An Analysis of "Sustainable Mobility" Research: From a Planning Perspective

Gonca Nurgul AKGUL

City and Regional Planning,
Faculty of Architecture, Yildiz Technical University, Istanbul, Turkey
goncanurgulakgul@gmail.com

Abstract

Factors such as housing, mobility, and recreation all cause environmental pressures. Lifestyles and consumption patterns play an important role here. When examining energy use rates, transportation is a key area. As one of the pillars of sustainable development, urban mobility is at the center of climate change debates, crucial to meeting targets for the reduction of greenhouse gas (GHG) emissions, and for quality of life. This paper aims to understand how this issue is handled within the academic literature and to reveal the research areas and geographies which deal with this issue. A combination set of keywords has been used as the basis for the literature review. The methodology applied is based on the Web of Science database, referencing the most recognized and trustworthy indices in academic areas such as the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The study focuses on (a) research area, (b) publication year, (c) geography of study, and (d) citation count in order to analyze the current situation of mobility research in the academic literature. The results are centered on the research fields of environmental science and technology, transportation, business economics, engineering and geography. Considering the significant role of urban planning and public administration on environmental implications of mobility, these research areas make up a small proportion of available research as a result of our literature review within these intersected

keywords and it should be noted that individual consumption habits have great emphasis on twenty-first century's dominated debates.

Keywords: Mobility, sustainability, climate change, ecological planning, greenhouse gas emissions, energy efficiency, sustainable lifestyles.

Introduction

Almost every sector has sought solutions to environmental problems that are occurring parallel to economic and technological developments. The demand for raw materials and its impact on the environment has been a constant issue throughout human history. In the first half of the 20th century, scientists' discussions focused on the limitations to the supply of raw materials and energy sources and warned against wasteful consumption. Current scientific evidence shows that global average temperature is rising and rainfall patterns are shifting. In 2014, global temperatures were 0.69°C above the 20th century global average. The severity of climate change will depend on how much and how quickly greenhouse gas emissions are cut (International Energy Agency [IEA], 2013). According to projections by the United Nations, global population is expected to exceed 9 billion by 2050 (European Environment Agency [EEA], 2015a). World demand for energy and water are both projected to rise by between 30% and 40% over the next 20 years (Krausmann et al., 2009).

Climate and energy policies can have a significant impact on greenhouse gas emissions, boosting energy efficiency, and the share of renewables in the energy mix. Human activities affect vital ecosystem dynamics at multiple scales and already these activities across the globe are significantly impacting the major bio-geochemical cycles. Factors such as food, housing, mobility

and recreation affect both environmental and human pressures. Lifestyles and consumption patterns partly shaped by individual choices play a major role here (EEA, 2015b).

Growing demand for mobility, particularly from emerging markets, threatens to continue to push up transport oil demand. As the demand for transportation inexorably increases, most rapidly in developing countries with growing economies, the environmental impacts of transportation potentially take on an increasing importance, and provide the impetus for exploring new technologies (Massachusetts Institute of Technology [MIT], 2000). The transport sector can impose numerous costs on the environment and society, particularly in terms of air and noise pollution, greenhouse gas emissions and landscape fragmentation, and is the second largest emitter of carbon dioxide (CO_2) emissions after power generation. There is a need to step up efforts to protect natural capital, stimulate resource-efficient, low-carbon growth and innovation. Policies, strategies, and complementary actions have a great importance in reducing the severity of climate change and the environmental implications of this increased consumption.

Background

Climate change signs shown by National Aeronautics and Space Administration (NASA) with values such as global average sea level have risen nearly 178 mm over the past 100 years, 9 of the 10 warmest years on record have occurred since 2000, Arctic summer sea ice shrank to lowest extent on record in 2012, Earth loses 281 gigatonnes (Gt) every year and carbon dioxide levels in the air at their highest in 650,000 years (NASA, 2016). Discussions on greenhouse gas (GHG) emissions, which are related with also climate change, sustainability, and ecological planning, are taking part at global scale. Addressing climate change while advancing global well-being is regarded as one of the key challenges of the 21st century. Transport is responsible for 22% of global energy related CO_2 emissions (IEA, 2012).

Climate Change as a Global Threat on Sustainability

The terms "sustainability" and "sustainable" appeared for the first time in the Oxford English Dictionary during the second half of the 20th century. In 1962, Carson's (1962) publication "Silent Spring" revealed the damage caused to the natural environment by human activities. And in the early 1970s, the well-known report of the Club of Rome, a group of economists and scientists, was published under the title "The limits to growth." The report warned that the Earth had a limited supply of physical resources and that exceeding the limits of exploitation could end in catastrophe (Pisani, 2006).

With global environmental change and the rise of global megacities, environmental and social externalities of urban systems, and especially of urban form, become increasingly prevalent. The question of optimal urban form has been debated and investigated by different disciplines in numerous contexts (Lohrey & Creutzig, 2016). Sustainable development and transport has become the subject of significant amount of research and various scholars. Despite being produced by different disciplines, and across different continents, many key themes remain constant. Five key research themes for sustainable urban transport are particularly prominent: (a) information and communications technology, (b) urban space and scale, (c) lifestyle and behavior, (d) regulation and pricing, and (e) institutions and governance (Stead, 2016).

Rapid urbanization and population growth have led to a challenge on urban transportation in developing countries. The car has been a key factor in the development of the 20th century, therewithal has given rise to the main dilemma facing cities today. This has led to chronic congestion and cause of a number of externalities such as air pollution and noise. There is a consensus among researchers and institutions as to the need for integrated transport strategies; however, there is still insufficient knowledge on implementation and compatibility of the policy

measures (Valdes, Monzon, & Benitez, 2016). As a local level transportation policy tool, Sustainable Urban Mobility Plan (SUMP), which is expected to contribute to reach the European climate and energy targets and contains sustainable vision for cities, should serve as a vehicle for the coordination of policies across sectors, in order to respond effectively to the mobility needs of people. Even then, there are some questions about social equity and environmental aspect of SUMPs (Arsenio, Martens, & Ciommo, 2016).

Energy Efficiency and Sustainable Lifestyles through Mobility

Energy efficiency now has an important place in the public policy agenda of most developed countries. As a policy objective, the importance of energy efficiency is linked to commercial and industrial competitiveness and energy security benefits, besides environmental benefits such as reducing CO_2 emissions (Patterson, 1996). Improvements in energy efficiency over the past six years have been accompanied by encouraging signs of increasing action on the policy front in many regions (IEA, 2013). Energy efficiency is usually defined by the ratio of energy consumed to the output produced or service performed. Reducing energy demand, or conserving energy, has been the main driver for energy efficiency policies. This goal is pursued primarily by improving the efficiency of products and processes on both the demand side and the supply side (IEA, 2014). The terms energy efficiency and energy conservation have often been used in policy discussions. Energy conservation is reduced energy consumption through lower quality of energy services, such as lower heating levels, through turning down thermostat levels and speed limits for cars. It is strongly influenced by regulation, consumer behavior, and lifestyle (Herring, 2006).

As the demand for transportation inexorably increases, most rapidly in developing countries with growing economies, one environmental consequence of transportation takes on increasing potential importance and provides the impetus for looking at new technologies. The transportation

sector accounts for about one-third of all CO_2 emissions (MIT, 2000). To promote the sustainability of transport systems, including the reduction of greenhouse gas emissions from the transport sector, different types of policy instruments have been developed and implemented. These range from land use, transport, and infrastructure planning instruments to economic, regulatory, and behavioral instruments focusing on fuel pricing, driving behavior, and vehicle technology (Bakker, Zuidgeest, Coninck, & Huizenga, 1996).

Energy efficiency and CO_2 emissions reduction is becoming more significant in the sustainability of urban transportation systems. Under the pressure of global warming and fluctuations in fuel prices, energy conservation and CO_2 mitigation have become important issues in transportation planning and management (Cheng, Chang, & Lu, 2015). A large amount of research has focused on material and energy inputs and outputs, energy efficiency, environmental footprint, environmental impacts of the urban transportation system, vehicles and transportation fuels (Meng et al., 2017). The impact on greenhouse gas emissions depends also on obtaining zero emission technologies and improvements to the fuel economy of conventional vehicles (Metz, 2015). In the context of climate change, the modeling literature has concentrated on the processes of switching to new low carbon technologies. There is a considerable recent literature on Hydrogen Fuel Cell Vehicles (Köhler et al., 2009) which is a type of alternative fuel vehicle that uses hydrogen and oxygen from the air to electrochemically produce electricity in fuel cells, powering its on-board electric (Chang, Hwang, & Wu, 2017). Besides, electric vehicles are shown as flexibly manageable to charge when low-cost or renewable energy is available, providing additional opportunity to secure economic and environmental benefits (Dennis, Colburn, & Lazar, 2016).

The main measures to mitigate transport greenhouse gas emissions comprise improved operational efficiency, promoting low carbon technologies, and improving the attractiveness of walking,

cycling and public transport. Technological and behavioral changes have attracted most attention for mitigation of transport greenhouse gas emissions, decisions on how cities respond growing populations have great impact on these efforts (Metz, 2015). Climate changes that threaten humanity represent a global process. The urgency for redressing the rise in global temperatures is becoming greater, as each recently released climate change report highlights additional evidence of warming oceans and rising sea levels, shrinking ice sheets, and rates of deforestation. Tackling the scale and complexity of climate change has obliged to act on local, national, and international levels a whole range of responses from intergovernmental protocols and national and local greenhouse emission targets to carbon trading schemes and local community climate action projects. Changes to human actions and behaviors are at the center of the climate change debate (Moloney, Horne, & Fien, 2010). It is clear that there is a need for behavioral change to reduce anthropogenic changes in the composition of the atmosphere, in land use and in the environment. In this regard, literatures have concentrated on sustainable lifestyles and low-carbon lifestyles in recent years.

Based on the provisional data of EEA from 2014, GHG emission shares by transportation modes such as road transport (heavy duty vehicles and buses, light duty vehicles, motorcycles, passenger cars) have great responsibility, with 72.6 %, aviation (international and domestic) 13.1%, maritime (international and domestic) 12.9%, railways (excluding electrical railways) 0.5%, and others 0.6% (EEA, 2016). The International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection estimates that emission volumes due to aviation will be four to six times higher by 2050 compared to the level in 2010, due to growth in air traffic (European Civil Aviation Conference Magazine, 2016). As noted by Barr, Gilg and Shaw (2011), tourism's impact on the climate has come to the forefront due to the importance of travel choice on climate

change emissions. Due to haul and more energy consumption, aviation related trips are more energy and GHG emissions intensive than everyday trips (Higham, Cohen, Cavaliere, Reis, & Finkler, 2016). Except for carbon trading and radical changes in supply in the aviation sector, responsibility for reducing personal transport emissions through behavior change has been largely devolved to individuals (Barr, Shaw, Coles & Prillwitz, 2010) and mode choice behavior gains emphasis on sustainable lifestyles studies.

The term "lifestyle" is applied within a variety of disciplines relating to sustainable consumption. For instance, in economics and transportation research, lifestyle has been defined by demographic variables such as income, urban density and accessibility, or transportation related patterns and interests (Axsen, Hageman, & Lentz, 2012). Lifestyle changes with socio-economic, institutional, and technological changes. Increasing income, decreasing working hours, and emerging technologies all contribute to the evolving lifestyle of urban residents. As stated by Kitamura (2009) to gain an understanding of lifestyle and to develop the capability to predict its changes in the future, it is necessary to examine changes that take place in various elements of urban life and see how these changes are related to changes in lifestyle and travel behavior.

Backhaus, Breukers, Mont, Paukovic and Mourik (2012) define sustainable lifestyles as "ways of living that allow people to meet their personal needs and aspirations while allowing current and future generations to do the same." Mont (2007) states that food, mobility, and housing are the three areas with the highest environmental impact at the household level. Backhaus et al. (2012) add tourism to the three aforementioned dimensions. As noted by Axsen et al. (2012), Giddens (1991) considered these four areas as "lifestyle sectors" which can be defined as "sets of activities that are perceived as coherent by a community of society."

In terms of infrastructural implementations, multimodality is important for achieving less car-dependent lifestyles and more sustainable transport behaviors. Studies of main travel modes show low cycling shares and a dominance of car driving with regard to everyday transport, which highlights how the car is profoundly integrated into the complex structures of modern everyday life (Olafsson, Nielsen, & Carstensen, 2016).

Methodology

The environmental implications of mobility have been at the center of recent scientific debates. Considering these implications, impacts that threaten humanity at global scale on widespread research area, existing discussions, studies, policies and practices are focused on ecological, environmental, engineering, technology, management, and urban planning sciences related studies furthermore in social sciences studies. Therefore, a literature review has been made with six intersected keywords as driven-factors of that study. In the web of science database, a search using the search terms: “mobility” in combination with “sustainability,” “ecological planning,” “climate change,” “greenhouse gas emissions,” “energy efficiency,” and “sustainable lifestyles” has been conducted between the date of 1975 to 2017 (Figure 1).

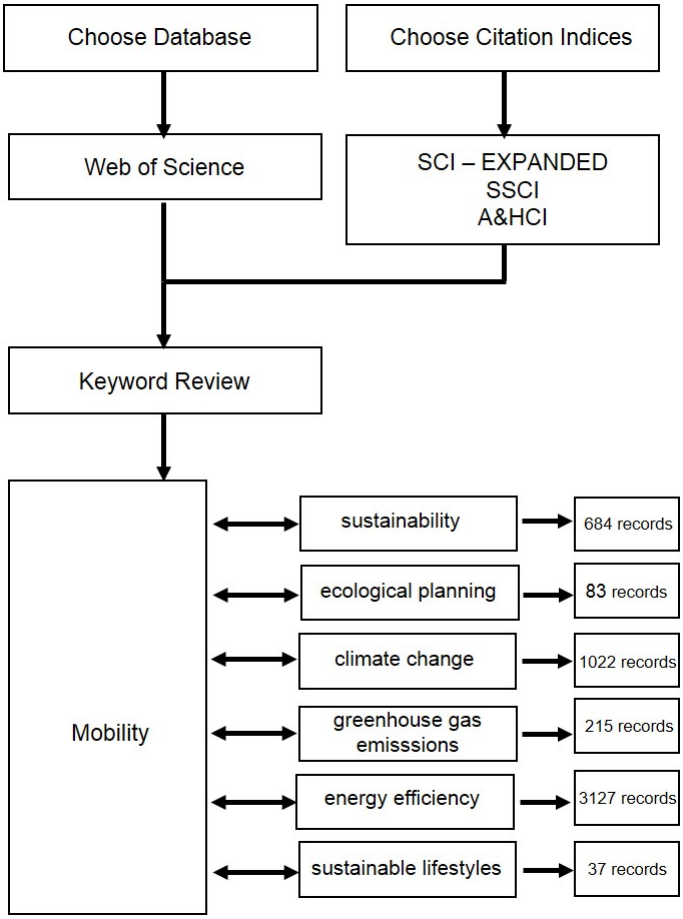

Figure 1. Keyword combination set

This study aims to understand how this issue is handled within the academic literature. Besides this, it aims to reveal in which research areas this issue is currently being conducted and taken into account. As a source of the literature review, the web of science database has been used that references the most recognized and trustworthy indices in this academic area, such as Science Citation Index Expanded, Social Sciences Citation Index, and Arts & Humanities Citation Index.

The search resulted in different types of document such as articles, reviews, editorial materials, book chapters, and reviews, extracted on the date of 26th January 2017. Each intersected keyword is searched within the database according to: (a) research area, (b) publication year, (c) geography of study, and (d) times of citation. These indicators are chosen to analyze the current situation of

"mobility research" which has ecological concern in the academic literature. Research area is chosen to understand where the issue has been discussed and which part of research area has focused on this topic. To understand what kind of research topics are more spread throughout in academic literature, top five records with the highest number of citations are identified for each keyword. Besides, the data about publication year is used for illuminating the milestones and breaking points of discussions related the issue and also geography of study is used to analyze geographies that are struggling with environmental implications of mobility. Also, to illuminate geographies that working for solutions and new technologies about these implications. Countries/territories which have less than 5% of total files are shown as other countries in the figures.

These intersected keywords are in the research area of multidisciplinary science fields thus it is necessary to specify that any kind of document that occurs as a result of keywords combination set may also could be contained in another keywords combination set. Thus, giving total number of search results may not be meaningful for this literature review.

Analysis Results

This literature review has a detailed analysis have been done with a keyword combination set which is shown before. Each intersected keyword in the context of literature review is analyzed according to the focused four indicators. When examining the combination of "sustainability" and "mobility" keywords in the academic literature, it is founded that most discussed files focused on environmental science and ecological environmental implications and changes of mobility. According to the files found within the database, environmental science and ecology research areas are at the forefront among scientific studies with 31.7% ratio. Mobility, one of the keywords of this intersection, is involved in 19% of the files found. Thus, transportation studies are taking place

secondly as a research area at this keyword combination. Business economics research area is taking third place with 16.8% while urban and social sciences related studies are involved in approximatively 6% of files found. While policy making and planning issues have substantial importance on preventing adverse effects of these environmental implications, only 4.2% of files are on public administration research area.

Historical roots of the term sustainability are based in the 18th century. In progress, scientific discussions focused on the limitations to the supply of raw materials and energy sources and warned against wasteful consumption at the first half of the 20th century. As a result of literature review with these intersection, mobility and sustainability, it is occurred that the first study within this intersection dates back to 1996 and 71% of files have been worked in the last six years. Likewise, the studies have been concentrated in the last three years (Figure 2). Energy costs of transportation sector, oil demand, energy efficiency and also environmental problems such as air quality stand out for foremost problems for territories. Mobility and sustainability intersection is worked in total 54 countries/territories. When examined the geographies of researches, first conspicuous country is United States of America (USA) and after that England. European countries are coming after them while research from China is at the top of CO_2 emitters (9th row) (Figure 3). When examined, the most cited top five research topics for understanding the issues that spread in the academic area, the research with the frame of environmental pollution emerges. Then the studies are made on topics that are (a) transport policy, (b) soil biology and biochemistry, (c) ecological economics, and (d) quality of life.

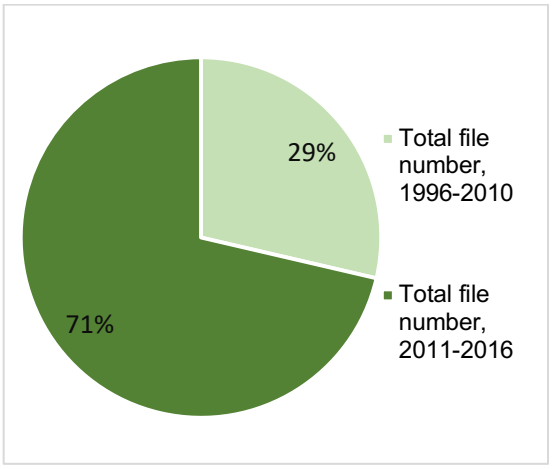

Figure 2. Publication years of research on sustainability intersection

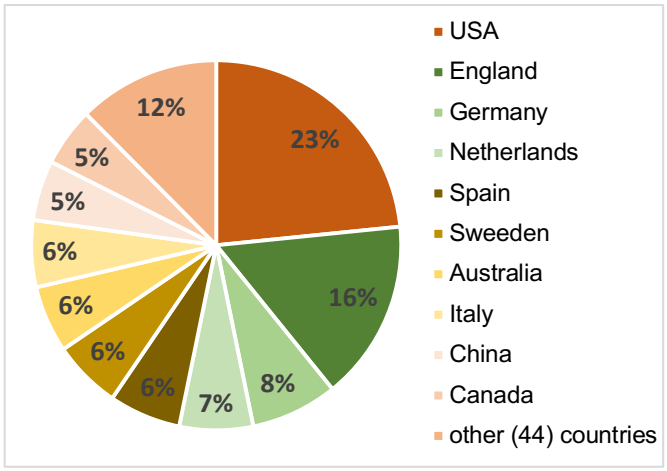

Figure 3. Geographies of research on sustainability intersection

Another keyword combination used in the literature review is "ecological planning" and "mobility." Results show that foremost research area is environmental science within this intersection (42.1%). Research areas such as geography (13%) and transportation (13%) are coming after. Urban studies are at the 10th row; however, most cited research is made on "landscape and urban planning." It shows the current scientific debates in the academic literature recently focused on mobility and its implications on urban and environment issues. And following most cited research are related with (a) conservation biology, (b) health & place, (c) psychology,

and (d) tourism management. As a result of analysis on publication years, 71% of total files have been worked in last six years (Figure 4). Research condensed in 2013, approx. 17% of research is done in 2013, after that year to present, decline is detected. It could be possible because of new trends urban and ecological planning research topics such as green urbanism and new urbanism. Ecological planning and mobility intersection are worked in total 17 countries/territories. Germany and USA are at the forefront geographies, followed by Canada, England, and China as geographies that have most researches within this intersection (Figure 5).

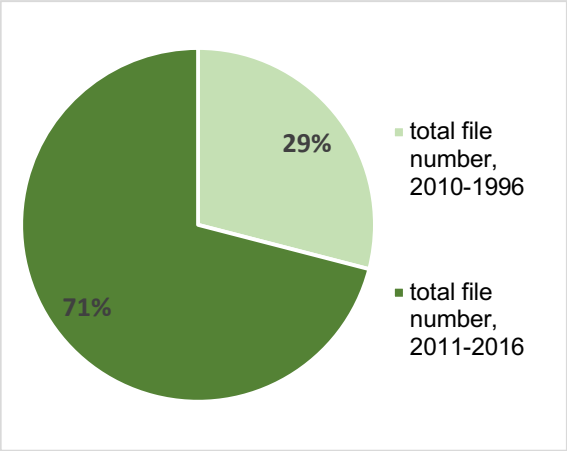

Figure 4. Publication years of research on ecological planning intersection

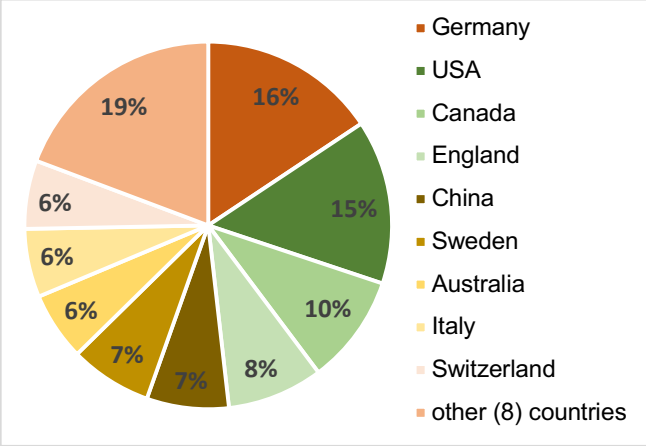

Figure 5. Geographies of research on ecological planning intersection

Discussions on climate change are being carried out in various scientific fields. As a global issue, especially after Cancun (2010) and Paris (2015) Agreements, climate change arguments extensively gained importance at many scientific disciplines and fields. As a result of "climate change" and "mobility" intersection on literature review, it is seen that mobility related researches are greatly increased in the last three years, almost 54% of files searched in the database. And 69% of files which are founded within these intersections are dated between 2010 and 2016 (Figure 6). When the research areas are analyzed, the environmental science and technology related research are the foremost by the rate of 36.5% then geology with approx. 16% and transportation research area is at the 9th row with 7.1%. Climate change and mobility intersection is worked in total 17 countries/territories. USA and Germany are at the forefront geographies, followed by Germany, Canada, and France as geographies that have most researches within this intersection (Figure 7). When analyzing top five cited files, it reveals (a) ecology evolution and systematics, (b) and (c) environmental sciences research areas are coming into existence. Following them, (d) water resources and (e) cultural studies research areas are also in the most cited files within the database.

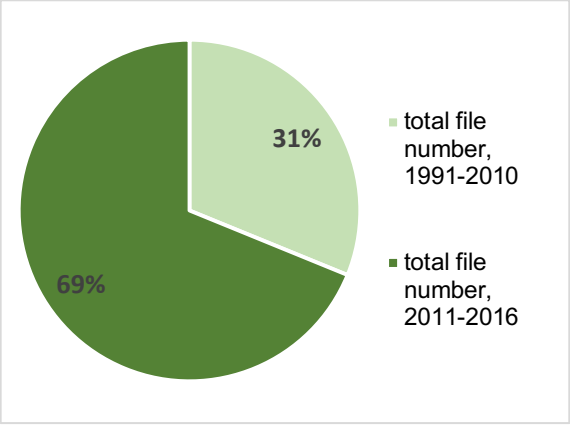

Figure 6. Publication years of research on climate change intersection

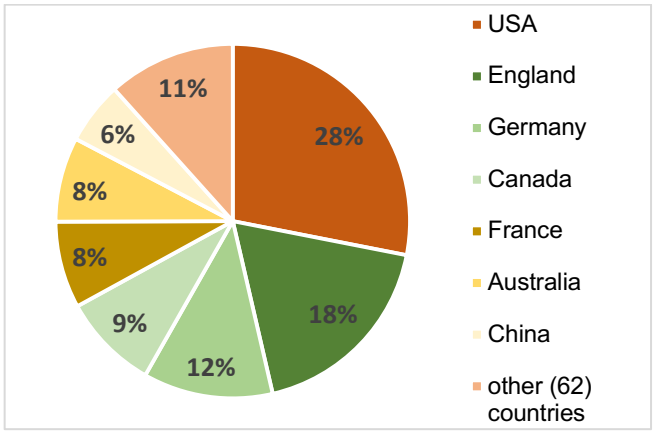

Figure 7. Geographies of research on climate change intersection

When examining the combination of "greenhouse gas emissions" and "mobility" keywords in the academic literature, recent discussions on greenhouse gas emissions are gathered around issues such as environmental strategies, mitigation and reduction policies, stabilization scenarios, and low-carbon technologies. When analyze the research areas, environmental science (41%), energy fuel (25%), engineering (24%), and technology (20%) related studies are coming forward while public administration (4%) and urban studies (3%) have a few part from the research areas. Besides (a) ecological applications, (b) environmental science and technology research areas are the most cited files. Other most cited files are on (c) natural resources, (d) alloys and compounds, and (e) sustainable tourism research areas. Files based on this intersection are dated between 2001 and 2016. As a result of analyze, 78% of files are worked in the last six years even almost 50% are worked in the last three years (Figure 8). Research areas on greenhouse gas emissions and mobility intersection are worked in totally 35 countries/territories in the database. USA, Germany, and England are the geographies where the majority of researches have been made (Figure 9).

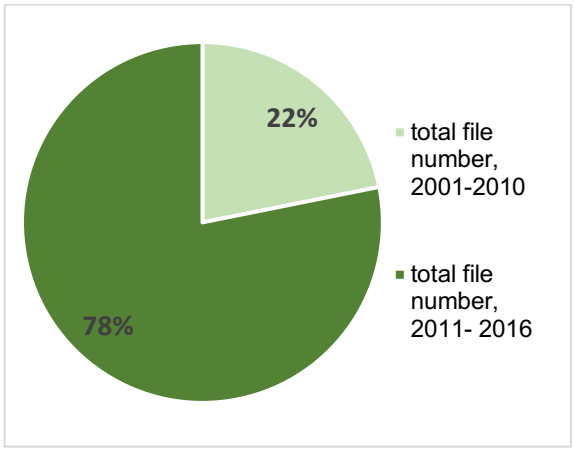

Figure 8. Publication years of research on greenhouse gas emissions intersection

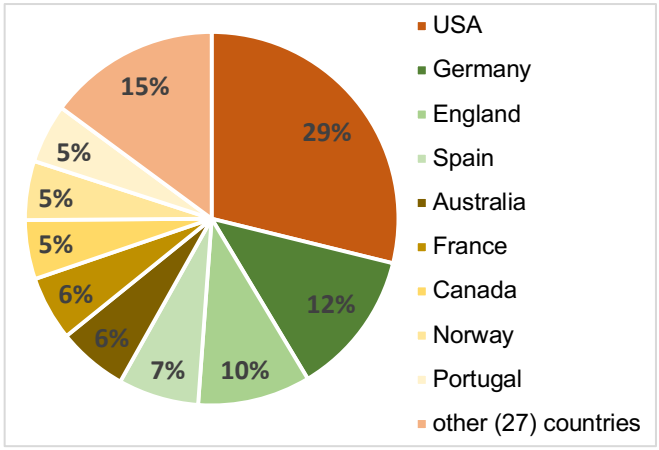

Figure 9. Geographies of research on greenhouse gas emissions intersection

Besides all these keyword combinations, “energy efficiency” and “mobility” intersection has the highest files in the database according to this study’s methodology. As it is understood from here, energy efficiency issue is at the center of mobility debates within the academic area. When analyzing the research areas that are worked within this intersection, according to nature of the energy efficiency concept, material science (34.3%), chemistry (33.9%), physics (33.8%), and engineering (15.8%) exist and also (a) nature, (b) nature materials, (c) technology, (d) advanced materials, and (e) nature materials related researches are the most cited files within this

intersection. 73% of total files are worked in the last seven years (Figure 10). When analyzing the geography of the research area on energy efficiency and mobility intersection, results show that most of the files are from Asian countries. The results contain major differences about the geographies of studies when compared with other keyword intersections (Figure 11).

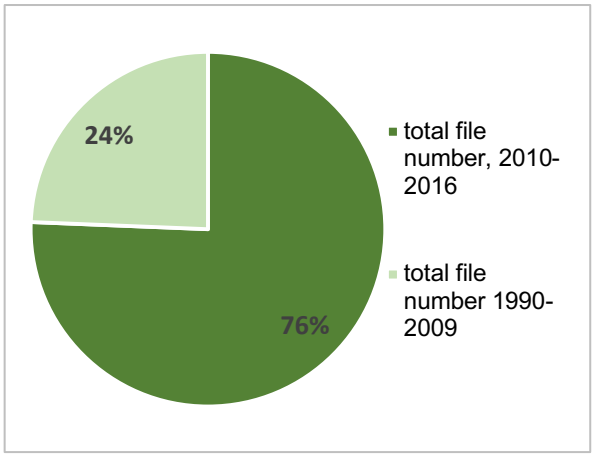

Figure 10. Publication years of research on energy efficiency intersection

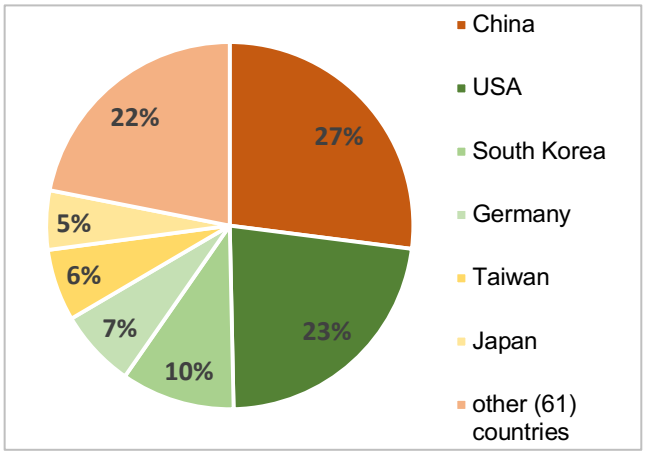

Figure 11. Geographies of research on energy efficiency intersection

Consumption is at the center of recent discussions in relation with energy, usage of non-renewable natural sources and raw materials scientific fields. Mobility, housing, and food are the three areas

with the highest environmental impact at the household level considering rapid population growth, and behavior of individuals have great importance. When examining the research areas on "sustainable lifestyles," it is seen that most of the research dated in the last seven years and first research dates back to 2004 (Figure 12). A number of files that resulted from this intersection are relatively few amounts (1%) when compared to other keyword intersections. Environmental science and ecology (37.8%), transportation (35.1%), and business economics (24.3%) are the foremost research areas and also results shows that most cited files are written in the concern of (a) transport policy, (b) and (d) ecological economics, (c) energy policy, and (e) applied geography research areas. When analyzing the geographies of researches, England, USA, and Netherlands are considered as conspicuous geographies (Figure 13).

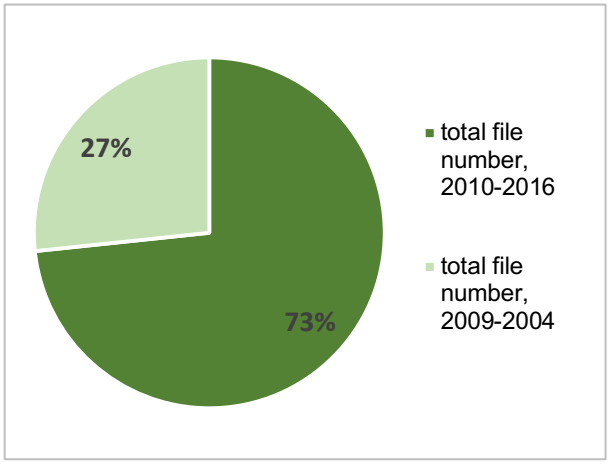

Figure 12. Publication years of research on sustainable lifestyles intersection

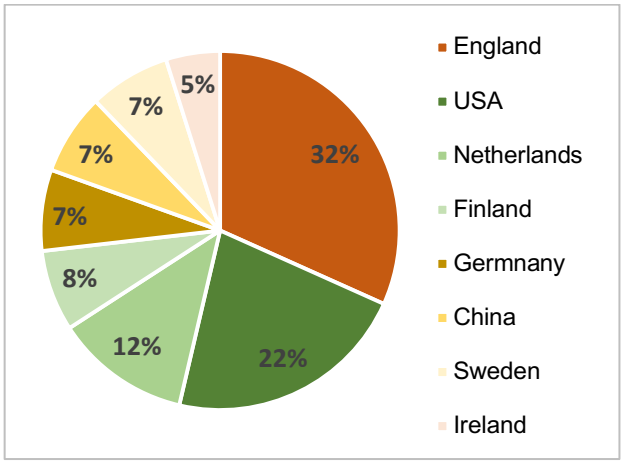

Figure 13. Geographies of research on sustainable lifestyles intersection

Conclusion

From our literature review, "energy efficiency" (60%), "climate change" (20%), and "sustainability" (13%) intersected keywords related searches are most common when looking at records occurring within this keyword combination set, as shown in Figure 1. This highlights those research topics that are more widely discussed in the academic research area. When examining the top five cited research areas for each intersected keyword, the most cited researches are within the energy efficiency and mobility intersection (top 5 of 30 most cited research areas) followed by climate change and greenhouse gas emissions intersected keywords.

The majority of the research identified through this literature review, is limited to the last five years. With regard to the historical antecedence of the research areas, except for the "greenhouse gas emissions" (2001) and "sustainable lifestyles" (2005) intersected keywords, all date back to the 1990's within the database. When analyzing the geography of the research in order to understand which context is more prevalent, "climate change" intersected keyword (69 countries/territories) and "energy efficiency" intersected keyword (67 countries/territories) are most common. Bearing in mind its later entrance year into the academic debate, the sustainable

lifestyles and mobility intersection is restricted in its geographical coverage, limited to only eight countries.

As a result of our literature review within these six intersected keywords, environmental science and technology, transportation, business economics, engineering and geography research areas emerge as the disciplines in the academic literature attracting the most work in this area. Considering the significant role of urban planning and public administration on environmental implications of mobility, these research areas make up small proportion of available studies due to literature review within these intersected keywords. It should also be noted that individual consumption habits have a great impact on the twenty-first century's dominant debates concerning (a) growing need on any kind of sources where energy is a priority and (b) conspicuous consumption on natural, material, and non-renewable sources. From this perspective, there is a need for research that promotes different scientific disciplines working together, to include especially the social sciences.

Acknowledgement

This paper is part of a research project entitled "Community Data-Loops for energy efficient urban lifestyles (CODALoop)" supported by the ERA-NET Smart City Programme through TÜBİTAK 116K011.

References

Arsenio, E., Martens, K., & Ciommo, F. (2016). Sustainable urban mobility plans: Bridging climate change and equity targets? *Research in Transportation Economics, 55*, 30–39.

Axsen, J., Hageman, J. T., & Lentz, A. (2012). Lifestyle practices and pro-environmental technology. *Ecological Economics, 82*, 64–74.

Backhaus, J., Breukers, S., Mont, O., Paukovic, M., & Mourik, R. (2012). *Sustainable lifestyles: Today's facts & tomorrow's trends*. Wuppertal, Germany: Centre on Sustainable Consumption and Production.

Bakker, S., Zuidgeest, M., Coninck, H., & Huizenga, C. (2014). Transport, development and climate change mitigation: Towards an integrated approach. *Transport Reviews, 34*(3), 335–355.

Barr, S., Shaw, G., Coles, T., & Prillwitz, J. (2010). A holiday is a holiday: Practicing sustainability, home and away. *Transport Geography, 18*(3), 474–481.

Barr, S., Gilg, A., & Shaw, G. (2011). "Helping people make better choices": Exploring the behavior change agenda for environmental sustainability. *Apply Geography, 31*(2), 712–720.

Carson, R. (1962). *Silent spring*. New York, NY: First Mariner Books.

Chang, W. R., Hwang, J. J., & Wu, W. (2017). Environmental impact and sustainability study on biofuels for transportation applications. *Renewable and Sustainable Energy Reviews, 67*, 277–288.

Cheng, Y. H., Chang, Y. H., & Lu, I. J. (2015). Urban transportation energy and carbon dioxide emission reduction strategies. *Applied Energy, 157*, 953–973.

Dennis, K., Colburn, K., & Lazar, J. (2016). Environmentally beneficial electrification: The dawn of emissions efficiency. *The Electricity Journal, 29*, 52–58.

European Environment Agency (EEA). (2015a). *Living in a changing climate*, Copenhagen, Denmark, ISBN: 978-92-9213-656-7.

European Environment Agency (EEA). (2015b). *The European environment- state and outlook*, (Synthesis report). Copenhagen, Denmark, ISBN: 978-92-9213-515-7.

European Environment Agency. (2016). Signals 2016: *Towards clean and smart mobility*, Copenhagen, Denmark, ISBN: 978-92-9213-739-7.

Cherfils I., Gandil P., Hupe J., Adolehoume A., Ziegler U., Lunter M., Delbeke J., Steele P., Viegas J., Micallef S., Kumar N., Bylinsky M. Johnson T. (2016). *Tackling climate change; Aviation's contribution to the global efforts*, European Civil Aviation Conference Magazine., Vol. 59.

Giddens, A. (1991). Modernity and self-identity: Self and society in the late modern age. Stanford university press. Stanford:USA

Herring, H. (2006). Energy efficiency: A critical view. *Energy, 31*, 10–20.

Higham, J., Cohen, S. A., Cavaliere, C. T., Reis, A., & Finkler, W. (2016). Climate change, tourist air travel and radical emissions reduction. *Cleaner Production, 111*, 336–347.

Birol F., Cozzi L., Gould T., Bromhead A., Baroni M., Olejarnik P., Dorner D., Gül T., Frank M., Al-Khshali S., Al-Maliky M., Al-Saffar A., Agarwal P., Besson C., Blasi A., Chan V.S., Cronshaw I., Elis D., Festa C., Kesicki F., Khara S., Kraeusel J., Kim S., Lee J.W., Lyro B., Marricchi C., Schers J., Topalgoekceli T., Wanner B., Wilkinson D., Wood P., Yanagisawa A., Mooney S., Sanocka M. (2012). *World energy outlook 2012*. International Energy Agency (IEA), Paris, France.

Birol F., Cozzi L., Gould T., Bromhead A., Besson C., Dorner D., Olejarnik P., Gül T., Al-Saffar A., Blasi A., Cronshaw I., Festa C., Frank M., Ikeyama S., Jurga B., Kesicki F., Kim S., Kurniadi C., Kurozumi A., Lee J.W., Magne B., Marricchi C., Petrosyan K., Schaber K., Selmet N., Suehiro S., Topalgoekceli T., Trüby J., Noort K.V., Wanner B., Wilkinson D., Zhang S., Mooney S., Sanocka M., Cleere M. (2013). *World energy outlook 2013*. International Energy Agency (IEA), Paris, France.

Campbell N., Ryan L., Rozite V., Lees E., Heffner G.. (2014). *Capturing the multiple benefits of energy efficiency*. International Energy Agency (IEA), Paris, France.

Kitamura, R. (2009). Life-style and travel demand. *Transportation, 36*(6), 679–710.

Köhler, J., Whitmarsh, L., Nykvist, B., Schilperoord, M., Bergman, N., & Haxeltine, A. (2009). A transitions model for sustainable mobility. *Ecological Economics, 68*, 2985–2995.

Krausmann, F., Gingrich, S., Eisenmenger, N., Erb, K. H., Haberl, H., & Fischer-Kowalski, M. (2009). Growth in global materials use, GDP and population during the 20th century. *Ecological Economics, 68*, 2696–2705.

Lohrey, S., & Creutzig, F. (2016). A sustainability window of urban form. *Transportation Research, Part D, 45*, 96–111.

Meng, F., Liu, G., Yang, Z., Casazza, M., Cui, S., & Ulgiati, S. (2017). Energy efficiency of urban transportation system in Xiamen, China: An integrated approach. *Applied Energy, 186*, 234–248.

Welss M. A., Heywood J. B., Drake E. M., Schafer A., AuYeung F.F. (2000). *On the road in 2020: A life-cycle analysis of new automobile technologies*, Energy Laboratory Report, Massachusetts Institute of Technology, Cambridge, October.

Metz, D. (2015). Peak car in the big city: Reducing London's transport greenhouse gas emissions. *Case Studies on Transport Policy, 3*, 367–371.

Moloney, S., Horne, R. H., & Fien, J. (2010). Transitioning to low carbon communities from behaviour change to systemic change: Lessons from Australia. *Energy Policy, 38*, 7614–7623.

Mont, O. (2007). *Concept paper for the task force on sustainable lifestyles*. Third International Expert Meeting on Sustainable Consumption and Production, 1–14. Stockholm,2007

National Aeronautics and Space Administration. (2016). *Climate change*. Retrieved from October 11, 2016 http://climate.nasa.gov/

Olafsson, A. S., Nielsen, T. S., & Carstensen, T. A. (2016). Cycling in multimodal transport behaviours: Exploring modality styles in the Danish population. *Journal of Transport Geography, 52*, 123–130.

Patterson, M. G. (1996). What is energy efficiency? Concepts, indicators and methodological issues. *Energy Policy, 24*(5), 377–390.

Pisani, J. A. (2006). Sustainable development, historical roots of the concept. *Environmental Sciences, 3*(2), 83–96.

Stead, D. (2016). Identifying key research themes for sustainable urban mobility. *International Journal of Sustainable Transportation, 10*(1), 1–8.

Valdes, C., Monzon, A., & Benitez, F. G. (2016). Sustainable urban transportation strategies: Searching for synergies. *KSCE Journal of Civil Engineering, 20*, 1066–1075.