

Climate Change, Agriculture, and Energy Transition: What Do the Thirty Most-Cited Articles Tell Us?

Dmitry A. Ruban ^{1,2,*} , Natalia N. Yashalova ³, Olga A. Cherednichenko ⁴ and Natalya A. Dovgot'ko ⁴

¹ K.G. Razumovsky Moscow State University of Technologies and Management (the First Cossack University), Zemlyanoy Val Street 73, 109004 Moscow, Russia

² Department of Management, Higher School of Business, Southern Federal University, 23-ya Linija Street 43, 344019 Rostov-on-Don, Russia

³ Department of Economics and Management, Business School, Cherepovets State University, Sovetskiy Avenue 10, Cherepovets, 162600 Vologda Region, Russia; natalij2005@mail.ru

⁴ Department of Economic Theory and Agrarian Economics, Stavropol State Agrarian University, Zootekhnicheskij Lane 12, 355017 Stavropol, Russia; chered72@mail.ru (O.A.C.); ndovgotko@yandex.ru (N.A.D.)

* Correspondence: ruban-d@mail.ru

Received: 1 September 2020; Accepted: 25 September 2020; Published: 28 September 2020



Abstract: The thirty journal articles dealing with the relationship between climate change and agriculture (the latter is treated in general, i.e., as an industry) and which have gained >1000 citations are thought to be sources of the most precious information on the noted relationship. They were published between 1994 and 2011. Many are authored by West European and North American experts. The most-cited articles are attributed to three major themes and eight particular topics, and the best-explored topic is the influence of climate change on agriculture. Moreover, they provide some essential information about the strong relation of both agriculture and climate change to energy transition. The general frame characterizing complex interactions of climate change and agriculture development is proposed on the basis of the most-cited works, but it needs further detail, improvement, and update. The considered articles are basic sources with historical importance.

Keywords: bibliographical survey; climatic factor; energy industry; sustainable development; world agriculture

1. Introduction

Global climate change has intensified in the last third of the 20th century, and it remains one of the most important environmental problems [1,2]. This phenomenon, as well as its multiple consequences for biodiversity, several planetary systems, and ecological processes have been addressed by the Intergovernmental Panel on Climate Change (IPCC) [2] and discussed, particularly, by Adger et al. [3], Bellard et al. [4], Crowley [5], Giorgi [6], Parmesan and Yohe [7], Patz et al. [8], Ramanathan and Carmichael [9], Solomon et al. [10], Trenberth [11], and Walther et al. [12] and more recently by Edmonds et al. [13], Huang et al. [14], Konapala et al. [15], Molina et al. [16], and Sanderson and O'Neill [17]. These works (among many others) provide clear evidence that human activity challenges the global environment in the form of the climate change, and this challenge affects society and its sustainable development. Adaptation, mitigation, and, more generally, creative thinking are required to address this challenge.

Undoubtedly, all major industries of the world economy are and will be disturbed by climate change, but agriculture seems to be the most vulnerable from them because its productivity depends

on climate conditions; moreover, agricultural development has a heavy environmental impact (see the literature reviewed below). The relevant knowledge, which has accumulated during several decades of intense international research, is outstandingly rich. According to the bibliographical database Scopus, boasting significant completeness and embracing thousands of scientific journals, there are about 40,000 works discussing various aspects of the relationship between climate change and agriculture (see the parameters of such a literature search below). If so, every researcher in this field (especially the newcomer) faces a serious challenge: the number of the sources is too big to treat them efficiently with qualitative literature reviews or even bibliometric approaches. Moreover, frequent additions to this knowledge undermine the utility of such reviews soon after their publication. To concentrate on more or less 'narrow' lines of this research is another possible approach [18,19], but the relationship between climate change and agriculture is too complex to avoid tracing far-going and very general consequences and feedbacks. For instance, energy transition is evidently related to both agriculture and climate change, and their joint action seems to be highly complex. So, a general (even very general) picture would be strongly demanded by both the newcomers and the senior researchers searching for themes for high-impact writing.

Among about 40 thousands of literature sources, there are a few works that are thought to be the most important, trustful, and influential. Their outstanding value is demonstrated by their numerous citations in the other papers. Evidently, these works seem to be the most important, and, thus, it appears to be reasonable to check what these works are and which issues they address. The objective of the present paper is to re-visit the thirty most-cited articles dealing with the agriculture–climate change relationship, with three particular aims. First, it is intended to collect the relevant bibliographical information and to provide the general characteristics of the most-cited works. Second, it appears necessary to link logically different pieces of the outstanding knowledge available 'here and there' in the literature. Third, it is intended to discuss whether the most-cited works provide a more or less comprehensive vision of the relationship between climate change and agriculture. This paper is not a subject review and does not aim at comprehensive characteristics of the noted relationship. Actually, it is based on a bibliographical survey and qualitative content analysis, with details explained below. This paper starts with the general characteristics of the selected literature. Special attention is paid to the relevance of the agriculture–climate change relationship to the problem of energy transition. This problem is emphasized because one of the aims of the energy transition is climate change mitigation and agriculture, on the one hand, depends on the energy transition, and, on the other hand, it is able to contribute to this (e.g., via biofuel production). Then, the main research themes linked to the relationship between climate change and agriculture are identified. Finally, the general contribution of the most-cited articles to the understanding of this relationship is discussed.

2. Bibliographical Survey

2.1. Methodological Remarks

The literature describing the relationship between climate change and agriculture constitutes the material of the present study. The online bibliographical database Scopus is used to select the most-cited articles dealing with this relationship. This database is preferred because of its significant coverage (especially after 2005) and easy functionality. The search is generally realized with the basic keywords, and the procedure is explained below.

The analysis itself consists of two procedures. First, the basic characteristics of the selected articles are examined. These include the number of citations (total and average annual), the year of publication, the number of authors, the authors' country affiliations, and the bibliometric parameters of the journals where the articles appeared. These characteristics shed light on the research that resulted in the most-cited articles. Indeed, there may be some papers with the average annual number of citations higher than those of the most-cited articles selected for the purposes of this study. This issue is not addressed in the present paper because its analysis would require separate study; moreover, it is evident

that the ordinary users of Scopus pay attention to the total number of citations only. Second, the content of the selected literature is addressed qualitatively. The general/global versus regional/country focus is established. Then, the topics of the articles are outlined (this is an intuitive and somewhat subjective procedure, but it is essential for literature categorization). Articles with a similar focus are attributed to the same topics. All topics are analyzed critically to find their logical connections, which allow ‘delineation’ of the major themes consisting from one to several topics. This analysis is tentative and does not pretend to be fully universal. Nonetheless, the literature categorization provides useful material for quick orientation within the general problem of the agriculture–climate change relationship (as it is reflected by the most-cited works). The relevance of the considered articles to this problem is examined: the most-cited works can bear important notions on this relationship linked to any other issue (low relevance), mix the extensive treatment of this relationship with the other knowledge (medium relevance), and be fully dedicated to the relationship (high relevance). This relevance indicates the degree of development of each theme in the most-cited papers.

2.2. Selection of Articles

The on-line bibliographical database ‘Scopus’ is searched to find all sources bearing the words ‘climate change(s)’ and ‘agriculture(-al)’ in their titles, abstracts, and key words. The entire time span represented in this database is taken into account. The number of these sources is ~38,000 (as of 7 July 2020). Naturally, these differ by the number of their citations in the other works. Among these sources, there are <50 journal articles that were cited more than 1000 times. These seem to be the cornerstone publications that are in the focus of the present study. The latter deals with only those papers that consider agriculture in general, i.e., not those papers that pay attention to the very particular issues (e.g., livestock practices) and omit notions to agriculture in their titles, abstracts, or key words. Alternatively, the number of possible papers to filter would be larger, but it appears unrealistic to treat all of them, as well as to make the sample fully homogeneous. Nonetheless, a tentative experimental search in the database has shown that the words “agriculture” or “agricultural” exist often in the papers addressing very ‘narrow’ aspects.

Initially, all journal articles (45 items) dealing with the relationship between climate change and agriculture and with a number of citations higher than 1000 are chosen. However, it is evident that these include several sources where the above-mentioned words appear ‘occasionally’ and in any other context. The content of each initially chosen paper is checked ‘manually’ in order to select only those articles that really deal with the noted relationship. A total of 30 articles are detected this way (Table 1). These articles still differ by the number of citations and the relevance to climate change and agriculture, and these issues are addressed below. Nonetheless, these seem to be really outstanding publications.

Table 1. The articles considered in the present study.

Article	Year	Number of Citations in Scopus (as of 7 July 2020)		Number of Authors	Number of Countries from the Authors’ Affiliations
		Total	Average Annual		
[20]	2010	1026	114	3	1 (UK)
[21]	2005	2079	149	33	9 (Belgium, Denmark, Finland, France, Germany, Italy, Spain, Switzerland, USA)
[22]	2009	1126	113	28	1 (UK)

Table 1. Cont.

Article	Year	Number of Citations in Scopus (as of 7 July 2020)		Number of Authors	Number of Countries from the Authors' Affiliations
		Total	Average Annual		
[23]	1997	1474	67	3	2 (UK, USA)
[24]	2008	2585	235	5	1 (USA)
[25]	2005	6071	434	19	2 (UK, USA)
[26]	2011	3017	377	21	4 (Canada, Germany, Sweden, USA)
[27]	2007	1128	94	6	1 (France)
[28]	2010	4613	513	10	1 (UK)
[29]	2003	1082	68	7	1 (Switzerland)
[30]	2003	1252	78	2	1 (USA)
[31]	2004	3360	224	1	1 (USA)
[32]	2004	1669	111	1	1 (USA)
[33]	2003	1332	83	3	1 (Belgium)
[34]	2008	1497	136	6	1 (USA)
[35]	2011	1606	201	3	1 (USA)
[36]	2010	3113	346	3	1 (Portugal)
[37]	2004	1012	67	5	4 (Austria, Spain, UK, USA)
[38]	2004	1255	84	9	2 (China, Philippines)
[39]	2010	1564	174	16	3 (China, France, UK)
[40]	2010	2324	258	6	4 (Germany, Switzerland, UK, USA)
[41]	1999	1196	60	2	1 (USA)
[42]	2009	1850	185	29	8 (Australia, Belgium, Denmark, Germany, the Netherlands, Sweden, UK, USA)

Table 1. Cont.

Article	Year	Number of Citations in Scopus (as of 7 July 2020)		Number of Authors	Number of Countries from the Authors' Affiliations
		Total	Average Annual		
[43]	2009	4608	461	29	8 (Australia, Belgium, Denmark, Germany, the Netherlands, Sweden, UK, USA)
[44]	1994	1033	41	2	2 (UK, USA)
[45]	2009	1079	108	2	1 (USA)
[46]	2005	1060	76	35	11 (Belgium, Finland, France, Germany, the Netherlands, South Africa, Spain, Sweden, Switzerland, UK, USA)
[47]	2010	1767	196	8	1 (Switzerland)
[48]	2001	2203	122	10	1 (USA)
[49]	2011	2435	304	4	1 (USA)

2.3. Basic Characteristics of the Articles

The selected articles dealing with the relationship between climate change and agriculture have received from 1012 (minimum value) to 6071 (maximum value) citations (Table 1), with the mean value of 2047 and the median value of 1585. Expectedly, the number of the articles with the higher number of citations decreases exponentially (Figure 1). Although one can suppose that the ‘older’ papers have gained naturally more citations than the ‘younger’ papers, this is not so in fact; for instance, the papers with the noted maximum and minimum values were published very closely (Table 1). Moreover, there were important papers before 1994 (when the ‘oldest’ of the considered articles that reached the threshold of 1000 citations was published), but these ‘too early’ works, surprisingly, have not gained 1000 citations (probably, they were published before the ‘critical mass’ of the literature allowed extensive citation records or the scarcity of online bibliographical resources and open-access mode of publishing limited their promotion among scientists). The average annual number of citations of the considered articles differs substantially, from <50 to >500 per year (Table 1). Notably, the work with the highest number of total citations [25] and the work with the highest average number of annual citations [28] are not the same. Nonetheless, the correlation between the total and average annual numbers of citations is strong (the correlation coefficient value is 0.91). The information from Table 1 also stresses that the number of citations does not depend on the year of their appearance. Some sources of the same year differ by the number of citations strikingly.

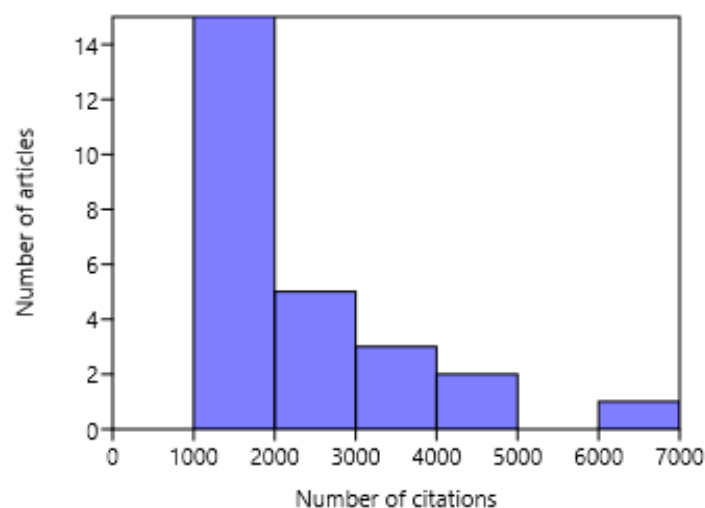


Figure 1. Frequency distribution of citations of the considered articles.

The present study deals with the almost unlimited time span (it is limited by the only entire time span of the resources of Scopus, which range from pre-19th century to 2021). However, the selected articles were published within the time period of 1994–2011 (Table 1). Notably, the two most ‘productive’ intervals were 2003–2005 and 2009–2011, when the majority of the most-cited papers appeared (Figure 2). Many most-cited articles appeared when the entire research field had started to grow (Figure 2). As a result, these papers became the primary, contemporaneous sources for citations in the other works. Together with the subsequent growth of the research, the specialists saw the already highly cited sources that, thus, were cited even more. It is also notable that no paper published after 2011 attracted more than 1000 citations, although the number of the potentially citing works increased substantially. Two possible explanations are the following. First, together with the increase in the number of the relevant publications, the authors of the following works faced a necessity to choose which one to cite. As a result, each new article, even if reporting results of outstanding importance, had less chance to be cited. Second, it is also possible that the scientific progress required a shift from too general, world-scale, and thus influential papers to those dealing with more particular issues in particular places of the world, and such papers were cited less intensively. Anyway, the correspondence of the publishing output and the citation dynamics is highly complex and non-linear, and, thus, it cannot be excluded that the concentration of the most-cited articles on the two noted time intervals is occasional.

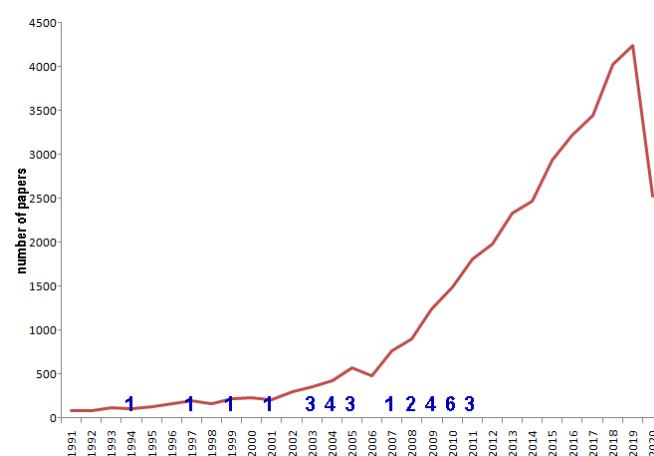


Figure 2. Dynamics of publishing papers dealing with the relationship between climate change and agriculture (brown line—all papers, blue numbers—the number of the most-cited papers by years). The information for 2020 is strongly incomplete, which explains the sharp drop.

The most-cited articles differ significantly by their author teams (Table 1). Although the majority have two and more authors (the only two papers have single author), the number of the authors is either relatively small or big (Figure 3). The mean number of authors is 10, and the median number of authors is 6. This means that the considered articles are the products of collective rather than individual work. In other words, groups (even ‘pools’) of experts and, speaking more broadly, relatively extensive research networks were required to generate such valuable knowledge. This inference also stresses the role of scientists’ consensus on global climate change as the environmental challenge of the world agriculture. It is interesting to state that the papers with a single author boast a number of citations above the median (Table 1), although the correlation coefficient between the number of authors and the number of citation is low (0.23 in the case of total citations and 0.24 in the case of average annual citations).

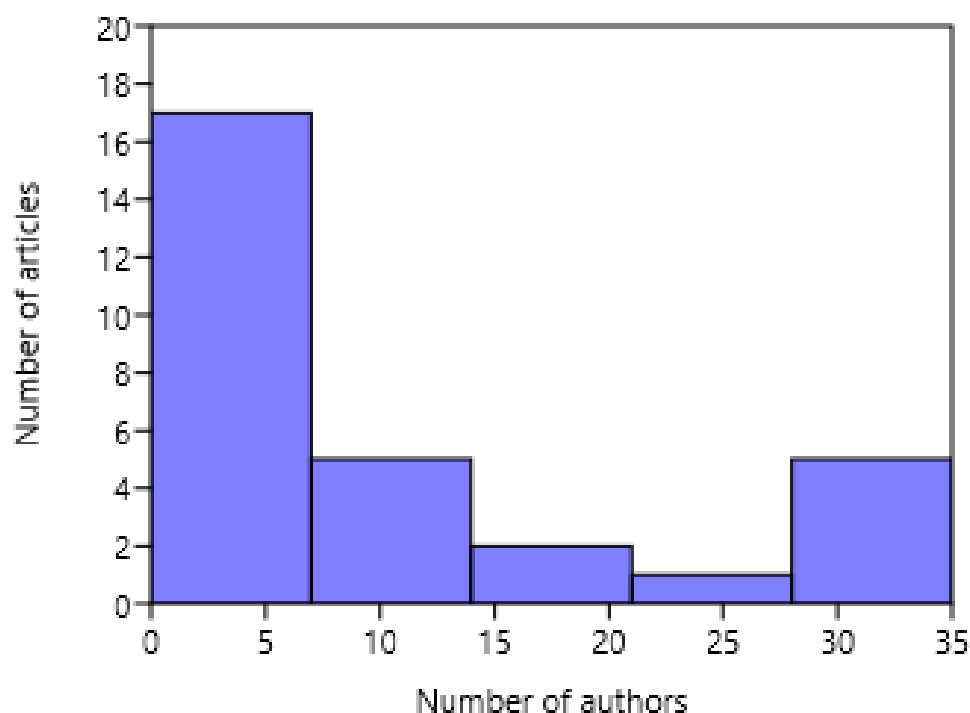


Figure 3. Frequency distribution of the author teams size in the considered articles.

Of big interest is how international (in regard to the authors’ affiliations) was the research that resulted in the most-cited articles. The bibliographical information allows ambivalent judgments (Table 1). On the one hand, many articles were written by the representatives of one–two countries (often, these are the UK and the USA) (Figure 4). On the other hand, there are articles authored by truly international teams (Table 1), and experts from a total of 19 countries authored the considered articles taken entirely (Figure 5). One should also note that the authors represent chiefly Western Europe and North America (Figure 5). Generally, it appears that the most-cited articles dealing with the relationship between climate change and agriculture resulted from the limited collaboration of experts representing different countries (when existing, this is chiefly North American–European collaboration). Notably, international collaboration does not affect the number of citations, because the correlation coefficient between the number of countries indicated in the author affiliations and the number of citations is very low (0.08 in the case of total citations and 0.09 in the case of average annual citations).

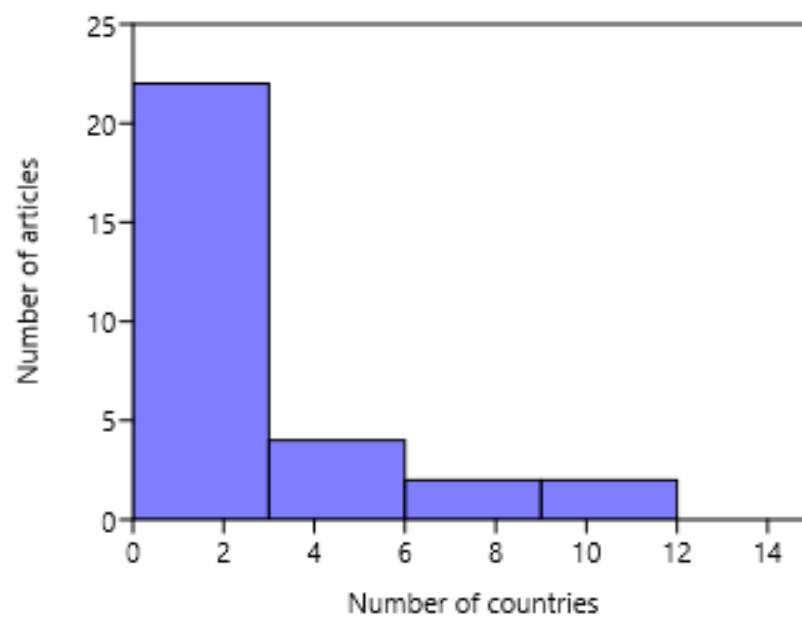


Figure 4. Frequency distribution of the number of countries indicated in author affiliations in the considered articles.

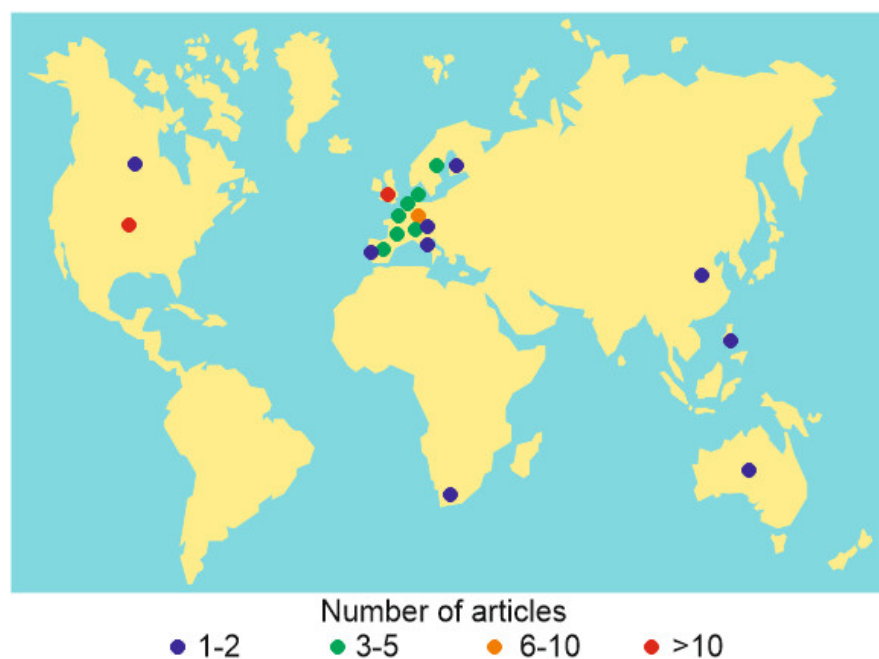


Figure 5. Geography of the authorship (country affiliations of the authors) of the considered articles.

The thirty articles considered in this study appeared in fifteen journals (Table 2). Two of them, namely *Science* and *Nature* hosted half of all articles. Although all fifteen journals boast outstanding metrics (high impact factor, high CiteScore value, and top quartile), they differ substantially. For instance, the impact factor ranges between 3.3 and 60.4 (Table 2), which complicates the relationship between journal prestige and the number of citations of the papers published there. Apparently, publishing in a high-prestige journal (every journal listed in Table 2 is high-prestige) is enough to make the paper highly citable, irrespective of whether this journal has higher or lower metrics relative to the other prestige journals.

Table 2. Bibliometric characteristics of the journals where the considered articles were published.

Journal	Number of Articles	Bibliometrics (for 2019)			
		Web of Science		Scopus	
		Impact Factor	Quartile	CiteScore	Quartile
<i>Annual Review of Environment and Resources</i>	1	8.065	1	15.8	1
<i>Annual Review of Plant Biology</i>	1	19.54	1	32.8	1
<i>Ecology and Society</i>	1	3.89	1	7.5	1
<i>Earth-Science Reviews</i>	1	9.724	1	15.0	1
<i>Geoderma</i>	1	4.848	1	7.6	1
<i>Global Biogeochemical Cycles</i>	1	4.608	1	9.4	1
<i>Global Environmental Change</i>	1	10.466	1	17.0	1
<i>International Journal of Life Cycle Assessment</i>	1	4.307	1, 2	8.5	1
<i>Nature</i>	7	42.778	1	51.0	1
<i>Plant and Soil</i>	1	3.299	1, 2	5.9	1
<i>Proceedings of the National Academy of Sciences of the United States of America</i>	3	9.412	1	15.7	1
<i>Renewable and Sustainable Energy Reviews</i>	1	12.11	1	25.5	1
<i>Science</i>	8	41.845	1	45.3	1
<i>The Lancet</i>	1	60.392	1	73.4	1
<i>Trends in Ecology and Evolution</i>	1	14.764	1	22.3	1

3. Relevance to Energy Transition

The agriculture–climate change relationship has an important dimension that requires special attention, also in regard to the reviewed literature sources. Energy transition is a fundamental and multidimensional problem of modern civilization [50–54]. Particularly, its solution is aimed at sustainable development of energy systems and industry in the whole, broad implementation of clean, innovative energy-related technologies, more attention to renewable energy sources, etc. Undoubtedly, the energy transition is not only important with regard to the global climate change and sustainable world agriculture (and food security), but it is strongly related to these two planetary-scale issues. The direct relevance of energy transition to the global climate change and the policies of its mitigation on municipal, national, regional, and global levels is explained by Hoppe and van Bueren [55], Fazey et al. [56], Newell and Bulkeley [57], Scheffran et al. [58], and Urban [59]. The strong relation of agriculture to the energy transition is also discussed. Probably, the most important contribution was made by Sutherland et al. [60] who explain how management of land and ecosystems in agriculture relates it to the renewable energy transition, although this requires significant policy support; moreover, these specialists note that agriculture competes with the electricity industry over access to natural resources. Importantly, this study also demonstrates the full complexity of the energy–agriculture–climate change nexus.

The literature reviewed in this work ‘touches’ the relevance of the agriculture–climate change relationship, and not superficially. This issue is considered in several works. First, the rise of energy demand together with the world agriculture development is noted by Foley et al. [25]. This means that agriculture can be judged a factor challenging the energy transition. Second, several works focus on energy crops and biofuel production. Fargione et al. [24] explain that whether low-carbon energy sources and biofuels contribute to climate change mitigation or not depends on agricultural practices,

and extensive clearance of forests and grasslands for energy crops results in too big carbon dioxide emissions. Lal [31] focuses on the positive side of energy crops growing and lists this among the other agricultural opportunities to mitigate the climate change. Mata et al. [36] stress the importance of microalgae for biofuel production. This means that the new agricultural practice is able to facilitate the energy transition with evident benefits for climate change mitigation. Generally, as biofuel production is thought to be an instrument towards energy transition [61–63], this means that the success of implementation of this instrument strongly depends on the mode of agricultural development. In other words, agriculture plays a critical role for achievement of the energy transition in regard to biofuels and the relevant policies.

Contrary to what will be said below about some thematic deficiencies of the most-cited articles addressing the agriculture–climate change relationship, it appears that the selected piece of literature, i.e., the thirty most-cited articles shed light on the relevance of this relationship to energy transition. This issue is considered adequately and in a very balanced way. This means that the most-cited works would be more or less enough for newcomers interested in the energy–agriculture–climate change nexus. This finding can be also interpreted so that this nexus is of crucial importance for the understanding of the relationship between climate change and agriculture. Nonetheless, the nexus has a lot of particular aspects that are addressed in some important, but less-cited articles. For instance, Bardi et al. [64] raise the theoretical question of agriculture adaptation to the energy transition and, particularly, to the use of sustainable energy sources; Chai et al. [65] indicate the possible importance of agriculture-related methane emissions as a new energy source; Safriel [66] hypothesizes that climate change and the relevant desertification may create not only challenges, but also opportunities for solar energy production and agricultural development. Importantly, the general ideas of the energy–agriculture–climate change nexus and the above-mentioned particular aspects contribute to the understanding of how strongly this nexus determines sustainable development in the modern world. It is worth noting the social application (also in regard to sustainability) of the relevant issues [67].

4. General Research Themes and Key Findings

The most-cited articles dealing with the relationship between climate change and agriculture are very different with regard to their content. Below, attention is paid to their geographical focus, themes and topics, main findings, and relevance. These are detected on the basis of the critical reading of each paper and the qualitative analysis of the context in which climate change and agriculture are considered.

The most-cited articles are either of a general nature and address planetary-scale issues or region- or country-focused. The former prevail, which is expected (Figure 6). Moreover, it is surprising that there are some papers focusing on particular countries and, nonetheless, attracting such a big number of citations. This means that there are issues of outstanding importance that can be analyzed deeply on the basis of case examples. The papers with a regional or country focus deal with the USA, Brazil, all of Europe, and China.

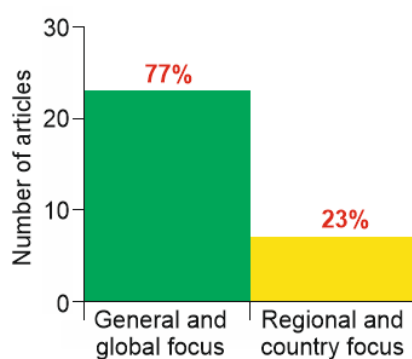


Figure 6. The focus of the considered articles.

The content of the articles is rather diverse. Three major themes can be outlined, namely, technologies, links, and adaptations (Table 3). These themes correspond to the main contexts in which climate change and agriculture are considered in the most-cited articles. The themes are represented by several particular topics (Table 3). Apparently, the most attention is paid to climate change influences on agriculture. The development of agriculture as a factor of climate change is considered in a slightly smaller part of the works. The thematic affinity of each considered paper is summarized in Table 4.

Table 3. Categorization of the content of the considered articles.

Abbreviation	Theme	Topic	Number of Articles
T1	Technologies (approaches, working schemes, procedures, etc.)	T1.1. Technologies addressing climate change and agriculture	5
		T1.2. Technologies addressing agriculture	2
T2	Links (what influences on what)	T.2.1. Climate change interacts with agriculture	3
		T.2.2. Agriculture influences on climate change	6
		T.2.3. Climate change influences on agriculture	9
		T.2.4. Linking through general frame	4
		T.2.5. Joint action of climate change and agriculture	1
T3	Adaptations (pragmatic vision of the problem)	T3.1. Incentives	1

Table 4. Thematic affinity of the considered articles.

Article	Theme	Topic	Relevance to the Agriculture–Climate Change Relationship
[20]	T1	T1.1	High
[21]	T2	T2.1	High
[22]	T1	T1.2	Low
[23]	T2	T2.1	Medium
[24]	T1	T1.1	High
[25]	T2	T2.2	Medium
[26]	T1	T1.2	High
[27]	T2	T2.2	Low
[28]	T2	T2.3	Low
[29]	T2	T2.4	Low
[30]	T2	T2.2	Low
[31]	T1	T1.1	High
[32]	T1	T1.1	High
[33]	T2	T2.5	Medium
[34]	T3	T3.1	High
[35]	T2	T2.3	High
[36]	T1	T1.1	Low
[37]	T2	T2.3	High
[38]	T2	T2.3	High
[39]	T2	T2.3	High
[40]	T2	T2.3	Medium
[41]	T2	T2.2	Medium
[42]	T2	T2.4	Low
[43]	T2	T2.4	Low
[44]	T2	T2.3	High
[45]	T2	T2.3	High
[46]	T2	T2.4	Low
[47]	T2	T2.3	Medium
[48]	T2	T2.2	Medium
[49]	T2	T2.2	High

Theme 1 (Technologies) is represented by two topics, one of which deals with approaches in both climate change and agriculture (T1.1), and the other topic focuses on agricultural approaches, although with reference to climate change (T1.2). Five papers contribute to the topic T1.1. Atkinson et al. [20] consider biochar application to soils. On the basis of the example from the Amazon Basin, they argue that highly stable organic black carbon waste increases the agronomic fertility of soils and contributes simultaneously to carbon sequestration. The authors extrapolate this knowledge to temperate regions. Fargione et al. [24] address a serious dilemma of biofuel production. On the one hand, biofuel allows reduction of greenhouse gas emissions. On the other hand, the relevant agricultural activities require land clearing, which triggers increase in the amounts of carbon dioxide to the atmosphere. The authors propose two solutions, namely, biofuel production from waste biomass and biofuel production on degraded/abandoned agricultural lands. In his two articles, Lal [31,32] addresses soil carbon sequestration as a tool to mitigate climate change. He indicates that the efficacy of this tool depends, particularly, on agricultural practices, and the relevant technologies are ‘win-win’, allowing to increase soil productivity and to reduce carbon dioxide emissions. Mata et al. [36] focus on microalgae for biodiesel production. Their cultivation can be linked to agricultural activities and facilitates renewable energy production, carbon sequestration, and improvement in agricultural food. Two papers contribute to the topic T1.2. Costello et al. [22] call for improvement in agricultural practices to increase carbon biosequestration. Foley et al. [26] review various solutions that would help agriculture to minimize its environmental impact and, particularly, its contribution to climate change. Essentially, the topic T1.2 is very similar to the topic T1.1. However, the authors of the T1.2 papers pay more attention to a ‘green’ shift in agriculture. Taking the entire theme T1 critically, it is possible to judge that it highlights many interesting opportunities, but it does not make clear how extensive these agriculture- and climate-friendly solutions may be and how long would be the road from their initial implementation to reaching the planetary-scale effects. The willingness and the readiness of the farmers and the other stakeholders to implement such advanced technologies appear to be questionable. Nonetheless, the local contribution to agricultural and climate change benefits with the mentioned approaches is undisputable. It should be stressed that the majority of the articles of the T1 theme demonstrate high relevance to the relationship between climate change and agriculture (Table 4), which implies significant development of this theme.

The theme T2 (Links) includes five topics, each of which corresponds to a definite causal relationship between climate change and agricultural development, namely their interaction (T2.1), agriculture as a factor of climate change (T2.2), climate change as a factor of agriculture (T2.3), phenomena linking through any general frame (T2.4), and joint action (T2.5). This theme is the most diverse, and it embraces 73% of the considered articles. The topic T2.1 is represented by two papers. Ciais et al. [21] explain that heatwaves in temperate regions (like the heatwave that struck Europe in 2003) cause reduction in ecosystem productivity (also agricultural), increase in carbon dioxide release to atmosphere, and reversal of carbon sequestration. Drake et al. [23] document the plant response to the elevated concentrations of carbon dioxide in the atmosphere and argue for an increase in nutrient use efficiency. These specialists extrapolated the noted effects to agricultural systems and stressed their fundamental changes. Six papers can be attributed to the topic T2.2. Foley et al. [25] note that the agricultural land expansion has limited the ability of natural ecosystems to regulate climate. Fontaine et al. [27] propose that agricultural practices are able to destabilize carbon pool in soils and, thus, to contribute to greenhouse gas emissions. Kalnay and Cai [30] model land-use changes linked to urbanization and agricultural activities, and these changes are able to contribute sufficiently to climate warming. Ramankutty and Foley [41] investigate changes in the global croplands during three centuries and claim that such changes could influence climate. Tilman et al. [48,49] pay attention to extraordinary environmental and climate change effects of the agricultural development and the relevant land clearing. These specialists call for improvement in agricultural practices in the both ‘rich’ and ‘poor’ countries. The topic T2.3 includes 30% of all considered articles. Godfray et al. [28] state that climate change is among the threats for the agricultural production and food security. Lobell et al. [35] consider

climate change as a significant negative factor of agriculture. They demonstrate that the decline in the global maize and wheat production in the 1980s–2000s was driven by climate change, and the latter can minimize positive effects of agricultural innovations. Parry et al. [37] consider several scenarios of the agricultural response to the climate change. Particularly, they find that the latter will strengthen regional differences of crop yields, with the negative socio-economic consequences (e.g., crop price increase). Peng et al. [38] explain that global warming triggers higher night temperatures decreasing rice yields. Piao et al. [39] conclude that it is impossible to state definite effects of climate change on agriculture in China in the past decades. Potts et al. [40] find that climate change and agricultural development are related, particularly, through pollinators, and the decline of the latter due to several factors, including climate change, challenges crop production. Rosenzweig and Parry [44] suppose that climate change will not alter significantly global food production, but such an influence will be really major in developing countries. Schlenker and Roberts [45] forecast a significant drop in crop yields (corn, soybeans, and cotton) in the USA in the 21st century because of the modeled climate change. Finally, Seneviratne et al. [47] propose that the understanding of the soil moisture–climate interactions helps to understand the perspectives of agriculture under climate change.

The topic T2.4 is represented by four papers. The works by Jolliet et al. [29], Rockstrom et al. [42,43], and Schroter et al. [46] indicate the relevance of climate change and the agricultural development to the major environmental challenges of modern society and put these into the general frame of sustainability-related mechanisms, factors, and consequences. In other words, the noted works link climate change and agriculture through a general frame. Undoubtedly, these papers are thought to be highly influential, although their focus is much broader than the relationship between the two phenomena. The topic T2.5 boasts the only paper by Lambin et al. [33] who consider cropland changes, agricultural intensification and expansion, land clearing, and some other processes that accompany climate change. Importantly, these specialists distinguish the climate change–agriculture interactions from the influences of these phenomena taken separately. Generally, the entire theme T2 sheds light on the causes of the links between climate change and agriculture. However, three peculiarities of the relevant literature deserve criticism. First, the links are treated too generally, and these are ‘secondary-order’ inferences from more general studies. Second, the topics are illustrated with representative, but very particular examples, and, thus, these topics do not boast comprehensive coverage. Third, there are conclusions based on modeling—on the one hand, the models need permanent update and refinement; on the other hand, no model escapes simplifications and, thus, these need to be tested by the factual information. Apparently, all principal mechanisms of the relationship between climate change and agriculture are considered within the theme T2, but this knowledge seems to be enough for the only very general conceptual frame. Notably, only 35% of the articles attributed to the theme T2 boast high relevance (Table 4), which means certain underdevelopment or even ‘marginalization’ of this theme in the most-cited articles considered in the present study. Importantly, the articles attributed to the topic 2.3 are not only the most numerous, but also the most comprehensive and boast high relevance (Table 4). This means that the climate change factor of the agriculture development is largely well understood.

The theme T3 (Adaptations) includes the only topic T3.1 dealing with incentives, and this topic is represented by the only paper of high relevance (Table 4). Lobell et al. [34] show that South Asia and Southern Africa need adaptation to climate change to avoid agriculture failures and disturbance to their food security. They call for adequate risk attitudes and investment activities. The importance of this work is undisputable, but the entire theme T3 seems to be restricted in the most-cited articles.

5. Discussion

5.1. General Vision

The thirty most-cited articles considered in this study contribute substantially to a general frame of the relationship between climate change and agriculture. First, these works prove that the global

environmental challenge has two sides, namely, the climate change influences and the agricultural influences (Figure 7). These influences can be both positive and negative, and these are realized via different mechanisms. Second, the relationship is highly complex because of feedbacks (Figure 7). Third, the articles highlight not only challenges to sustainability, but also opportunities to achieve this sustainability (Figure 7). One of the most important opportunities is linked to carbon sequestration in soil that can be facilitated by agricultural practices. Many considered articles also imply that the agriculture–climate change relationship cannot be understood comprehensively if considered alone. In fact, many other mechanisms and phenomena (biological, socio-economical, etc.) should be taken into account.

The critical analysis of the themes of the considered papers (see above) indicates some incompleteness (these are found in the only most-cited literature, not in all ~38,000 publications). Several potentially important topics are not found in the analyzed literature. For instance, these include (and not limited to) livestock farming in the changing conditions, climate change influences on distribution channels of agricultural products (and food trade networks), new challenges for local communities and labor force under the climate change–agriculture interactions, cost of climate-friendly agricultural innovations, new agricultural opportunities after climate amelioration, tax policy modification, etc. (these topics are selected provisionally as nothing more than examples and with regard to the authors' research experience; many other topics can be proposed). Indeed, the literature on these topics is available (Table 5), but these works are not among the most-cited. Some sources were available decades ago, but these are also not among the most-cited. When the amount of literature is really vast, it is very probable that the researchers (especially the newcomers) tend to base their own ideas on the most respected works. When the latter do not provide some information, the chances for the rise of the relevant topics are lower. A possible solution would come from the authoritative books (e.g., [68–70]). However, the book distribution channels are significantly more limited than those of journal articles, and not all potentially interested specialists may easily acquire the necessary book. Moreover, searching for highly cited papers in the on line bibliographical databases appears to be a technically easier and logical option for a newcomer than struggling with book collecting. Additionally, as shown above (Figure 2), the most-cited articles are older than 2012. This means they do not bear certain up-to-date knowledge.

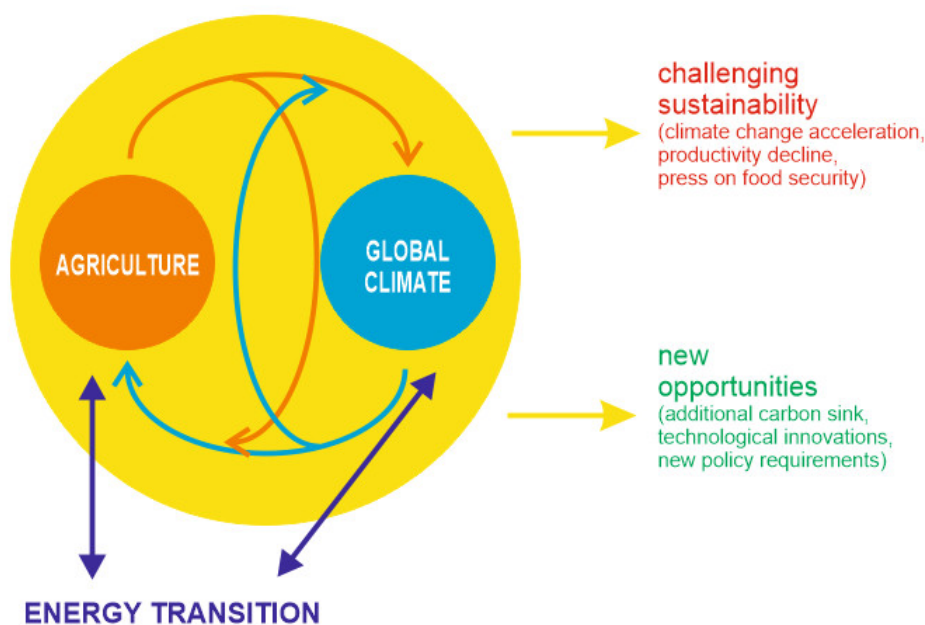


Figure 7. The general frame for judgment of the relationship between climate change, agriculture, and energy transition, as follows from the most-cited articles. Arrows within the circle represent influences, arrows outside the circles represent outcomes.

Table 5. Selected topics extending the vision of the agriculture–climate change relationship.

Topic	Some Findings	Literature Sources	Year of Publishing; Total Number of Citations
Livestock farming and climate change	Negative effects on animal husbandry with negative socio-economic effects (e.g., increase in food price)	[71]	2020; 1
Climate change and distribution of agricultural products	European meat and dairy supply chains are linked to greenhouse gas emissions	[72]	2020; 1
Climate change–agriculture interactions as challenge to local communities and labor force	High percentages of labor forces employed in agriculture of an Australian region as a driver of local vulnerability to climate change	[73]	2018; 0
Economical and political aspects of climate-friendly agricultural innovations	The Climate-Smart Agriculture Prioritization Framework (CSA-PF) in Mali as example of successful adaptation scheme	[74]	2017; 25
Agricultural opportunities due to climate change	Extending potential for wheat cultivation and higher wheat yields in some areas of Russia	[75]	2018; 6
Tax policy modification in regard to agriculture and climate change	Nitrogen tax implementation in Germany; more generally, new taxes in the face of new challenges, similarly to raising new taxes together with Internet service growth	[76] (see also [77] for general reference)	2020; 0

5.2. Utility of the Most-Cited Articles

The results of the present study allow for discussion of the utility of the most-cited articles for the understanding of the relationship between climate change and agriculture. Three lines of evidence should be taken into account. First, the considered articles bear enough knowledge to construct the conceptual frame of this relationship (Figure 7) and to realize the diversity of the latter (Table 3). Second, not all articles demonstrate high relevance to climate change and agriculture (Table 4), and the knowledge they provide may be incomplete (see above). The best-understood is the influence of climate change on agriculture. Third, the most-cited articles reflect the opinion of experts from a limited number of countries, not the entire international research community (Figure 5), even if the scope of many articles is global. With regard to this evidence, it is possible to state that the most-cited articles are really basic, ‘classical’ for the understanding of the relationship between climate change and agriculture on the planetary scale, but their utility in modern research is somewhat limited. Nonetheless, these articles are of evident historical importance, and they indicate the principal research directions.

Previous research [78–80] has examined the role of the highly-cited papers in the modern science. Some of their conclusions match the findings of the present study. Marx et al. [78] analyzed the bibliographical records for climate change and noted some really outstanding papers, many of which are of historical importance. The present study also indicates that the most-cited papers appeared at the time of research acceleration (Figure 2), i.e., their historical role is outstanding. Liu et al. [79] found that the highly cited papers in food science are often authored by US and Chinese specialists. Ma et al. [80] investigated the highly cited papers from environmental science. They also found that the number of these papers accelerates and that American and Chinese experts are especially productive. These findings coincide with the outcome of the present study only partly: the most-cited papers are not new and, thus, no acceleration in their number is visible (Figure 2), and the number of the Chinese works among them is limited (Figure 5). Generally, the three above-mentioned papers, as well as

the present study prove the utility of the highly cited papers in modern research. However, with regard to the agriculture–climate change relationship, this utility appears to be lesser than in the other cases.

Currently, a discussion of the importance of the open-access mode of publishing articles for attraction of the other researchers' attention and citations goes on [81–83]. Undoubtedly, such a mode can increase the influence of some articles. As for the literature considered for the purposes of the present study, these works appeared before the mid-2010s when, apparently, the distribution and the importance of open access was limited. However, when some sources gained importance, their copies appeared for free in Internet. Such 'open access' contributes to the current promotion of these papers and may stimulate the growth of their citations.

6. Conclusions

The present study combines the knowledge of the relationship between climate change and agriculture from the thirty most-cited papers and examines the utility of the latter. Three very general conclusions are possible on the basis of the findings of this study.

First, the thirty most-cited articles revealing the relationship between climate change and agriculture were published within a limited time interval and chiefly by specialists from Western Europe and North America. This implies certain biases. However, these articles appeared in high-reputation journals, which is the sign of their outstanding importance (at least, historical).

Second, energy transition is reflected in several articles (the different functions of agriculture are shown), which indicates a particular, but highly important issue. More generally, the content analysis of the works implies that the complex interactions between global climate change and agricultural development have as many negative effects as new opportunities for sustainable development.

Third, the most-cited articles can be judged as fundamental for the understanding of the relationship between climate change and agriculture, but the knowledge from only them, when taken entirely, does not avoid incompleteness. Nonetheless, the most-cited articles provide some essential knowledge from a borderless research field (especially for the newcomers). Moreover, the most-cited articles form a valuable basis for the understanding of the energy–agriculture–climate nexus.

The outcomes of the present paper imply that the conceptualization of the relationship between climate change and agriculture is yet to become comprehensive in the most-cited articles. This conclusion means new synthetic works by the world-leading experts are necessary to review this relationship on a modern basis. Undoubtedly, a lot of knowledge is already available, but it is scattered over a big number of works. In other words, specialists in climate change and agriculture need to make efforts for systematization and proper communication of the available information, which is a task for theoretical research. The researchers also need to train their vision to not miss some potentially valuable, even if less-cited works, either old or new.

Author Contributions: Conceptualization, N.N.Y. and O.A.C.; formal analysis, D.A.R. and N.A.D.; writing—original draft preparation, D.A.R. and N.N.Y. All authors have read and agreed to the published version of the manuscript.

Funding: The reported study was funded by RFBR, project number 20-010-00375 (project "Formation methodology and development of organizational and economic mechanism for achieving sustainable development goals in the national agri-food system").

Acknowledgments: The authors gratefully thank the special issue editors E. Karasmanaki (Greece) and G. Tsantopoulos (Greece) for their kind invitation and a lot of support, as well as the reviewers for their helpful recommendations.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Houghton, J. *Global Warming. The Complete Briefing*; Cambridge University Press: Cambridge, UK, 2009.
2. IPCC. *Climate Change 2014: Synthesis Report*; IPCC: Geneva, Switzerland, 2014.

3. Adger, W.N.; Arnell, N.W.; Tompkins, E.L. Successful adaptation to climate change across scales. *Global Environ. Chang.* **2005**, *15*, 77–86. [\[CrossRef\]](#)
4. Bellard, C.; Bertelsmeier, C.; Leadley, P.; Thuiller, W.; Courchamp, F. Impacts of climate change on the future of biodiversity. *Ecol. Lett.* **2012**, *15*, 365–377. [\[CrossRef\]](#) [\[PubMed\]](#)
5. Crowley, T.J. Causes of climate change over the past 1000 years. *Science* **2000**, *289*, 270–277. [\[CrossRef\]](#) [\[PubMed\]](#)
6. Giorgi, F. Climate change hot-spots. *Geophys. Res. Lett.* **2006**, *33*, L08707. [\[CrossRef\]](#)
7. Parmesan, C.; Yohe, G. A globally coherent fingerprint of climate change impacts across natural systems. *Nature* **2003**, *421*, 37–42. [\[CrossRef\]](#)
8. Patz, J.A.; Campbell-Lendrum, D.; Holloway, T.; Foley, J.A. Impact of regional climate change on human health. *Nature* **2005**, *438*, 310–317. [\[CrossRef\]](#) [\[PubMed\]](#)
9. Ramanathan, V.; Carmichael, G. Global and regional climate changes due to black carbon. *Nat. Geosci.* **2008**, *1*, 221–227. [\[CrossRef\]](#)
10. Solomon, S.; Plattner, G.-K.; Knutti, R.; Friedlingstein, P. Irreversible climate change due to carbon dioxide emissions. *Proc. Natl. Acad. Sci. USA* **2009**, *106*, 1704–1709. [\[CrossRef\]](#)
11. Trenberth, K.E. Changes in precipitation with climate change. *Clim. Res.* **2011**, *47*, 123–138. [\[CrossRef\]](#)
12. Walther, G.-R.; Post, E.; Convey, P.; Menzel, A.; Parmesan, C.; Beebee, T.J.C.; Fromentin, J.-M.; Hoegh-Guldberg, O.; Bairlein, F. Ecological responses to recent climate change. *Nature* **2002**, *416*, 389–395. [\[CrossRef\]](#)
13. Edmonds, H.K.; Lovell, J.E.; Lovell, C.A.K. A new composite climate change vulnerability index. *Ecol. Indic.* **2020**, *117*, 106529. [\[CrossRef\]](#)
14. Huang, J.; Yu, H.; Han, D.; Zhang, G.; Wei, Y.; Huang, J.; An, L.; Liu, X.; Ren, Y. Declines in global ecological security under climate change. *Ecol. Indic.* **2020**, *117*, 106651. [\[CrossRef\]](#)
15. Konapala, G.; Mishra, A.K.; Wada, Y.; Mann, M.E. Climate change will affect global water availability through compounding changes in seasonal precipitation and evaporation. *Nat. Commun.* **2020**, *11*, 3044. [\[CrossRef\]](#)
16. Molina, C.; Akçay, E.; Dieckmann, U.; Levin, S.A.; Rovenskaya, E.A. Combating climate change with matching-commitment agreements. *Sci. Rep.* **2020**, *10*, 10251. [\[CrossRef\]](#) [\[PubMed\]](#)
17. Sanderson, B.M.; O'Neill, B.C. Assessing the costs of historical inaction on climate change. *Sci. Rep.* **2020**, *10*, 9173. [\[CrossRef\]](#)
18. Jussi, L.; Sanna, L.; Markku, O. Climate change mitigation and agriculture: Measures, costs and policies—A literature review. *Agric. Food Sci.* **2020**, *29*, 110–129.
19. Praveen, B.; Sharma, P. A review of literature on climate change and its impacts on agriculture productivity. *J. Public Aff.* **2019**, *19*, e1960. [\[CrossRef\]](#)
20. Atkinson, C.J.; Fitzgerald, J.D.; Hips, N.A. Potential mechanisms for achieving agricultural benefits from biochar application to temperate soils: A review. *Plant Soil* **2010**, *337*, 1–18. [\[CrossRef\]](#)
21. Ciais, P.; Reichstein, M.; Viovy, N.; Granier, A.; Ogue, J.; Allard, V.; Aubinet, M.; Buchmann, N.; Bernhofer, C.; Carrara, A.; et al. Europe-Wide reduction in primary productivity caused by the heat and drought in 2003. *Nature* **2005**, *437*, 529–533. [\[CrossRef\]](#)
22. Costello, A.; Abbas, M.; Allen, A.; Ball, S.; Bell, S.; Bellamy, R.; Friel, S.; Groce, N.; Johnson, A.; Kett, M.; et al. Managing the health effects of climate change. Lancet and University College London Institute for Global Health Commission. *Lancet* **2009**, *373*, 1693–1733. [\[CrossRef\]](#)
23. Drake, B.G.; Gonzalez-Meler, M.A.; Long, S.P. More efficient plants: A Consequence of Rising Atmospheric CO₂? *Ann. Rev. Plant Biol.* **1997**, *48*, 609–639. [\[CrossRef\]](#) [\[PubMed\]](#)
24. Fargione, J.; Hill, J.; Tilman, D.; Polasky, S.; Hawthorne, P. Land clearing and the biofuel carbon debt. *Science* **2008**, *319*, 1235–1238. [\[CrossRef\]](#) [\[PubMed\]](#)
25. Foley, J.A.; DeFries, R.; Asner, G.P.; Barford, C.; Bonan, G.; Carpenter, S.R.; Chapin, F.S.; Coe, M.T.; Daily, G.C.; Gibbs, H.K.; et al. Global consequences of land use. *Science* **2005**, *309*, 570–574. [\[CrossRef\]](#) [\[PubMed\]](#)
26. Foley, J.A.; Ramankutty, N.; Brauman, K.A.; Cassidy, E.S.; Gerber, J.S.; Johnston, M.; Mueller, N.D.; O'Connell, C.; Ray, D.K.; West, P.C.; et al. Solutions for a cultivated planet. *Nature* **2011**, *478*, 337–342. [\[CrossRef\]](#)
27. Fontaine, S.; Barot, S.; Barr  , P.; Bdioui, N.; Mary, B.; Rumpel, C. Stability of organic carbon in deep soil layers controlled by fresh carbon supply. *Nature* **2007**, *450*, 277–280. [\[CrossRef\]](#)

28. Godfray, H.C.J.; Beddington, J.R.; Crute, I.R.; Haddad, L.; Lawrence, D.; Muir, J.F.; Pretty, J.; Robinson, S.; Thomas, S.M.; Toulmin, C. Food security: The challenge of feeding 9 billion people. *Science* **2010**, *327*, 812–818. [\[CrossRef\]](#)
29. Jolliet, O.; Margni, M.; Charles, R.; Humbert, S.; Payet, J.; Rebitzer, G.; Rosenbaum, R. IMPACT 2002+: A New Life Cycle Impact Assessment Methodology. *Int. J. Life Cycle Assess.* **2003**, *8*, 324–330. [\[CrossRef\]](#)
30. Kalnay, E.; Cai, M. Impact of urbanization and land-use change on climate. *Nature* **2003**, *423*, 528–531. [\[CrossRef\]](#)
31. Lal, R. Soil carbon sequestration impacts on global climate change and food security. *Science* **2004**, *304*, 1623–1627. [\[CrossRef\]](#)
32. Lal, R. Soil carbon sequestration to mitigate climate change. *Geoderma* **2004**, *123*, 1–22. [\[CrossRef\]](#)
33. Lambin, E.F.; Geist, H.J.; Lepers, E. Dynamics of land-use and land-cover change in tropical regions. *Ann. Rev. Environ. Resour.* **2003**, *28*, 205–241. [\[CrossRef\]](#)
34. Lobell, D.B.; Burke, M.B.; Tebaldi, C.; Mastrandrea, M.D.; Falcon, W.P.; Naylor, R.L. Prioritizing climate change adaptation needs for food security in 2030. *Science* **2008**, *319*, 607–610. [\[CrossRef\]](#) [\[PubMed\]](#)
35. Lobell, D.B.; Schlenker, W.; Costa-Roberts, J. Climate trends and global crop production since 1980. *Science* **2011**, *333*, 616–620. [\[CrossRef\]](#)
36. Mata, T.M.; Martins, A.A.; Caetano, N.S. Microalgae for biodiesel production and other applications: A review. *Renew. Sustain. Energy Rev.* **2010**, *14*, 217–232. [\[CrossRef\]](#)
37. Parry, M.L.; Rosenzweig, C.; Iglesias, A.; Livermore, M.; Fischer, G. Effects of climate change on global food production under SRES emissions and socio-economic scenarios. *Global Environ. Chang.* **2004**, *14*, 53–67. [\[CrossRef\]](#)
38. Peng, S.; Huang, J.; Sheehy, J.E.; Laza, R.C.; Visperas, R.M.A.; Zhong, X.; Centeno, G.S.; Khush, G.S.; Cassman, K.G. Rice yields decline with higher night temperature from global warming. *Proc. Natl. Acad. Sci. USA* **2004**, *101*, 9971–9975. [\[CrossRef\]](#) [\[PubMed\]](#)
39. Piao, S.; Ciais, P.; Huang, Y.; Shen, Z.; Peng, S.; Li, J.; Zhou, L.; Liu, H.; Ma, Y.; Ding, Y.; et al. The impacts of climate change on water resources and agriculture in China. *Nature* **2010**, *467*, 43–51. [\[CrossRef\]](#) [\[PubMed\]](#)
40. Potts, S.G.; Biesmeijer, J.C.; Kremen, C.; Neumann, P.; Schweiger, O.; Kunin, W.E. Global pollinator declines: Trends, impacts and drivers. *Trends Ecology Evol.* **2010**, *25*, 345–353. [\[CrossRef\]](#) [\[PubMed\]](#)
41. Ramankutty, N.; Foley, J.A. Estimating historical changes in global land cover: Croplands from 1700 to 1992. *Global Biogeochem. Cycles* **1999**, *13*, 997–1027. [\[CrossRef\]](#)
42. Rockstrom, J.; Steffen, W.; Noone, K.; Persson, A.; Chapin, F.S., III; Lambin, E.; Lenton, T.M.; Scheffer, M.; Folke, C.; Schellnhuber, H.J.; et al. Planetary boundaries: Exploring the safe operating space for humanity. *Ecol. Soc.* **2009**, *14*, 32. [\[CrossRef\]](#)
43. Rockstrom, J.; Steffen, W.; Noone, K.; Persson, E.; Chapin, F.S.; Lambin, E.F.; Lenton, T.M.; Scheffer, M.; Folke, C.; Schellnhuber, H.J.; et al. A safe operating space for humanity. *Nature* **2009**, *461*, 472–475. [\[CrossRef\]](#) [\[PubMed\]](#)
44. Rosenzweig, C.; Parry, M.L. Potential impact of climate change on world food supply. *Nature* **1994**, *367*, 133–138. [\[CrossRef\]](#)
45. Schlenker, W.; Roberts, M.J. Nonlinear temperature effects indicate severe damages to U.S. crop yields under climate change. *Proc. Natl. Acad. Sci. USA* **2009**, *106*, 15594–15598. [\[CrossRef\]](#) [\[PubMed\]](#)
46. Schroter, D.; Cramer, W.; Leemans, R.; Prentice, I.C.; Araujo, M.B.; Arnell, N.W.; Bondeau, A.; Bugmann, H.; Carter, T.R.; Gracia, C.A.; et al. Ecology: Ecosystem service supply and vulnerability to global change in Europe. *Science* **2005**, *310*, 1333–1337. [\[CrossRef\]](#) [\[PubMed\]](#)
47. Seneviratne, S.I.; Corti, T.; Davin, E.L.; Hirschi, M.; Jaeger, E.B.; Lehner, I.; Orlowsky, B.; Teuling, A.J. Investigating soil moisture-climate interactions in a changing climate: A review. *Earth-Sci. Rev.* **2010**, *99*, 125–161. [\[CrossRef\]](#)
48. Tilman, D.; Fargione, J.; Wolff, B.; D’Antonio, C.; Dobson, A.; Howarth, R.; Schindler, D.; Schlesinger, W.H.; Simberloff, D.; Swackhamer, D. Forecasting agriculturally driven global environmental change. *Science* **2001**, *292*, 281–284. [\[CrossRef\]](#)
49. Tilman, D.; Balzer, C.; Hill, J.; Befort, B.L. Global food demand and the sustainable intensification of agriculture. *Proc. Natl. Acad. Sci. USA* **2011**, *108*, 20260–20264. [\[CrossRef\]](#)
50. Bridge, G.; Bouzarovski, S.; Bradshaw, M.; Eyre, N. Geographies of energy transition: Space, place and the low-carbon economy. *Energy Policy* **2013**, *53*, 331–340. [\[CrossRef\]](#)

51. Chlebna, C.; Mattes, J. The fragility of regional energy transitions. *Environ. Innov. Soc. Transit.* **2020**, *37*, 66–78. [\[CrossRef\]](#)
52. Meadowcroft, J. What about the politics? Sustainable development, transition management, and long term energy transitions. *Policy Sci.* **2009**, *42*, 323–340. [\[CrossRef\]](#)
53. Sovacool, B.K. How long will it take? Conceptualizing the temporal dynamics of energy transitions. *Energy Res. Soc. Sci.* **2016**, *13*, 202–215. [\[CrossRef\]](#)
54. Verbong, G.; Geels, F. The ongoing energy transition: Lessons from a socio-technical, multi-level analysis of the Dutch electricity system (1960–2004). *Energy Policy* **2007**, *35*, 1025–1037. [\[CrossRef\]](#)
55. Hoppe, T.; van Bueren, E. Guest editorial: Governing the challenges of climate change and energy transition in cities. *Energy Sustain. Soc.* **2015**, *5*, 19. [\[CrossRef\]](#)
56. Fazey, I.; Schöpke, N.; Caniglia, G.; Patterson, J.; Hultman, J.; van Mierlo, B.; Säwe, F.; Wiek, A.; Wittmayer, J.; Aldunce, P.; et al. Ten essentials for action-oriented and second order energy transitions, transformations and climate change research. *Energy Res. Soc. Sci.* **2018**, *40*, 54–70. [\[CrossRef\]](#)
57. Newell, P.; Bulkeley, H. Landscape for change? International climate policy and energy transitions: Evidence from sub-Saharan Africa. *Clim. Policy* **2017**, *17*, 650–663. [\[CrossRef\]](#)
58. Scheffran, J. Adaptive management of energy transitions in long-term climate change. *Comput. Manag. Sci.* **2008**, *5*, 259–286. [\[CrossRef\]](#)
59. Urban, F. Climate-Change mitigation revisited: Low-Carbon energy transitions for China and India. *Dev. Policy Rev.* **2009**, *27*, 693–715. [\[CrossRef\]](#)
60. Sutherland, L.-A.; Peter, S.; Zagata, L. Conceptualising multi-regime interactions: The role of the agriculture sector in renewable energy transitions. *Res. Policy* **2015**, *44*, 1543–1554. [\[CrossRef\]](#)
61. Dalmat, Y.-M. Biofuels, an asset for energy transition and independence. *Option/Bio* **2020**, *31*, 10.
62. Osunmuyiwa, O. Politics of Energy Transitions: A decade after Nigeria’s biofuels crusade, a tale of non-commercialization and lost opportunities. *Environ. Policy Gov.* **2017**, *27*, 632–646. [\[CrossRef\]](#)
63. Stokes, L.C.; Breetz, H.L. Politics in the U.S. energy transition: Case studies of solar, wind, biofuels and electric vehicles policy. *Energy Policy* **2018**, *113*, 76–86. [\[CrossRef\]](#)
64. Bardi, U.; El Asmar, T.; Lavacchi, A. Turning electricity into food: The role of renewable energy in the future of agriculture. *J. Clean. Prod.* **2013**, *53*, 224–231. [\[CrossRef\]](#)
65. Chai, X.; Tonjes, D.J.; Mahajan, D. Methane emissions as energy reservoir: Context, scope, causes and mitigation strategies. *Progress Energy Combust. Sci.* **2016**, *56*, 33–70. [\[CrossRef\]](#)
66. Safriel, U. Deserts and desertification: Challenges but also opportunities. *Land Degrad. Dev.* **2009**, *20*, 353–366. [\[CrossRef\]](#)
67. Schwartzman, D.; Schwartzman, P. A rapid solar transition is not only possible, it is imperative! *Afr. J. Sci. Technol. Innov. Dev.* **2013**, *5*, 297–302. [\[CrossRef\]](#)
68. Choudhary, K.K.; Kumar, A.; Singh, A.K. (Eds.) *Climate Change and Agricultural Ecosystems*; Woodhead Publishing: Cambridge, UK, 2019.
69. Iizumi, T.; Hirata, R.; Matsuda, R. (Eds.) *Adaptation to Climate Change in Agriculture*; Springer: Singapore, 2019.
70. Kang, M.S.; Banga, S.S. *Combating Climate Change: An Agricultural Perspective*; CRC Press: Boca Raton, FL, USA, 2013.
71. Gomez-Zavaglia, A.; Mejuto, J.C.; Simal-Gandara, J. Mitigation of emerging implications of climate change on food production systems. *Food Res. Int.* **2020**, *134*, 109256. [\[CrossRef\]](#)
72. aan den Toorn, S.I.; Worrell, E.; van den Broek, M.A. Meat, dairy, and more: Analysis of material, energy, and greenhouse gas flows of the meat and dairy supply chains in the EU28 for 2016. *J. Ind. Ecol.* **2020**, *24*, 601–614. [\[CrossRef\]](#)
73. Smith, E.F.; Lieske, S.N.; Keys, N.; Smith, T.F. The socio-economic vulnerability of the Australian east coast grazing sector to the impacts of climate change. *Reg. Environ. Chang.* **2018**, *18*, 1185–1199. [\[CrossRef\]](#)
74. Andrieu, N.; Sogoba, B.; Zougmore, R.; Howland, F.; Samake, O.; Bonilla-Findji, O.; Lizarazo, M.; Nowak, A.; Dembele, C.; Corner-Dolloff, C. Prioritizing investments for climate-smart agriculture: Lessons learned from Mali. *Agric. Syst.* **2017**, *154*, 13–24. [\[CrossRef\]](#)
75. Di Paola, A.; Caporaso, L.; Di Paola, F.; Bombelli, A.; Vasenev, I.; Nesterova, O.V.; Castaldi, S.; Valentini, R. The expansion of wheat thermal suitability of Russia in response to climate change. *Land Use Policy* **2018**, *78*, 70–77. [\[CrossRef\]](#)

76. Henseler, M.; Delzeit, R.; Adenäuer, M.; Baum, S.; Kreins, P. Nitrogen Tax and Set-Aside as Greenhouse Gas Abatement Policies under Global Change Scenarios: A Case Study for Germany. *Environ. Resour. Econ.* **2020**, *76*, 299–329. [\[CrossRef\]](#)
77. Artemenko, D.; Aguzarova, F.; Artemenko, G.; Novoselov, K.; Vertakova, Y. Media resources in education: The taxation aspect. In Proceedings of the 33rd International Business Information Management Association Conference, IBIMA 2019: Education Excellence and Innovation Management through Vision 2020, Granada, Spain, 10–11 April 2019; pp. 4372–4376.
78. Marx, W.; Haunschild, R.; Thor, A.; Bornmann, L. Which early works are cited most frequently in climate change research literature? A bibliometric approach based on Reference Publication Year Spectroscopy. *Scientometrics* **2017**, *110*, 335–353. [\[CrossRef\]](#)
79. Liu, B.; Chen, L. A Bibliometric Study on Highly Cited Papers of Food Science. *J. Chin. Inst. Food Sci. Technol.* **2020**, *20*, 308–318.
80. Ma, Q.; Li, Y.; Zhang, Y. Informetric analysis of highly cited papers in environmental sciences based on essential science indicators. *Int. J. Environ. Res. Public Health* **2020**, *17*, 3781. [\[CrossRef\]](#)
81. Gaulé, P.; Maystre, N. Getting cited: Does open access help? *Res. Policy* **2011**, *40*, 1332–1338. [\[CrossRef\]](#)
82. Holmberg, K.; Hedman, J.; Bowman, T.D.; Didegah, F.; Laakso, M. Do articles in open access journals have more frequent altmetric activity than articles in subscription-based journals? An investigation of the research output of Finnish universities. *Scientometrics* **2020**, *122*, 645–659. [\[CrossRef\]](#)
83. Li, Y.; Wu, C.; Yan, E.; Li, K. Will open access increase journal CiteScores? An empirical investigation over multiple disciplines. *PLoS ONE* **2018**, *13*, e0201885. [\[CrossRef\]](#)



© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).