MANTECH Publications
Journal of Remote Sensing, Environmental Science & Geotechnical Engineering
Volume 9, Issue 3, September-December, 2024

Study on Impact of Bio fuels on Environmental Sustainability by Using Life Cycle Assessment: A Review

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Abstract

Bio fuels are being promoted as a low-carbon alternative to fossil fuels as they could help to reduce greenhouse gas (GHG) emissions and the related climate change impact from transport. However, there are also concerns that their wider deployment could lead to unintended environmental consequences. Rising energy prices, geopolitics and concerns over the impact of greenhouse gas emissions on climate change are increasing the demand for bio fuel production. The aim of this research is to review and analyse the latest available evidence to provide a greater clarity and understanding of the environmental impacts of different bio fuels and also discuss the impacts of bio fuels on climate change, water use, and land use, also the life cycle assessment is studied. A Survey in Bio fuel Manufacturing plants is done. Policies should promote the development of sustainable bio fuel programs that have very low inputs of fossil fuels and chemicals that rely on rainfall or abundant groundwater, and that use land with little or no economic or

ecological value in alternative uses. The recent historic use of bio fuels in the context of Government policy developments will be presented.

***Keywords**: Biofuels, Green house gases, geopolitics, Life cycle assessment*

INTRODUCTION

The oil crisis of the 1970s generated a high interest in bio fuels as a possible replacement for fossil liquid fuels used in transportation. In the 1980s and 1990s, increased consciousness of climate change also contributed to the popularity of bio fuels as an alternative to fossil fuels. Consequently, global production of bio fuels experienced sharp increase, especially in the new millennium. While high oil prices might have contributed to this growth, it was mainly driven by government policies such as mandates, targets and subsidies which were justified on the grounds of energy security and climate change considerations. However, the concerns raised by the global food crisis in 2007/2008 and the ambiguity with respect to environmental impact of bio fuels led many governments to reconsider their earlier optimism with respect to bio fuels. Many new alternative fuels such as bio fuel and hydrogen have been explored to lessen the dependency on fossil fuel for transportation. Bio fuels can be defined as renewable fuels made from organic material that have potential to partly or fully replace the fossil fuel application in transportation sector. Two main bio fuels that been used today are biodiesel and bioethanol. Biodiesel and bioethanol can be synthesized by using food crops. The choice of raw material depends on the local crops availability, such as United States use corn for producing bioethanol and Malaysia use palm oil for producing biodiesel. Bioethanol plays an important role as an alternative fuel since the price of crude oil has risen at a rapid rate.

Life cycle assessment (LCA) is a technique used to quantify the environmental impacts of a product or service that incorporates and aggregates the related resource consumption, emissions, and impacts across the various stages of the product‘s life. LCA has been touted as a relevant tool for assessing the environmental sustainability of emerging technologies, and has had significant application in the developing field of biofuels and bio-products. LCA can be used to identify process inefficiencies and environmental __hotspots‘‘ along a supply chain; therefore, facilitating efficient eco-design, and helping support environmentally sound decision making. For these reasons, LCA is a germane and powerful tool for assessing emerging biofuel technologies.

HISTORY OF BIOFUEL IN INDIA

India initiated its biofuel programme more than a decade ago and launched several policy measures to promote biofuels since then. In 2002, India launched its ―Ethanol Blending Programme‖ and mandated a 5% blending of ethanol (E5) with petrol in nine States and four Union Territories with effect from January 2003. The Planning Commission of India constituted a Committee on Development of Biofuels in July 2002.The report of the Committee, released in 2003, recommended India to progressively move towards higher targets regarding blending of biofuels, including strengthening of the ethanol blending programme.

Biofuel Resources

Bio-fuel is most commonly defined as a renewable source of energy which is produced from biological materials or biomass, such as sugar cane, corn or vegetable oils. The strategic goal of Bio-fuel is to supplement or even replace fossil fuels. But the policies focus on the use of non-food biomass for biofuels. India has a plethora of species that can be used produce from conventional oil seeds, woody materials, and wastes from agriculture and municipal solids. Indeed, there are over 300 oil-seed bearing tree species in India. India is rich in biomass and majority of Indian population used bio-fuels traditionally but in many cases inefficiently which led to a couple of major social problems particularly health effects of air pollution.

Appropriate technology for making bio-fuels available to the people and its effective utilization would have significant impact on India‘s socio-economic conditions. Bio-fuels production technologies include the following: 1. Energy plantation 2. Accumulation and/or reclamation of wastes 3.Conversion of biomass to bio-fuels A. Using mechanical process i. Extraction (Eg. bio-diesel) ii.Compression (Eg.Pelletization) B. Using chemical process i. Liquefaction (Eg.Conversion of cellulosic biomass to oil) ii.pressurized water reactor in a hydrothermal medium a. hydrolysis b. fractionation c. gasification and d. reaction C. Using bacteria (Eg. Biogasification through biomethanisation) D. Using algae for Conversion of micro-algal biomass to biofuels i. Oil extraction from microalgae ii. Micro-algal wastewater treatment a. Hydro-thermal gasification b. super-critical water as reaction medium c. ultrasonic treatment.

RECENT STUDIES IN BIOFUEL

Life cycle assessment (LCA) - tool for assessing the environmental sustainability of biofuels

In the recent studies, the author studied issues of energy independence and security, global climate change, and the depletion of fossil resources drive research into biofuels and bio-products. While emerging biofuels and bio-refineries pursue lower carbon transportation fuels, careful consideration of a wide range of potential environmental impacts is necessary to avoid unintended consequences. These concerns can be addressed by holistic life-cycle evaluation of bioenergy / biofuel supply chains from raw materials acquisition, to fuel conversion and end use. The current bio-feed stocks and fuels, introduces the methodological framework of LCA, and explores challenges, critiques, benefits, and applications of LCA in evaluating the environmental performance and sustainability of emergent biofuels and co-product systems. Life cycle assessment (LCA) is a technique used to quantify the environmental impacts of a product or service that incorporates and aggregates the related resource consumption, emissions, and impacts across the various stages of the product‘s life. LCA has been tested as a relevant tool for assessing the environmental sustainability of emerging technologies, and has had significant application in the developing field of biofuels and bio-products. Holistic evaluation of various biofuel supply chains from a life cycle perspective can help to indicate the degree to which these objectives are met.

Types of biofuels

The study discusses two types of biofuel that are widely used globally, which are bioethanol and biodiesel. Fossil fuels, such as diesel and gasoline, are the major source of energy for the transportation industry for many years. The limited resources and combustions of fossil fuel raise environmental concerns such as global warming. Biofuel has become popular as countries strive to reduce environmental impacts of carbon emissions generated from petroleum diesel burning. Even though the combustion emission from biofuel has been proven to be more environmental friendly compared with fossil fuel, the result may be different based on the whole biofuel life cycle. The sustainability of biofuels is discussed based on their advantages and disadvantages of the production and utilization of biofuels on Life Cycle Assessment perspective. Biofuels can be defined as renewable fuels made from organic material that have potential to partly or fully replace the fossil fuel application in transportation sector. Two main biofuels that been used today are biodiesel and bioethanol.

There are environmental impact categories where biofuel shows poor environmental performance than fossil fuel such as in terms of acidification, eutrophication, photochemical oxidation, and agricultural land use. The selection of environmental impacts categories to be prioritized depends on which impacts are the most sensitive to the region and are also related to the society‘s perception about these environmental impacts (which are reflected in the public policies).

Biofuel- a potential source of renewable energy

The study presents the social and economic impact of biofuel production in industrialized countries and developing countries that are or could become, efficient producers in export markets and profitable new. Biofuels could lead to major new markets for farmers. However, only some of the current biofuel programs are feasible, and most involve high social costs and environmental ironically. The economic, environmental and social impacts of biofuels are widely debated and needs to be carefully assessed before extending public support to programs of biofuels on a large scale. The country strategy on biofuels should be based on a thorough assessment of these opportunities and costs in the medium and long term. For the use of biofuels actually be an advantage in the economic, social and environmental care, should take care of the following 1. Biofuels policy: The success of biofuels depends on their use mandatory, tax facilities, subsidies provided by the State, pricing to consumers, the recognition of the rights of workers and the thousand and one ways develop from the rural communities and effective use of their land. 2. Grants: The production of biofuels in the world is profitable because of subsidies and incentives for renewable energy, but must ensure that these subsidies are allocated to the most vulnerable. 3. Soil use: The problem of land use represents the medium and long term environmental liabilities are hardly balanced with assets derived from the production of biofuels. 4. Second generation biofuels: They should turn the attention to second generation biofuels, the advantages is that they can be obtained from biomass that is not appropriated for food supplies or compete with them and protect this soil use. 5. Research &Development: Both developed and developing nations must pay attention to the benefits associated with research and development, adopt new technologies, resulting in improved environmental heritage and obtaining economic benefits in the development of biofuels. 6. Profit vs. environmental benefits: The ambition for the profits do not should exceed the benefits of environmental preservation. In relation to environmental preservation

any effective path leading to a reduced consumption of nonrenewable energy collides with the same difficulty: the decrease of the gain or extraordinary profits.

Utilization of biomass as a fuel for energy generation

Governments worldwide are promoting the development of biofuels in order to mitigate the climate impact of using fuels. This paper investigates the utilization of biomass as a fuel for energy generation. One use of biomass fuels that also takes care of environmental impact issues of agriculture is biogas. Another use of biomass is biodiesel application that may increase the levels of certain pollutants which are associated with both environmental and health risks. This paper identifies some of the key environmental impacts associated with biomass, biogas and biodiesel technologies and suggests appropriate responses to them. The use of biomass energy has many unique qualities that provide environmental benefits. It can help mitigate climate change, reduce acid rain, soil erosion and help maintain forest health through better management. The reduction of greenhouse gases pollution is the main advantage of utilizing biomass energy. Biomass and biogas technology has helped to improve the quality of our environment by eliminating agricultural wastes that would otherwise accumulate and become a major source of pollution and possible contamination. Biogas use may reduce air pollution and certainly reduces greenhouse gases, therefore it has an effective role in the protection of the environment and the public health. The main benefits of biodiesel use are reductions in petroleum consumption and greenhouse gas emissions. When biodiesel is used, the total net emission of CO2 is considerably less than that of diesel oil and the amount of energy required for the production of biodiesel is less than that obtained with the final product, and the emission of pollutants is somewhat less. Another important benefit of renewable energy systems is the decrease of environmental pollution. The environmental impacts from biomass production, conversion and use can be minimized by implementing careful planning and conservation practices, employing appropriate environmental control technology and utilizing any by-products produced.

Leading to intense pressures on land supply

The study shows that a global biofuels program will potentially lead to intense pressures on land supply and cause widespread transformations in land use. These transformations can alter the Earth climate system by increasing greenhouse gas (GHG) emissions from land use changes and by changing the reflective and energy exchange characteristics of land

ecosystems. Using an integrated assessment model that links an economic model with climate, terrestrial biogeochemistry, and bio-geophysics models, we examined the biogeochemical and bio-geophysical effects of possible land use changes from an expanded global second-generation bioenergy program on surface temperatures over the first half of the 21st century. Our integrated assessment model shows that land clearing, especially forest clearing, has two concurrent effects—increased GHG emissions, resulting in surface air warming; and large changes in the land‘s re effective and energy exchange characteristics, resulting in surface air warming in the tropics but cooling in temperate and polar regions. Overall, these biogeochemical and bio-geophysical effects will only have a small impact on global mean surface temperature. Therefore, global land use strategies that protect tropical forests could dramatically reduce air warming projected in these regions.

Use of biodiesel in CI engines and its environmental impacts

The author studied that the environmental pollution and global warming associated with the use of fossil fuels, has forced a search for alternative fuels in transportation. Also, presents that there is a significant reduction in the emission of unburned hydrocarbons, polyaromatic hydrocarbons and soot, particulate matters, carbon monoxide, carbon dioxide and sulfur dioxide with biodiesel. Smoke opacity also decreases, but the NOx emission is more with biodiesel. It is evident from the study that biodiesel can only replace conventional diesel to some extent due to economic, social and other constraints. The main aim of this work was to review the environmental impacts of biodiesel-fuelled CI (diesel) engines. The various types of feedstock‘s (including vegetable oils) from which biodiesel can be produced are listed.

Different properties of biodiesel, which are crucial for the assessment of performance and emission characteristics of an engine, have been discussed and compared to those of petro-diesel. Biodiesel has higher cetane number and viscosity than petro-diesel. It is renewable, biodegradable, non-flammable and non-toxic. Although biodiesel is gaining worldwide acceptance, especially in the USA, Europe and Asia, there are some limitations. The higher production costs, huge land requirement and the food vs. fuel debate are most important among them. It is now realised that biodiesel can replace only a part of diesel fuel used in transportation.

Social and environmental costs and benefits of biofuels in Asia

It was studied that the major factors that will determine the impacts of biofuels are: (1) their contribution to land-use change, (2) the feedstock‘s used, and (3) issues of technology and scale. Biofuels offer economic benefits, and in the right circumstances can reduce emissions and make a small contribution to energy security. Feedstock‘s that involve the conversion of agricultural land will affect food security and cause indirect land-use change, while those that replace forests, wetlands or natural grasslands will increase emissions and damage biodiversity. Biofuels from cellulose, algae or waste will avoid some of these problems, but come with their own set of uncertainties and risks. In order to ensure net societal benefits of biofuel production, governments, researchers, and companies will need to work together to carry out comprehensive assessments, map suitable and unsuitable areas, and define and apply standard relevant to the different circumstances of each country. The greatest benefits may come from feedstock produced on a modest scale as co-products of smart technologies developed for phytoremediation, waste disposal and emissions reduction. While biofuels will not fully replace other fuels in Asia they have the potential, if implemented at an appropriate scale, and if they avoid displacing other crops or replacing land-uses high in carbon or biodiversity, to provide smart solutions to local problems. If that is to happen, biofuels companies, researchers and national governments will need to align their interests and capacities to carry out strategic assessments and mapping, ensure that land use plans and standards are adhered to, and develop incentives which are calculated to avoid negative impacts and deliver societal benefits.

Biofuels-a low-carbon alternative to fossil fuels

In a study, it is observed that biofuels are being promoted as a low-carbon alternative to fossil fuels as they could help to reduce greenhouse gas (GHG) emissions and the related climate change impact from transport. However, there are also concerns that their wider deployment could lead to unintended environmental consequences. Numerous life cycle assessment (LCA) studies have considered the climate change and other environmental impacts of biofuels. However, their findings are often conflicting, with a wide variation in the estimates.

Thus, the aim of this paper is to review and analyse the latest available evidence to provide a greater clarity and understanding of the environmental impacts of different liquid biofuels. It is evident from the review that the outcomes of LCA studies are highly situational and

dependent on many factors, including the type of feedstock, production routes, data variations and methodological choices. Despite this, the existing evidence suggests that, if no land – use change (LUC) is involved, first-generation biofuels can—on average— have lower GHG emissions than fossil fuels, but the reductions for most feedstock‘s are insufficient to meet the GHG savings required by the EU Renewable Energy Directive (RED). However, second-generation biofuels have, in general, a greater potential to reduce the emissions, provided there is no LUC. Third-generation biofuels do not represent a feasible option at present state of development as their GHG emissions are higher than those from fossil fuels. As also discussed in the paper, several studies show that reductions in GHG emissions from biofuels are achieved at the expense of other impacts, such as acidification, eutrophication, water foot print and biodiversity loss. The paper also investigates the key methodological aspects and sources of uncertainty in the LCA of biofuels and provides recommendations to address these issues.

Biofuels Production: A Review on Sustainable Alternatives to Traditional Fuels and Energy Sources Cost Savings

It is studied that with increased worldwide energy demand and carbon dioxide emissions from the use of fossil fuels, severe problems are being experienced in these times. Energy is one of the most important resources for humankind, and its needs have been drastically increasing due to more energy consumption, the rapid depletion of fossil fuels, and environmental crises. Therefore, it is important to identify and search for an alternative to fossil fuels that provides energy in a reliable, constant, and sustainable way that could use available energy sources efficiently for alternative renewable sources of fuel that are clean, non-toxic, and eco-friendly also. In this way, there is a need to develop technologies for biofuel production with a focus on economic feasibility, sustainability, and renewability.

Several technologies, such as biological and thermo chemical approaches, are derived from abundant renewable biological sources, such as biomass and agricultural waste, using advanced conversion technologies for biofuel production. Biofuels are non-toxic, biodegradable, and recognized as an important sustainable greener energy source to conventional fossil fuels with lower carbon emissions, combat air pollution, empower rural communities, and increase economic growth and energy supply. The purpose of this review is

to explain the basic aspects of biofuels and their sustainability criteria, with a particular focus on conversion technologies for biofuel production, challenges, and also future perspectives.

CONCLUSION

The studies done in this research area show us that the strategic goal of bio-fuel is to supplement or even replace fossil fuels. Biofuels could lead to major new markets for farmers. The success of biofuels depends on their use mandatory, tax facilities, state subsidies, pricing to consumers, the recognition of the rights of workers and the thousand and one ways develop from the rural communities and effective use of their land. . It can help mitigate climate change, reduce acid rain, soil erosion and help maintain forest health through better management. Also, global biofuels program will potentially lead to intense pressures on land supply and cause widespread transformations in land use. Also, the outcomes of LCA studies are highly situational and dependent on many factors, including the type of feedstock, production routes, data variations and methodological choices. In all, the biofuel made up with the best combination and the highest efficiency can be used as the primary alternative for the fossil fuels.

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