STUDY N° 2018-05

RENEWABLE RESOURCES INDICATOR

Summary

January 2020

Scientific coordinators :

– **Grégory Herfray, Marion Sié**
VERSo, 5 quai Victor Augagneur, 69003 Lyon

SCORE LCA is an association that has been created to financially support collaborative research on LCA and related topics. It aims to promote and organize cooperation between companies, institutional and scientists in order to support the evolution of LCA methods and its practical implementation at European and international level.

- This work has been supported by ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie) www.ademe.fr
- The views and recommendations expressed in this publication are those of the authors and do not necessarily reflect, unless otherwise stated, the views of all members of SCORE LCA.
- The information and conclusions presented in this document were established on the basis of scientific and technical data and regulatory and normative framework in force at the date of the drafting of documents.

Introduction

As ecological transition is becoming a common concern of the general public[1][2][3], the benefic nature of renewable resources use, often described as the solution to all current environmental issues, has to be investigated. The French Energy Transition Act for Green Growth aims to increase the share of renewable energy to more than 30% of final energy consumption by 2030. In addition, the Roadmap for Circular Economy presents concrete measures that could enable sustainable consumption and production patterns, including by maximizing the use of renewable resources from the technosphere. However, the impacts and/or benefits associated with the increase of renewables use are neither characterized nor measured. LCA is adapted to this challenge, but it is still necessary to better understand the concept of "renewable" and to identify the impacts induced by their exploitation, and more particularly the impact on renewability, potentially induced by overexploitation. This is the goal of this research project.

This study is first based on the establishment of a typology of so-called renewable resources. It will then focus on a state of the art of renewable resources accounting in LCA practice, the identification of existing limitations and the needs of practitioners. It then includes methodological proposals for calculation of criticality indicators for each type of resource considered. These proposals are then tested on case studies.

Definition

The concept of renewable resources is first explored. The bibliography analysis shows that there is today no definition that allows to take into account the various flows concerned in a comprehensive and coherent way. Several categorizations exist. Resources can be for example distinguished between natural resources, from the ecosphere, and anthropogenic resources, from the technosphere. Each can either be stock, renewable fund or flow resource. "Potentially renewable resources" can be then considered as renewable fund and flow resources.

Renewability appears to be a real issue that can be undermined by exploitation. Because renewable resources are not necessarily renewed, we wanted to move towards an indicator measuring renewability, which would take into account the compatibility of the way the resource is exploited with its qualitative (quality resource, low degradation) and quantitative renewal. To be considered effective, this renewal must be regular and carried out in a human time scale, under the current conditions of human pressure and biodiversity.

The following definition of renewable and renewed resources is then proposed:

"Renewable resources are physical flows from ecosphere (primary renewable resources) or technosphere and simili-ecosphere (secondary renewable resources) that can be exploited without impacting their availability (in quality and quantity) on a human time scale, under current human pressure and biodiversity conditions. They can be inexhaustible, because from a flow, or they can be maintained, because from a fund that can decrease as well as increase, and be renewed on a regular basis. »

---

[1] https://www.novethic.fr/actualite/environnement/climat/isr-rse/l-affaire-du-siecle-devient-la-petition-la-plus-signee-de-l-histoire-en-france-signe-d-un-vrai-sursaut-climatique-146741.html

[2] https://www.francetvinfo.fr/sante/environnement-et-sante/il-n-y-a-rien-de-traditionnel-chez-lui-aurelien-barrau-l-astrophysicien-philosophe-qui-defend-l-ecologie_2958039.html

[3] https://reporterre.net/Ces-youtubeurs-qui-parlent-d-ecologie-au-plus-grand-nombre

Methodological principles

To determine if a resource meets this definition, a two-step methodology is proposed:

(1) Determination of the potential renewability. Resources are classified in categories based on their intrinsic characteristics. This allows to characterize the resource as potentially renewable or not.
(2) Estimation of effective renewability. On the base of parameters that may affect it, the actual renewability (or loss of renewability) of the resource is discussed. It mainly depends on the consequences of the exploitation mode of the resources that support production (supporting resources) has on the quantity and quality of the renewed resource. Example: Does the way soil is used undermine the renewability of biomass production (in quantity and/or quality)?

State of the art of Life Cycle Impact Assessment (LCIA) methods

The second part of the study consist in a methodological proposal to assess effective renewability, based on a state of the art of existing LCA methodologies.

Biotic resources

Among works that have been done to calculate an indicator regarding biotic resources, some focus on resource depletion. They include methods that evaluate (1) the amount of resource taken in the environment, compared with an available stock (e.g. CML, EDIP, BIRD); (2) the remaining margin before depletion (EcoPoint 2006); (3) the number of years without catch possibility per ton of resource taken at t=0 (BRD-fish); (4) potentially lost future yield (LPY-fish). Many of these methods take into account an anthropogenic extraction rate and/or a renewal rate, but this parameter appears to be an estimated fixed input parameter, often evaluated on the basis of the intrinsic characteristics of the resource alone, i.e. without consideration of any variation (natural or anthropogenic) of the environmental conditions in which the species under consideration evolves. These interventions are precisely the ones that will improve the renewal rate (because there is cultivation or breeding, the ecosphere is then modified in a simili-ecosphere to improve production) and/or degrade it (because the exploitation mode is not sustainable), or even cancel it irreversibly (if the ecosystem carrying capacity is exceeded, the resource is no longer renewed). These are the effects that we seek to measure.

Other indicators, based for example on emergy, exergy, financial cost to avoid an impact, number of years for resource renewal, are not relevant for our study.

The primary production required (PPR), as a tool to link exploitation of supporting resources for biotic resources production and carbon flow, is of a particular interest, as it permits to integrate anthropogenic effects. This indicator could contribute to the elaboration of a common metric for both ecosphere and simili-ecosphere fund resources, animal or vegetal. The use of this indicator, compared with a total primary production on a relevant scale, could be a way to evaluate the scarcity of a resource and its renewability [Cashion & al, 2016].

It should be noted that most of the methods cited here show limited operationality. They mostly come from a specific field of expertise, are not distributed in generalist LCA tools and databases, and depend on elementary flows often not available in inventories.

Soils and subsoils

The way soils flows are considered in most common inventory databases (nomenclature, flow types) is consensual. These soil-specific flows include: the type of use (*forest, arable crop, urban land...*), the exploitation mode (*intensive vs. extensive, irrigated vs. non-irrigated...*), and the occupancy and change of use dynamics. On this basis, taking into account soils and their uses in LCA can be done, in a first approach, in two main ways.

The first is to consider them as a resource as such, and therefore to consider flow indicators, aggregating the type of soil and use, the area used and the duration of use.

The second involves considering soils as a support for other services (biodiversity, water treatment, CO2 sequestration, biotic production, etc.). Soils as a resource is then only a way to assess the impact of the production of biotic resources. The different soils characteristics are well covered by the available methods: LANCA, SALCA-SQ, ReCiPe… Some of them thus provide information on soils quality as a "supporting" resource, and calculated indicators can be considered as proxies to assess renewability of resources derived from their exploitation (including biotic production potential).

Water

Recent developments (2017) for water accounting in LCA allows the accounting of most aspects for a good evaluation of renewability (see for example the work of Boulay & al[4] on AWARE approach, Available Water Remaining). A criticality indicator is developed. It takes into account the water availability from a hydrogeological point of view (with a differentiated approach regarding localization) and both ecosystem and human background needs. In order to assess all the aspects influencing water renewability, the use of criticality indicators for water should be done along with other evaluations about water quality. Water quality may affect its availability for specific uses or implies ecosphere pollution.

Energy resources

Energy resources are considered within LCA in a specific way. The resource, strictly speaking, being energy, the differentiation is based on the nature of the source. There is no physical difference between a MJ from the sun and a MJ from oil. However, the differentiation between energy vectors remains relevant, to take into account their characteristics (exploitation mode, energy transformation).

Thus, while most so-called renewable energy sources can in fact be considered as non-depletable and therefore instantly renewed (solar, wind, geothermal, hydropower), their exploitation involves variable impacts on the ecosphere. Biomass, considered as an energy resource, will have a renewability that will be influenced by the same parameters than biotic resources.

Renewability evaluation for energy resources therefore implies, except for biomass, a particular angle of analysis. It will not correspond to the determination of a level of exploitation that jeopardizes the availability of the resource, nor to the evaluation of a dynamic for the renewal. On the other hand, it can incorporate the notion of availability/accessibility and exploitation mode.

Existing indicators, through the use of primary energy conversion factors, can provide such information. But they do not allow an assessment of the criticality of the resource. It will then rely, in the case of flow resources, on aspects linked with the impact of their exploitation.

Learnings

The criticality approach seems to permit the accounting of maintaining supporting resources. If the term has been first used in economics and geopolitics, the criticality of a resource describe the difficulty of obtaining it. Applied to the environmental field, we can consider that the criticality of a resource, combined with its availability for use, can be used to assess renewability. By considering the part of the resource that needs to be preserved to ensure its sustainability on the one hand, and the part needed by the ecosystems using the resource, on the other hand, it will be possible to determine

---

[4] BOULAY, Anne-Marie, BARE, Jane, BENINI, Lorenzo, *et al.* The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE). *The International Journal of Life Cycle Assessment*, 2018, vol. 23, no 2, p. 368-378.

the amount of resources available for human use, and thus determine the impact of current consumption levels. However, this approach should incorporate or be accompanied by assessments addressing the quality of the resource under consideration, whether this quality is affected by its exploitation or indirectly.

Criticality assessment method applied to all potentially renewable resources

We make a proposal for the calculation of a set of indicators for all the resources considered as renewable in this study. Our goal is here to allow the evaluation of the renewability loss due to the exploitation of this type of resource, on the base of its actual availability. We choose to evaluate a criticality indicator, derived from the AWARE approach developed for water, in relation to their respective intrinsic characteristics.

The calculation process is simplified: where possible, we seek to take advantage of existing inventory flows, which can be proxies to take into account determined resources properties. A more precise approach, requiring the consideration of specific flows and thus the analysis and modelling of their characteristics, may constitute a second stage of development.

The method focuses on so-called "secondary" or "produced" resources. As a result of anthropogenic or natural transformations, the dynamic of their renewal relies heavily on the availability and quality of "supporting" resources.

The integration of several supporting resources into the method, and the evaluation of the renewal of supporting resources through a set of indicators of criticality may be the subject of further developments.

Natural biotic resources (from ecosphere)

The exploitation of natural biotic resources consists of a catch on a fund. The importance of this fund depends on the intrinsic characteristics of the resource, the conditions under which it evolves and the intensity of the catch. The evaluation of the renewability of the resource, and of an indicator of criticality, can thus be done on the basis of quantities related to the characteristics of the resource, and its modes of evolution. We will consider here the quantity that can be exploited without undermining the renewability, and the quantity actually taken.

We propose here, as a first approach, to base the calculation of the indicator on the notion of Maximum Sustainable Yield (MSY), expressed in number of individuals or in mass (we choose here the ton as unit). This quantity, although presenting several limitations, allows us to combine the availability of the resource with the quantity of resource to be preserved in order to ensure its renewal (which will be considered here as a "need" of the ecosystem). Considering the calculation of these quantities on a relevant area for the species studied (which will be determined on the base of the characteristics of the species, as well as the characteristics of the ecosystem in which it evolves and climate data), we can consider that

$$B_i = MSY_i + MSB_i$$

where B_i is the total quantity of biomass for the species i (in the considered area), MSY_i the maximum sustainable yield associated, and MSB_i (Minimum Sustainable Biomass) the minimal quantity of biomass to be preserved in order to ensure the renewal. We will then get, by considering a criticality indicator of the type calculated as :

$$AMD_i = \frac{(B_i - C_i - MSB_i)}{S_i}$$

With : C_i the actual catch for species i

We find that the expression is simplified by:

$$AMD_i = \frac{(MSY_i \; - C_i)}{S_i}$$

MSY_i the maximum sustainable yield for species i, C_i the actual catch for species i, S_i the surface of the zone considered for species i.

Considering that

$$CF_{\ ABRRE} = \frac{\overline{AMD_i}}{AMD_i}$$

$\overline{AMD_i}$ the world average value of AMD weighted by catches for the species i.

The indicator evaluation is then :

$$NOBR\ scarcity\ index = H * CF_{\ ABRRE}$$

$NOBR$: Naturally Occuring Biotic Ressources, $ABRRE$: Available Biotic Ressource Remaining, H $(Harvest)$ representing the amount of animal biomass collected (in tons).

Terrestrial anthropic vegetal resources

We propose to base the calculation of the indicator on the theoretical maximum content of SOC (Soil Organic Carbon, used as a measure of the amount of soil organic matter, SOM) that can be reached in the soils considered, and on the degradation of this amount of SOC related to land use:

$$AMD = \frac{\left(SOC_{potential} \; - \Delta SOC_{biotic\ land}\,\right)}{S}$$

$SOC_{potential}$ is the potential quantity of SOC on the considered zone (on biotic lands), $\Delta SOC_{biotic\ land}$ is the difference between the potential quantity of SOC and actual SOC content of biotic soils (depending on the soil use type), S area of the considered zone.

The $\Delta SOC_{biotic\ land}$ value is thus considered to evaluate both the amount of SOC consumed by humans on cultivated biotic soils and the amount needed to maintain existing ecosystems on non-exploited biotic soils.

This approach is an approximation: there is no consensus on a threshold value of SOC below which the crop will lose its renewability [Fageira, 2012]. We thus consider the needs of ecosystems to be those of ecosystems existing on uncultivated biotic soils (uncultivated does not mean unused). By considering that the quality of the ecosystems on these soils is the minimum state in which they must be in order to ensure their functioning (as well as to ensure the ecosystem services necessary for crops), this approach constitutes however a good approximation.

The difference between potential SOC and current SOC is calculated over a given area by adding up the amounts of SOC corresponding to current land use. These quantities, provided in particular by the IPCC databases [Penman-al, 2003] (SOC per hectare of soil, depending on the nature of the soil) and by various mapping tools, are calculated as follows:

$$\Delta SOC_{biotic\ land} = \sum_{S_{land\ use_i}}^{S} (SOC_{Potential_i} - SOC_{Actual_i})$$

The expression of AMD, by using this way to calculate $\Delta SOC_{biotic\ land}$ is then :

$$AMD = \frac{SOC_{Actual}}{S}$$

The corresponding characterization factor is then :

$$CF_{ASOCRE} = \frac{\overline{AMD}}{AMD}$$

$\overline{AMD}$ world average value of AMD.

The indicator is then calculated as the product of the characterization factor and the value obtained for the land use indicator of the ILCD method [Brandao - Mila i Canals, 2013], assessing the soil carbon deficit associated with the system studied :

$$AVBR\ scarcity\ index = LandUse_{ILCD} * CF_{ASOCRE}$$

$AVBR$: Anthropic Vegetal Biotic Ressources, $ASOCRE$: Available Soil Organic Carbon Remaining.

Terrestrial anthropic animal resources

The renewability of anthropogenic terrestrial animal resources (from livestock) is closely linked to the renewability of plant inputs used to feed livestock. Livestock farming is indeed an artificial reproduction of the mechanisms of the food chain: the environmental pressure on support resources can thus be postponed, in the end, to an impact on soil quality.

We propose to base the evaluation of the renewability of animal biomass on the evaluation of the impact associated with plant biomass consumed for livestock, based on the ASOCRE approach in the case of cultivated biomass, and the ABBRE approach in the case of biomass taken from the ecosphere.

Evaluation of impact on SOC of animal biomass farming

We consider that the renewability of animal anthropic biomass is directly determined by the renewability of plant biomass consumed by livestock breeding, and used as an input. We can then consider the quantity of such vegetal biomass and its characteristics (natural or anthropic, species and cultivation mode in the anthropic case) as inputs to evaluate animal biomass renewability.

When performing an LCA on the production of anthropic animal biomass, we propose to base the evaluation on:

- The ASOCRE method in the case of cultivated plant inputs
- The ABBRE method in the case of natural biotic inputs

The criticality indicator for anthropic animal resources will then be:

$$AABR\ scarcity\ index = A * \left(\frac{AVBR\ scarcity\ index}{V_{tot}} + \frac{NOBR\ scarcity\ index}{V_{tot}}\right)$$

With

$$AVBR\ scarcity\ index = \sum_{i}^{\substack{ressources\\ anthropiques\\ végétales}} V_{anthro_i} * CF_{ASOCRE_i}$$

$$NOBR\ scarcity\ index = \sum_{j}^{\substack{ressources\\ anthropiques\\ végétales}} V_{natural_j} * CF_{ABBRE_j}$$

V_{anthro_i} the quantity of vegetal anthropic resource i (in tons), CF_{ASOCRE_i} the characterization factor associated to species i, $V_{natural_j}$ the quantity of natural vegetal resource j (in tons), CF_{ABBRE_j} the characterization factor associated to species j, V_{tot} the total quantity of vegetal biomass consumed (in tons), A the quantity of animal biomass produced.

Abiotic resources

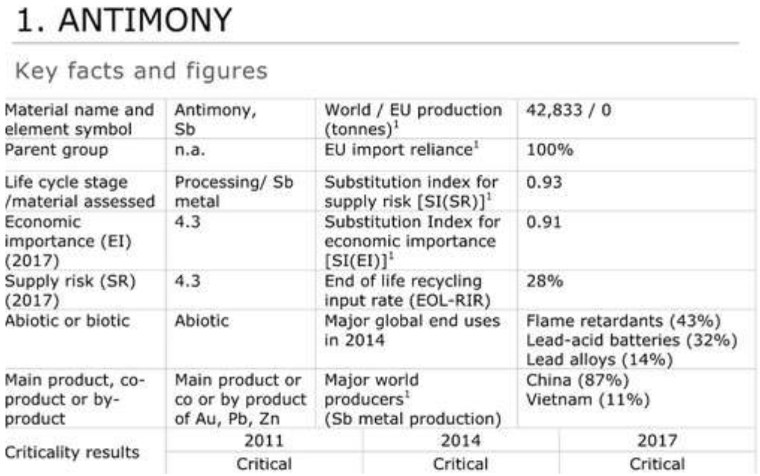
Renewable abiotic resources correspond here to flow energy resources, considered infinite and inexhaustible on a human time scale. The notion of criticality and the logic evaluating are thus modified. Without ecosystem needs, availability is only conditioned by anthropogenic needs and aspects of resource exploitation: it is then possible to consider the depletable resources mobilized by exploitation as the equivalent of a supporting resource. The criticality, and therefore the availability of these resources, appears influenced by elements related to their depletion, but also by their dissemination, their difficulty of extraction, and the need for refinement/transformation for exploitation.

The European Commission recently published the latest version of its list of critical raw materials (numbering 27) for Europe[5]. This publication is accompanied by a document outlining the methodology to assess criticality [European Commission, 2017a], as well as the detail of the studies conducted for resources considered critical [European Commission, 2017a].

This assessment is based in particular on four indicators:

- The Economic Importance, EI
- The Supply Risk, SR
- A Substitution Index for economic importance, SI(EI)
- A Substitution Index for Supply Risk, SI(SR)

Figure 1 : provides an illustration of these indicators in the case of antimony.



1. ANTIMONY

Key facts and figures

Material name and element symbol	Antimony, Sb	World / EU production (tonnes)[1]	42,833 / 0
Parent group	n.a.	EU import reliance[1]	100%
Life cycle stage /material assessed	Processing/ Sb metal	Substitution index for supply risk [SI(SR)][1]	0.93
Economic importance (EI) (2017)	4.3	Substitution Index for economic importance [SI(EI)][1]	0.91
Supply risk (SR) (2017)	4.3	End of life recycling input rate (EOL-RIR)	28%
Abiotic or biotic	Abiotic	Major global end uses in 2014	Flame retardants (43%) Lead-acid batteries (32%) Lead alloys (14%)
Main product, co-product or by-product	Main product or co or by product of Au, Pb, Zn	Major world producers[1] (Sb metal production)	China (87%) Vietnam (11%)
Criticality results	2011	2014	2017
	Critical	Critical	Critical

Figure 1 : characterization of the criticality of the antimony, [European Commission, 2017b]

---

[5] https://eur-lex.europa.eu/legal-content/FR/TXT/PDF/?uri=CELEX:52017DC0490&from=EN

The economic importance of a resource is calculated regarding the importance of the material considered in the final uses of materials for Europe, as well as on the performance of possible substitutes for its applications. The supply risk is estimated by factors measuring the risk of disruption in the supply of the material (e.g. global inputs, internal EU inputs, dependence on imports, governance performance of countries measured by the World Governance Indicator (WGI), trade restrictions and agreements, availability and critical nature of alternative products). Substitution indices are values, between 0 and 1, characterizing the possibility of substituting the material considered by another, a value of 1 corresponding to a non-substitutable material.

We propose to build our methodology on supply risk factors, in order to calculate a criticality indicator for the production of renewable abiotic energy resources. These factors will be combined with the evaluation of the Abiotic Depletion potential (ADP) [Guinée, 2001], to determine a criticality index.

Our proposal involves the consideration of the LCI of the considered energy carrier exploitation: we identify the quantities of each critical material consumed for the production of a given amount of final energy.

Thus, for a given renewable energy carrier, we consider:

$$IC_{Renewable\ Energy} = \sum_{i}^{Critical\ EF} \frac{m_i}{m_{tot}} * ADP_i * \mathrm{SR}_i * SI(SR)_i$$

$IC_{Renewable\ Energy}$ the criticality index for a renewable abiotic energetical resource, m_i the elementary flow for the critical resource i, m_{tot} the sum of all elementary flows for critical resources, ADP_i the characterization factor for abiotic resource depletion associated to critical resource i, SR_i supply risk factor for resource i, $SI(SR)_i$ the substitution index for supply risk for resource i. All those values should be identified for every critical resource identified in the inventory of renewable energy exploitation.

For a given energetic elementary flow, we then evaluate, a characterization factor based on the energy vector considered characteristics (technological aspects, hypothesis for inventory calculation):

$$CF_{PAREC} = \sum_{i}^{critical\ EF} \frac{m_i}{m_{tot}} * ADP_i * \mathrm{SR}_i * SI(SR)_i$$

m_i elementary flow for the critical resource i, m_{tot} the sum of all elementary flows for critical resources, ADP_i the characterization factor for abiotic resource depletion associated to critical resource i, SR_i supply risk factor for resource i, $SI(SR)_i$ the substitution index for supply risk for resource i.

$$Abiotic\ Renewable\ Energy\ criticity\ index = EF_{energy} * \frac{EF_{energy}}{\sum EF_{energy}} * CF_{PAREC}$$

EF_{energy} : energy elementary flow, $PAREC$: Primary Abiotic Renewable Energy Criticality

Case study

Our methodological proposals have been tested on two case studies, enlightening the interest of the proposed indicators. The first study is an evaluation of the cultivation of 1ha of miscanthus, herbaceous rhizomes plant often grown as biomass energy. This plant has several potential interests, including the capability to increase the carbon content of soils (SOC). Its cultivation has thus been compared to a more conventional crop rotation system, using the ASOCRE method and specific values for the variation of related SOC.

The second case study is based on INCAS houses, test platforms for energetical aspects of buildings. We compared here, on a scope limited to heating and DHW needs, different choices of energy carriers to meet these needs, as well as different methodological choices (allocation, perimeter). This comparison was based on generalist methods of impact assessment and the PAREC method proposed in this study.

Conclusion and perspectives

The methods presented in this work aim to propose an approach taking into account the renewability of potentially renewable resources with common methodological principles. They are based on the notion of criticality.

This approach does not evaluate the renewal of the resource: it integrates it into the estimated value. Criticality thus reflects the context in which the resource is taken. It can integrate the link between produced and "supporting" resources.

The proposed methods are based on available data, either in the scientific literature or in databases. They are mostly quantitative: future research would permit to investigate the possibility of dealing with qualitative aspects of supporting resources in an integrated way.

Investigating the assessment of renewability with LCA and the development of an indicator on this aspect raise fundamental interrogations around the method and its operational nature. It appears that LCA's ability to carry out this assessment highly depend on the structure of inventories, and the integration of missing data into inventories. Many "elementary" flows absent from LCIs are necessary to make the methodologies presented in this operational document. The relevance of extending inventories to these flows is open to debate: for operational issues, but also according to the level of transformation of the resource under consideration, and therefore its categorizing in ecosphere or technosphere. Awaiting these potential developments, it is still possible to develop indicators that use necessary flows integrated by hand.

The methodological developments proposed here are at a crossroads: they rely on existing elementary flows in databases, but also require some expertise to provide the missing information during simulation.

Their coherence could also be improved by the production of the necessary inventory flows, and the calculation of corresponding characterization factors.

As we can see, the logics mobilized are significantly different depending on the type of resources considered. If the methodology is based on the same principle, an indicator of criticality, the characteristics used to calculate it vary. More specifically, the difference is clear when considering biotic or abiotic resources: in the second case, the indicator relies on elements regarding the exploitation mode, considering that its sustainability constitutes a proxy to evaluate a simili-renewability of resources inherently non-depletable. In the first case criticality relies either on the characteristics of the resource itself, or on the "supporting" resources used for its renewal.

This differentiated approach is a limitation, as it stands, of the proposed methodology. Developments for a better consistency, and in particular homogenization of the amplitudes of variation for characterization factors, may allow a homogeneous analysis of all so-called renewable resources, and a possible aggregation into one single indicator.

This work should be based on threshold values potentially representative of the renewal of the resource. Thus, the maximum value of the characterization factor, corresponding to an overexploited resource (demand higher than availability), should ideally represent the consequence of overexploitation.

Considering the levels of transformation of a resource (natural or anthropogenic transformation), and the distinction between supporting and produced resource, it seems appropriate to seek to harmonize approaches to integrate, for each type of resource considered, the final impact on all supporting resources. These will constitute a base whose quality, availability and renewal will determine the conditions of produced resources renewability.

In particular, it should be noted that climate as a supporting resource has not been integrated into the models, while the IPCC points out in its latest report that various trusted studies indicate that climate change is reducing the ability of species to maintain (renewability of natural resources) and agricultural yields (renewability of anthropogenic resources).

We can, within LCA, consider that the loss of renewability is ultimately reported into the protection areas considered by the method, and that the impact on the quality of "supporting" resources conditions this loss.

Thus, the proposed method could be implemented as a weighting method for midpoint indicators illustrating the preservation of supporting resources. It would provide the severity of the scenario studied addressing the exploitation of potentially renewable resources and the available fund.