

2040: Climate Change Documentary Analysis

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Abstract

This paper examines the impacts of climate change on human health and well-being, utilizing insights from the documentary *2040*, directed by David Gameau. It explores how agriculture and ocean ecosystems can contribute to climate change mitigation. While the agricultural industry is a significant source of emissions, it is also particularly vulnerable to climate impacts (Gameau, 2019). Rising ocean temperatures and acidification threaten biodiversity and disrupt vital ocean circulation (Gameau, 2019).

This paper highlights the interrelation of climate change, planetary health, and human well-being and advocates for a multisectoral approach. It emphasizes strategies like sustainable agriculture and marine permaculture alongside adaptation measures to reduce vulnerability. This research accentuates the importance of environmental justice and the need for equitable and inclusive climate action.

Through examination of the United Nations Sustainable Development Goals (SDGs), such as zero hunger and responsible consumption, this paper identifies crucial intervention areas. Recommendations include reducing waste, promoting sustainable consumption, and implementing upstream policies to support climate mitigation. The research highlights the urgent need for global action to combat climate change and protect human health for future generations. Given the climate crisis's implications for nursing practice, adopting planetary nursing approaches is essential to safeguard both the planet and its population.

Part I: Analysis

The documentary *2040*, directed by Damon Gameau, follows a man in search of feasible interventions for the climate crisis. In this film, Damon travels the globe in search of current technologies that seek to reduce carbon emissions and draw down carbon to foster the resilience of our planet. Most importantly, Gameau seeks solutions that would ensure improved quality of life for future generations across the globe. Notably, the documentary identifies agriculture as a significant contributor to carbon emissions. Additionally, the film recognizes the effects of climate change on the agricultural industry and the world's oceans. Life on land and in the water is threatened by the effects of climate change due to human activity (Gameau, 2019).

Climate change can be considered one of the greatest threats to human life on this planet (Scoones et al., 2024). Since the Industrial Revolution in the 1800s, human activity has become the most significant contributor to greenhouse gas emissions and climate change, and these anthropogenic changes in climate threaten the health and safety of all people (Gameau, 2019). Due to the effects of climate change on agriculture and the ocean, humans are at risk for concerns such as food insecurity, exposure to natural disasters, and increased incidents of

illness and disease (Mohanty, 2021). Without swift and effective interventions by the global community, anthropogenic climate change will have disastrous and irreversible consequences for our planet and human life overall.

Agriculture

As indicated in the documentary *2040*, the agricultural industry significantly contributes to the production of anthropogenic emissions (Gameau, 2019). According to Gameau (2019), agricultural activities such as tillage results in a greater release of carbon into the atmosphere than burning fossil fuels. Inversely, the agricultural industry is inherently sensitive to changes in climate (Mohanty, 2021). The contribution to and effect on agriculture concerning climate change is complex and cyclical in nature.

Soil acts as a carbon sink; "a carbon sink is any process, activity, or mechanism that absorbs more carbon dioxide from the atmosphere than it releases" (United Nations Development Programme, 2023, p. 17). Efforts should be made to ensure that the stored carbon is not released into the atmosphere (Ruis et al., 2022). Tilling the land in preparation for seeding releases carbon from this reserve and contributes to greenhouse gas emissions (Gameau, 2019). Traditional tilling methods also alter the soil's organic matter, water content, and temperature (Ruis et al., 2022). This will inevitably lead to adverse effects on crop yield.

The agricultural industry is very susceptible to the effects of climate change (Mohanty, 2021). Two significant outcomes associated with climate change are changes in temperature and precipitation. Crops are particularly susceptible to these changes, and crop yield will be reduced due to these alterations and the inability of crops to adapt (Mohanty, 2021). Food scarcity will result in severe consequences for vulnerable populations (Ericksen et al., 2009). Namely, increased food prices have occurred in response to diminished food production, thus imposing greater challenges on the socioeconomically disadvantaged. Malnutrition, especially in developing nations, will only worsen because of climate change (Howard, 2017).

Additionally, the food currently being produced is of lower nutritional value due to changes in soil quality. Current farming practices decrease the nutrient content of the soil and result in the production of nutrient-poor food (Gameau, 2019). This land degradation can be evidenced by a lack of earthworms and microorganisms living in the soil, as they require carbon and nutrient-dense soil to thrive. As soil is tilled and loses nutrients, it becomes nonporous and can no longer absorb water necessary for crop growth (Gameau, 2019). The release of carbon from soil is responsible for both biodiversity loss and changes in hydrology that negatively affect crops and food production (Ericksen et al., 2009).

Ocean Biodiversity

According to the film *2040*, the ocean absorbs approximately 93% of the greenhouse gasses in the atmosphere each year (Gameau, 2019). A significant consequence of increased CO₂ in the atmosphere due to agricultural impacts and other emissions is the gradual increase in warming and acidification of the oceans. According to a study by Pedersen and Hanssen (2018), ocean acidification and rapid warming are preeminent threats to ocean biodiversity. When carbon

dioxide dissolves in the ocean, it causes lowered pH or acidification of the water (Arunkumar et al., 2023). Ocean acidification directly influences the energy required to calcify shells and exoskeletons of plankton, crustaceans, and coral species (Arunkumar et al., 2023; Schoeman et al., 2023). The increased vulnerability is two-fold because of the direct effect on specific species and the subsequent effect on the food chain (Arunkumar et al., 2023).

Furthermore, the warming and acidification of the ocean subsequently have detrimental effects on overturning circulation (Gameau, 2019). According to the film *2040*, decreased overturning circulation contributes to biodiversity loss due to inadequate nutrition availability (Gameau, 2019). Overturning circulation is the currents in the ocean; they are often considered a "global conveyor belt" – transporting water, nutrients, and density to the most appropriate areas (Lee et al., 2023, p. 2; National Oceanic and Atmospheric Administration [NOAA], 2024). This process is necessary for life-sustaining nutrients and warmer water to be moved to parts that require it to sustain biodiversity and ecosystems (NOAA, 2024). Overturning circulation also helps regulate climate because the ocean absorbs carbon dioxide and prevents the Earth's surface from overheating and adverse weather events (Lee et al., 2023; Arunkumar et al., 2023).

As a result of anthropogenic emissions, polar ice caps are also beginning to melt, further exacerbating the water warmth distribution in the ocean (Lee et al., 2023). According to the National Aeronautics and Space Administration [NASA], as the polar ice caps melt, they release large amounts of fresh water into the ocean, diluting the salinity and decreasing warmer surface water's density (NASA Science Editorial Team, 2023). Decreased density near the surface decreases the ability of warm water to sink to the depths. Due to anthropogenic and non-anthropogenic climate change in the last decades, there has been a decrease in the sinking of surface waters and, thus, a slowing down of overturning circulation (Lee et al., 2023). Scientists believe this circulation will continue to slow down or even collapse due to anthropogenic emissions (Praetorius, 2018).

Other anthropogenic actions, such as ocean waste and plastic disposal, also significantly affect marine biodiversity (Gameau, 2019). Human consumption and purchase of many single-use plastics and loss of fishing gear and equipment have accumulated massive amounts of garbage in our oceans (Rhodes, 2018). These wastes can potentially entangle marine life, disrupt the structure and function of ecosystems, and disintegrate into microplastics, contaminating the waters and harming marine life.

Part II: Making Connections

Global and Planetary Health

The importance of global and planetary health has become more prevalent in recent years. Global health focuses on the health of the human population on Earth, while planetary health is concerned with the health of humans and the ecosystem in which we live (Parsons, 2020). As the planet's health deteriorates, so will the health of humans. Direct effects of climate change on health include changes in weather patterns, flooding, droughts, water pollution, and changes to vector-borne illness (Howard, 2017). Additionally, climate change will have significant indirect

effects on human life. Due to the effects of climate change, the world will likely witness the mass migration of climate refugees (Howard, 2017). Consequently, many populations will be affected by climate change, whether it be due to food insecurity, loss of homes, or the conflict associated with a potential fight for resources. When challenges such as droughts or famine drive populations out of their current region, a struggle for land and resources will ensue. Inevitably, mental health challenges will arise due to displacement and climate conflict (Howard, 2017). Thus, climate change will also significantly strain the mental health and well-being of the affected populations. In this way, the political climate will also contribute to the negative health consequences arising without climate interventions. Due to this issue's integrated and complex nature, a multisectoral approach is mandatory to address the political, psychosocial, and environmental challenges arising from the climate crisis.

Environmental Health and the Socio-Environmental Perspective

Environmental health acknowledges the physical, chemical, and biological factors and how they relate to health (Fournier et al., 2021). Thus, the issue of environmental health is intimately related to the social determinants of health. The socio-environmental view of health recognizes that several factors contribute to individuals' health, including the political, psychosocial, and physical environment (Fournier et al., 2021). This perspective recognizes that individuals are subject to social determinants more than individual choices when making health decisions. As mentioned in the documentary *2040*, many populations lack essential resources, including access to food, water, and housing (Gameau, 2019). Because of this issue, climate initiatives should focus on lifting vulnerable populations out of poverty and seeking equity for all while working within environmental limits.

Environmental racism explains that vulnerable groups are more susceptible to environmental hazards due to discriminatory government inaction (Fournier et al., 2021). For example, the consequences of food scarcity due to inadequate agricultural production are more likely to be felt by those of lower socioeconomic status. The effects of climate change on food production significantly contribute to poor health and increased incidence of disease (Mohanty, 2021). As mentioned in *2040*, agricultural corporations produce nutrient-poor food (Gameau, 2019). For example, a significant amount of arable land is used to grow sugar cane, a significant contributor to diabetes. Additionally, feedlots and poor diets fed to livestock result in unhealthy meat products that are then disseminated around the globe. Consuming a low-meat or grass-fed meat diet may be beneficial in preventing hypertension and heart disease; however, consuming a healthy diet may be out of reach for the socioeconomically disadvantaged.

Conversely, the concept of environmental justice supports the involvement of all people during the development process for environmental policy (Fournier et al., 2021). In alignment with this concept, policymakers should strive to prevent disease and promote health through policy change and infrastructure development. Health equity is achieved when everyone, regardless of socio-demographic characteristics, has a fair opportunity to reach optimal health (Fournier et al., 2021). To ensure sustainable global health, changes must be made to promote health for all populations.

Climate Mitigation vs. Adaptation

Presently, the majority of climate-related interventions are reactionary. Instead of acting to prevent climate change and the subsequent health challenges, governments currently react through disaster management rather than prevention. Climate change mitigation includes actions taken at many levels to "reduce or prevent greenhouse gas emissions" and reduce the potential for adverse events (United Nations Development Programme, 2023, p. 55). In contrast, climate change adaptation includes measures to decrease vulnerability and the negative results of climate change events, such as decreased ocean biodiversity, slowing overturning circulation, and food insecurity. While climate adaptation remains of the utmost importance due to the issues resulting from already present emissions, it is essential to look towards more approaches to mitigate this.

Climate change and its subsequent impacts, such as food insecurity, decreased ocean biodiversity, and extreme weather, can potentially create detrimental consequences for population health (Centers for Disease Control and Prevention [CDC], 2022). To address climate change consequences and combat the rise of emissions, strategies should be aimed at multisectoral approaches taken at multiple governmental levels. Upstream approaches are multisectoral and require the involvement of governments to create change through community-based strategies, healthy public policy, and addressing inequalities. A health-in-all policies (HiAP) approach asks policymakers to mitigate detrimental health effects while maximizing health promotion in policy decisions (Fournier et al., 2021). It would be the responsibility of the global community to implement policies discouraging harmful agricultural practices and encourage strategies to reverse the detrimental effects on marine biodiversity and overturning circulation.

Part III: Sustainable Development Goals (SDGs)

The United Nations Sustainable Development Goals are 17 established goals for the global community to improve the health of the planet and its people (United Nations, n.d.-e). These goals are focused on ending poverty, increasing education, reducing inequality, and improving economic growth. Furthermore, the SDGs emphasize the importance of addressing these concerns in the context of climate change and seek to preserve the planet's health in the process. In relation to the documentary *2040*, Sustainable Development Goals #2, zero hunger, #12, responsible consumption and production, #14, life below water, and #15, life on land, are most applicable to this discussion.

SDG #2 - Zero Hunger

SDG #2 of zero hunger is influenced by SDG #12, #14, and #15,¹ with relevant concerns such as food insecurity and nutrient-poor food related to the loss of biodiversity on land and in the oceans. As stated above, 93% of the world's greenhouse gas emissions are stored in the ocean, which leads to many adverse effects (Gameau, 2019). If increased anthropogenic

¹ See appendix for visual representation

emissions are addressed and the production of CO₂ and other pollutants is decreased, it will lead to increased biodiversity and availability of safe ocean life for consumption. This shows the link between SDG #14 and SDG #2, as healthy life below water leads to increased availability of ocean life used for human consumption (United Nations, n.d.-a). Another SDG that impacts #2, specifically the target 2.1 of zero hunger by 2030, is #12 and the negative impacts of overconsumption and overproduction (United Nations, n.d.-a). In 2021, the UN estimated that the average person wastes approximately 79 kgs of food per year or up to 60% of the food purchased for consumption, yet malnutrition and food insecurity are still prevalent (United Nations, 2024). This excess waste demonstrates that consumption and production patterns must be addressed to ensure zero hunger for all. Lastly, SDG #15 impacts SDG #2, Target 2.4, of ensuring sustainable food production and resilient agricultural practices because current agricultural practices have led to increased emissions, unhealthy soil, and non-nutritious foods. Implementing more resilient agricultural practices will lead to increased land biodiversity, more nutritious food, and increased availability of healthy food, showing that SDG #15 impacts zero hunger immensely (United Nations, n.d.-a).

SDG #12 - Responsible Consumption and Production

SDG #12 plays a crucial role when addressing all of the other SDGs, as human consumption and production patterns can have detrimental effects on the environment. One concern in Part I was irresponsible food production in agriculture due to tilling practices and its massive contribution towards carbon emissions and implications towards land degradation and ocean acidification. All of this goes against SDG #12, Target 12.4, of reducing "chemicals and all wastes... [in] air, water, soil to minimize their adverse impacts" (United Nations, n.d.-b). This waste also includes single-use plastic waste produced from irresponsible consumption that can cause the death of many organisms both on land and in water. Thus, the need for SDG #12, Target 12.5, to "reduce waste generation through prevention, reduction, recycling and reuse" is pertinent (United Nations, n.d.-b). Because of these negative implications, SDG #12 can be deemed highly influential towards SDG #14 and #15's biodiversity and food availability, which is needed to achieve SDG #2. Sustainable food production must be created and maintained to achieve the targets set in SDG #2. As stated previously, current agricultural practices of tilling are not considered sustainable; hence, the United Nations has also presented SDG #12, Target 12.7, to "promote public procurement practices that are sustainable" (United Nations, n.d.-b).

SDG #14 - Life Below Water

SDG #14 is another great contributor to SDG #2, as the ocean contains an abundance of food that humans rely on greatly. Part I explains that the greenhouse emissions created by agriculture directly affect the oceans by causing acidification and a decrease in overturning circulation (Gameau, 2019). Another concern mentioned is that the waste and pollution released into the oceans negatively impact the life within them. Both concerns can be linked to the loss of biodiversity as they endanger the organisms in the ocean due to irresponsible consumption and production of human foods, emphasizing the need for SDG #12 to create a responsible and sustainable means of consumption and production. This can be done by reducing land-based activities that emit pollution and emissions, such as agriculture, reflecting SDG #14, Target 14.1

and thus preventing the further acidification of the oceans, indicated by SGD #14, Target 14.3 (United Nations, n.d.-c). All of this will aid SDG #14, Target 14.2, to "sustainably manage and protect marine and coastal ecosystems... to achieve healthy and productive oceans" (United Nations, n.d.-c) that directly affects SDG #2 by increasing the availability of food for human consumption.

SDG #15 - Life on land

SDG #15 is a contributor towards the success of SDG #2 because of the reliance on soil for food production. The quality of the food produced from the ground is highly dependent on soil quality; hence, it is crucial to maintain healthy soil to produce nutritious foods (Gameau, 2019). Additionally, the health of the soil also affects the other organisms that rely on that land. This highlights the importance of SDG #12 to maintain this healthy soil by creating responsible and sustainable agriculture practices to prevent and mitigate the negative effects of tilling resulting in land degradation. This reflects upon SDG #15, Target 15.5, as it requires us to take action against degradation and halt biodiversity loss, thus aiding in providing the necessary nutritious foods for SDG #2 (United Nations, n.d.-d).

Part IV: Recommendations

Food waste, packaging, and consumption have significantly impacted the environment, ocean health, and ocean biodiversity. Of all plastic produced, approximately 79% will be transferred to landfills or released into the environment (Rhodes, 2018). Furthermore, one-third of this plastic waste is a product of consumer packaging, and nine megatons of plastics were discarded into the ocean in 2010 alone. Waste removal is needed to combat rising sea levels, decreased biodiversity, and pollution. If governments worldwide cannot halt illegal dumping through an upstream approach of policies and regulations, collaboration with private businesses and environmentalists may improve the planet's sustainability. An example of an adaptive measure is the Seabin, which was created in Australia to reduce the amount of ocean pollution. The Seabin is a floating filtration device that has a suction effect, which traps debris and filters out clean water (GreenSpot, 2015). The filter improves water quality by filtering oil spills, fuel, chemicals, and other toxic pollutants that are toxic to humans and animals. It is also a sustainable option over time as it "can be powered by solar, wind, or grid electricity and has a low carbon footprint" (GreenSpot, 2015, Solutions section, para. 3).

Once the waste disposal issue is addressed through adaptive means, the focus should turn towards mitigating solutions that restore ocean health. Marine permaculture is beneficial for decreasing ocean temperatures and sea levels, increasing the reuptake of carbon dioxide, and improving ocean diversity (Gameau, 2019). Marine permaculture creates and maintains underwater ecosystems that maintain the same stability and diversity as natural systems (Spillias et al., 2024). Using this method, humans can sustainably meet their needs in terms of food and energy. Marine permaculture can renew local overturning circulation (von Herzen et al., 2018). Improved circulation will positively affect fisheries and improve food security for expanding populations. As mentioned above, food consumption and production habits increase greenhouse emissions in the atmosphere. The growing global population has placed an

immense strain on the Earth's ecosystem, namely marine life. Changes need to be made to relieve this pressure while continuing to meet nutritional requirements for the global community (von Herzen et al., 2018). Fortunately, marine permaculture mitigation utilizes deep, nutrient-rich water that allows extensive seaweed growth (Gameau, 2019). This seaweed becomes a habitat for local fish populations and improves marine biodiversity (von Herzen et al., 2018). Seaweed permaculture is an effective method for carbon drawdown, which inevitably restores ocean water alkalinity and enables marine life to flourish (Gameau, 2019). Marine permaculture may also improve food scarcity as the return of fish and ocean life will act as an additional source of protein, providing essential nutrients to the global population (von Herzen et al., 2018).

Addressing the agricultural sector's contribution to climate change is essential for managing this crisis. Tillage practices release carbon from soil reservoirs, contributing to the greenhouse effect (Gameau, 2019). Through photosynthesis, plants absorb carbon and transfer it to the soil, which acts as a carbon sink (Wu, 2022). Furthermore, agronomic practices such as no-till farming improve carbon sequestration in soil, which increases organic matter input and reduces the cycling of carbon out of the soil. Soil has a finite capacity for carbon sequestration; however, with no-till farming, it is possible to maximize the amount of carbon retained within the soil (Gameau, 2019; Wu, 2022). Instead of using machinery to overturn the soil, no-till farming creates small holes in the soil to plant seeds (Coogan, 2024). This practice improves soil health by conserving and regulating moisture, thus increasing the holding capacity of the soil. No-till farming is an effective solution to maintain healthy soil and reduce erosion (Coogan, 2024).

Soil is composed of various materials like sand and clay that combine with organic matter and form pores that can hold air, water, and minerals, which are essential for the health of microorganisms and plants that grow within it (Coogan, 2024). Till farming breaks the aggregates and pores apart, while no-tilling preserves these pores, minimizes soil disturbances, and decreases the loss of nutrients and carbon (Ruis et al., 2022). Because no-till improves soil health, it will also improve the nutritional value of the food grown in it (Gameau, 2019). The production of this nutrient-dense food will improve consumers' health; this is essential in a world facing food scarcity challenges. No-till farming is an effective solution that not only decreases carbon emissions but improves the soil's health and the food it produces (Gameau, 2019).

Part V: Reflective Thinking

The film significantly influenced our understanding of climate change. This documentary briefly discussed the effect of climate change on human health. However, after analyzing the film, we concluded that it may have been enhanced by further exploring the implications of climate inaction on human health. While we appreciate the optimistic approach to climate solutions, the real dangers of the global population should not be neglected. By elaborating on both the direct and indirect health effects of climate change, the film may have more effectively demonstrated how the impacts of climate change are debilitating not only to the Earth but also to humanity. Overall, this documentary was well-produced and engaging to watch. Visuals were used effectively and improved our understanding of new and interesting technologies.

While watching the film and developing this paper, it became abundantly clear that problems occur daily in our society that we did not know existed. It is frightening and disheartening how much climate change affects the planet's state and life on land and underwater. We had a somewhat general understanding of climate change and some contributing factors; however, it was less in-depth than the issue truly is.

Throughout this process, we garnered an understanding that individual action alone is not enough to combat climate change and that more global approaches need to be utilized in addition to individual and community action. Due to the enormity of this issue and the fact that governments and major corporations are the most prominent stakeholders and contributors, it feels nearly impossible to make any difference on an individual scale. However, due to the enormous stakes and positions of power these groups hold, they have the most considerable ability to develop public policy to mitigate the climate crisis. Although individual action feels insignificant at times, this film has inspired us to make changes in our own lives and encourage others to do the same. Even minor changes, such as purchasing items in bulk containers or opting for reusable containers over single-use plastic, can make a difference. Essentially, this process has influenced us to make more conscious decisions in our consumption habits. Ultimately, policy changes and multisectoral approaches are necessary; therefore, we are all responsible for making changes and advocating for climate change initiatives.

The issue of climate change extends into the discipline of nursing. We have a responsibility to protect the environment and advocate for effective changes. Global nursing focuses on the social determinants of health, the ethics of respect, the preservation of human dignity, and the inclusion of cultural diversity (Rosa & Upvall, 2019). A shift from global nursing to planetary nursing will ensure the health of the global population and the planet we live on. As new nurses, we should continue to advocate for climate change initiatives and continue the conversation about harmful environmental practices for the betterment of the global community.

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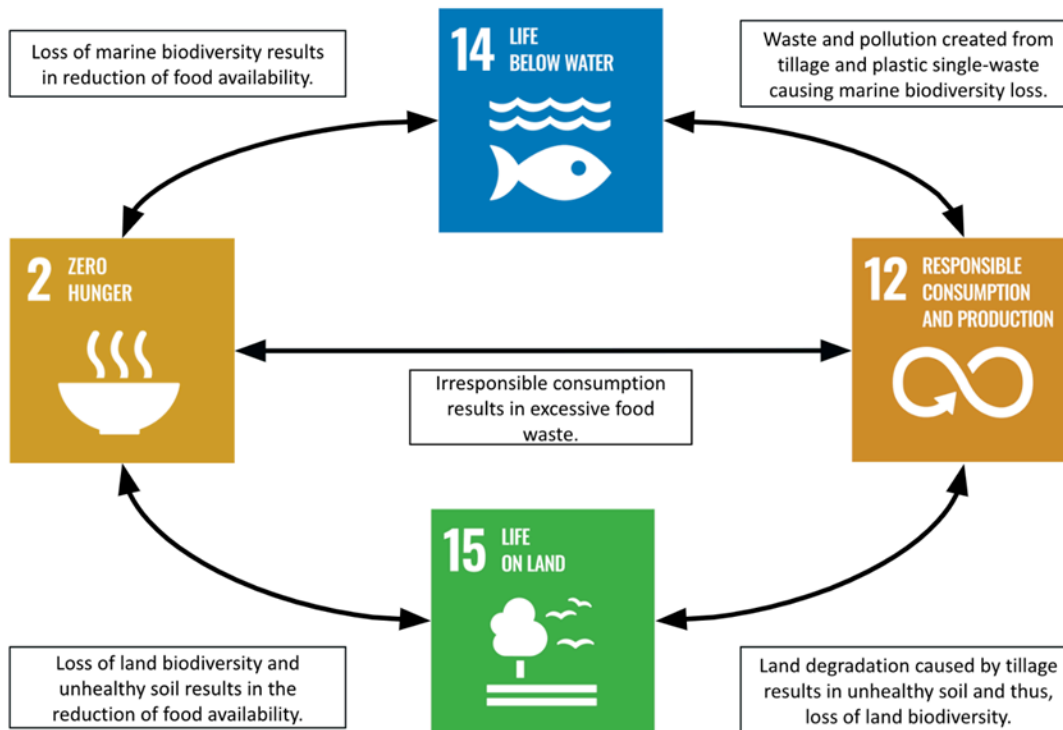
References

- Arunkumar, P., Muthiah, M., Sivarethinamohan, R., Sivarethinamohan, S., Gaddam, M. K. R., Velusamy, P., Ramalingam, G., Ravindiran, G., Gurugubelli, T. R., & Munisamy, S. K. (2023). Impact of climate change and anthropogenic activities on aquatic ecosystem – A review. *Environmental Research*, 238(Part 2), Article 117233. <https://doi.org/10.1016/j.envres.2023.117233>
- Centers for Disease Control and Prevention [CDC]. (2022). *Climate Effects on Health*. Retrieved September 2024, from <https://web.archive.org/web/20220428235314/https://www.cdc.gov/climateandhealth/effects/default.htm>
- Coogan, K. (2024). No-till farming with technology: Experts weigh in on no-till tools that will preserve the health of your soil. *Mother Earth News*, 323, 39–40.
- Fournier, B., & Karachiwalla, F. (2021). *Public Health and Preventive Health Care in Canada: Public Health and Preventive Health Care in Canada* (6th ed). Elsevier Health Sciences.
- Ericksen, P. J., Ingram, J. S. I., & Liverman, D. M. (2009). Food security and global environmental change: Emerging challenges. *Environmental Science & Policy*, 12(4), 373–377. <https://doi.org/10.1016/j.envsci.2009.04.007>
- Gameau, D. (Writer & Director). (2019). *2040* [Film]. Good Thing Productions; ReGen Pictures. <https://www.documentaryarea.com/video/2040/>
- GreenSpot. (2023). *Floating seabin collects ocean waste, Australia*. EcoHubMap. <https://www.ecohubmap.com/green-spot/floating-seabin-collects-ocean-waste-australia/3cm7kkallsm0mfg5>
- Howard, C. (2017, November). *Healthy Planet, Healthy People* [Video]. TEDxMontrealWomen. https://www.ted.com/talks/courtney_howard_healthy_planet_healthy_people
- Lee, S.-K., Lumpkin, R., Gomez, F., Yeager, S., Lopez, H., Takglis, F., Dong, S., Aguiar, W., Kim, D., & Baringer, M. (2023). Human-induced changes in the global meridional overturning circulation are emerging from the Southern Ocean. *Communications Earth & Environment*, 4, Article 69. <https://doi.org/10.1038/s43247-023-00727-3>
- Mohanty, A. (2021). Impacts of climate change on human health and agriculture in recent years. In *2021 IEEE Region 10 Symposium (TENSYP)* (pp. 1–4). IEEE. <https://doi.org/10.1109/TENSYP52854.2021.9550876>
- NASA Science Editorial Team. (2023, June 5). *Slowdown of the Motion of the Ocean*. National Aeronautics and Space Administration [NASA]. <https://science.nasa.gov/earth/earth-atmosphere/slowdown-of-the-motion-of-the-ocean/>
- National Oceanic and Atmospheric Administration [NOAA]. (2024, June 16). *What is the Atlantic Meridional Overturning Circulation (AMOC)?* National Ocean Service. <https://oceanservice.noaa.gov/facts/amoc.html>
- Parsons, J. (2020). Global and Planetary Health. In W. Leal Filho, T. Wall, A. M. Azul, L. Brandli, & P. G. Özyar (Eds.), *Good Health and Well-Being* (pp. 225–236). Springer International Publishing. https://doi.org/10.1007/978-3-319-95681-7_5

- Pedersen, S. A., & Hanssen, A. E. (2018). Ocean acidification ameliorates harmful effects of warming in primary consumer. *Wiley: Ecology and Evolution*, 8(1), 396–404. <https://doi.org/10.1002/ece3.3526>
- Praetorius, S. K. (2018). North Atlantic circulation slows down. *Nature*, 556(7700), 180–181. <https://doi.org/10.1038/d41586-018-04086-4>
- Rhodes, C. J. (2018). Plastic Pollution and Potential Solutions. *Science Progress*, 101(3), 207–260. <https://doi.org/10.3184/003685018X15294876706211>
- Rosa, W. E., & Upvall, M. J. (2019). The case for a paradigm shift: From global to planetary nursing. *Nursing Forum*, 54(2), 165–170. <https://doi.org/10.1111/nuf.12310>
- Ruis, S. J., Blanco-Canqui, H., Jasa, P. J., & Jin, V. L. (2022). No-till farming and greenhouse gas fluxes: Insights from literature and experimental data. *Soil and Tillage Research*, 220, Article 105359. <https://doi.org/10.1016/j.still.2022.105359>
- Schoeman, D. S., Bolin, J. A., & Cooley, S. R. (2023). Quantifying the ecological consequences of climate change in coastal ecosystems. *Cambridge Prisms: Coastal Futures*, 1, Article e39. <https://doi.org/10.1017/cft.2023.27>
- Spillias, S., von Herzen, B., & Holmgren, D. (2024). Marine permaculture: Design principles for productive seascapes. *One Earth*, 7(3), 431–443. <https://doi.org/10.1016/j.oneear.2024.01.012>
- United Nations. (n.d.-a). *Sustainable Development Goal #2: Zero Hunger*. Department of Economic and Social Affairs. Retrieved March 23, 2024, from <https://sdgs.un.org/goals/goal2>
- United Nations. (n.d.-b). *Sustainable Development Goal #12: Responsible consumption and production*. Department of Economic and Social Affairs. Retrieved March 23, 2024, from <https://sdgs.un.org/goals/goal12>
- United Nations. (n.d.-c). *Sustainable Development Goal #14: Life below water*. Department of Economic and Social Affairs. Retrieved March 23, 2024, from <https://sdgs.un.org/goals/goal14>
- United Nations. (n.d.-d). *Sustainable Development Goal #15: Life on land*. Department of Economic and Social Affairs. Retrieved on March 23, 2024, from <https://sdgs.un.org/goals/goal15>
- United Nations. (n.d.-e). *The 17 Goals*. Department of Economic and Social Affairs. Retrieved on December 15, 2024, from <https://sdgs.un.org/goals>
- United Nations. (2024, March 27). *With 783 million people going hungry, a fifth of all food goes to waste*. UN News. <https://news.un.org/en/story/2024/03/1148036>
- United Nations Development Programme [UNDP]. (2023). *The Climate Dictionary*. <https://www.undp.org/publications/climate-dictionary>
- von Herzen, B., Theuretzbacher, T., Harrington, S., Layton, C., Stover, K. C., Tubal, P. M., & Munier, M. (2018, December 11). *Marine Permaculture to Regenerate Ocean Productivity* [Poster presentation abstract]. American Geophysical Union, Fall Meeting, Washington, DC. <https://agu.confex.com/agu/fm18/meetingapp.cgi/Paper/403932>

Wu, L. (2022). Sequestering organic carbon in soils through land use change and agricultural practices: A review. *Frontiers of Agricultural Science and Engineering*, 10(2), 210–225.
<https://doi.org/10.15302/J-FASE-2022474>

Appendix: Simplified Sustainable Development Goal Connections



Note. This figure contains United Nations Sustainable Development Goal logos (<https://sdgs.un.org/goals>), which were adapted into this diagram.

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This appendix shows the interconnections between Sustainable Development Goals (SDGs) #2 (Zero Hunger), #12 (Responsible Consumption and Production), #14 (Life Below Water) and #15 (Life On Land) while providing brief descriptions adjacent to the connections with simplified causes and results.