead may aim at storing objects and scrap material before entering them again into the economic circuit. However, practical reuse is not the only aim of hoarding: the practice had various other possible meanings, such as votive functions (Naylor, 2015).

After items are collected, the objects can undergo different processes. One of these is curation, which is generally motivated by a variety of reasons, such as scarcity of goods, status display, memories, and cults (Swift, 2012, p. 168). Curated goods can be passed on as heirlooms, and heirlooms can be objects that have been first reclaimed. Naturally, not all curated goods are heirlooms, depending on the meaning of the objects, biography/lack of biography (on the process of "sacralisation" in the medieval period, see Gilchrist, 2013; see also Costello & Williams, 2019). Maintenance includes conservatory processes such as repair and renovation, aiming to prolong the life of an item or building (Peña, 2007, pp. 209–210; Schiffer, 1996, p. 32). Repair was a common activity for putting an item back into use: the item can afterwards be used for the same function it was originally made for, or its function might change (Dooijes & Nieuwenhuyse, 2009, p. 8; on pottery, Peña, 2007; on glass, Eggert & Straub, 2009; written sources mentioning repair include, e.g. Cato, *De agri cultura* 39.1, and Juvenal, *Satura* 14.308–10). Renovation is instead applied to buildings, as well as to decorative elements, like mosaic floors (Ng & Swetnam-Burland, 2018).

The easiest way of reuse is lateral cycling, in which the item remains largely unchanged but is used by someone else for the same purpose (second-hand material; Schiffer, 1972, p. 159; 1996, p. 29). Instead, secondary use means that an item is used with a different purpose and function, without extensively changing the object (Schiffer, 1996, p. 31). Recycling, on the other hand, changes an artifact so that it loses its original function and becomes part of a new production process (Peña, 2007, p. 11; Schiffer, 1996, pp. 29–30). It is a reprocessing of a material (Peña, 2020, p. 12) that "went hand in hand with production" (Ng & Swetnam-Burland, 2018, p. 4). We can distinguish between upcycling and downcycling: upcycling refers to a transformation of an object into something of higher quality, while downcycling is the opposite (Peña, 2020, p. 12). Remanufacturing can apply to a variety of actions, such as repainting, recarving, and rewriting. Recarving, for instance, applies to architecture and sculpture that show traces of physical intervention by the carver, e.g. traces of recutting (Pollini, 2010; Prusac, 2011). During the production and reuse processes, discard is accumulated (Peña, 2007, p. 12; Schiffer, 1996, pp. 27–46). We can distinguish between provisional discard, that is the temporary accumulation of waste to be then reintroduced in the system, and definitive discard, which is not returned in the economic circuit (Peña, 2020, pp. 10–11).

All these different activities can be understood as part of the umbrella-term reuse, which is a conservatory process (Schiffer, 1996, pp. 32–35). In pre-modern societies, reuse processes were motivated by the shortage or disappearing of raw materials, as well as by ideological factors (e.g. Barker, 2020; Eckardt & Williams, 2003, pp. 141–143; Fleming, 2012; Longfellow, 2018). The definitions used above lay the groundwork for the question of how we can approach economic circularity in the best way possible. The concepts were developed within

the framework of behavioural archaeology to explain formation processes and the passage of artifacts from the systemic context to the archaeological context. However, they have never been fully utilised for the study of premodern societies from an economic perspective.

The model used here is not universal for all materials and objects, some materials can be remanufactured, repaired, and recycled, while others may only be recycled; objects can also go through the cycle multiple times, in various ways. For instance, a metal object could be repaired and then recycled in a later step; or it could be remelted to make a new object. Thus, the model should be understood as an adaptable *chaîne opératoire*. In the following, we will explore different methodologies and approaches that are needed to expose past CE.

3 How do We Study CE in Past Societies?

Although much has been done with regard to individual CE processes in past societies, there is more that can be achieved based on an interdisciplinary and more holistic approach to the topic (Figure 2). This not only includes a dramatic shift in current research agendas but also changes the way we collect, study, and make available our data to the scholarly community.

3.1 Developing a New Research Agenda

An interdisciplinary approach is crucial to assess the characteristics of CE and how they changed through time. The written sources provide fundamental information to answer broader socio-economic and cultural

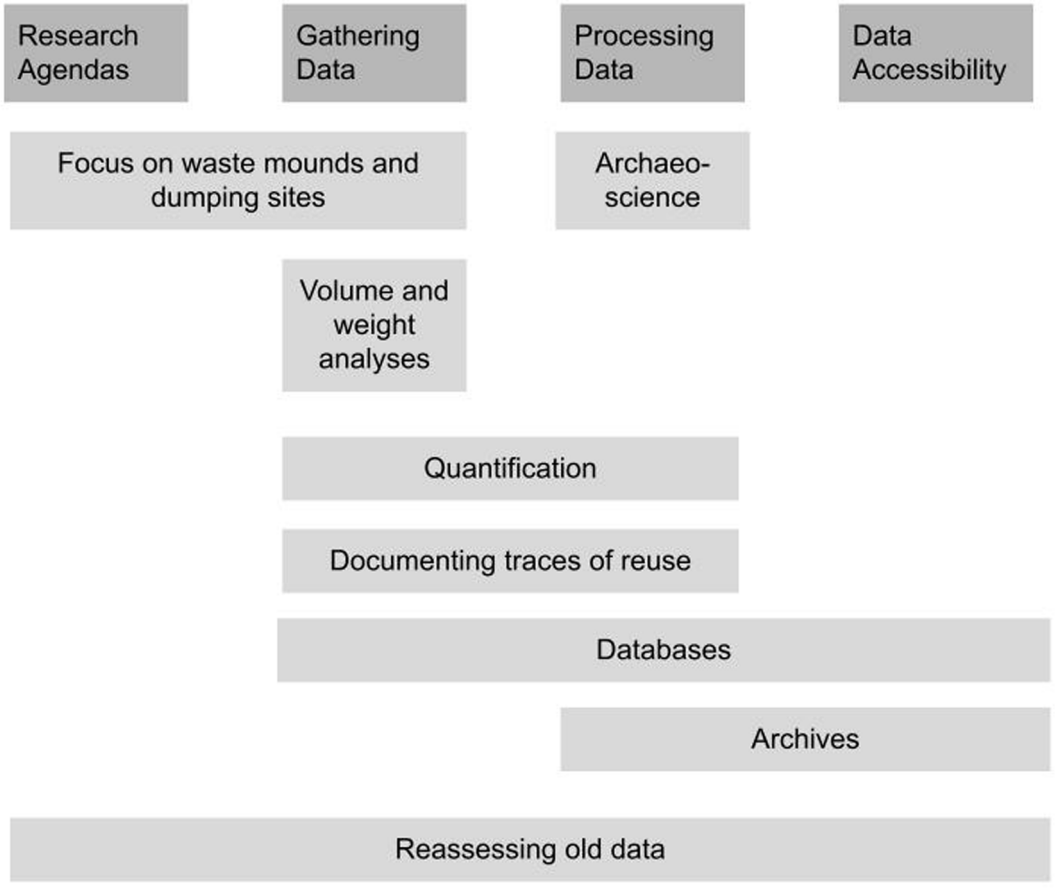

Figure 2: Approaching circular economies – an overview (© The authors).

questions, such as which actors were involved in processes of reuse, and at which level; how the circuits of production and distribution were shaped; which mechanisms were at work, e.g. commercial and non-commercial; which logics CE responded to, e.g. aesthetics, ideology, practical needs, etc.

From an archaeological perspective, there is a need for research into common processes and dynamics rather than single classes of artifacts: this kind of integrated research is still rare but would be of great benefit for the study of ancient economies. Some aspects of circular economy, particularly the recycling of glass and metals, are among the main research lines pursued in archaeometry; the reuse of pottery, particularly amphorae, is conversely a main topic in archaeology. Nonetheless, besides the existence of individual lines of enquiry, there is no proper structured archaeological approach to the study of CE in the past. A pronounced separation between studies concerning different typologies of materials can be easily detected in the available literature, if on the one hand, as just observed, the process of recycling is well-studied for glass, on the other hand, the recycling of pottery as temper is almost completely absent from economic studies.

A holistic approach to archaeology and an interdisciplinary perspective combining history and archaeology would allow us to study how circular processes were managed, and to what degree they were integrated. Workshops investigated at the site of Spolverino, Tuscany, (Sebastiani & Derrick, 2020) show that the very same complex could host a range of activities, including the recycling of different metals, glass, and bone. These workshops shared common facilities and access to a regional market, thus indicating that forms of integration certainly occurred and that they are to be better studied and understood.

An additional fundamental aspect that needs to be fully investigated is the bulk quantity of materials and objects that entered the circular processes. This focus is invaluable to shed light on the impact of circular dynamics in the general economy, that is, to understand whether these practices had a limited or strong impact on the economy, and how this impact may have changed in different periods.

These shifts in archaeological research and an interdisciplinary approach can prove conducive to a more complex picture of circular dynamics in the past, and thus help scholars assess the relationship between circularity and broad economies. Recent research has strongly questioned the assumption that reuse should necessarily be associated with economic stagnancy and decay. Starting from this new understanding, research can now explore whether and how economic reasons behind CE changed through time, for instance between the Roman and the early medieval period. A further question would be whether regional differences can be recognised in changing patterns of recycling in connection to changing networks of access to resources and trade.

We will now look in detail at potential, desirable developments in archaeological practice and historical research in the next future.

3.2 New Targets for Field Archaeology and Material Studies

The absence of a structured research agenda is well-perceivable in the field of archaeology; in fact, a change is necessary at the excavation level as archaeological excavations represent, together with ancient written documentation, the main, basic source to investigate past economic practices, including CE.

Research-driven excavations still mostly target public or private buildings and funerary contexts. With few exceptions (e.g. Acero Pérez, 2018; Bar-Oz et al., 2019; Maxfield & Bingen, 2001; see also Ballet, Cordier, & Dieudonné-Glad, 2003), dumping areas are rarely among the primary objectives of field projects. This general lack of interest is so evident that waste mounds are still rarely indicated in maps and reconstructions of ancient sites, thus providing a distorted view of ancient suburbia.

Nonetheless, the suburban rubbish mounds of Roman and medieval towns represent the obvious counterpart to what is found inside the settlements if we are to gain a balanced view of their economies. For instance, the comparative study of glass and metals (some of the most easily recyclable materials) in *intra moenia* primary deposits and in suburban dumps has recently been decisive to demonstrate and quantify the effectiveness of their recycling in Roman towns (Furlan & Andreatta, forthcoming). Similar studies could be devoted to the presence/absence of reusable building materials or to the incidence of repaired items.

Indeed, not only would a much better knowledge of CE practices benefit from the inclusion of large, communal dumping areas into our agendas but the knowledge of other economic aspects, such as the dynamics of imports and consumption, would also take great advantage. Our appreciation of ancient waste management practices, so heavily affecting the archaeological record of urban centres, would be also improved (Furlan, 2017).

Temporary disposal features (e.g. pits, reused large storage vessels, and whole rooms) and minor waste assemblages (both domestic and productive) are more commonly investigated within urban centres, but they do not represent a primary target of field projects; yet their systematic investigation and mapping would provide precious insights into the organisation of the collection of reusable materials, about which we still know so little.

Secondary workshops making use of materials to be recycled are certainly more difficult to target before excavations take place but, whenever they come to light, their complete investigation should be considered a priority. The excavations and analyses carried out through the years at Jalame, Israel (Davidson Weinberg, 1988), London, Basinghall street (Wardle, Freestone, McKenzie, & Shepherd, 2015), and in different workshops at San Vincenzo al Volturno, Italy (Hodges, Francis, & Leppard, 2011; Mitchell, 2011; Schibille & Freestone, 2013; a different reading of the available evidence is proposed in Marazzi & D'Angelo, 2009) represent good examples for the Roman and medieval periods. Nonetheless, other major issues are still to be fully tackled, like the lack of adequate evidence for secondary glass working (therefore based on recycling) in the Italian peninsula during the Roman Republican and Early Imperial age, which has been explicitly and repeatedly stressed (Boschetti, Gratuze, Cavalieri, Lenzi, & Schibille, 2022).

Besides a shift in the selection and study of archaeological contexts, a substantial change should involve the study of artifacts. The issue of repair, which is addressed again further on, is illustrative of this point. Repair involved a variety of artifacts; from a quantitative point of view, it is likely that it had a certain importance for ceramic vessels but so far it has been very difficult to evaluate the impact of the phenomenon because of a general lack of reliable quantitative data, which is discussed below.

Reporting evidence of repair on potsherds cannot be considered routinary, even when it is observed and registered. Training for find specialists in this field is lacking to some extent and the evaluation of the issue of repair becomes even more complicated when moving beyond the most obvious cases involving the use of metal staples. The application of organic adhesives or of leather strings is more likely to go undetected, therefore contributing to a biased evaluation of the phenomenon of ceramic repair as a whole.

Besides difficulties in recognising repair whenever it occurred, this shortcoming seems to be due to a more general lack of interest. This, in turn, may well derive from the failure to appreciate the importance of ancient CE dynamics.

The issue of curation is also seldom addressed systematically; indeed, it is usually raised only for funerary contexts (i.e. when it is more visible), on the condition that some artifacts are clearly older than others. Surprisingly, the social value of curated objects is usually appreciated (and studied), whereas the economic impact of curation, which *de facto* prolongs the systemic life of artifacts, is seldom investigated.

Finally, issues such as scavenging and the bulk reclamation (Acero Pérez, 2018, pp. 342–347; Bonetto, Furlan, & Ghiotto, 2017; Emmerson, 2020, pp. 118–120) of wasted material still draw insufficient attention and their economic impact is largely understudied: careful field practice (see below) may cast new light on these aspects.

3.3 The Construction of a Suitable Field Archaeological Methodology

The pursuit of the objectives of a new agenda entails the development of appropriate methodologies. In this regard, the analysis of dumping sites well exemplifies what could be applied, with some variations, also to other target deposits. Recent investigations conducted at Elusa, Israel, demonstrated that a combined approach, including the use of geophysics, 3D mapping, field surveys, and test trenches, leads to a precise definition of the extension and depth of the refuse dumps surrounding an urban site (see also Bar-Oz et al., 2019, 2022; Millet, 2013, pp. 24–44; Vermeulen, Slapšak, & Mlekuž, 2013). LIDAR acquisitions can supplement this toolkit and eventually manual or mechanical coring can be profitably employed, as has been demonstrated in Pompeii (Furlan, Bonetto, & Nicosia, 2019; Nicosia, Bonetto, Furlan, & Musazzi, 2019).

Reconstructing the distribution and average depth of rubbish heaps has a twofold output: it allows to target the areas to be excavated and enables the evaluation of the investigated sample in relation to the whole dump (Orton, 2000). The digging of large waste mounds entails specific issues (De Sena & Rivello, 2006; Filippi, 2008), qualitative and chronological heterogeneity and discontinuity in the deposit must be considered and could be tackled by expanding the number of test trenches. This could also shed light on the possible internal organisation of extramural dumps (again, an understudied aspect), which in turn could have fostered practices of dump mining. Careful stratigraphic observations, paying particular attention to labile, blurred negative features, could highlight traces of two important activities in CE, that is selective scavenging and the bulk reclamation of volumes of waste and sediments to be employed for building activities within the urban centre.

Should thick rubbish deposits appear homogeneous, artificial horizontal distinctions may be helpful for appreciating chronological differences and the evolution of the related assemblage through time.

Sieving always represents a complicated issue in urban contexts (Barker, 1975; Clason & Prummel, 1977); volumes of sediment, particularly if the presence of small items (such as production waste) is suspected, could be screened through sieving only when necessary. Eventually, given the informative potential of such deposits, the collection of samples for absolute dating and for gaining geoarchaeological, botanical, and animal evidence could be reasonably maximised.

Typically, small or large dumps contain large quantities of artifacts and, whether preserved, organic materials. Handling great numbers of finds may require the adoption of ad hoc strategies for their cleaning, cataloguing, and study. Realistically, the use of more rapid approaches, such as spot dating, for some classes of well-studied finds may turn out to be necessary; drawings could well be reserved only to particularly relevant items.

On the other side, exact quantification (Arcelin & Tuffreau-Libre, 1998; Orton, 1993, 2005), represents a fundamental aspect of this kind of study; alongside sherds count, MNI, and EVE are being employed increasingly. However, these techniques should be preferably accompanied by weighting. Simply weighting finds according to their material (not a highly time-consuming practice) seems to be the best practice when dealing with the percentage of recyclable materials within assemblages, as in this perspective artefacts are not important *per se* but as raw materials potentially re-entering the productive chain. This also makes comparisons with contexts and materials affected by different fragmentation indexes easier. However, although simply collectable, data of this kind are still often unavailable (Furlan & Andreatta, forthcoming).

The study of traces of repair should be routinely included in the immediate post-excavation work on assemblages; concerning ceramics, the possible use of resins could be tested archaeometrically on a small number of selected pieces and then macroscopically recognised and counted on a global scale. Clearly, these adjustments in the routine study of finds imply that, if necessary, the databases employed should be shaped in a convenient way. This would mean, in turn, that the publication of conspicuous quantitative data could be later speeded up (see below).

As anticipated, what has been briefly summed up for the investigation of dumps could be profitably applied, with adequate variations, to the other key deposits listed above, particularly to assemblages of provisionally discarded materials. The fundamental issue remains, indeed, the same: without a real interest and proper strategies, important data for dealing with different aspects of CE are hopelessly lost already in the field, and during the immediate post-excavation phase.

The application of a proper methodology is not helpful only when dealing with current excavations and new batches of artifacts. The re-evaluation of old reports, for instance, can significantly clarify the function and internal dynamics of workshops when, at first, they had not been fully understood (Boschetti et al., 2022). This aspect is closely related to the availability of archive data, which is discussed below.

3.4 Archaeological Data Processing

Post-excavation activities, such as the study of bulk/small finds or laboratory analyses, are equally crucial to shed light on processes of circularity.

As a matter of fact, the CE-oriented mindset discussed above is often not sufficient to explore the full array of potential circular economic processes in past societies, especially those that are not detectable by the naked eye. Glass recycling, for example, involves destructive/regenerative processes (i.e. remelting) that aim to erase the old to make space for the new and which are impossible to identify autoptically (Peña, 2020). Archaeoscience is particularly apt to explore invisible circularity. If autoptic examination of remains is generally enough to identify urban mining and the reuse of building material, only chemical analyses can prove that metal and glass artifacts were produced with recycled material. The application of analytical techniques to the study of bulk and small finds dedicated to CE processes has grown exponentially in the past couple of decades. However, given their high costs, most of the studies are necessarily limited to selected sets of artifacts from chosen contexts and rarely approach circularity through a full quantitative perspective. Therefore, if identifying CE processes with archaeoscience is possible and indeed necessary, the scale to which these given processes occur is more difficult to pinpoint.

If autoptic and laboratory analyses allow us to explore circularity qualitatively in past societies, full quantification of finds is needed to appreciate the scale of individual CE components in a given environment. The application of full quantification is often perceived as given in archaeological studies (VanPool & Leonard, 2011, p. 1). Yet practical factors often come into play that hinder this process and cause the full scale of these behavioural practices to remain unknown (Duckworth & Wilson, 2020a). One of these factors is limited storage space in archaeological bases or museums which can lead to the decision of selecting the material on site. However, discarding or ignoring the existence of artifacts because of their seeming unimportance (e.g. a plain ceramic body sherd) can lead to conclusions based on faulted data and erroneous statistics (Peña, 2007, pp. 246–247). Full quantification has recently seen a surge of interest in archaeological studies also thanks to the growing role played by Big Data Science within this discipline (Gattiglia, 2015; Van Valkenburgh & Dufton, 2020; see also Romanowska, Campmany Jiménez, Bobou, & Raja, 2021b). Yet it has rarely been applied to CE processes.

A good example showing the potential of full quantification in this perspective is a study conducted on the repair of pottery from Olbia Pontica, Ukraine, from the sixth to first century BCE, where the authors have identified higher rates of repair coinciding with fewer imports from the west and phases of unrests and economic changes. This tells us not only of the level of isolation of Olbia Pontica, as opposed to other sites in the Black Sea and the Mediterranean but also of the high level of resilience and adaptability of its urban community (Guldager Bilde & Handberg, 2012). Similar conclusions have been reached by Amick on lithic recycling in the Palaeolithic (Amick, 2015). In different geographical and historical realities, quantification has allowed undermining preconceived notions that deem regenerative processes to be the result of systemic collapses. For e.g. a recent study on the recycling of ground stones, ceramics, and architecture at Ucanal, Guatemala has demonstrated that recycling and reuse occurred frequently over the *long durée* regardless of alleged periods of material scarcity (Halperin, 2021).

3.5 Archaeological Data Accessibility

Collating and comparing data, which can be done through targeted literature reviews, remain paramount in order to investigate the extent of CE processes through space and time. However, it is often the case that this type of data collection suffers severe constraints due to limited data accessibility.

In principle, one would need all quantifiable data to be published and accessible to the scholarly community. This would also include photographs of artifacts or structures taken from different angles. However, rare are the instances in which final publications of excavations or excavation reports provide thorough and systematic overviews of evidence about CE. This makes full quantification through literature review a daunting task. In the case study of Olbia Pontica mentioned above, for e.g. the authors tried to collate data on ceramic repair from several Black Sea sites based on publications only to conclude that “the lack of comprehensive pottery publications from most Black Sea sites makes formal comparisons difficult” (Guldager Bilde & Handberg, 2012). The reason behind this lacuna has to do with several practical concerns such as publication

costs and word limits. Moreover, as seen above, selective data collection can also lead to false statistics. The publication of summarising charts of large datasets accompanied by exact figures on paper is a good solution to this issue. However, it is never an ideal replacement, for it does not allow researchers to re-check the evidence.

A solution can, in some cases, be provided by open-access databases, in which data can be stored and presented online – therefore avoiding the need for printed catalogues – and can be accessed by scholars with an internet connection anytime and anywhere in the world. Databases, whose development often needs technical support and can, then, be expensive, can be used to record all sorts of archaeological data (e.g. Schlader, 2002; for challenges of digital data reuse, Faniel, Kansa, Whitcher Kansa, Barrera-Gomez, & Yakel, 2013). However, if made available, they allow researchers to share data with other scholars in a easily accessible way and without the need to revisit the physical material. In the case of data collection for databases, the most important work must be done during the research project, as traces of reuse need to be recorded in the first place (see above), but including this information in databases can then make it available to the scholarly community. For those consulting a database, a search function often simplifies the collection of relevant data. Ideally, a list of terms used should be available with the database, so that different terminology does not prevent information from being found.

A good example of the usability and pitfalls is the online database created by the project *Last Statues of Antiquity* that collected published evidence for statuary and inscribed statue bases dating after AD 284 (http://laststatues.classics.ox.ac.uk). The database is a very helpful tool to explore late antique statues and their context. In the database, one can specifically search for inscriptions mentioning relocation or repair, which makes it easy to find all objects that provide literal evidence of the reuse of statuary. The portrait discussions frequently include specifications on the re-working of the item, and it is possible to filter inscriptions mentioning relocation and repair; however, the research is made difficult because the search function does not allow for searching “re-worked” items. The benefit of databases is thus highly dependent on the information computerised and the overall functionality of the search.

3.5.1 Notes on Legacy Data

The study of legacy data deserves a separate discussion here because of its still untapped potential. Despite the growing scholarly interest in archive archaeology (Baird & McFayden, 2014; Bobou, Miranda, & Raja, 2022; Swain, 2012. See also https://projects.au.dk/archivearcheology and, for the publication according to the FAIR Standards, https://www.go-fair.org/fair-principles/), the study of data from past archaeological fieldworks has rarely led to a reassessment of processes of economic circularity. The general lack of research agendas targeting this particular phenomenon in the past, as discussed above, can translate into a gap in relevant data in archaeological literature – a certain artifact could not have been considered worthy of being documented or collected. Yet the study of, for e.g. excavation diaries, travel accounts, or photos, puts the researcher in the fortunate position of reassessing missed clues of CE processes and, therefore, filling important gaps in the research.

The work of archive archaeologists is, first, particularly important when it focuses on material that documents the state of a site or monument before its destruction or reconstruction in recent decades. These archives are, therefore, often the only surviving evidence proving that CE processes actually occurred. During the late twentieth century, on-site reconstructions were common (e.g. Çetin, İpekoğlu, & Laroche, 2010; Stanley-Price, 2009), removing the original evidence. Looting of sites and the use of monuments as quarries has often changed the archaeological sites (Kinney, 2013; Proulx, 2013); in recent times, political and religious conflicts, especially in the Near East, resulted in the destruction of monuments (Bobou et al., 2022; Jackson, Jamieson, Robinson, & Russell, 2021). In addition, human interventions (Usmanov, Nicu, Gainullin, & Khomyakov, 2018) and changing climate (Sesana, Gagnon, Ciantelli, Cassar, & Hughes, 2021) are altering the record. All these impacts possibly disguise the original (re)use of building materials. On a smaller scale, the reconstruction and restoration of objects could also hide traces of ancient repair, patching, or restorations (Schöne-Denkinger, 2007). Archival records – and, more importantly, photographs – allow us to look at monuments and

objects through the lens of past scholars and travellers and discover their original setup and context (Lyons, Papadopoulos, Stewart, & Szegedy-Maszak, 2005; McFadyen & Hicks, 2020). An example of how to make use of photo archives for examining economic circularity is the study of reuse practices in relation to the Sanctuary of Baalshamin in Palmyra, Syria. In Late Antiquity and the Early Islamic period, this monumental religious complex appears to have undergone significant changes, including the construction of private residential buildings within its limits. These buildings were often constructed by employing extensive architecture and sculpture scavenged from earlier structures. The ways in which different reuse practices were employed in these new compounds could only be identified through the study of the original documentation of the excavation, now held at the *Fonds d'Archives Paul Collart* at the University of Lausanne, since its post-Roman walls were dismantled by the excavators to retrieve reused inscriptions and classical architecture and sculpture (Intagliata, 2017, 2021, 2023).

Second, the study of archives, excavation diaries, and excavation reports can contribute to the comprehension of the excavation results and uncovered remains. As an example, knowing what was kept and documented and what not is important to distinguish between the absence of evidence and the absence of recording. Furthermore, the excavation documentation can help with a re-evaluation of the archaeological context; with new questions in mind that are more focused on economical processes, we may reach new results.

3.6 The Use of Written Sources

The use of written sources of the classical age for the study of CE is affected by the same lack of a structured agenda and approach which has been discussed in relation to the field of archaeology. In general, the available sources are limited; moreover, the panorama is not homogeneous. For instance, the issue of the reuse of building materials has been largely addressed using literary and juridical sources (Marano, 2012), while glass recycling benefits from a limited corpus of sources which have been addressed specifically (Leon, 1941; Stern, 1999). Fewer sources corroborate what we know about some aspects of the reuse of textiles (Wild, 2020), whereas other aspects of ancient CE practices, such as the repair and lateral cycling of several classes of artifacts, remain largely understudied.

A re-reading on the very same sources may open important new perspectives, and the monumental work of Pliny represents a good example in this sense. Pliny's work has been exploited in many ways, as a formidable source for challenging several productive aspects of Roman economy; nonetheless, so far, scholars have mainly focused on single technological aspects or, again, on single materials, more than aiming at a global economic syntheses (Saller, 2022), focused on topics other than CE.

Forms of reuse were not generally discussed *per se* in medieval sources: they are rarely the immediate, or principal focus of early medieval texts – although *spolia* may be a partial exception, as is well shown by Cassiodorus' *Variae* in sixth-century Italy (De Vecchi, 2012; Marano, 2012). This aspect has important methodological repercussion. In order to investigate questions such as those enumerated above, a holistic approach combining a large variety of texts is key, and moreover, for many of them an interdisciplinary approach can indicate new important directions. In addition, as shown below, valuable perspectives are gained from a focused re-reading of sources normally used to investigate other themes.

In the context of early medieval economic circularity, the reuse of Roman materials is perhaps the best researched theme, and the one in which an interdisciplinary perspective has been applied most frequently. Several narrative sources mention the reuse of Roman materials, and thus can be used to examine the degree of inclusion of this practice into different circuits of distribution. Long-distance networks are famously exemplified by the columns and marbles brought to Aachen from Rome and Ravenna in Charlemagne's times, and by the epistolary exchange between Hadrian I and Charlemagne, discussing the removal of Ravenna's mosaics and marbles (Hadrian's letter to Charlemagne: *Codex Carolinus* ep. 81; see also Herrin, 2020; Nelson, 2016). Besides these cases involving the highest social strata in the context of diplomatic and political relations, no less important is the fact that the written sources permit exploring other circuits of exploitation of Roman materials, restricted to micro-regional areas and involving local communities.

Given the nature of the written sources and the importance of churches in the early medieval economic sphere, it is not surprising that much of the extant evidence on circular economies should refer to ecclesiastical contexts. This evidence often offers remarkable insights into the interactions between communities and their landscapes. A good example is an episode reported by Bede (d. 735), narrating that Sexburg, the abbess of Ely, Cambridgeshire, wished to place the remains of Ely's founder Etheldreda in a new coffin, in search of the stone, "they came to a small ruined city," where "they discovered a white marble sarcophagus of very beautiful workmanship" (Bede, *Historia ecclesiastica gentis anglorum* IV.19; transl. Sherley-Price, 1990; see also Liverani, 2004). Bede stresses that the monastic community chose to reuse an ancient sarcophagus because they had no access to stones the proper size in the surroundings of Ely. He thus implies that they could – in principle, had the stones been available – have made a new sarcophagus. While we do not know if this was the actual reason for that community to choose an ancient one, this passage sheds some light on the various motivations behind early medieval reuse among religious communities. Reasons behind practices of reuse included a wide spectrum of possibilities, from functional to ideological, and ritual, which are well illuminated by the written sources (e.g. Pazienza, 2014). This holds true even when ancient objects are deployed for entirely new purposes, a practice well attested in archaeological records – for the early post-Roman period, perhaps the most productive context in this sense was the use of Roman objects as grave goods. The existence of a complex rituality surrounding the reuse of ancient objects is well exemplified by the prayers included in the *Liber sacramentorum Gellonensis* (eighth century), which could be performed in order to purify the vessels found in *loci antiqui* (*Liber sacramentorum Gellonensis*, p. 450: *Oblationes super vasa reperta in locis antiquis*; see also Effros, 2001, stressing that these prayers reflect a new concern over these objects in the liturgy from the eighth century, and Pazienza, 2014).

The connection between local circuits and broader networks is another aspect that can be investigated in detail in ecclesiastical contexts. The restoration of churches is one activity that can illuminate such a connection; it is frequently referred to in the sources, and is likely to have had a strong impact on local communities, particularly in terms of labour involved. From sixth-century Gaul, Gregory of Tours reports cases in the *Decem libri historiarum*: in one episode, King Chlothar I (d. 561) takes care of the reparation to Saint Martin's church since "the previous year much of the city of Tours had been burnt down and many of its churches had been left desolate." Gregory mentions that the king had the church roofed with tin, and "restored to its former glory" (Gregory of Tours, *Decem libri historiarum* IV.20; transl. Thorpe, 1974). This case shows that the repairing process can involve the use of materials purchased from long distances, a source for tin in Francia during this period was Britain.

Re-reading certain types of sources can prove particularly useful to reconstruct dynamics of circularity within specific economic spheres and social networks. Early medieval wills and craft treatises are cases in point. Early medieval wills often mention objects to be bequeathed to heirs and churches. Many of these texts only provide plain lists of items, without any description; in some cases, however, longer descriptions of these objects can illuminate practices of circularity at a family level. In the corpus of Anglo-Saxon wills, for instance, the will of Wynflaed (a wealthy widow who died around the middle of the tenth century) is notable for its meticulous attention to such items, also detailing the specific ways in which her heirs can use their inheritance. Some items can be dismantled to be reused as materials for modifying other objects or can be sold. Wynflaed specifies the value of the individual heirloom, a practice which is common in early medieval testaments (see the Will of Wynflaed, in Whitelock, 2011). Practices of circularity linked to social dynamics at the family level are particularly difficult to detect from other types of sources; thus, wills may be especially important to see how circularity played out in social micro-networks. Yet this type of circular practice was not restricted to the sphere of the family. Instead, specifications about the ways in which the inherited objects can be (or are to be) modified can also be found in cases when the heir is an ecclesiastical institution. A much earlier case appears in the testament of Remigius of Reims (ca. 533), in which the bishop instructed that silver vessels go to churches of Reims and Laon for the making of liturgical objects – specifically patens, chalices, and a thurible; to that end, the silver resulting from one of the vessels had to be divided between the two institutions (Hincmar, *Vita Remigii Episcopi Remensis*; see also Janes, 1998; Jones, Grierson, & Crook, 1957). These two examples of practices of recycling from testaments may have quite different meanings. Unlike that particular entry in Wynflaed's will, the transformation of luxurious secular goods into religious objects in

Remigius' testament belongs in the sphere of devotion – thus, reuse entered the religious and devotional sphere. Remigius' will shows that circular practices played a role in the networks formed by bequests to churches and monasteries, which in turn had fundamental repercussions on the shaping of early medieval societies (Lusuardi Siena, 1999).

Craft treatises constitute a second excellent example, as they provide extensive information on a large variety of technologies in use during the early medieval period; thus, they deserve specific research under the lens of circularity. Scholars have already focused on specific passages referring to reused materials. Particularly studied have been those relating to glassmaking, such as the passage from Heraclius' *De coloribus et artibus Romanorum* (a composite work dated between the eighth and twelfth century) on how to make gems from Roman glass (Heraclius, *De coloribus et artibus Romanorum*, I.XIV; see also Freestone, 2015; Tosatti, 2007). A further passage which is often cited derives from Theophilus' *De diversis artibus*, a twelfth-century craft treatise: Theophilus writes that the Franks, "who are most skilled in this work" (*in hoc opere peritissimi*), collected glass vessels for window-making (Theophilus, *De diversis artibus*, II.XII; transl. Dodwell, 1961; Lusuardi Siena, 1999). Glass-making techniques compound a large part of the *De diversis artibus*, including specific information on how to repair glass objects (Theophilus, *De diversis artibus*, II.XXX). Moreover, several of these treatises also deal with metals, and Theophilus is one of the most important sources for our understanding of metalworking practices. Many of the metals treated in handbooks such as Theophilus' could be recycled in the medieval period, and the reusing practices may have also involved the tools of metalworking. An example here is the recycling of old crucibles that can be found in the *De diversis artibus* (Theophilus, *De diversis artibus*, III.XXII). Thus, targeted research can also provide information on reuse at the specific level of workshops.

In addition to dynamics of circularity within specific networks and socio-economic spheres, the written sources can be particularly fruitful to investigate how and how far the different phases of the reuse were managed and organised. The abovementioned passage by Bede on the reuse of sarcophagi raises questions about the degrees of organisation of the collection activity. This is important to understand how embedded reuse was in the local economy, and the role of reuse in the economy generally. The issue of the organisation of collection is not a new one in scholarship, and important contributions have appeared, for instance, on collection in Roman *villae* in the late Roman and post-Roman periods, and, in later centuries, on the famous glass workshop at San Vincenzo al Volturno (on collection at *villae* see Munro, 2020; see also the above cited case of San Vincenzo). Leaving aside the question of reuse of building materials, our sources do provide references to scavenging, but they are generally not much more than scattered mentions. It is thus particularly difficult to formulate general models on the organisation of scavenging on a textual basis only. The case of the sarcophagus of Etheldreda attests to a certain organisation of the collection within the confines of the monastery, although for an *ad hoc* event. Further evidence on modalities and contexts of scavenging comes from a much-cited passage from the *Liber in Gloria martyrum* by Gregory of Tours. In this narrative, a thief broke the windows of a church at Yzeures and took both the metal and the glass; after putting the glass in a furnace, "he took from the furnace glass that had been changed into some sort of small strand and sold it to the merchants who had arrived" – interestingly, divine punishment then falls on the thief every year on the anniversary of this desecrating act (Gregory of Tours, *Liber in Gloria martyrum* 58; transl. Van Dam, 2004; see also Duckworth, 2020). This text thus provides information on the practice of collection of materials, and on the market of broken glass in sixth-century Gaul. Other sources on practices connected to scavenging can interestingly attest to the coexistence of a more structured and top-down organisation. For instance, in a letter included in Cassiodorus' *Variae* and dated ca. 507–11, King Theoderic orders one of his officials to recover the gold and silver deposited at a burial site, the collection is to be carried out in the presence of the public officials, and the recovered wealth is then claimed for the state (Cassiodorus, *Variae* IV.xxxiv; see also Lafferty, 2014; La Rocca & Tantillo, 2017).

The present discussion has focused on different dynamics of circularity, socio-economic networks, and actors and organisation of collection and reuse practices. While this brief examination was certainly not exhaustive – and much more could be added by investigating written sources – it does highlight how much an integrated investigation on diverse types of sources can offer to reach a more refined understanding of reuse practices and the different mechanisms through which, and in which, they were carried out.

4 Conclusion

The case studies discussed throughout the article have sketched what current approaches to past CE have achieved; more importantly, they allowed us to highlight those elements still lacking in our research strategies and how some adjustments could be beneficial to our knowledge of past CE.

These adjustments range from the very basic targets of field archaeology to the proper dissemination of relevant data. First and foremost, to be able to work with the concept of circularity, we need clear definitions of processes and activities involved; this is not only important to understand what we try to conceptualise, but also to allow for a scholarly communication as a starting point for comparative studies. The necessity to establish clear objectives at every research stage, together with the requirement for an integrated methodological approach, also became evident. The latter point deserves particular attention; specific aspects investigated individually, or only through the lens of one, single methodology, do not lead to a better understanding of CE in the past. What emerged is both the importance of interdisciplinary research (history, archaeology, social and economic sciences, and archaeometry) and the value of focusing on the bigger picture, avoiding the temptation of sectorialism. A more holistic approach, looking at common processes and agents more than at single classes of artifacts, seems to be the most promising way to pursue in future research.

Finally, the most striking aspect that emerged is a general and widespread lack of basic awareness about the topic. A simple change in attitude, although not sufficient, still represents a first, necessary step to achieve a better knowledge of CE in past societies. This, in turn, can lead to challenging perspectives on even bigger topics on a new, fresh basis; these include, by way of example, variations on regional basis, the issue of economic development or decay, and the investigation of patterns of urban and regional complexity through time.

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