

Article

An Incursion into Actuality: Addressing the Precautionary Principle in the Context of the Circular Economy

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Abstract: The circular economy (CE) and the precautionary principle (PP) are two current and contemporary notions; however, they are far from being sufficiently explored and exploited, since each is considered questionable in part. Sensing a niche at the conceptual and scientific research level regarding the unitary approaches of the CE and PP, we carried out a parallel analysis of the notions of the CE and PP with the aim of evaluating and identifying areas of manifestation and interaction. By superimposing the two concepts in feasible situations and analyzing one notion in connection with the other, within the presented examples, the particularities of the CE–PP manifestation were obtained, as well as the consequences of the non-uniform application of the mentioned factors. Also, the results of the research support the hypothesis of the compatibility between the CE and PP in certain cases and attest to the usefulness of the PP in fulfilling the wishes of the CE. Despite the generally parallel existence of the CE and PP, these concepts are not mutually exclusive; the CE cannot be manifested discretarily but only with certain standards and limits including the requirements imposed by the PP. The results obtained, combined with the provision of an analysis of the current state of knowledge in the field, make the proposed study a useful material for future in-depth research activities on the topic.

Keywords: circular economy; precautionary principle; compatibility; environment; resources use



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1. Introduction

The accelerated evolution of society has inevitably triggered various changes in the environment, including changes in climate and space, a decline in biodiversity and the biosphere, damage to ecosystems that support life on Earth, and an alarming increase in water and air pollution as well as the quantity of waste, all to the detriment of depleting resource reserves. In this context, aspects related to the re-evaluation of relationships and human activities related to the environment have been gradually highlighted. Thus, interventions have been made through legal, economic, political, educational, and environmental channels to limit and counteract the negative consequences to nature and the environment. The reconsideration of the human–environment–science relationship in a period marked by modernization through a galloping technological evolution has been seen as imperative.

Globally, the growing popularity of the concept of the circular economy (CE) in the context of exacerbating the inefficiencies of the linear economic system and the accentuation of environmental problems [1–7]. The circular economy was conceptually perceived as a new area of research [1,3], as a current economic model in continuous metamorphosis, which is very dynamic and does not benefit from a singular definition despite the multitude of attempts to crystallize it theoretically [1,3,4,8–12]. In this sense, it is worth mentioning the approach of Kirchherr et al. (2017) [10] on the conceptualization of the CE in light of a

selection of 114 definitions, which concluded that so far, no systematic and comprehensive analysis specific to the current understanding of CE has been carried out [10]. Although the number of theoretical approaches and studies has increased tenfold in the last decade thus showing a rapid increase [3], it is considered that the CE field continues to remain a fertile environment for in-depth scientific analysis, which requires perseverance in academic research, crystallization, and improvement of its theoretical sphere, more so as its conceptual framework is improperly structured, fragile, and can be exploited in an inefficient manner [13].

The literature [13] considers that the CE has a strategically chosen name, intended to capture attention. The essence of this concept expressed somewhat historically by EMAF [14] has been taken over, reconsidered, and nuanced in various forms depending on the area of manifestation of the actors. Thus, from a purely theoretical perspective, the CE is perceived in a plastic way as an “umbrella” concept incorporating different meanings that include lowering material input and minimizing waste generation to decouple economic growth from natural resource use [15] (p. 452). Developed at the institutional level, the definitions capture a circular economic model capable of protecting against resource scarcity, volatile industry prices, and energy waste; creating new jobs; and supporting social cohesion, thus helping to avoid irreversible damage to the climate and biodiversity [16]. Therefore, in this vision, the CE becomes a system in which the maintenance and optimal use of resources, products, and materials prevail while minimizing the generation of waste. The definition of the CE states that these guidelines are not limited to economy and industry but extend to the entire way of life of both the population and the individual [17]. Over time, the CE has steadily gained support in terms of its promoted values and promised benefits. Circular economy initiatives have mostly been identified in Europe (with a minority being roughly equally distributed between East Asia and North America) [18] and cover extremely important issues, such as the reduction of environmental pressures, management of the production–consumption relationship, management of waste (estimated at around 2.5 billion tons per year in the EU), consumption of raw materials, moderation of energy consumption, and reduction of CO₂ emissions by 2–4%, as well as other greenhouse gases, encouraging competitiveness and stimulating innovation [19]. Although the theoretical opportunities offered by the circular economic model are considered categorically superior compared to the prospects of the linear economic model, unfortunately, it is believed that a mentality based on the linear economy still predominates in several companies [20]. In order to reap the benefits of implementing the circular economic model, concrete objectives and directions of action have been set at the EU level. These include achieving climate neutrality by 2050 [21,22], rethinking recycling and setting targets for the consumption and use of materials for 2030, transitioning to sustainable products [22,23], combating “greenwashing” and programmed obsolescence (i.e., limited product life), strengthening consumer rights and the right to reparations, and transforming key sectors into circulars and areas of extreme importance where circularity needs to be implemented (waste, electrical, and electronic equipment; plastics; textiles; building and construction; packaging; batteries and vehicles; water and nutrients; and food) [24]. In connection with the systematic promotion of the CE, another growing trend has been noticed, that is, the understanding, analysis, and deepening of its conceptual pillars. The principles promoted by the circular economic model have undergone some theoretical “grinding” and adaptation to the practical realities imposed by the transition to the CE and its implementation. The results of these processes are reflected in the new business models being promoted, which are more focused on innovation, resource management, and waste resulting from economic activity, for example, circular suppliers, extending the life of products, product recovery, the product seen as a service, and platform sharing [25].

The context generated by contemporary “economic expansion” imposed the need to adopt a community environmental policy (Paris European Council, 1972), with the specific aim of protecting Europe’s natural heritage and “greening” the economy [26], the rational use of resources, the conservation of environmental quality, and the protection of human

health (Single European Act, 1987) [27]. The “environment” became an official part of European community policies with its attestation through the Maastricht Treaty (1993) and later, the Amsterdam Treaty (1999) and the Lisbon Treaty (2009); therefore, the promotion of sustainable development has been integrated into EU sectoral policies [27]. Environmental policies are based on principles such as the precautionary principle (PP), the principle of prevention, the “polluter pays” principle, and the principle of correcting pollution at the source. The PP is in a delimited position, having been assimilated into an effective risk management tool that is able to lead, for example, to the provision of instructions on the removal of a product from the market or the prohibition of the distribution of a product in the case of uncertainties related to the potentially dangerous effects of the product, which has been confirmed by an objective scientific assessment [27,28]. Therefore, in the above sense [27], in the risk management process, the application of the PP can be invoked in a situation where a scientific uncertainty attests to a potential risk (including one arising from the political sphere or a certain action) to the environment or human health. Considering the preconditions to be met for the application of the PP, it is necessary to identify the potential adverse effects and evaluate the available scientific data to qualify the degree of uncertainty [28]. Summarized as “a need for an anticipatory and prudent approach to decision-making in the interests of Sustainable Development” [28] (p. 175), the PP has been proven to function as an essential guide for EU action (at all its political and decision-making levels), accounting for its insertion in 2004 into over 50 multilateral agreements.

Assessing the size and “acceptability” of a risk is a prerequisite for the applicability of the principle in question, more so as it operates mainly to prevent environmental events and not the subsequent management of the consequences or inconveniences caused [29].

Although the principle has been promoted globally in environmental legislation while governing relevant international agreements, it remains by far a general one, theoretically accepted and understood [30–32]. In a sense, it is vehemently contested and is not considered a principle by law, but rather a maxim, a possible excuse in the case of questionable and arbitrary decisions, an inadequate principle, a spurious principle [33], and a veiled extension of trade protectionism [34].

Moreover, having been perceived as imprecise and vague with a general lack of legal content [35] and as incoherent and trivial [36], in a sense [36,37], this principle does not seem appropriate to function as a regulatory standard or a sufficient basis for public policy.

In an antagonistic and extremely positive view, however, the precautionary principle is considered to provide a useful general guideline [35] and to have the capacity to develop new psychology on the integration of prevention policy into parameters of action or decisions in the case of uncertain or unknown risks [38].

Coupled with the Aristotelian conception, it results in a significant ethical principle that is meant to provide important landmarks in the context of contemporary reality for decision-making practices [39].

Other opinions present the PP as one of the most important current principles of international environmental law [40] and it has been the subject of numerous specialized studies. It has been implemented in environmental legislation, taking as an example the Swedish model [41]. A hypothetical waiver (considered in 2017 in France) of the PP (included in the Constitution) led to alarming prospects that it would lead to “truly incalculable consequences, possibly with the effect of a snowball for other European states” [42]. With substantial applications in positive law and French jurisprudence, the PP has established itself as a constitutional principle in the true sense, given its intrinsic evolution and its institutional consecration [38].

Despite the differences of opinion, the wide range of areas in which the mentioned principle operates is noticeable. It has been attached to general aspects of environmental and health policies [35]; used to target specific environmental and health issues (ocean dumping of pollutants, human exposure to radiofrequency fields) [34]; used to generate new approaches in the context of rising global temperatures and the greenhouse effect [32]; invoked in the banning of certain categories of pesticides, the protection of endangered

species, the management of fisheries, and more recently, the context of evolving technologies dedicated to commercial drones [43]; applied in the field of food security and trade policies [44]; invoked in the protection of the ozone layer, the conservation of biodiversity, the application and identification of the degree of safety of new technologies, as an intervention in the problem of genetically modified organisms (GMOs) [43], and in the protection of health and food consumption (consumer and health protection) [34]; and used as a mechanism for promoting sustainable development [45].

Recent decades have seen developments in the legal framework for the application of the circular economy concept, an increase in the importance of this economic model, and an acceleration of the efforts of decision makers in the transition to a global circular economy [46–49].

In parallel, there is a strengthening of the PP's position by promoting it as a basis for public policies [50] and including it in the political visions of national governments [40]. In addition, courts in the EU have recently chosen the status of "rule enshrined in Community law" for this principle as a response to the urgent needs dictated by the surrounding socio-economic reality to attest to a vigorous and influential precautionary principle (for example, the ban on the genetic manipulation of human germ cells, the import into the EU of hormone-treated meat, the ban on the use of certain categories of pesticides in agriculture in some EU countries [39], and the ban on the export of UK beef in the context of the risks of "mad cow disease" [28,44] were instituted under the PP).

Moreover, along with other principles (the principle of preventive action, the "polluter pays" principle, and the principle of priority correction of damage to the environment), the PP is definitively established as a basic principle in European environmental policy [38]. In addition, we are reminded of the provisions of art. 191 al. 2 of the Treaty on the Functioning of the EU [51], which gives this principle the status of guarantor of a high level of environmental protection by taking preventive decisions in the event of risks.

Therefore, based on the above, the following observations are considered optimal regarding the practical application of the PP in the perspective of the circularity of the economy:

- It is necessary to develop environmental legislation for the application of the PP. The initiation of legal and economic instruments and the support of national programs that include strategies and directions of action in the economic and environmental sphere in accordance with the requirements of the PP are mandatory steps to be taken.
- It is useful to extend the proportional application of this principle in relation to the evolution, needs, and dangers that threaten the environment, safety, and well-being of society.
- It is estimated that limiting prejudices regarding the PP determines its easier absorption/implementation, thereby increasing its usefulness as a guide for economic processes and environmental protection activities.
- A consequence of the aspects previously highlighted is the need for the immediate application of this principle even from the first manifestations of a catastrophic event.
- Promoting preventive educational and informative tools and appropriate behavior in the context of the accelerated evolution of society to anticipate and reduce the dangers is more or less scientifically validated.
- Correlatively, in the socio-economic context, the identification and implementation of the safest technologies and ways of materializing the needs of society are crucial.
- The objective analysis of the benefit–effective measure equation by initiating the action or omitting the initiative is a condition for progress in the PP implementation process.
- The perseverance in the academic research of the PP and the CE allows a refinement of the conceptual aspects of the two notions and their assimilation as naturally as possible in order to implement them practically.

Interdisciplinary scientific research also imprints coherence and fluency in the application of the PP and offers innovative visions and solutions in the CE implementation process.

Having identified the niche regarding the theoretical approaches and the nuances of the precautionary principle with regard to its application in the sphere of the circular

economy, in the following sections we propose the analysis of these two notions. Thus, Section 2 (Methods) records two distinct activities: the comparative interpellation of the conceptual substratum specific to the CE–PP associated literature and an analysis of some examples (including European jurisprudence) of incidences of the PP from the perspective of the circular economy model. The purpose of this approach is to present the answers on the topicality and usefulness of the precautionary principle in the current framework of the circular economy, which is the information contained in Section 3 (Results and Discussions). Furthermore, the issue of PP–CE compatibility is addressed, resulting in a redefinition of the circular economy in terms of the applicability of the precautionary principle, and offering suggestions for improving synopses in the application of the PP. Section 4 (Conclusions) contains the necessary conclusions to the study.

The purpose of this paper is to analyze the possibility of complementarity between the CE and PP, as well as evaluate the areas of manifestation and interaction where the two concepts overlap in feasible situations. The working hypothesis is that on a case-by-case basis, the CE cannot exercise discretion except with certain limits including those imposed by the requirements of the PP. The PP functions as a valuable auxiliary tool for guidance and support for the implementation of the CE.

Thus, the question arises regarding the degree of compatibility between the two notions and the possibility of identifying their areas of confluence when applied to known practical situations. As a result of the research approach, a contribution to the degree of analysis and knowledge in the field is generated by addressing the issue of the two concepts in parallel for the same case. The case of *Băcilă v Romania* (2004) (the “*Copșa Mică*” case) is analyzed through the prism of the CE and PP alike, with the possibility of identifying their areas of congruence.

2. Methods

The chosen research methodology has a double purpose: on the one hand, it aims to “probe” the conceptual substratum characteristics of the notions of the PP and CE, and on the other hand, it aims to foray into the practical applications of the PP by identifying the aspects related to the characteristic specificity of the CE. In accordance with the specified purpose, the research methodology was structured on two levels: in the first stage, the specialized literature and non-academic sources (press and political documents, press releases, NGOs) were studied in order to obtain a palette of information as diverse as possible on the proposed topic. Thus, during the documentation process carried out between January 2021 and May 2022, the following scientific databases were queried: Web of Science, ScienceDirect, Google, and Google Books Ngram Viewer. The keywords used were “circular economy” (avoiding the use of synonymous terminology so as not to generate false-positive results) and “precautionary principle”.

In the second phase, we proceeded to identify the manifestation and application of the PP and natural “intrusion”, which is inherent in this principle in the circular economic context, in order to support the compatibility of the PP–CE. The intention of the second section of the research methodology is to analyze so as to obtain a position on the PP in the current context of the CE and to identify the scope of congruence of the concepts analyzed by identifying their level of symbiosis. This approach was taken by referring to the literature consulted using the following methods: application of conceptual comparative analysis on the dynamics of the CE–PP evolution, distribution of the two concepts by areas of interest, and identification of their areas of interference and association. Not least, the research methodology was based on the analysis applied to some examples from European jurisprudence in order to highlight the diversity of the incidences of the PP and to support the consolidation of its position in international law.

3. Results and Discussion

The research conducted using the methodology led to a series of results that highlight some key questions: How current is the precautionary principle (PP) in the context of the circular economy (CE)? To what extent are the PP and CE compatible?

Thus, according to Google Books Ngram Viewer, a somewhat parallel coexistence of the two concepts for a specific period of time (2000–2008) was identified. Starting with the period 2012–2014, there is an increasing trend (which will be maintained for the next period) in terms of interest in the CE, which is synonymous with validating the positive trends in the development of this notion (Figure 1):

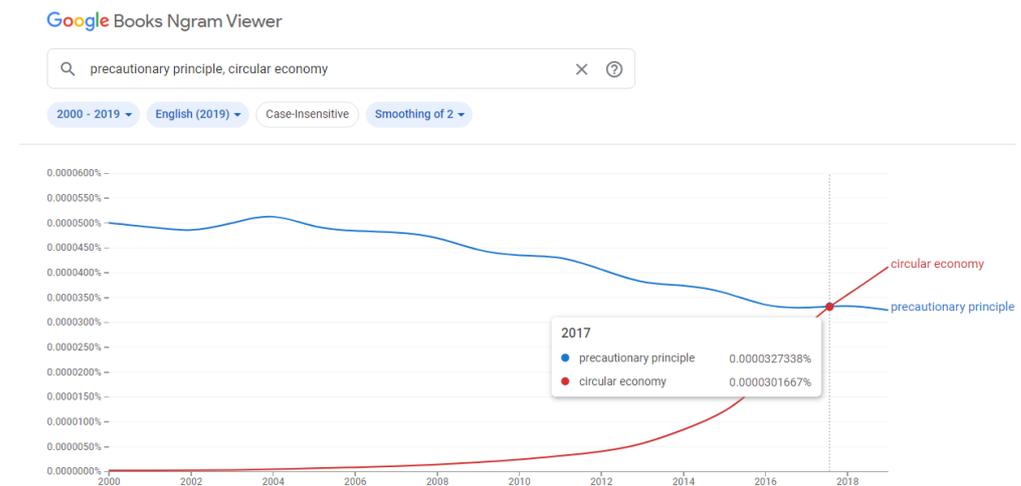


Figure 1. The evolution of the theoretical spheres related to CE and PP concepts between 2000 and 2019.

The comparative evolution report of the concepts is also reflected in the number of papers published between 2000 and April 2020 that have as keywords the terms “circular economy” and “precautionary principle” (according to Scienedirect). There is some consistency regarding the “literary evolution” of the PP throughout the period, unlike the CE, which shows a rapid growth (Figure 2):

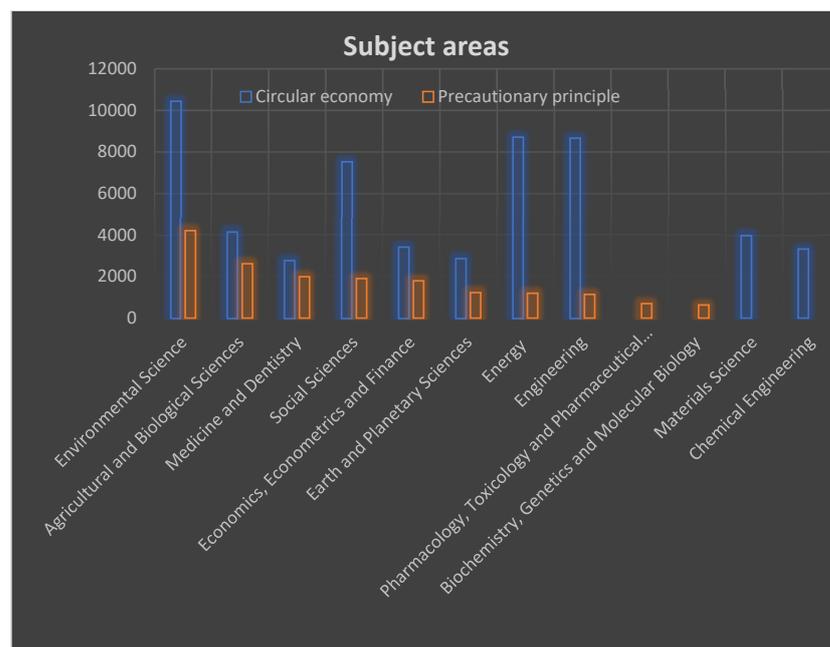


Figure 2. The literary evolution of CE and PP concepts.

The conclusion obtained after the incursion into the theoretical sphere of the manifestation of the PP and CE leads to the idea of a more parallel coexistence of the two analyzed notions without signaling extraordinary interactions or associations in a conceptual plan. With regard to the PP, some stagnation can be seen in its evolution at the theoretical level, whereas the notion of the CE enjoys a distinct rise.

The concept of the circular economy is a topical one and is vast, dynamic, in perpetual progress, and impossible to limit in a spatial-temporal context. The circular economy has become a natural and ubiquitous component of the global economy in recent years. This is indicated by the evolution presented in the specialized literature (Figures 1 and 2). The results show that, until the period 2010–2011, the upward trend of the CE in the literature was relatively low; however, as seen in the slope on the right-hand side, there is an increase in the development speed of the analysis of this topic, after 2012.

In analyzing the evolution of the CE for different fields of activity (Figure 2), we observed the key sectors in which the implementation of the CE mainly takes place. Thus, the most important concerns regarding the feasibility of applying the CE concept are found, in particular, in the areas of environmental, social, energy, materials, and engineering sciences.

The CE is perceived as a new, emerging perspective on sustainable development [52]. As a result of increasing environmental awareness, the last two decades have seen a redefinition of the consumption–production equation and a resizing of activities to protect the environment and achieve sustainability [53]. The idea of harmonizing the deficiencies registered at the industry–ecology level can be achieved through the appropriate use of various legal, technical, economic, and innovative instruments by promoting environmental policies, implementing the concept of ecological modernization [54], and applying the precepts of the circular economy as faithfully as possible.

Although it was anthropomorphized by its ardent supporters into a hero capable of saving the environment and streamlining the world economy [12], it should be noted that this model cannot function alone economically and cannot be implemented unilaterally without the human factor supported by appropriate auxiliary tools (theoretical and practical). From the synthesis of these means, the precautionary principle is highlighted as one of the controversial European environmental principles that converges toward the conceptual basis of the CE, and its practical contribution to the CE implementation process will be established later on.

The PP has registered a presence in the global economic context in recent decades. This fact is confirmed both in terms of its conceptual evolution in the literature (Figure 1) and in terms of the interest given to this notion for its application in different spheres of interest (Figure 2). Although the results attest to an inconsistent trend in its evolution for the period 2000–2008 and a slightly decreasing trend starting in 2017 (Figure 1), the applicability of the PP demonstrates a diversified palette of spheres of interest (Figure 2).

It is considered that the precautionary principle has a defining role in guiding environmental protection and sustainable development [29], being perceived as an influential mechanism in terms of risk assessment. It can be invoked in the event of “the existence of a scientific uncertainty as to a possible risk to human health or the environment, arising from a particular action or policy” [27,55], and is therefore considered to be a principle of anticipation [56].

Using the association of the CE and PP in the form of the search term “circular economy and precautionary principle”, a largely unfavorable result is obtained (according to Web of Science) which reflects the small number of papers that included the intended association (Figure 3).

From the point of view of the analysis of some examples from European jurisprudence [57] where the principle is incidental among other principles of law, it is found that the PP operates in a variety of situations and areas and has the legal capacity to function as an independent element to direct a case in a legal context. This aspect is equivalent to the idea of consecrating the legal norms of the PP objectively and undoubtedly in the sphere of European jurisprudence [38] (p. 37).

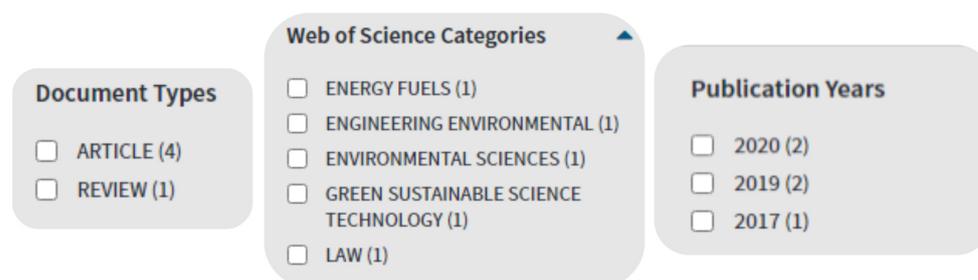


Figure 3. The results regarding the association between the CE and PP concepts.

(Note: Although the examples provided are relevant in terms of the wide range of applications of the PP, the legal aspects of these cases are not dissected in this work as this would go beyond the proposed topic, making it difficult to understand.)

From the case studies identified and presented in Table 1, in order to carry out an applied analysis from the point of view of the existence of interference zones between the CE and PP, the *Băcilă v Romania* Case (2004) (the “*Copșa Mică*” case) was chosen [58], which, due to the specificity of its matter, can illustrate the possibility of applying both the CE and PP.

Table 1. Examples from European case law in which the application of the precautionary principle was incidental.

Case	Involved Parties	The Object of the Case
Case T-13/99 [59]	Pfizer Animal Health SA (Belgium) v Council of the European Union	Transfer of resistance to antibiotics from animals to humans
Case T-70/99 [60]	Alpharma Inc. (USA) v Council of the European Union	Transfer of resistance to antibiotics from animals to humans
Joined cases T-74/00, T-76/00, T-83/00, T-84/00, T-85/00, T-132/00, T-137/00, T-141/00 [61]	Artegoda GmbH and Others v Commission of the European Communities	Medicinal products for human use
Case T-392/02 [62]	Solvay Pharmaceuticals BV (Netherlands) v Council of the European Union	Community authorization of an additive, Nifursol, in feed products
Case 19234/2004 [58]	<i>Băcilă v Romania</i>	The pollution generated by the Sometra plant (<i>Copșa Mică</i> , Romania) is claimed to be responsible for the serious damage to the health of the party and the environment
Case T-257/07 [63]	French Republic v the European Commission	Animal health: protection against transmissible forms of spongiform encephalopathy (sheep and goats)
Case C-343/09 [64]	Afton Chemical Limited (United Kingdom) vs Secretary of State for Transport	Use of metal additives in motor fuels: content limit of methylcyclopentadienyl manganese tricarbonyl (MMT or MCMT)
Case T-584/13 [65]	BASF Agro Bv (Netherlands; BASF is a producer and trader of fipronil at the EU level) and Others v the Commission of the European Union	Conditions for the authorization of the active substance fipronil; prohibition of the use and sale of seeds treated with plant protection products containing the active substance fipronil
Case T-433/13 [66]	Petropars Iran Co (Iran) v the Council of the European Union	Common foreign and security policy: restrictive measures taken against Iran for the purpose of nuclear proliferation
Case T-719/17 [67]	FMC Corporation (USA) v the European Commission	Phytosanitary products, active substance DPX KE 459 (flupirsulfuron-methyl/FPS), broad-spectrum herbicide used for some cereal crops
Case T-251/18 [68]	International Forum for Sustainable Underwater Activities (Spain) v the Council of the European Union	Fishing: conservation of the biological resources of the sea

Historically speaking, the case started in 1939 in the town of *Copșa Mică* (Sibiu County, Romania) with the commissioning of a zinc and lead processing plant from mining concentrates in the area adjacent to a carbon black factory [69]. This type of industrialization

specific to communist states had a strong negative impact on the environment and the health of the population (acid rain; “black snow”; slow poisoning from zinc; lead and sulfuric acid factories; the decrease in average life expectancy to a maximum of 60 years; and the contracting of various ailments such as heart disease, vision impairment, loss of hair and teeth, and the registration in 1950 of the first cases of professional saturnism) [70], and the policies of the time not taking into account sustainable development, sustainability, and to a lesser extent, the principles of the CE and PP. In 2004, as a result of the activity of the Sometra plant (abbreviation of Societatea Metalurgică Transilvană), a non-ferrous metals company controlled since 1998 by Mytilineos Holdings (Greece), the Romanian state was sued in court. A ressortissant of this state (represented by a Romanian NGO, the Organization for the Defense of Human Rights) pursuant to art. 34 of the Convention for the Protection of Human Rights and Fundamental Freedoms notified the Court on 27 January 2004, submitting in this regard request no. 19234/2004. The object of the notification concerned the pollution generated by the Sometra company, which seriously affected the health of the local population and the environment. Furthermore, the passivity of the authorities regarding the remediation of the massive pollution in the area was invoked. The evidence submitted demonstrated a high degree of water, air, and soil pollution, with a strong negative impact on the quality of life of the population and the environment (for example, the analysis bulletins issued for the period July–October 2000 attest to constant pollution of the air in the area, registering values of more than 30 times higher than the maximum allowable limits) [58].

The contractual clauses assumed by the Greek buyer (referring to the obligation to invest USD 3 million for “increasing the degree of the recovery of sulfur dioxide from the gases from the agglomeration of zinc-lead concentrates, by modernizing the sulfuric acid factory”) were not respected [71]. Thus, the industrial by-product, namely sulfur dioxide, was not recovered in order to be re-introduced into specific technological circuits, thereby becoming a strong polluting element having a strong impact on health. These details attest to the existence of an example of non-compliance with both the CE and PP. Therefore, this emblematic case can be viewed and analyzed on the one hand through the prism of the implementation and (non)respect of the values that are the basis of the concept of the CE, and on the other hand, from the perspective of the PP.

The non-assumption of another contractual clause by the buyer of the Sometra factory (regarding the greening of the slag dump) [72], leads to the idea that non-compliance with the CE principle also led to non-compliance with the PP, a sign that these two principles are closely related.

Slag, as an industrial by-product, can be easily introduced as a raw material in various technological processes, thus ensuring the implementation of the CE. However, for this purpose, preliminary preparation and treatment activities are necessary for it to be able to function as a quality raw material. In the present case, this greening required a lower degree of effort, “the greening of the current dump by waterproofing the slopes, covering it with a layer of clay, covering it with a layer of fertile soil and fixing it with a vegetal carpet”, followed by “making new ecological landfills on a new site with waterproofing of the substratum, drainage and collection system for meteoric waters percolating the ramp, station for neutralization and disinfection of the resulting waters and their evacuation into a surface watercourse” [72,73].

In addition to the two aspects reported, in the case of Sometra, a series of other pollutants were also identified in the form of powders and gases in which the content of lead and other toxic metals (cadmium, sulfur, zinc) was recorded [72,74–79]. Even in this case, the CE and PP implementation methods were not applied, which led to a high degree of water, air, and soil pollution. A risk analysis, a key element of the PP, would have highlighted the need to take measures to prevent polluting emissions. An analysis of the specialized literature would have highlighted the negative implications for the population, flora, fauna, and the entire ecosystem, as well as the economic consequences.

A study by the Lucian Blaga University in Sibiu (Romania) regarding the Copșa Mică case, highlighted the impact on the ecosystem, the disappearance of some species of spontaneous flora, the degree of degradation and erosion of the soil, the damage to fauna through the nutritional reduction of the biomass, and perhaps more importantly, the decrease in the level of the health of the population, especially children, through the appearance of the “Copșa Mică syndrome” (anemia, delayed ossification, extreme metalemia, deficit of neuropsychic development) [72]. The quoted source details the extent of the disastrous situation demonstrated by the results of the samplings carried out in 2003 according to which, in a radius of approximately 35 km, contamination with heavy metals in quantities much higher than the permitted limits reached the vegetation, soil, and all the water courses in the city and surrounding areas. The ecological decline was also furthered by the effect of acid rain, which was caused by the excessive release of sulfur dioxide into the atmosphere.

The PP and CE could have been easily implemented by exchanging the current cyclone-type purification system for a multi-cyclone battery system that would allow the recovery of polluting metal powders and their reuse while reducing pollution and increasing the health of the entire ecosystem.

The presented case is an eloquent example of non-compliance with the PP and the lack of respect for the fact that “for any activity that may have effects on the environment, the precautionary principle must indicate a remedy” [80] (p.265), thereby not fulfilling, by way of consequence, the structural elements of the PP regarding knowledge, the degree of danger, and the proposed remedy [81] (p.126). It also represents an obvious example of non-compliance with the CE due to the lack of any element aimed at reintroducing waste from industrial activity into the economic cycle (some being the basis of industrial by-products such as slag heaps).

The last few years have seen certain relatively consistent initiatives [82] regarding the implementation of protection and depollution measures in the area based on the correct and complete assessment of the risks and the taking of substantiated decisions. The measures in question provide for the installation of filtration systems for the recovery of metal powders and the identification of the possibilities for the elimination of slag heaps. Although there have been recent improvements in terms of air quality, water, and soil pollution [83,84], the well-known repercussions for Copșa Mică remain a lasting and difficult problem.

In conclusion, it is worth noting that the previously described context is favorable to the analysis of the possible complementarity between the two concepts addressed, the CE and PP, to reveal their possible coexistence (of mutual non-exclusion). Auxiliary to the analysis of the theoretical aspects, in the framework of the paper, a case study (the Copșa Mică case) emblematic in the European space was chosen. Starting with the issue that determined the appearance of this case (social implications, aspects regarding the health of the population, impact on the environment), a parallel analysis was carried out, both from the point of view of the CE and the point of view of PP, identifying the elements or areas of interference of the two concepts. Thus, it was highlighted that the lack of a correctly and fully documented analysis of the risks, the measures to reduce them, and the lack of an analysis of the specialized literature indicating the seriousness of the potential consequences—all elements specific to the PP—led to a serious impact on the health of the population and the environment, and simultaneously, incurred high associated costs. In such a situation, the application of the specific principles of the CE to the actions undertaken, would have constituted prevention and risk reduction measures, a fact that highlights the interference between the CE and PP. The analysis of the evolution of this case indicated that later, by initiating some depollution measures that made it possible to capture and demonstrate the possibilities for the reuse of some industrial waste and by-products, which are CE-specific attributes, the premises for the simultaneous implementation of some PP characteristic elements were also established. The study in question also demonstrates that the lack of simultaneous implementation of the two concepts can lead to the appearance of a problematic state; resolving and ameliorating the consequences involves resources and

longer periods compared to the correct approach to the implementation of the PP. Currently, these problems that have arisen in the area are far from being completely solved, but fortunately, we have reached the stage of awareness and of taking measures in this regard.

The presented case was also chosen because the disastrous situation in Copșa Mică is representative, even if not at this scale, of many heavily industrialized areas in Romania such as the cities built strictly around an industrial point.

Superficial or non-existent risk analysis in some areas such as Baia Mare, Călan, Hunedoara, Reșița, or Mintia (thermal power plants, large industrial complexes existing during the communist period) led to air, water, and soil pollution and the worrying accumulation of massive deposits of waste and industrial by-products, all of which ultimately have a strong impact on the health of the population. Although complex legal actions have not been initiated as in the Copșa Mică situation, the consequences are known but are still being “tolerated”. Currently, research efforts are being focused on “recovery”, including with the help of the CE, through the identification of possibilities for the reuse of slag, power plant ashes, and sludge [85–90].

Next, in order to support its practical implications, other examples are presented that apply the PP.

In this sense, the Mining Strategy of Romania for the period 2017–2035 [91] is discussed, a document developed to protect the environment, areas rich in natural mineral resources, and affected local communities. The strategic objectives and directions for action of the strategy are guided by the applicability of three principles, including the precautionary principle. Under the PP, the strategy developed by the Directorate of Mineral Resources within the Ministry of Economy is meant to comply with several requirements imposed by the PP [92], which are presented schematically in the following figure (Figure 4).

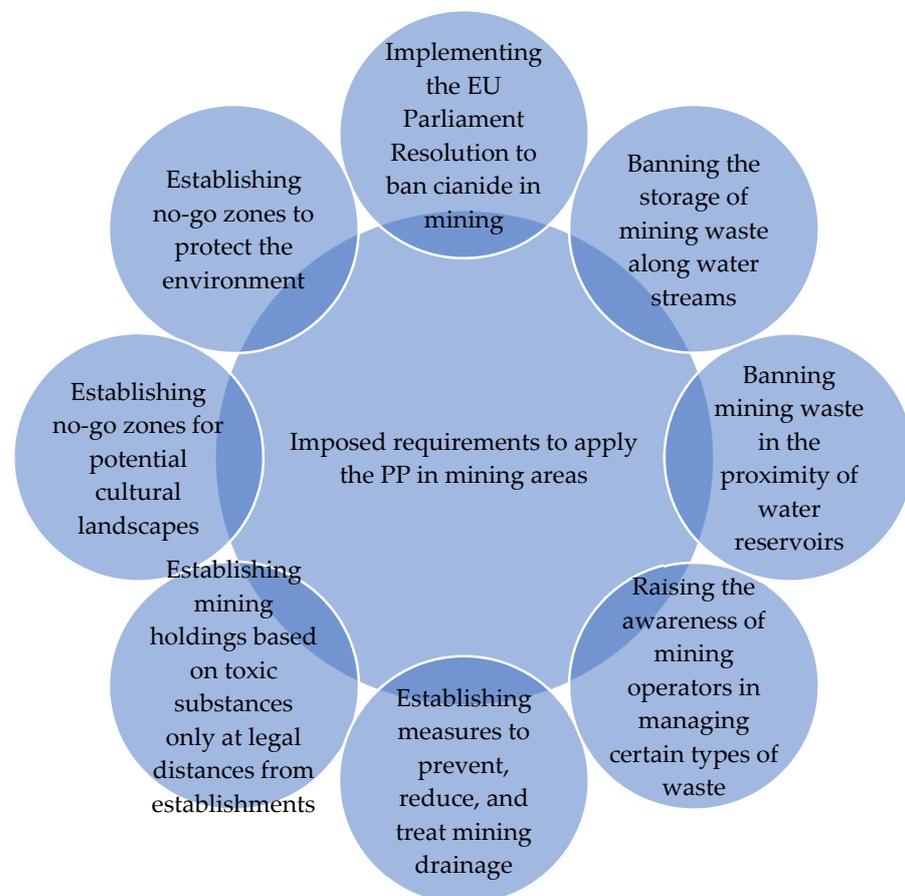


Figure 4. Requirements imposed by the PP in the field of mining [92].

As can be seen, in the field of mining there is an accumulation of conditions that lead to reaching the defining lines of the PP. By analyzing the same situation from the perspective of the CE, it is found that the PP intervenes by supporting and completing the sphere of circularity, leading to solutions to the major problems facing society and industry: waste, resource use, pollution, and the environment.

Another argument in favor of supporting the usefulness of the applicability of the PP in the context of the circular economy model is obtained by focusing the analysis related to the field of mining and the waste generated by this industry on the individual. Thus, following the national inventory elaborated by ANPM (between 2007 and 2008, with a subsequent update) [93], 210 contaminated sites and, respectively, 1183 potentially contaminated sites were identified in Romania.

The results of the analysis of the distribution of contaminated sites by activity sector demonstrate the significant share of waste generated by the mining industry along with the issue of municipal waste storage and industrial management (Figure 5):

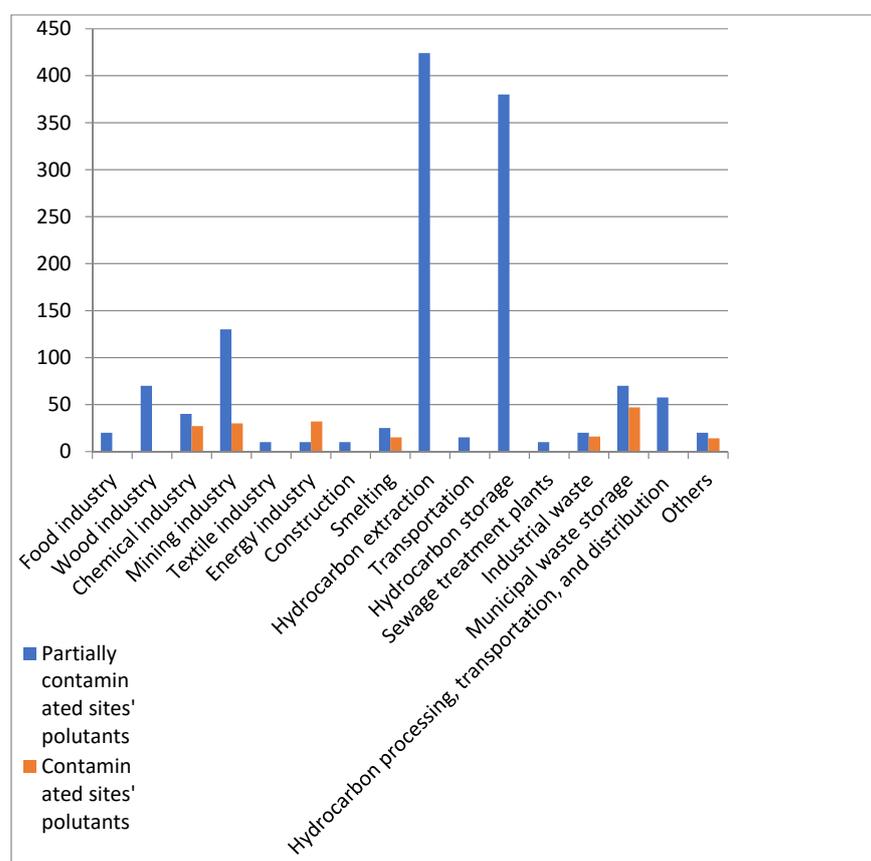


Figure 5. Distribution of economic activities (risk contamination) [93].

Regarding the distribution of potentially contaminated sites (soils) by economic sector, the mining industry is one of the main pollutants in terms of soil and the environment (Figure 5) along with the hydrocarbon extraction industry, the wood industry, and activities related to industrial waste storage.

In the context of identifying the results of the presented situations, the need for PP “intervention” in economic areas aimed at preventing significant damage to soil quality and the environment as a result of its contamination by industrial activities and waste storage is supported.

Another example of an extremely important field that is subject to the transition to the circular economy is that of water resources and their specific uses. Considered both a resource of capital importance and a source of waste (industrial wastewater, domestic wastewater, radioactive wastewater, wastewater resulting from irrigation of agricultural

land, wastewater from river or sea vessels [56]), the current global water situation attests to the vulnerability of natural resources and society's dependence on raw materials [17]. Regardless of the nature of the legislation in the field (characteristic of national law or international regulations of matter), the purpose governed by the precautionary principle remains the same: the qualitative, quantitative, and sanitary protection of water [56,94,95]. Thus, to protect water resources, Law no. 107/1996 [96] (or the Water Law, with subsequent amendments and completions) adopted by the Romanian Parliament establishes clear rules on the right to use and manage water and the obligations incumbent on water users, establishing from specific cases a cumulation of prohibitions (art. 15, 16 of the Law). The mentioned normative act represents an instrument of management and regulation of the activity of key economic subjects in the sphere of water protection [97].

Under the same principle, the rationale for the adoption of international water regulations pursues objectives such as sustainable and equitable water management, the application of preventive approaches to potential hazards (accidents with hazardous substances, pollution, damage to aquatic ecosystems), avoidance of long-term ecological damage, and continuous access to natural resources (Convention for the Protection of the Danube River, signed on 29 June 1994 in Sofia) [98].

The analysis of the dynamics of the environmental protection concerns (including the mandatory aspect of "resource-waste" water) registered in Romania in 2020 [99], is reflected in the distribution of expenditure undertaken by different entities (non-specialized producers, specialized producers, public administration) to the various environmental fields (Figure 6):

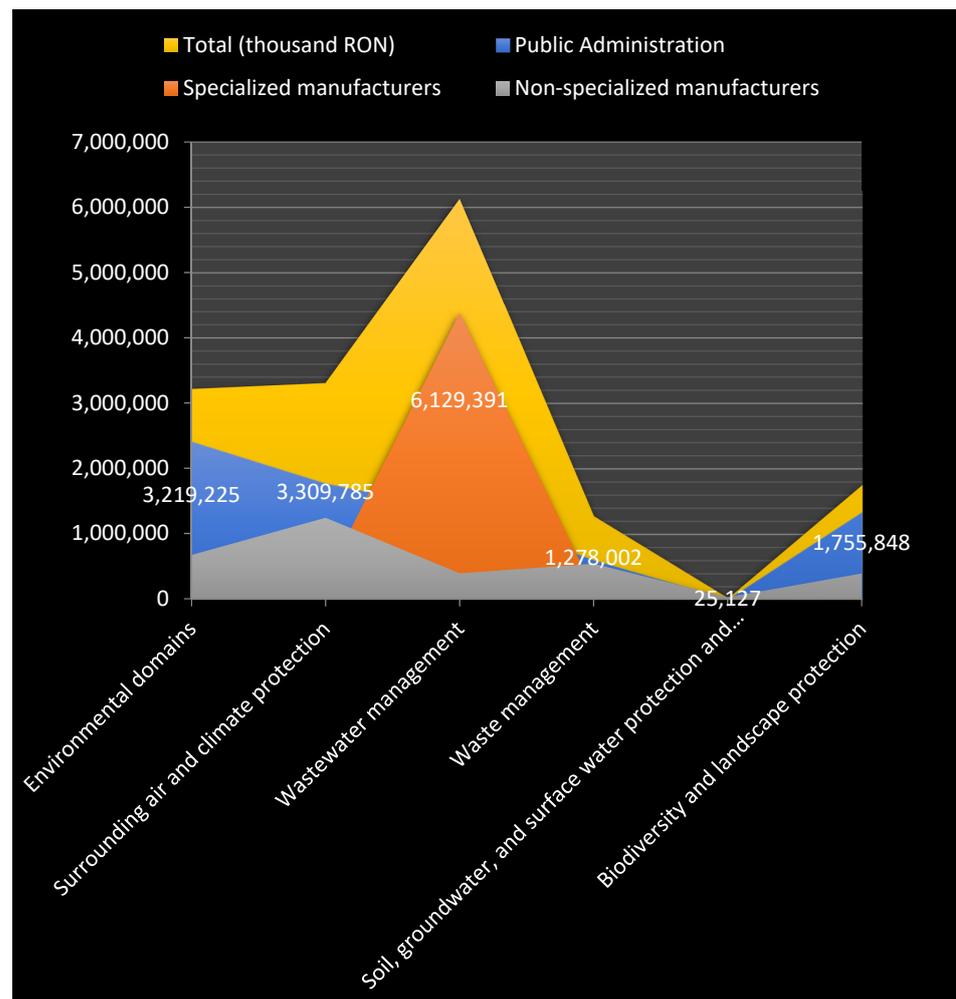


Figure 6. The analysis of environmental protection concerns [99].

The results highlight the involvement of all categories of producers (mainly public administration) in wastewater management and attest to the importance of environmental protection at various levels, including terrestrial or underground water resources.

The adoption by decision makers (including at the political and legislative levels) of efficient, transparent initiatives and preventive approaches to water waste has a positive premise given the validation of the role of the PP in water recycling activities [100].

The interest in the field of water is also confirmed by the initiatives to manage and transform linear models into circular business models. Thus, within the Program for the Adoption of Circular Solutions (developed in January–March 2020 for 32 countries including Romania) [101], various innovative solutions with application to water resources were highlighted. For example, a Danish company has supported water and energy savings by developing a device that detects shower water consumption through motion, humidity, temperature, sound, and display sensors, which prompts the user to use water as efficiently as possible and shorten shower times, and a Swedish company has proposed a solution for mining water purification by developing an innovative graphene-based filter. Within the Acceleration Program for the Circular Economy, 2nd-March 2020 Edition (in which 90 projects of companies from 26 countries were registered), the expertise developed by a Romanian company in the field of wastewater was noted, and the “Planctonid Environment’s microalgae-based water treatment solution” was designated as one of the six winning projects [101]. Particular attention is paid to the water sector by the EurEau (European Federation of National Water Service Associations), which brings together public and private drinking water and sewerage operators in Europe and aims to deliver drinking water, treat wastewater, and ensure their safe return to the cycle of nature, as well as focus on the recovery of water resources [102]. The actions undertaken by this body (at a European, national, and local level) for the conservation and protection of water resources and the environment comply with the provisions of art. 191 of the Treaty on the Functioning of the EU [51] (which states the PP is the basis of EU environmental policy). The approaches aim for an integrated approach to the problem and the most efficient management of the challenges faced by the water sector (restoration of aging infrastructure in the water services sector, efficiency of resources in the water sector, reducing the impact of climate change on water, water recovery in the circular economy) by creating new jobs, promoting sustainable economic growth, and reducing the impact of human activities on water resources as well as the number of emerging pollutants and traditional wastewater pollution [102]. Proper application of specific community legislation and compliance with the rules imposed by the PP (along with the principles of “polluter pays” and “control at the source”) leads to substantial benefits in terms of environmental protection, human health, increased accessibility to water services, streamlining the management of the water sector and specific resources, and implementing the circular economy.

Arguments in favor of these opinions include the following aspects, which are found in the selected and analyzed literature:

- The CE and the precautionary principle have coexisted naturally in parallel in their primary forms, finding manifestations throughout human civilization [31,103].
- Although they express a tendency to manifest a generally independent existence, the CE and PP register common concerns, especially in the area of sustainability.
- Although the CE encourages development, promotes innovation, and supports sustainability [15], the PP intervenes practically and subtly in the management of science and technology allowing the implementation of the safest forms.
- A precautionary element can be found in the details that define the CE. The purpose of the CE is to decouple environmental pressure from economic growth, protect resources and the environment, establish a balance between production and consumption, minimize and manage waste, and balance the relationship between the human–environmental–socio-economic factors.
- The CE is intended as an alternative to the linear economy and for this reason, it implies a level of caution that the previous economic model minimized and largely ignored by

perpetuating harmful socio-economic and environmental behaviors such as continuous excessive and exhaustive use of resources, a minimum degree of conservation, waste generation, and environmental damage.

- The CE essentially supports the metamorphosis, reversibility, conversion, and perpetuation of the life and cyclicity (closing the loop) of resources, products, and products converted into services.
- The CE wants to be a viable solution for the future of humanity to maintain balance on Earth in all its dimensions (environmental, social, economic) and the PP meets this vision, intervening (against potential dangers and threats) to protect the environment, health, life, and society for the sake of sustainable development.
- The PP intervenes in order to protect the environment in the event of a potentially catastrophic evil threat with serious and irreversible consequences, even in the absence of scientific certainty, considering that it is more useful to prevent than to intervene too late and repair the usually irreparable consequences (Rio Declaration on Environment and Development 1992, Principle no. 15) [104]. The preventive arm of the CE is also obvious and present as long as this economic model has been designed to minimize the “evil” caused by the rampant and highly technological evolution of contemporary society, to maintain and protect natural resources from raw materials, and to limit waste.
- The CE is a link between the efforts of community environmental policies and political and business environments, as the PP is perceived as a “central plank of community policy” [105].
- The idea of “caution” is found in both notions. In the case of the PP, the precautionary prudential factor coordinates the response in the face of uncertainty [31,104,106], and in the case of the CE, the caution/precaution factor dictates the response in the face of potential economic and environmentally harmful behaviors. The uncertainty factor represents the selection criterion regarding the applicability of the PP in situations that may or may not involve circularity.
- The conclusion highlights that both concepts encompass an educational function and encourage a proactive attitude, intervening by relating humanity to the socio-economic, political, and environmental dimensions of its existence.

In addition to the statements above, we propose the following method of defining the concept of CE while emphasizing the preventive function found in the subsidiaries of its contents, which is compatible with the requirements of the PP. Thus, the CE can be seen as a set of actions, activities, and preventive/innovative initiatives that are applied in circular stages in order to close the loops of resource consumption (insofar as this process is technically feasible) and is undertaken to protect the reserves of natural resources; regulate the responsible use of raw materials, disposal of waste and by-products, and recovery of renewable sources; and protect the environment to achieve socio-economic balance in a sustainable society.

The role of precaution/prevention in decision making is highlighted in the context of economic circularity; no raw material or natural resource is meant to be used exhaustively/excessively until stocks are depleted. However, they are incorporated into products or converted into services in order to extend the life cycle of the finished product, and all these steps, including the finished products and the technological processes used, must be safe and environmentally friendly.

Therefore, it can be deduced that the transition to the circular economy is meant to adjust the syncope of the linear economic system of a “production-use-disposal” type and thus repair the consequences generated over time to the environment and human life. Being complex and long-lasting, this process requires involvement, determination, and perseverance on the part of the responsible actors. It requires a lasting effort, which requires a broadening of the sphere of knowledge; flexibility in developing pragmatic, useful, and realistic policies; constant monitoring of progress; overcoming barriers; and alterations to perception and mentality. The manifestations of this new economic system,

no matter how well-intentioned from a theoretical or socio-economic point of view, cannot be registered/produced unhindered, as they can generate harmful consequences and damage human health or the environment. The key aspects of the CE implementation process, with direct reference to the application of innovative trends in production and consumption processes, are to research modalities, promote and use new technologies, and “circular products from the design stage” [107–109], which must be the filter of the objective cost–benefit analysis and (effect)–risk assessment. In this respect, in relation to the economic sphere of circularity, the PP cannot be seen as a barrier to the evolution of this economic system but rather functions in a supporting role as a guiding or auxiliary tool. It is considered that the PP cannot justify arbitrary decisions in any form, and the use of the PP for protectionist purposes or to avoid its effective application under various pretexts (a “brake in the face of innovation”, its arbitrary use, the “too expensive principle” [28]) represent inappropriate practices.

The accumulation of the definitions and interpretations provided by the researched literature, the oscillating attitude towards it (attractive, but incoherent; strong, but inadequate; a psychological engine [110]; promotes “paralysis” when faced with speculative dangers, which is blamed on improper application [111,112]) or on the contrary, its use by practitioners and courts [58,113,114], leads to the questionable reality of its legal application. Regardless of the optics through which it is approached and perceived (from the point of view of the political, economic, sociological, or philosophical plans of the legal field or the environmental sciences), the PP must be understood and applied objectively, the use to it bringing more safety in terms of technology, innovation, economic evolution, society, and the environment.

4. Conclusions

The scientific contribution of the proposed study is justified by the following considerations:

- The topic addressed (respectively the CE–PP relationship) is new and it has been identified as a niche within the researched literature. The incursion at the theoretical level could not provide satisfactory results (“discoveries or perspectives”) in the sense of the results assumed by the study in question such that, in the absence of a common topic (“CE and PP”), comparisons with other works were not possible.
- It represents a subject suitable for debate, with the concepts of the CE and PP being current and far from properly exploited according to the attached bibliography. The specialized literature that deals with the concepts of the CE and PP is limited, a fact demonstrated by the research undertaken.
- In its introductory part, the study makes a foray into the literature in order to obtain some benchmarks regarding the current state of knowledge in the field.
- The originality (“finesse in interpretation”) resides in the association of two concepts (CE and PP) usually treated separately in the specialized literature; the purpose of the paper is aimed at their unitary interpretation, that is, the assessment of the usefulness of the PP in the context of the CE in feasible situations, their spheres of interdependence, as well as the possibility of the application of both the CE and PP for the same case.
- Through the examples presented, a parallel analysis of the notions of the CE and PP was carried out with the aim of evaluating and identifying their areas of manifestation and interaction.
- From the European case studies, the case of “Copșa Mică” (Romania) was extracted for analysis because it is considered to be one of the most eloquent situations that attests to the interconnected application of the CE and PP. By superimposing the two concepts in the given situation and analyzing one notion in relation to the other, the results obtained are the particularities of the CE–PP relationship and consequences of the non-uniform application of PP–CE characteristic factors (impact on the environment, damage to human health, involvement of material resources, additional fees for remedying the “evil” produced, impossibility of “resetting to the previous

situation”, other legal implications). (*Note:* Aspects regarding the particularities of CE implementation in Romania were the subject of a previously published work, and the presented study intends to complete this research by bringing into debate some CE-related elements in the presented study, that is, the association between the CE and PP).

- The results of the undertaken research support the hypothesis of compatibility between the CE and PP in certain given situations and attest to the role of the PP. Moreover, through the analysis carried out, the PP proves to be not only a useful tool but also extremely current in the field of CE manifestation.

The research conclusions show, from a theoretical point of view, the need to deepen the “CE and PP” relationship in future research as a consequence of the lacunar substrate identified at the conceptual level. Although it cannot be applied universally, it is considered that for certain situations, the “interference” of the PP in the area of the manifestation of the CE is a beneficial one, as it facilitates the fulfillment of the wishes of this economic model. The PP intervenes as an important guiding principle, establishing an inherent relationship with the CE and considering their intrinsic elements. Assimilated as an indispensable tool in the context of increasing the “circularization” of the economy, the PP attests to the fact that the process of implementing the CE cannot be carried out discretionarily as it is extremely complex with deep implications for the environment and society.

The upward trend in the evolution of society has brought with it an awareness of the effects of reaching the peak of development on the environment on the one hand, and the consequences of the brutal intervention of humans (mainly socio-economically) to the natural environment on the other hand.

The viable alternative in the face of the threat to environmental balance in a time of exacerbating gaps and the obsolescence of the global economic system is to embrace the values promoted by the CE and use a combination of instruments (legal, economic, socio-political, informational, and educational) able to support such a transition. Aiming at protecting and conserving the environment and natural resources, preventing and combating pollution, managing waste, improving environmental conditions and sustainable development, and supporting a balanced economic development by adopting the “closed loop” system, the PP and CE support the premise of creating a functional, harmonious society with adequate contemporary needs and the requirements imposed by the millennium in which we live.

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