Journal of Environmental Treatment Techniques
Volume 12, Issue 4, DOI 10.18502/jett.v12i4.17969
Production and Hosting by KnE Publishing

KNE Publishing

Check for updates

Review Article

Climate Change in Iran: Challenges and Solutions – A Short Communication

Amirreza Talaie[1,2,3]* and Shahabaldin Rezania[4]

[1]Department of Civil Engineering, Jami Institute of Technology, Isfahan, Iran
[2]Plant Design Department, Pars Abnoos Sanat Consulting Engineering Company, Shiraz, Iran
[3]Department of Natural Sciences, West Kazakhstan Marat Ospanov Medical University, Aktobe 030012, Kazakhstan
[4]Department of Environment and Energy, Sejong University, Seoul, 05006, South Korea

Abstract

Climate change, driven by human activities such as fossil fuel combustion and deforestation, poses significant environmental and economic challenges globally and particularly affects Iran. This article explores the primary causes of climate change, including industrial emissions, agriculture, deforestation, and transportation. It examines the severe impacts on Iran, such as rising temperatures, decreased precipitation, and increased drought, which exacerbate water scarcity, agricultural decline, and health issues. The article outlines strategies for addressing these challenges, including optimizing water use with advanced irrigation technologies, developing renewable energy sources, increasing vegetation cover, and enhancing education and infrastructure. Effective climate change mitigation in Iran requires comprehensive policies, international cooperation, and sustainable practices to safeguard the environment and improve quality of life.

Keywords: Climate Change, Greenhouse Gases, Iran, Mitigation Strategies

Corresponding Author:
Amirreza Talaie; email:
amirtkh@yahoo.com

Received: 21 September 2024
Accepted: 3 December 2024
Published: 20 December 2024

Production and Hosting by KnE Publishing

OPEN ACCESS

1. Introduction

Climate change is one of the most significant environmental issues facing the world today [1]. This phenomenon has occurred due to human activities such as burning fossil fuels, deforestation, and releasing greenhouse gases into the Earth's atmosphere, leading to major changes in global climate patterns. Iran, as a country with a dry and semi-arid climate, is particularly affected by these changes. Rising temperatures, decreased precipitation, increased droughts, and shifts in rainfall patterns are just a few of Iran's impacts of climate change [2]. This article will examine the causes and effects of climate change in Iran, its economic and social consequences, and strategies to address this phenomenon.

2. Main Causes of Climate Change

Climate change primarily occurs due to increased greenhouse gases in the Earth's atmosphere [2]. These gases are largely produced by human activities such as burning fossil fuels, deforestation, and agriculture. Various factors have contributed to the rise in greenhouse gases in Iran [3]:

2.1. Industry and Energy

Iran, as one of the largest producers of oil and gas in the world, heavily relies on its vast fossil fuel resources for energy production [4]. This reliance has led to high levels of fossil fuel consumption across various sectors, including transportation, industry, and residential use [5]. The widespread use of oil, natural gas, and coal in these sectors has significantly contributed to the country's carbon dioxide (CO_2) emissions, which are among the highest in the region [6]. As a result, Iran faces growing environmental challenges, such as air pollution and the long-term impacts of climate change [7]. The country's dependence on fossil fuels underscores the urgent need for sustainable energy solutions and efforts to reduce greenhouse gas emissions to mitigate environmental degradation [8].

2.2. Major Greenhouse Gas Producers

The largest greenhouse gas emitters in the world based on annual CO_2 and other greenhouse gas emissions are China, the United States, India, the European Union, Russia, Japan, and other countries [9]. China is recognized as the largest emitter of greenhouse gases globally [10]. Due to its extensive use of coal for electricity generation and rapid industrial development, it has the highest CO_2 emissions. In recent years, China has made efforts to reduce greenhouse gas emissions through the development of renewable energy and increased energy efficiency. The United States is the second-largest emitter of greenhouse gases. Major sources of these emissions in the U.S. include power plants, transportation, and industry [11]. Despite efforts to reduce emissions, the U.S. still has a significant share in global greenhouse

gas production. India, as the third-largest emitter, has substantial emissions due to its rapid economic growth and large population. Major sources of greenhouse gas emissions in India include coal, oil, and natural gas. The European Union, as a collective unit, is the fourth-largest emitter of greenhouse gases [9]. However, EU member states are making significant efforts to reduce emissions through green policies and the development of renewable energy. Russia is another major greenhouse gas emitter, with key sources including heavy industry and energy. Japan is also among the largest greenhouse gas producers due to its heavy reliance on fossil fuel imports for energy production. Other countries such as Canada, Brazil, Indonesia, Mexico, and Australia are also significant greenhouse gas producers. Iran, as one of the largest oil and gas producers in the world, contributes to greenhouse gas emissions [12]. Unlike air pollutants, which typically have localized effects in the regions where they are produced and released into the atmosphere, greenhouse gases have global impacts. This means that their emissions anywhere in the world can contribute to global temperature increases. Thus, this issue is a global challenge, and all countries must implement various strategies to reduce their greenhouse gas emissions.

2.3. Agriculture and Deforestation

Changes in land use patterns, including the conversion of forests to agricultural lands and urban areas, have led to increased greenhouse gas emissions [13]. Deforestation and agriculture play crucial roles in climate change. Forests, often referred to as the “lungs of the Earth,” are vital for absorbing carbon dioxide and producing oxygen. When trees are cut down and forested areas are converted to other uses such as agriculture, residential, or industrial purposes, the amount of carbon dioxide in the atmosphere increases. This is because the cut trees are no longer able to absorb CO_2, and the carbon stored in them is released [14]. Deforestation results in reduced biodiversity, changes in local climate patterns, and soil erosion—all of which contribute to exacerbating climate change. Agriculture also has several impacts on climate change [15]. Methane production is a major agricultural impact, particularly noticeable in livestock farming and rice paddies [16]. Ruminant animals like cows produce methane during digestion, and rice cultivation increases methane emissions due to flooded fields [17]. The use of nitrogen fertilizers in agriculture leads to the release of nitrous oxide, a potent greenhouse gas. Additionally, land use changes such as converting forests to agricultural land result in habitat destruction and increased atmospheric CO_2 levels [18]. High water consumption in agriculture and improper use of water resources can lead to reduced water supplies and water crises, which affect local and global climate patterns [19]. Unsustainable agricultural practices can also cause soil erosion and degradation, reducing the land’s ability to absorb and store carbon [20]. To mitigate the negative impacts of deforestation and agriculture on climate change, several measures can be taken. Sustainable forest management, preventing illegal logging, reforestation, and protecting existing forests can help reduce greenhouse gas emissions [21]. Adopting sustainable agricultural practices such as no-till farming, cover cropping, and crop rotation can help maintain soil health and reduce greenhouse

gas emissions. Optimizing water use in agriculture through techniques like drip irrigation and smart water management can alleviate pressure on water resources and prevent water crises. Given the significant role of deforestation and agriculture in climate change, fundamental changes in resource management and utilization are needed. Implementing sustainable techniques, improving energy efficiency, and proper management of natural resources can contribute to reducing greenhouse gas emissions and preserving the environment.

Transportation: Transportation is a key sector in the global economy with significant impacts on climate change. These impacts arise from greenhouse gas emissions, energy consumption, and changes in consumption patterns and transportation infrastructure. Transportation is one of the largest sources of greenhouse gas emissions worldwide. Motor vehicles such as cars, trucks, buses, and motorcycles predominantly use fossil fuels like gasoline and diesel, leading to the release of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). These gases contribute to global warming and climate change [22]. In countries experiencing rapid industrial and economic growth, the level of these emissions has significantly increased. Transportation accounts for a large portion of global energy consumption. As demand for transportation increases, so does the need for fossil fuels, leading to higher greenhouse gas emissions. Despite efforts to develop electric vehicles and use renewable energy in transportation, fundamental changes in infrastructure and energy consumption patterns are still required. In addition to greenhouse gases, transportation also emits other pollutants that negatively affect air quality [23]. Air pollution and emissions of particulate matter (PM), nitrogen oxides (NOx), and volatile organic compounds (VOCs) from motor vehicles can lead to health problems such as respiratory, cardiovascular diseases and even infertility [24]. These pollutants can also exacerbate global warming. The development of transportation infrastructure such as roads, highways, airports, and ports can also have significant environmental impacts. Land use changes for building these infrastructures result in habitat destruction, increased soil erosion, and changes in local climate patterns. Furthermore, urban development and increased population density in urban areas increase the demand for both public and private transportation, which, in turn, contributes to higher greenhouse gas emissions. To mitigate the negative impacts of transportation on climate change, several measures can be implemented: (1) Investing in public transportation systems such as metros, electric buses, and bike-sharing programs can reduce reliance on personal vehicles and thus lower greenhouse gas emissions. (2) Increasing the production and use of electric and hybrid vehicles can help reduce dependence on fossil fuels and greenhouse gas emissions. (3) Developing new technologies to improve fuel efficiency in cars and heavy vehicles can help reduce energy consumption and greenhouse gas emissions. (4) Promoting active transportation methods like walking and cycling can reduce the use of motor vehicles and lower greenhouse gas emissions. (5) Designing and improving transportation infrastructure to facilitate the use of clean vehicles and public transportation can contribute to reducing greenhouse gas emissions. Transportation plays a significant role in climate change and requires fundamental changes in energy

consumption patterns and infrastructure development. By adopting sustainable policies and strategies, the negative impacts of transportation on climate change can be mitigated, moving towards sustainable development. International cooperation and the use of new technologies can also greatly assist in this process.

3. Effects of Climate Change in Iran

Climate change has had extensive effects on the environment and society of Iran, including rising temperatures, reduced precipitation, dwindling water resources, droughts, air pollution, and floods. The increase in average annual temperatures, especially during the hotter seasons, has intensified the phenomena of heat and drought in Iran. Changes in precipitation patterns have led to decreased rainfall and longer periods of drought. Reduced precipitation and increased evaporation have resulted in diminished surface and groundwater resources. Central and southern regions of Iran have been particularly affected by drought, which has led to decreased agricultural output. Rising temperatures and reduced rainfall have also contributed to increased dust and air pollution in major cities. Changes in precipitation patterns have caused sudden floods in certain areas. Climate change has far-reaching economic and social consequences beyond its environmental impacts. Reduced water resources and changes in precipitation patterns have led to decreased agricultural production and rising prices, directly affecting the livelihoods of farmers and food security in Iran. Increased temperatures and air pollution have contributed to a rise in respiratory, cardiovascular, and other health issues. There has also been an increase in heat-related illnesses. Water scarcity and drought in rural areas have led to widespread migration to urban centers, exacerbating urban sprawl and increasing pressure on city infrastructure, potentially leading to social problems. The decline in agricultural and industrial production due to water shortages and the effects of climate change can reduce national income and increase unemployment in Iran.

4. Strategies for Addressing Climate Change

To combat climate change and reduce its harmful effects, Iran needs to adopt effective policies and strategies across various sectors.

4.1. Optimizing Water Use

One essential approach is optimizing water use, especially in agriculture and industry, by incorporating modern technologies to reduce water consumption and improve resource efficiency [25]. These efforts are crucial for addressing Iran's water crisis and mitigating the effects of climate change. The application

of technologies such as drip irrigation and smart irrigation systems provides significant benefits. Drip irrigation is an effective method that delivers water directly to the plant roots, reducing evaporation and minimizing water wastage, thus improving overall water efficiency [26]. These systems can be controlled manually or automatically using soil moisture sensors to adjust water supply as needed. Smart irrigation takes this concept further by using data from soil moisture sensors, temperature readings, and humidity levels. Automated systems can optimize the timing and quantity of irrigation, accurately predicting plant water needs and preventing over-irrigation [27].

Another innovation is hydroponic and aquaponic farming, which allow for agriculture with much lower water usage [28]. In hydroponic farming, plants are grown without soil, using nutrient solutions in a controlled environment. This approach can reduce water usage by up to 90% compared to traditional methods and offers higher productivity [29]. Similarly, aquaponic farming combines fish farming with plant cultivation, where fish waste acts as a natural fertilizer for the plants. This system is highly efficient, helping to reduce water consumption and improve overall resource use.

Additionally, growing drought-resistant crops offers a sustainable solution for regions facing water scarcity [30]. Using drought-resistant seeds and plants can significantly reduce water needs, especially in arid and semi-arid areas [31]. Ongoing research in plant breeding and biotechnology is advancing the production of crops with higher drought tolerance and water efficiency, which is increasingly important for sustainable agriculture in a changing climate [32].

4.2. Developing Renewable Energy

Investing in renewable energy sources, such as solar and wind power, is another fundamental strategy to combat climate change [33]. Clean energy sources reduce reliance on fossil fuels and lower greenhouse gas emissions, which is essential for preserving the environment. Solar and wind energy are nearly emission-free and therefore do not contribute to air pollution, making them beneficial for mitigating the effects of climate change [34]. Moreover, renewable energy reduces dependence on finite resources like oil, coal, and natural gas, which are limited and environmentally damaging to extract and use [35]. This shift enhances energy security and promotes sustainable energy use.

Beyond environmental benefits, renewable energy development fosters economic growth by creating new job opportunities in research and development, manufacturing, installation, and maintenance of related technologies [36]. For example, the growth of solar and wind industries can stimulate job creation, reduce unemployment, and contribute to a greener economy. Furthermore, renewable energy production preserves natural resources, as it reduces the need for underground resource extraction, thereby protecting biodiversity and ecosystems [37].

However, some challenges exist in expanding renewable energy use [38]. High initial installation costs can be a barrier, but government support through financial incentives, subsidies, and tax breaks can

encourage investment. Technological advances and economies of scale can also help reduce costs over time. The intermittency of energy supply from solar and wind sources, due to weather conditions, poses another challenge. To address this, energy storage technologies like batteries and hydrogen storage systems are essential for ensuring grid reliability and stability [38]. Building the necessary infrastructure, including smart grids, electric vehicle charging stations, and energy management systems, is also critical for efficient renewable energy use. Additionally, raising public awareness and education about clean energy can increase adoption rates. Public awareness campaigns, educational programs, and specialized guidance for investors and consumers are effective strategies to promote renewable energy.

4.3. Increasing Vegetation Cover

Expanding forest and pasture areas is crucial for reducing global warming effects and improving air quality [39]. Forests, often called the “lungs of the Earth,” absorb carbon dioxide and release oxygen [40]. By increasing the coverage of forests and pastures, carbon dioxide concentrations in the atmosphere can be reduced, which helps to moderate Earth’s temperature [41]. Establishing green belts around urban areas improves air quality by absorbing pollutants, lowering temperatures, and providing shade, which creates a healthier environment for city residents.

Implementing these initiatives involves restoring degraded forests through reforestation programs and protecting existing forests to rejuvenate ecosystems and conserve biodiversity. Designing green belts around cities and industrial zones also helps reduce air pollutants and enhances urban air quality. To achieve success in these programs, financial support and community involvement are essential. Sufficient funding and active engagement from local communities in tree planting and green space development can ensure effective implementation and long-term sustainability.

4.4. Education and Awareness

Raising public awareness about water and energy conservation and educating people on climate change impacts can positively shape community behavior [42]. Schools and media play key roles in spreading knowledge on these issues. Educating future generations on climate change, the importance of resource conservation, and methods to minimize environmental damage is essential for fostering sustainable attitudes [43]. Activities such as workshops, media campaigns, and awareness programs can build public knowledge, promote sustainable consumption patterns, and encourage eco-friendly lifestyles. These efforts contribute to preserving natural resources and addressing climate challenges. Additionally, they create an informed and responsible community that understands the importance of sustainable practices.

4.5. Infrastructure Development

Strengthening infrastructure for water and wastewater management, as well as establishing flood and drought warning systems, can significantly reduce climate change impacts [44]. Upgrading water distribution networks, developing wastewater treatment facilities, and improving water storage and management practices enhance water efficiency and address critical water shortages [45, 46]. Advanced flood and drought warning systems enable better planning and quicker emergency responses, reducing the damage caused by these natural events. Furthermore, improving disaster management capabilities, such as training emergency personnel, enhancing coordination between agencies, and developing preparedness plans, can improve responses to climate-related emergencies. These measures reduce community vulnerability and enhance resilience to climate change challenges.

4.6. International Cooperation

Participating in international agreements, such as the Paris Agreement, and collaborating with global organizations is vital in reducing greenhouse gas emissions [47]. These efforts enable countries to work together toward shared goals in combating climate change, fostering an environment of collective responsibility and action. International cooperation allows for resource sharing, knowledge exchange, and coordinated policy development, which can help accelerate progress in addressing climate change on a global scale.

By adopting these policies and strategies, Iran can move toward sustainable development and mitigate the adverse effects of climate change. Through a combination of domestic efforts and international cooperation, supported by advancements in technology, Iran can build a more resilient and sustainable future.

5. Conclusion

Climate change, as one of Iran's most significant environmental and economic challenges, requires special attention and serious actions. By adopting appropriate policies and strategies, it is possible to mitigate the negative effects of this phenomenon and move toward sustainable development. International cooperation and leveraging global experiences can also significantly aid in this process. By utilizing available resources and advancing new technologies, Iran can play a crucial role in combating climate change and improving the quality of life for its people while preserving natural resources.

References

[1] Adedeji, O.J.J.o.G. and E. Protection, *Global climate change.* 2014. **2**(02): p. 114.

[2] Abbaspour, K.C., et al., *Assessing the impact of climate change on water resources in Iran.* 2009. **45**(10).

[3] Hosseini, S.E., et al., *The scenario of greenhouse gases reduction in Malaysia.* 2013. **28**: p. 400-409.

[4] Aien, M. and O.J.S. Mahdavi, *On the way of policy making to reduce the reliance of fossil fuels: Case study of Iran.* 2020. **12**(24): p. 10606.

[5] Newman, P., T. Beatley, and H. Boyer, *Resilient cities: Overcoming fossil fuel dependence*. 2017: Island Press.

[6] Nejat, P., et al., *A global review of energy consumption, CO2 emissions and policy in the residential sector (with an overview of the top ten CO2 emitting countries).* 2015. **43**: p. 843-862.

[7] Atash, F.J.C., *The deterioration of urban environments in developing countries: Mitigating the air pollution crisis in Tehran, Iran.* 2007. **24**(6): p. 399-409.

[8] Akpan, J. and O.J.E. Olanrewaju, *Sustainable energy development: History and recent advances.* 2023. **16**(20): p. 7049.

[9] Olivier, J.G., K. Schure, and J.J.P.N.E.A.A. Peters, *Trends in global CO2 and total greenhouse gas emissions.* 2017. **5**: p. 1-11.

[10] Sugar, L., C. Kennedy, and E.J.J.o.I.E. Leman, *Greenhouse gas emissions from Chinese cities.* 2012. **16**(4): p. 552-563.

[11] Andress, D., T.D. Nguyen, and S.J.E.f.s.d. Das, *Reducing GHG emissions in the United States' transportation sector.* 2011. **15**(2): p. 117-136.

[12] Nong, D., P. Simshauser, and D.B.J.A.E. Nguyen, *Greenhouse gas emissions vs CO2 emissions: Comparative analysis of a global carbon tax.* 2021. **298**: p. 117223.

[13] Houghton, R.A., et al., *Carbon emissions from land use and land-cover change.* 2012. **9**(12): p. 5125-5142.

[14] Abbate, S., et al., *Carbon uptake dynamics associated to the management of unused lands for urban CO2 planning.* 2021. **178**: p. 946-959.

[15] Malhi, G.S., M. Kaur, and P.J.S. Kaushik, *Impact of climate change on agriculture and its mitigation strategies: A review.* 2021. **13**(3): p. 1318.

[16] Nikolaisen, M., et al., *Methane emissions from rice paddies globally: A quantitative statistical review of controlling variables and modelling of emission factors.* 2023. **409**: p. 137245.

[17] Rad, A.K., et al., *Manure Management to Reduce Methane Emissions*, in *Strategizing Agricultural Management for Climate Change Mitigation and Adaptation*. 2023, Springer. p. 29-46.

[18] Foley, J.A., et al., *Global consequences of land use.* 2005. **309**(5734): p. 570-574.

[19] Hanjra, M.A. and M.E.J.F.p. Qureshi, *Global water crisis and future food security in an era of climate change.* 2010. **35**(5): p. 365-377.

[20] Hossain, A., et al., *Agricultural land degradation: processes and problems undermining future food security*, in *Environment, climate, plant and vegetation growth*. 2020, Springer. p. 17-61.

[21] Corbera, E., M. Estrada, and K.J.C.c. Brown, *Reducing greenhouse gas emissions from deforestation and forest degradation in developing countries: revisiting the assumptions.* 2010. **100**(3): p. 355-388.

[22] Kiribou, A.-R.I., *Greenhouse Gas Emission in road Transport and Urban Mobility in Ouagadougou: Evaluation and Modelling of its Effect on Air Pollution*. 2021, WASCAL.

[23] Reynolds, C.C.O., *Strategies to reduce transportation emissions in India: Identifying air quality and climate co-benefits for the developing world*. 2010, University of British Columbia.

[24] Alaee, S., *Air Pollution and Infertility.* Journal of Environmental Treatment Terchniques, 2018. **6**(4): p. 72-73.

[25] Lakhiar, I.A., et al., *A review of precision irrigation water-saving technology under changing climate for enhancing water use efficiency, crop yield, and environmental footprints.* 2024. **14**(7): p. 1141.

[26] Jarwar, A.H., et al., *Performance and evaluation of drip irrigation system, and its future advantages.* 2019. **9**(9).

[27] Hassan-Esfahani, L., A. Torres-Rua, and M.J.A.W.M. McKee, *Assessment of optimal irrigation water allocation for pressurized irrigation system using water balance approach, learning machines, and remotely sensed data.* 2015. **153**: p. 42-50.

[28] Kloas, W., et al., *A new concept for aquaponic systems to improve sustainability, increase productivity, and reduce environmental impacts.* 2015. **7**(2): p. 179-192.

[29] Lee, S. and J.J.S.H. Lee, *Beneficial bacteria and fungi in hydroponic systems: Types and characteristics of hydroponic food production methods.* 2015. **195**: p. 206-215.

[30] Rosero, A., et al., *A dual strategy of breeding for drought tolerance and introducing drought-tolerant, underutilized crops into production systems to enhance their resilience to water deficiency.* 2020. **9**(10): p. 1263.

[31] Khajeddin, S., S. Matinkhah, and Z.J.J.o.A.L. Jafari, *A drought resistance index to select drought resistant plant species based on leaf water potential measurements.* 2019. **11**: p. 623-635.

[32] Nuccio, M.L., et al., *Where are the drought tolerant crops? An assessment of more than two decades of plant biotechnology effort in crop improvement.* 2018. **273**: p. 110-119.

[33] Sims, R.E.J.S.e., *Renewable energy: a response to climate change.* 2004. **76**(1-3): p. 9-17.

[34] Towoju, O.A., O.A.J.E. Oladele, and T. Journal, *Electricity generation from hydro, wind, solar and the environment.* 2021. **39**(9): p. 1392-1398.

[35] Arutyunov, V.S. and G.V.J.R.C.R. Lisichkin, *Energy resources of the 21st century: problems and forecasts. Can renewable energy sources replace fossil fuels.* 2017. **86**(8): p. 777.

[36] Usman, F.O., et al., *Integrating renewable energy solutions in the manufacturing industry: challenges and opportunities: a review.* 2024. **5**(3): p. 674-703.

[37] Gasparatos, A., et al., *Renewable energy and biodiversity: Implications for transitioning to a Green Economy.* 2017. **70**: p. 161-184.

[38] Kochtcheeva, L.V.J.E.-I.R., *Renewable energy: global challenges.* 2016. **27**.

[39] Smith, P., et al., *The role of ecosystems and their management in regulating climate, and soil, water and air quality.* 2013. **50**(4): p. 812-829.

[40] Quah, E. and R. Toh, *Preservation of the Amazon rainforest*, in *Cost-Benefit Analysis*. 2011, Routledge. p. 133-139.

[41] Reilly, J., et al., *Global economic effects of changes in crops, pasture, and forests due to changing climate, carbon dioxide, and ozone.* 2007. **35**(11): p. 5370-5383.

[42] Patchen, M.J.P.c.c.r.c.o.p., *Public attitudes and behavior about climate change.* 2006. **601**.

[43] Williamson, K., et al., *Climate change needs behavior change: Making the case for behavioral solutions to reduce global warming.* 2018.

[44] Sadoff, C. and M. Muller, *Water management, water security and climate change adaptation: early impacts and essential responses*. 2009: Global Water Partnership Stockholm.

[45] Ghanbarnejad P, G.A., Bayat B, Barzkar H, Talaiekhozani A, Bagheri M, Alaee S *Evaluation of Formaldehyde Adsorption by Human Hairand Sheep Wool in Industrial Wastewater with High Concentration.* Journal of Environmental Treatment Terchniques, 2014. **2**(1): p. 12-17.

[46] *Evaluation of Nitrate Removal from Wastewater Using Electrochemical Method*. Journal of Environmental Treatment Terchniques, 2014. **2**(1): p. 18-21.

[47] Council, N.R., et al., *Verifying greenhouse gas emissions: methods to support international climate agreements*. 2010: National Academies Press.