



ELŻBIETA SZCZYGIEŁ

Pedagogical University in Kraków

Institute of Law and Economics

ORCID: 0000-0002-8804-1071

elzbieta.szczygiel@up.krakow.pl

Circular economy – a new concept or a necessity

Gospodarka o obiegu zamkniętym –
nowa koncepcja czy konieczność

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This article presents the idea of a circular economy (CE) as a practical implementation of postulates of the sustainable development of the economy. The focus is on the current situation of the use of natural resources and their capacity to meet global needs. The article has a theoretical character, enriched by presenting up-to-date statistical data concerning the use of natural resources. The main thesis of the article assumes that the CE model appears to be a proper solution for achieving sustainable development aims as it links environmental aspects with economic challenges. The aim of this article is to show the relationship between the increasing usage of natural resources and the need to save them through implementation of this complex solution. The results of the preliminary analysis indicate that the use of natural resources, corresponding to the level of global consumption, is still increasing and could threaten the possibility of meeting the needs of future generations.

Gospodarka o obiegu zamkniętym – nowa koncepcja czy konieczność

Artykuł przedstawia ideę gospodarki o obiegu zamkniętym (GOZ) jako praktyczną realizację postulatu zrównoważonego rozwoju gospodarki. Główna uwaga skupiona jest na prezentacji aktualnej sytuacji w zakresie wykorzystania zasobów naturalnych i ich zdolności do zaspokojenia globalnych potrzeb. Artykuł ma charakter teoretyczny, wzbogacony o prezentację aktualnych danych statystycznych dotyczących wykorzystania zasobów naturalnych. Główna teza tego artykułu zakłada, że model gospodarki o obiegu zamkniętym wydaje się właściwym rozwiązaniem dla osiągnięcia celów zrównoważonego rozwoju ze względu na powiązanie aspektów środowiskowych z wyzwaniami gospodarczymi. Celem tego artykułu jest ukazanie związku między wzrostem wykorzystania zasobów naturalnych a koniecznością ich oszczędzania poprzez wdrożenie kompleksowego rozwiązania. Wyniki wstępnej analizy wskazują, że wykorzystanie zasobów naturalnych odpowiadających poziomowi globalnej konsumpcji wciąż rośnie i może zagrozić możliwości zaspokojenia potrzeb przyszłej generacji.

Introduction

The world's development is usually described by using various adjectives such as constant, stable or efficient. Among these, a significant one is the word *sustainable*. This describes development in a coherent way. This concept was an effect of the long process of rethinking our vision of economic development. Based on 200 years of the history of contemporary economic thought, and going from the concept of growth to development theory, new aspects have begun to be considered. Since the presentation of the problems of the human environment by U Thant – Secretary-General of the United Nations¹ – in 1969 and the United Nations Conference on the Human Environment, which was held at Stockholm from 5 to 16 June 1972, and after acceptance of the Stockholm Declaration,² protection of the environment became the primary function of states. *Ipsa facto*, environmental aspects in the economy became more important and a crucial change in thinking about economic development has become necessary. The Stockholm Declaration coincided with the publication of the report prepared by Meadows *et al.*, better known as *The Report of the Club of Rome's Project* or *The Limits to Growth*.³ This report, aimed at analysis of the use of the world's natural resources and their sufficiency, stated that our common future depends on constraints on usage (which is caused by: *the exponential nature of human growth within a closed system, a concept rarely mentioned or appreciated in practical politics in spite of its immense implications for the future of our finite planet*).⁴ The next milestone

- 1 U Thant, *Human environment and world order*, "International Journal of Environmental Studies" 1970, vol. 1, issue 1–4, p. 13–17. (And also earlier ex. in year 1962 by R. Carson in her monograph entitled *Silent spring*, See: M. B. Teagarden, *The circular economy – Past, present, and future*, "Thunderbird International Business Review" 2018, vol. 60, p. 723).
- 2 *Report of the United Nations Conference of the Human Environment, Stockholm 5–16 June 1972*, A/Conf.48/14/Rev.1, United Nations, New York 1973.
- 3 D. H. Meadows, D. L. Meadows, J. Randers, W. W. Behrens III, *The limits to growth*, Universe Books, New York 1972.
- 4 *Ibidem*, p. 189. Further Reports of Club of Rome's brought some new findings, but their undertone was not so catastrophic as in the first one. What is worth to underline, in the first Report the expected environmental pollution will reach its maximum in 2020. It seems to be truth given the circumstances our planet is going through right now. See: *Ibidem*, p. 124.

towards the creation of the sustainable development concept was the publication of the so-called Brundtland Report in 1987,⁵ where the phrase *sustainable development* was used for the first time. It was explained by the following description: *a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*⁶ Since then, the notion of *sustainable development* has become popular. As Lang and Murphy write: *the notion of "sustainable development" quickly diffused into the main environmental discourses and received widespread attention.*⁷ It seems that the next strategic declarations, analysis reports, policy documents, etc. are based on that definition, but deepen it and present the directions for future actions. The cited authors recalled in their book the provisions from the other report, where *a collective responsibility to advance and strengthen the interdependent and mutually reinforcing pillars of sustainable development* was assumed.⁸ The three original pillars⁹ of economic development, social development and environmental protection were agreed as the main reference directions for actions devoted to the world's development. Also, an indication of the levels at which they are being considered (local, national, regional and global), allows for a better understanding and precise indications of the planned aims, objectives and tasks for each. Some authors proposed to enrich the analysed pillars of sustainability by adding other dimensions, but these propositions are not so popular or commonly used.¹⁰ The key underlying significance of the Brundtland Report is the fact that it defined two principles of sustainable development¹¹: the concept of *needs* and the idea of *limitations*. The first is connected with

5 G. H. Brundtland, *Our common future. Report of the World Commission on Environment and Development*, An Annex to document A/42/427 – Development and International Cooperation: Environment, United Nations, 1987.

6 Ibidem, p. 15 (Part I, Par. 27).

7 A. Lang, H. Murphy, *Business and sustainability. Between government pressure and self-regulation*, Springer, Cham 2014.

8 *Report of the World Summit on Sustainable Development*, United Nations, New York 2002, p. 1 (Chapter 1).

9 G. H. Brundtland, *Our common future...*, p. 12 (Part I, Par. 11).

10 A. Lang, H. Murphy, *Business and sustainability...*, p. 8; J. H. Spangenberg, O. Bonniot, *Sustainability indicators: A compass on the road towards sustainability*, "Wuppertal Papers" 1998, no. 81, p. 9.

11 R. Bermejo, *Handbook for a sustainable economy*, Springer, Dordrecht 2014, p. 72.

*the essential needs of the world's poor, to which overriding priority should be given, while the second is about the limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.*¹²

Analysing these, we notice that their time perspective is not specified, therefore we need to consider not only the present, but also the future. It also concerns needs as well as the resources required to meet them. This is the origin of the research problem concerning the possibility of reconciling present consumption needs with the possibility of satisfying them for future generations. The present paper is the first in a publication series devoted to the circular economy (CE) and sustainable development matters. The adopted layout of the article series determines that the initial ones will be mostly devoted to theoretical considerations, with subsequent ones to practical aspects based on the author's own research. In this paper – as indicated in the abstract – the focus will be on presenting the CE concept as a practical implementation of the postulates of sustainable development aimed at saving natural resources.¹³ Based on available statistical data, a primary analysis of the amount of resources needed will be conducted. The results obtained will be used to analyse the validity of the implementation of a CE, allowing the author to respond to the question: Is a circular economy a new concept or a necessity?

1. Selected aspects of the current state of natural resource usage – a global perspective

The development process requires the use of appropriate resources. The first choice concerns the use of natural ones, which are fundamental. However, if using these seems to be the one and only option for development, we need to accept constraint. Natural resources are limited and the main problem is related to the level of consumption, which means the rate these

12 G. H. Brundtland, *Our common future...*, pg. 37 (Chapter II, Par. 1).

13 Circular economy is one of the concepts that were drawn from the sustainable development agenda. See: M. A. Camilleri, *The circular economy's closed loop and product service systems for sustainable development: A review and appraisal*, "Sustainable Development" 2019, vol. 27, p. 530–536.

resources are used.¹⁴ As Sariatli accurately notes, *although the environmental burden of the humanity has been known to accelerate since the industrialization, by the new millennium 1.5 Planet Earths are estimated to be needed to support our social, economic and demographic existence.*¹⁵ Although this perspective is very serious, compared with others, it could be one of the more optimistic. Esposito and colleagues estimate that, if consumption remains at the current level, by 2030 we will need resources corresponding to two earths, while by 2050 it will be an amount similar to up to three earths.¹⁶ This is the actual scenario under the condition consumption remains at its current global level. When we use models from other countries, especially developed ones, the requirement for resources will be higher. Wijkman and Skånberg state that *if all citizens of the world would live by US standards, for instance, we would need more than 4 planet earths.*¹⁷ These kinds of calculations can be done from different points of view. One of the most popular analyses in this topic is regularly prepared by the Global Footprint Network¹⁸ and is available as a free data source.¹⁹ Apart from the publication of the raw data, the authors of the database prepare classifications of the demand for resources (the number of earths required) in countries according to, for example, income or the continent where the country is located. The overall analysis in this topic, based on research which takes the long-term horizon into account, allows the authors to calculate the number of earths required (Chart 1).

14 "Between 1970 and 2010 global resource use has grown from 23.7 to 70.1 billion tonnes, driven by population and economic growth and changing consumption patterns". See: A. P. M. Velenturf, S. A. Archer, H. I. Gomes, B. Christgen, A. J. Lag-Brotons, P. Purnell, *Circular economy and the matter of integrated resources*, "Science of the Total Environment" 2019, vol. 689, p. 964.

15 F. Sariatli, *Linear economy versus circular economy: A comparative and analyzer study for optimization of economy for sustainability*, "Visegrad Journal on Bioeconomy and Sustainable Development" 2017, vol. 6, issue 1, p. 31.

16 M. Esposito, T. Tse, K. Soufani, *Is the circular economy a new fast-expanding market?*, "Thunderbird International Business Review" 2017, vol. 59, issue 1, p. 10.

17 A. Wijkman, K. Skånberg, *The circular economy and benefits for society. Jobs and climate clear winners in an economy based on renewable energy and resource efficiency*, Club of Rome, 2017, p. 12.

18 National Footprint and Biocapacity Accounts, database, Global Footprint Network, 2019 Edition [accessed: 28 IV 2020]: <https://www.footprintnetwork.org/>.

19 On Creative Commons Attribution-ShareAlike 4.0 International License (CC-BY-SA 4.0).

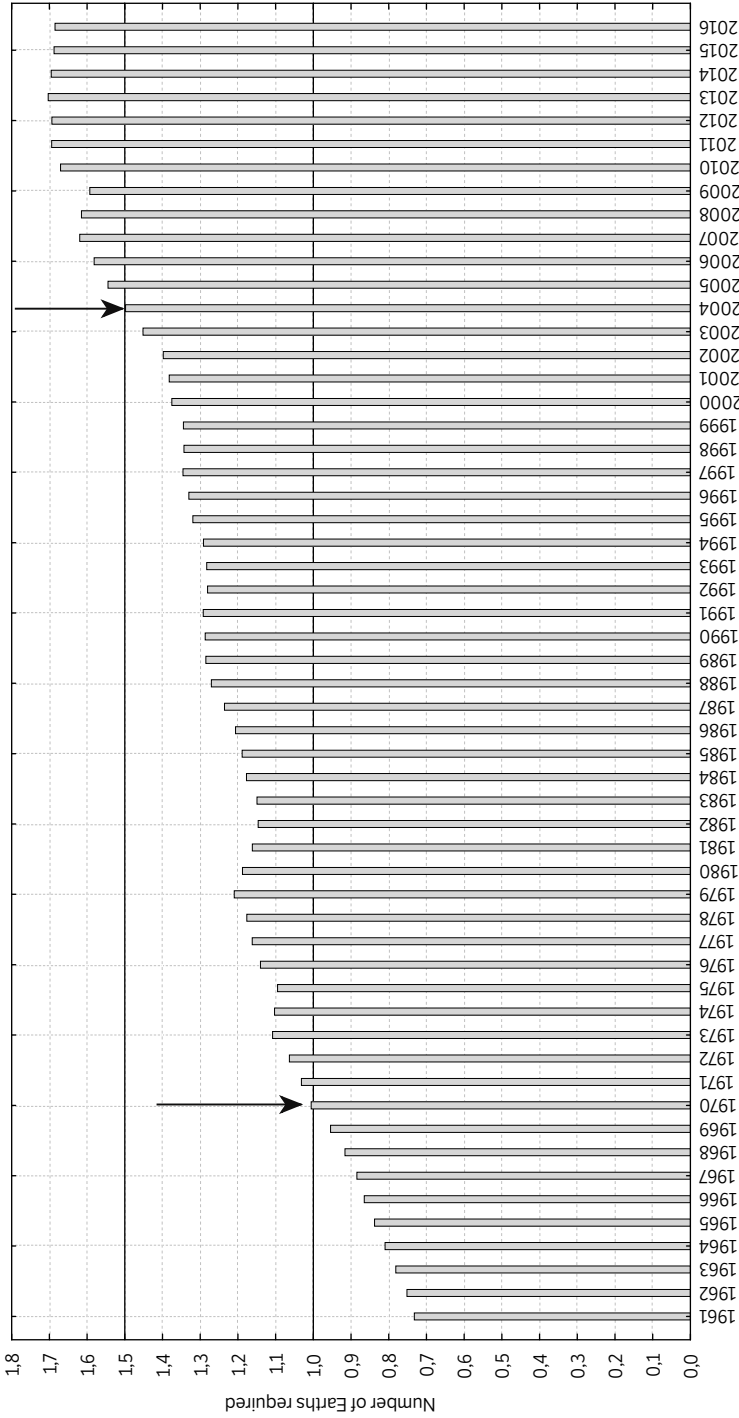


Chart 1. Ecological footprint (the number of earths required)

Source: own elaboration based on data available on the website [footprintnetwork.org](http://data.footprintnetwork.org)²⁰

²⁰ Global Footprint Network, Online resources, [accessed: 28 IV 2020]: <<http://data.footprintnetwork.org/>>.

Starting in 1961, the calculation shows that after nine years, in 1970, people at that level of consumption required one earth. Thirty-four years later, in 2005, the level of consumption had grown to an amount requiring 1.5 planet earths. The highest amount (1.70 earths) was calculated for the year 2013. Since then, it has slightly decreased (2016: 1.68). This situation has huge implications in terms of climate change.²¹

The number of earths required is not homogeneous for each country or region and depends on many factors (Chart 2).

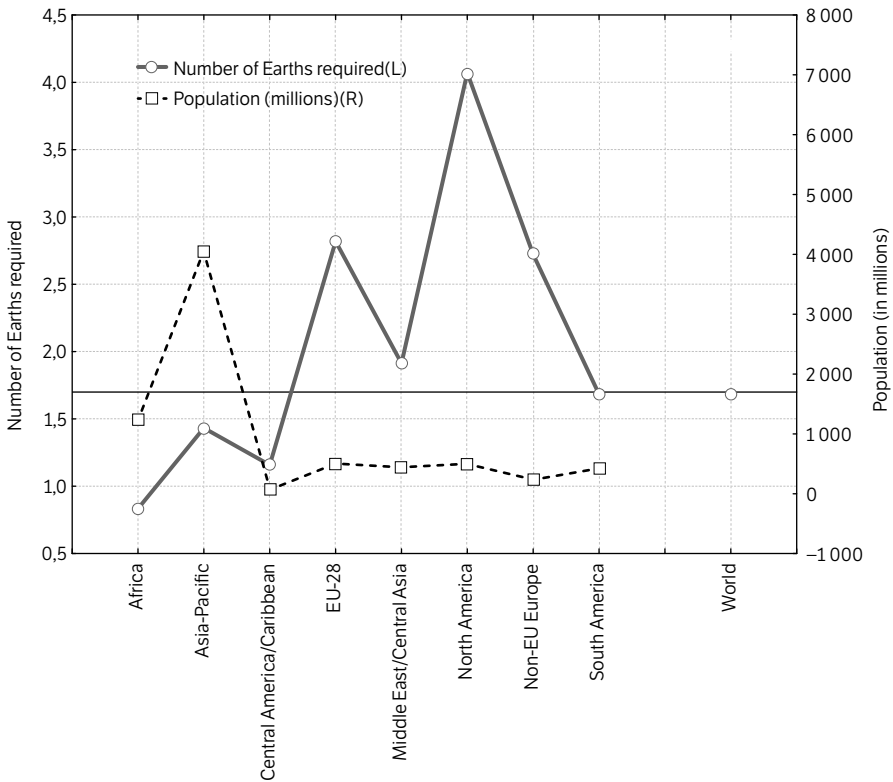


Chart 2. The number of earths required divided into global macro regions (groups of countries)

Source: own elaboration based on the Global Footprint Network database.²²

21 B. Baran, *The circular economy in EU policy as a response to contemporary ecological challenges*, "Gospodarka Narodowa" 2019, vol. 300, issue 4, p. 31–51.

22 National Footprint and Biocapacity Accounts...

Africa, the Pacific part of Asia, Central America (Caribbean) and South America require less than the average amount for the whole world.²³ Developed economies need much more. For European Union countries, the amount is calculated at a level of 2.8 earths, similar to that for the non-EU countries of Europe (2.7). For the Middle East and Central Asia, the level is lower (but higher than the average) and amounts to 1.9. The highest amount is calculated for the North American countries (4.1).

The analysis included income categories which allows the simple dependence between the higher number of earths required and higher income categories to be shown (Chart 3).

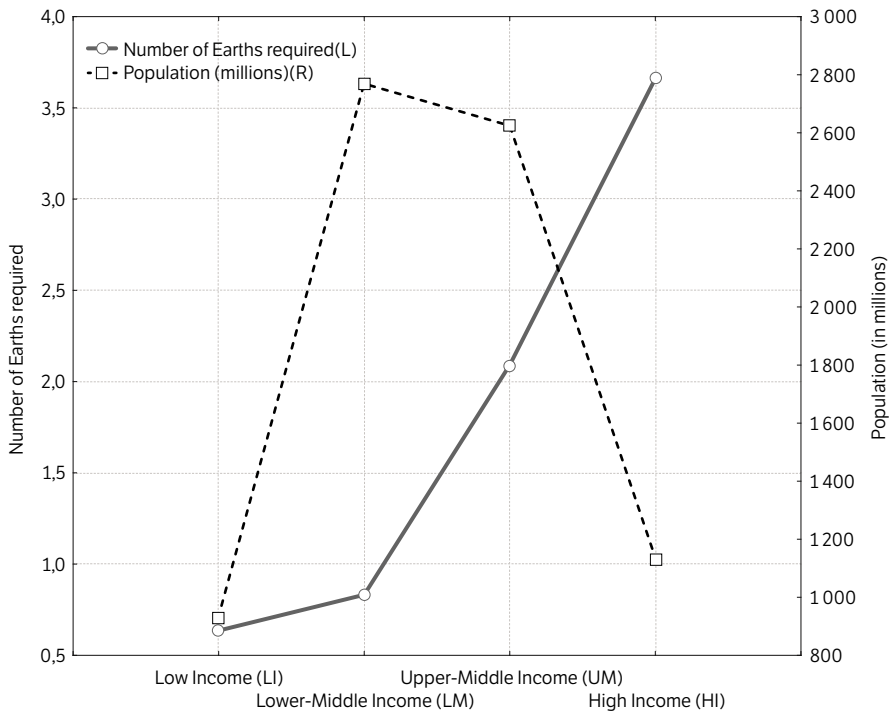


Chart 3. The number of earths required divided into groups of countries by level of income

Source: own elaboration based on the Global Footprint Network database.²⁴

23 Apart from analysis if this amount of need for resources required is positive or negative, we could assume that the average amount could be the second reference point (after the amount of 1.0).

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In low and lower-middle income countries (83 countries from a total of 187), the average number of earths required reaches 0.6 and 0.8, respectively. In the next two groups – upper-middle and high income – the number of earths required increases at a minimum of twice, to 2.1 and 3.7.

It is obvious that developed economies need resources to produce goods and to provide services, and a huge part of these are exported to non-developed countries.²⁵ The production methods are also important, often related to carbon emissions and material waste (during production as well as after the product has been used). In this case, there is a need to use an economic model aimed at reducing carbon emissions through *lessening demand for materials by increasing the life of raw materials and then substituting and reusing them*.²⁶ The CE concept seems to be such a solution. It is part of a broader concept of interdependence, analysed both in terms of the main aspects of sustainable development (economic, social and environmental) and in territorial and temporal terms.²⁷ The emphasis on each of the elements of sustainable development should be optimised to ensure balance. Economic development must not be at the expense of social or environmental development and vice versa. Similarly, the development of one territorial area should not be to the detriment of another. All

- 25 *Developing and transition economies which consists so-called Global South. North refers to developed economies. The trade between North and South amounted in 2018 US\$ 6.9 trillion which was 36% of total World's trade. See: United Nations Conference on Trade and Development (UNCTAD), Handbook of statistics, United Nations 2019.*
- 26 R. M. Deus, J. P. Saviotto, R. A. G. Battistelle, A. R. Ometto, *Trends in publications on the circular economy*, "Espacios" 2017, vol. 38, no. 58: <<http://hdl.handle.net/11449/179432>> [accessed: 28 IV 2020].
- 27 M. Zürn, *From interdependence to globalization*, [in:] *Handbook of international relations*, W. Carlsnaes, T. Risse, B. A. Simmons, Sage, London – Thousand Oaks – New Delhi 2005, p. 236; S. Zikic, *A modern concept of sustainable development*, "Progress in Economic Sciences" 2018, vol. 5, p. 143–151; Onishi A., *Futures of global interdependence (FUGI) global modeling system: Integrated global model for sustainable development*, "Journal of Policy Modeling" 2005, vol. 27, issue 1, p. 101–135; T. Bal-Woźniak, M. G. Woźniak, *O potrzebie sprzężenia gospodarki w obiegu zamkniętym z rozwojem zintegrowanym i podmiotowymi narzędziami zarządzania innowacyjnością*, [in:] *Gospodarka o obiegu zamkniętym*, red. D. Wyrwa, M. Hajduk-Stelmachowicz, B. Ziółkowski, M. Jankowska-Mihułowicz, Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszów 2021.

the more so, there should be no lack of intergenerational responsibility. It is the CE that provides balance and responsibility in this regard.

2. The idea of a circular economy – from past to present

The first time the term *circular economy* was used was by Pearce and Turner in 1990 in their book *Economics of Natural Resources and the Environment*.²⁸ The authors explain that the linear economy concept as an integral part of an economic system, where production, consumption of goods, capital goods and resources are the inputs and ignoring the environment affects its linearity. Here, *the linear economy* is understood as the traditional way of production, delivery and consumption, during which all resources used within a product's preparation process are used only once (they are not used again). The simplest way to explain this concept is included in the statement: *take-make-dispose*.²⁹ In this chain of consumption, *only the original material enters the beginning of the value chain*.³⁰ The historical roots of this approach should be sought in the uneven distribution of wealth by geographic region, when materials (resources) were the cheaper substitute of human labour.³¹ As a result, producers replaced the more expensive human labour by using more and more resources and achieving the same economic effects. Extensive resource use connected with the disposal of used products in effect means only a minimal amount of resources go back into the economy (Figure 1). As a result, this linear model of the economy causes a waste of resources which can be described as *unnecessary* (e.g., production chain and end-of-life waste, excessive energy consumption and erosion of ecosystems).³²

28 D. Pearce, R. K. Turner, *Economics of natural resources and the environment*, Johns Hopkins University Press, Baltimore 1990.

29 S. Geisendorf, F. Pietrulla, *The circular economy and circular economic concepts – a literature analysis and redefinition*, "Thunderbird International Business Review" 2018, vol. 60, issue 5, p. 771.

30 G. Micheline, R. N. Moraes, R. N. Cunha, J. M. H. Costa, A. R. Ometto, *From linear to circular economy: PSS conducting the transition*, "Procedia the 9th CIRP IPSS Conference: Circular Perspectives on Product/Service-Systems" 2017, vol. 64, p. 2.

31 See. F. Sariatli, *Linear Economy versus...*, p. 31.

32 G. Micheline, R. N. Moraes, R. N. Cunha, J. M. H. Costa, A. R. Ometto, *From linear...*, p. 2.

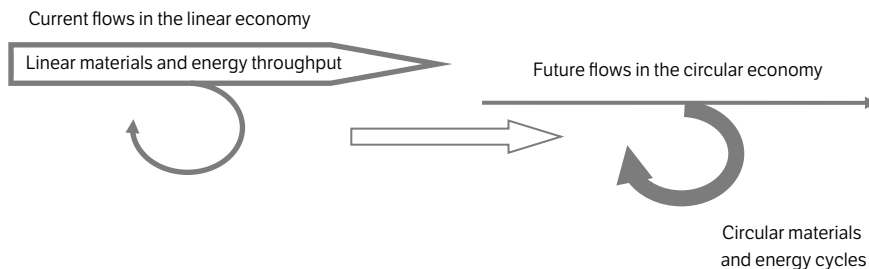


Figure 1. Moving from a linear to a circular economy

Source: Moreau *et al.*, *Coning full circle. Why social and institutional dimensions matter for the circular economy*, "Journal of Industrial Ecology" 2017, vol. 21, issue 3.

In a CE, it is the opposite way of thinking. The value of the resources and the materials used to prepare the products are maintained in the economy for as long as possible. This causes waste generation to be minimised.

This frame (assumption) looks simple, but a CE is not an easy to use concept. This is related not only with the complexity of production processes, but firstly with defining the notion of a CE and its dimensions and depths. Since Kirchherr *et al.*'s³³ crucial publication in 2017, the Web of Science database has included 3 345 articles including the words *circular economy*.³⁴ It can be seen that the number of papers concerning CE has increased exponentially, and in 2018 amounted to more than 1 000 papers³⁵ (Chart 4).

The main problem with the concept of a CE is related to *a lack of a clear and unified definition*.³⁶ In many papers, the authors use the most recent cited definitions, but in some cases, they try to explain their approach to CE by preparing their own.

33 J. Kirchherr, D. Reike, M. Hekkerts, *Conceptualizing the circular economy: An analysis of 114 definitions*, "Resources, Conservation & Recycling" 2017, vol. 127, p. 221–232.

34 Own elaboration of the Author. Some of the Authors enrich the analysis by using related keywords. See: N. M. P. Bocken, P. Ritala, P. Huotari, *The circular economy. Exploring the introduction of the concept among S&P 500 firms*, "Journal of Industrial Ecology" 2017, vol. 21, issue 3, p. 487–490; P. Centobelli, R. Cerchione, D. Chiaroni, P. Del Vecchio, A. Urbinati, *Designing business models in circular economy: A systematic literature review and research agenda*, "Business Strategy and the Environment" 2020, vol. 29, issue 4, p. 1734–1749.

35 Only in this database.

36 L. Alaerts, K. Van Ackera, S. Rousseau, S. De Jaeger, G. Moraga, J. Dewulf, S. De Meester, S. Van Passel, T. Compernelle, K. Bachus, K. Vrancken, J. Eyckmans, *Towards a more direct policy feedback in circular economy monitoring via a societal needs perspective*, "Resources, Conservation & Recycling" 2019, vol. 149, p. 363.

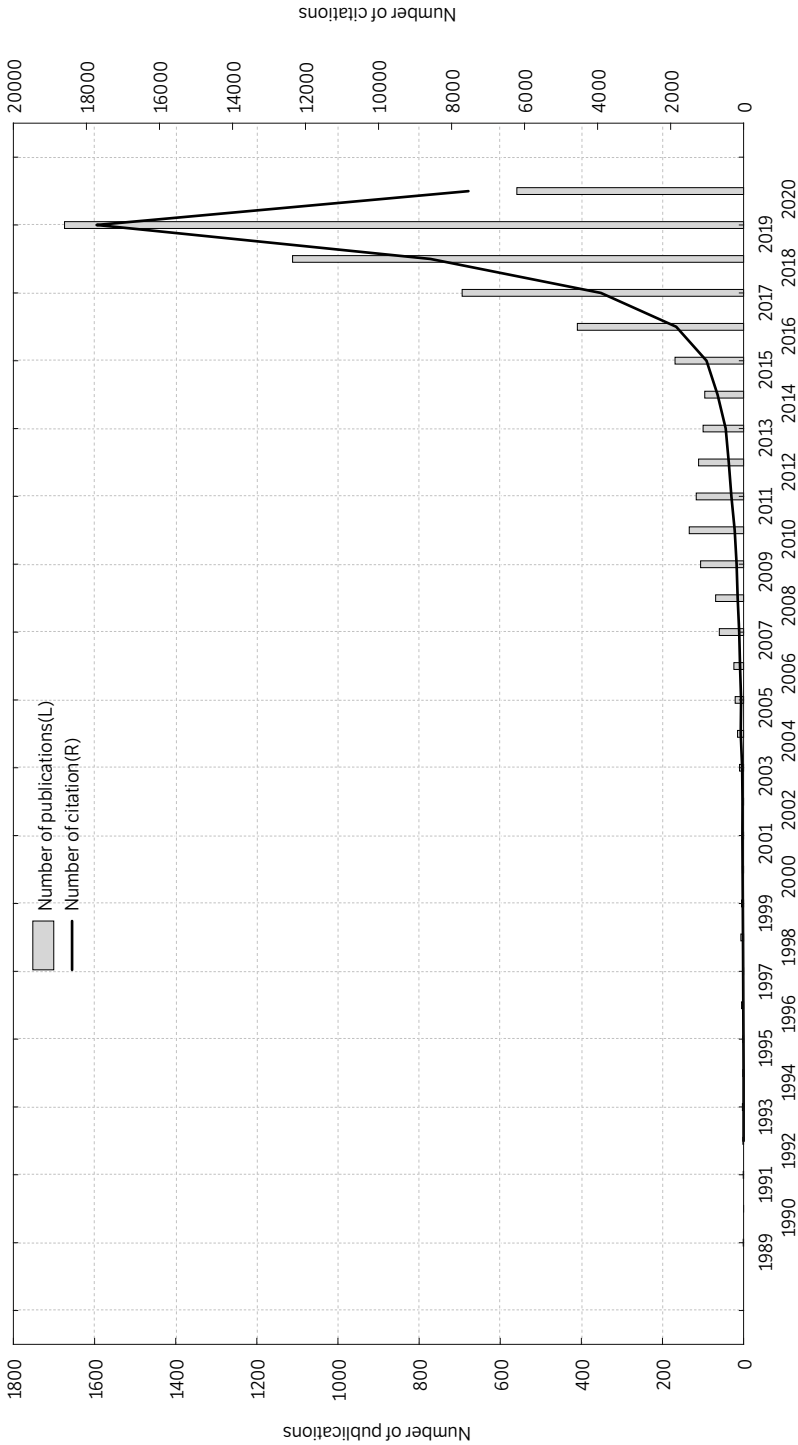


Chart 4. The number of publications including the phrase *circular economy* and overall citations in the Web of Science database (date of analysis: 25 IV 2020)

Source: own elaboration based on the Web of Science database.

This is related to the approach used for the concept of a CE. As Reike *et al.* noted, the concept of a CE was understood in a minimum of three ways³⁷:

- CE 1.0 (1970–1990s): Dealing with waste
- CE 2.0 (1990s–2010): Connecting input and output in strategies for eco-efficiency
- CE 3.0 (2010±): Maximising value retention in the age of resource depletion.

The time intervals in the above enumeration should be treated as propositions.³⁸ For example, the definition proposed in 2012 by Yu-Shan Liu underlines waste recycling and the effective use of resources: *an economy system which is characterized by the principle of sustainable growth and depends less on the depletion of natural resources than traditional economies through the mechanism of recycling the waste output of its system.*³⁹

Two of most popular definitions⁴⁰ – the first produced by Kirchherr *et al.*⁴¹ and the second by Prieto-Sandoval *et al.*⁴² – underline that a CE is *an economic system, based on the mechanism of changing (concept or paradigms) aimed at the Rs approach (see later in the article) regarding resources and implemented at various levels (micro, meso and macro), which requires innovative environmental processes to be conducted (Table 1).*

- 37 D. Reike, W. J. V. Vermeulen, S. Witjes, *The circular economy: New or Refurbished as CE 3.0? – Exploring controversies in the conceptualization of the circular economy through a focus on history and resource value retention options*, "Resources, Conservation & Recycling" 2018, vol. 135, p. 248–249.
- 38 Alternative stages of the circular economy concept were presented in paper: F. Blomsma, G. Brennan, *The emergence of circular economy. A new framing around prolonging resource productivity*, "Journal of Industrial Ecology" 2017, vol. 21, issue 3, p. 603–614.
- 39 J. Yu-Shan Liu, *Circular economy and environmental efficiency – the case of traditional Hakka living system*, "Procedia – Social and Behavioral Sciences" 2012, vol. 57, p. 255–260.
- 40 There are, of course, a number of very interesting definitional overviews of GOZ, i.e.: J. Kulczycka, E. Pędziwiatr, *Gospodarka o obiegu zamkniętym – definicje i ich interpretacje*, [in:] *Gospodarka o obiegu zamkniętym w polityce i badaniach naukowych*, red. J. Kulczycka, IGSMiE PAN, Kraków 2019.
- 41 J. Kirchherr, D. Reike, M. Hekkerts, *Conceptualizing the circular economy...*, p. 224.
- 42 V. Prieto-Sandoval, C. Jaca, M. Ormazabal, *Towards a consensus on the circular economy*, "Journal of Cleaner Production" 2017, vol. 179, p. 613. DOI: <<https://doi.org/10.1016/j.jclepro.2017.12.224>>.

Table 1. Comparison of the elements using to prepare the definitions of a CE

Element of the definition	J. Kirchherr, D. Reike, M. Hekkerts	V. Prieto-Sandoval, C. Jaca, M. Ormazabal
concept	<i>an economic system</i>	<i>an economic system</i>
mechanism of changing	<i>replace the 'end-of-life' concept</i>	<i>a change of paradigm in the way that human society is interrelated with nature</i>
aim	<i>[replace the 'end-of-life' concept] reducing, alternatively reusing, recycling and recovering materials in production/ distribution and consumption processes</i>	<i>to prevent the depletion of resources, close energy and materials loops, and facilitate sustainable development</i>
level of implementation	<i>the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond)</i>	<i>the micro (enterprises and consumers), meso (economic agents integrated in symbiosis) and macro (city, regions and governments) levels</i>
requirements	<i>accomplishing sustainable development, which implies creating environmental quality, economic prosperity and social equity, for the benefit of current and future generations</i>	<i>cyclical and regenerative environmental innovations in the way society legislates, produces and consumes</i>

Source: Kirchherr *et. al.*, *Conceptualizing the circular economy: An analysis of 114 definitions*, "Resources, Conservation & Recycling" 2017, vol. 127; Prieto-Sandoval *et. al.*, *Towards a consensus on the circular economy*, "Journal of Cleaner Production" 2017, vol. 179.

A literature review conducted by Prieto-Sandoval *et al.* allowed an indication of the four main components which should be included in the definitions of a CE⁴³:

- 1) *the recirculation of resources and energy, the minimization of resources demand, and the recovery of value from waste,*
- 2) *a multilevel approach,*
- 3) *its importance as a path to achieve sustainable development,*
- 4) *its close relationship with the way society innovates.*

We can assume that, in essence, a CE is about maintaining products and materials at their highest application level.⁴⁴ In effect, the whole economic system could be closed and many of our resources safe and used once again.⁴⁵ The actions related to the implementation of a CE should be understood as making an effort to take care of the stocks of materials while minimising their environmental impact.⁴⁶ This implies more manageable

43 V. Prieto-Sandoval, C. Jaca, M. Ormazabal, *Towards a consensus...*, p. 613.

44 L. Alaerts, K. Van Ackera, S. Rousseau, S. De Jaeger, G. Moraga, J. Dewulf, S. De Meester, S. Van Passel, T. Compernelle, K. Bachus, K. Vrancken, J. Eyckmans, *Towards a more direct...*, p. 363.

45 D. Pearce, R. K. Turner, *Economics of natural resources...*, p. 35–40.

46 L. Alaerts, K. Van Ackera, S. Rousseau, S. De Jaeger, G. Moraga, J. Dewulf, S. De Meester, S. Van Passel, T. Compernelle, K. Bachus, K. Vrancken, J. Eyckmans, *Towards a more direct...*, p. 363.

waste, recyclable resources, profitable organisations and a more sustainable environment.⁴⁷ Similarly, as in the case of a linear economy, we can describe a CE by using a set of single words: *reduce-reuse-recycle-recover*. This is one of the many propositions in the so-called *Rs* approach, which is focused not only on waste management or limiting waste, but on concrete actions dedicated to using the natural resources within the product lifecycle. The first proposition of this was the 3Rs, which means: *reduce*, *reuse* and *recycle* used materials or natural resources.⁴⁸ The deepening of this concept has brought new words describing – in fact – the proposed actions or behaviours which can be undertaken by society (also firms, institutions, and citizens) within the process of the production, consumption and recovery of goods.⁴⁹

In effect, we can now talk about the 9Rs approach,⁵⁰ which means: *refuse* (starting from R0), *rethink*, *reduce*, *reuse*, *repair*, *refurbish*, *remanufacture*, *repurpose*, *recycle*, *recover* (ending with R9)⁵¹ (Chart 5).

The order of these actions are related to their priority. It can be stated that the first one (or indicated as basic by the 0 number), *refuse*, is the most important and the most difficult, but it is related to 90% of the circularity of the economy.

47 F. Sariatli, *Linear economy versus...*, p. 33.

48 H. Yoshida, K. Shimamura, H. Aizawa, *3R strategies for the establishment of an international sound material-cycle society*, "Journal of Material Cycles and Waste Management" 2007, vol. 9, p. 101–111; A. Pariatamby, S. H. Fauziah, *Sustainable 3R practice in the Asia and Pacific regions: The challenges and issues*, p. 15–40, [in:] *Municipal Solid Waste Management in Asia and the Pacific Islands*, eds A. Pariatamby, M. Tanaka, Environmental Science and Engineering. Springer, Singapore 2014; P. Manickam, G. Duraisamy, *3Rs and circular economy*, p. 77–93, [in:] *Processing, manufacturing, and design. The textile institute book series*, ed. S. S. Muthu, Woodhead Publishing, Hong Kong 2019.

49 For example: Worldsteel Association proposes 4Rs approach with using: *reduce*, *reuse*, *remanufacture* *recycle*, see. Worldsteel Association [accessed: 28 IV 2020]: <<https://circulareconomy.worldsteel.org/>>; J. Kirchner *et al.* propose also 4R: *reduce*, *reuse*, *recycle*, *recover*, see: J. Kirchner, D. Reike, M. Hekkerts, *Conceptualizing the circular economy...*, p. 223.

50 In fact there are 10 actions, because the first one is marked as "zero".

51 J. Kirchner, D. Reike, M. Hekkerts, *Conceptualizing the circular economy...*, p. 224. In publication written by J. Cramer *refuse* is treat as the first one step, but *rethink* is missing out, see: J. Cramer, *Moving towards to circular economy in the Netherlands: challenges and directions*, Utrecht University, Utrecht 2014.

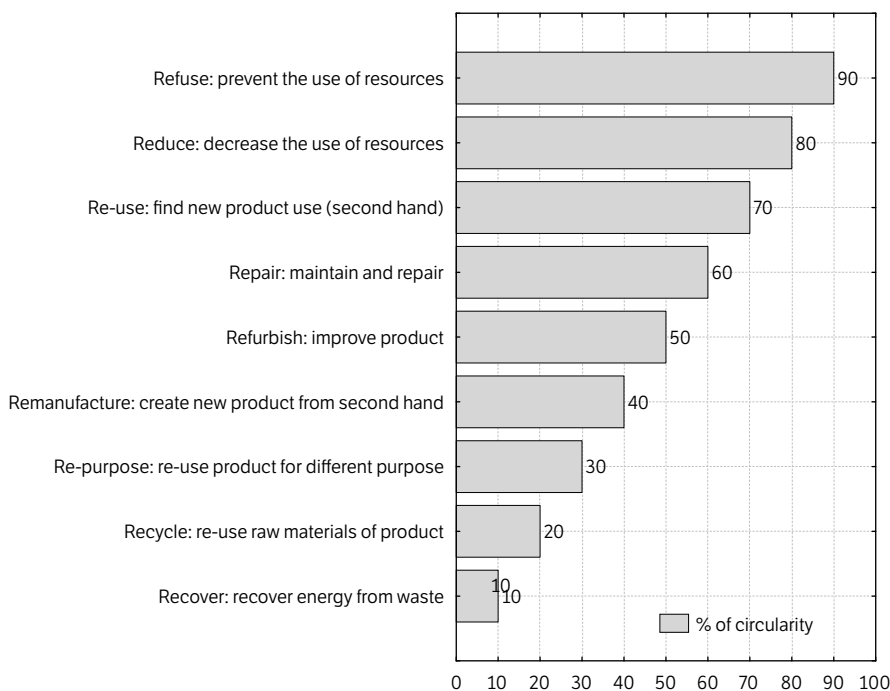


Chart 5. Levels of circularity: 9Rs

Source: Czikkely, et al., *Waste water treatment with adsorptions by mushroom compost: The circular economic valuation concept for material cycles*, "International Journal of Engineering Business Management" 2018, vol. 10.

The definition of a CE and its dimensions are not the only problems. It may seem that, despite the positive impact on the environment and our quality of life (in the long-term perspective), implementing the concept of a CE is a constant problem in practice.⁵² Many authors underline the weaknesses or limitations and the barriers to implementing it. The barriers could be divided into a few groups depending on the nature

52 This process requires a change of our behaviours. See i.a.: K. Parajuly, C. Fitzpatrick, O. Muldoon, R. Kuehr, *Behavioral change for the circular economy: A review with focus on electronic waste management in the EU*, "Resources, Conservation & Recycling: X" 2020, vol. 6, 100035 (pp. 9). However, it is not impossible, i.e. E. Jastrzębska, *Gospodarka o obiegu zamkniętym – nowa idea czy stare podejście? Dobre praktyki społecznie odpowiedzialnych przedsiębiorstw*, "Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu" 2017, vol. 491, p. 220–234; P. Nowicki, P. Kafel, U. Balon, M. Wojnarowska, *Circular economy's standardized management systems. choosing the best practice. Evidence from Poland*, "International Journal for Quality Research" 2020, vol. 14, issue 4, p. 1115–1128.

of the conditioning factor.⁵³ Due to the limit of length of this article and its introductory function for the publication series, the problem of the barriers to the implementation of a CE will be presented in a future paper.

Conclusions

Without an in-depth analysis of the reasons behind the emergence of CE, the concept can only be regarded as a new trend in the economy (a kind of something that is fashionable but without much significance for the economy, and as happens with novelties, it may remain a fad that disappears). Linking this topic to environmental issues could lead to rethinking our consumption patterns. Analysing specific, aggregated data, not just referring to individual resources, enables a comprehensive look at the condition of our world. The data presented in this article indicate the growing rate of the use of natural resources, which affects the growing demand for them. On the one hand, this is the natural process of growing the economy, but – on the other – the increasing rate of demand is dangerously high. Now, we need 1.7 earths to meet our needs, and the scientific predictions are not optimistic. We will need more and more. Due to the fact that natural resources are only partially renewable, there is an urgent need to save resources through extending their usage. Only their repeated use could save the supply. The concept of a CE closes the production and consumption loop. From this point of view, resources are saved by using them at least once more, and – in effect – limiting the need to extract new resources. Bearing in mind the earth's capabilities in terms of natural resources, and not limiting analysis to the needs of only our generation, we need to take steps aimed at meeting the needs of our descendants. This is one of most important assumptions of sustainable development, according to which our common and future behaviour will be the same or at the same level (as the word *sustain* indicates). If we want to ensure the possibilities for future

53 G. D. Araujo Galvão, J. de Nadae, D. H. Clemente, G. Chinen, M. Monteiro de Carvalho, *Circular economy: Overview of barriers*, 10th CIRP Conference on Industrial Product-Service Systems, IPS2 2018, 29–31 May 2018; J. Hart, K. Adams, J. Giesekam, D. Densley Tingley, F. Pomponi, *Barriers and drivers in a circular economy: the case of the built environment*, "Procedia CIRP – CIRP Life Cycle Engineering (LCE) Conference" 2019, vol. 80, p. 619–624.

generations to live as we would like to live, we have to guarantee the availability of resources. A CE meets this requirement, so we should accept that this is not only a concept, but a necessity.

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