

Born from a passion for science communication, the McGill Scientific Writing Initiative (MSWI) aims to help students navigate the intricacies of scientific texts in order to effectively convey scientific material to a variety of audiences. They strive to make science communication accessible to McGill students with efforts such as the SciComm Case Competition where teams of 2-4 students were tasked to research a creative topic pertaining to this year's theme of environment. The teams completed three writing prompts based on their research topic and were challenged to tailor their writing to target diverse audiences. The teams first wrote news articles, and then the top 11 finalists were asked to write children's books and literature reviews.

MSURJ is proud to collaborate with MSWI by publishing the following review from the 2021 SciComm Case Competition Symposium winning team.

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Review Article

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Changing Climate Change: Examining efficacy of community based initiatives and micro-scale climate action

Abstract

It is well established that global warming surpassing 1.5-2°C above pre-industrial levels will cause irreversible damage to our world. The adverse rise in global temperatures is accelerated by anthropogenic activity such as greenhouse gas emissions and environmental degradation. While certain scenarios have been projected to significantly lower global warming rates, most of these developments will require immediate global top-down policy shifts. Several international treaties and agreements have been created to combat climate change. Nonetheless, these remain ineffective at creating meaningful progress and cast doubt on how realizable a positive climate scenario is.

In this review, we analyze how regional policies and actions combat the climate crisis by examining how specific community initiatives impact climate indicators such as reforestation, greenhouse gas emissions reduction, and sustainable agriculture. Our findings conclude that local initiatives have shown more immediate success compared to their global counterparts. Thus, additional locally led climate initiatives is warranted.

Introduction

Climate change is a crisis associated with ocean acidification, ice field melting, mass extinction, desertification, and ecosystem collapse. Each of these effects will severely impact civilization and global ecosystems. While the impacts of the climate crisis are well established, understanding and implementing effective actions to prevent these events has proven challenging. The standard classical analysis of Rayleigh-Bénard convection uses the Boussinesq approximation, (9) in which variations in the density of the fluid are only accounted for in the buoyancy term, and thus the fluid is considered to be incompressible. This approximation requires low Mach-number and neglects acoustic frequencies. Work has been done to study the validity of the Boussinesq approximation in a compressible fluid in the context of the onset of convection, (10) which shows that it is only valid when the vertical dimension of the fluid is much less than any scale height. This implies that, in this context, the Boussinesq approximation will not hold at the spatial scales of the atmosphere.

For decades, scientists, philosophers, and economists have called upon decision makers to take action, but the response has been at best inconsistent and at worst regressive. Progressive results have could result from heavily sanctioning global emissions; however little guidance or motivation is present for policymakers below the international level. (1)

To mitigate climate change, nations have attempted to create legally binding policies that reduce environmentally harmful anthropogenic activities. In 2015, the United Nations drafted the first treaty calling to ratify international parties accounting for at least 55% of the world's annual greenhouse gas emissions. (2) The treaty's goal to avoid global warming of 1.5-2 °C above pre-industrial levels has made insufficient progress. (3) Although intergovernmental action is has led to little success, there are climate solutions which do not exist within the traditional climate scenario models.

Recently, small-scale actions intended to provide solutions to local effects

have formed. Because the effects of climate change are most quickly felt by the individuals which live on land being impacted, these communities have two options: wait for national and international treaties to take effect, or choose to take action that incorporates knowledge of the local issue.

With the emergence of social movements and grass-root organizations, there is much debate as to whether small actions have a meaningful effect. If these actions are in fact effective, the first accessible and realizable climate scenario which avoids climate collapse appears. The following literature examines the efficacy of these movements by considering the effect of community-based initiatives on deforestation, CO2 emission policy, and sustainable agriculture.

Examining Impact

Community Initiatives and Combating Deforestation

Over the past several hundred years, the concentration of forested area across the globe has decreased dramatically. (4) A large portion of this loss can be attributed to increased human habitation and natural resource extraction. It has been demonstrated that large-scale deforestation directly impacts ecosystems through biodiversity loss, decrease in soil cycling, and pollution of freshwater systems. (5) Additionally, deforestation contributes significantly to the negative impacts of climate change; tropical deforestation accounted for up to 40% of global CO2 emissions annually in the 1980s. (6) Particularly, in biodiverse, tropical climates, the removal of forested regions leads to elevated levels of CO2 in the atmosphere caused by the decrease in greenery which can absorb greenhouse gases. This phenomenon creates a feedback loop known as the Greenhouse Gas Effect, leading to an increase in temperatures. (5)

Given the impacts of large-scale deforestation, communities which have

felt these effects directly have become increasingly invested in reforestation: the process of replanting and restoring forests on land that was traditionally forested. The act of reforestation has proven to be an effective method in combating the climate crisis. (7) Reforestation promotes biodiversity which decreases the susceptibility of species and ecosystems to climate change (8) and has the potential to directly combat the effects of global warming through increasing carbon sequestration, reducing the amount of CO₂ in the atmosphere. (9)

There is evidence that reforestation at the local level confers environmental benefits. In north Queensland, Australia, the Community Rainforest Reforestation Project (CRRP) occurred between 1993 and 2000. Its goals were to create a sustainable lumber source, ensure land protection, enhance water quality, and train a workforce to aid with rainforest. (10) Though this program was initiated at the federal level, planning was aided by local governments and the program was implemented at the community level through local landholders. (10) A report that estimated both the economic and environmental impacts of the program predicted that it would lead to increased water quality, conservation, and would have carbon sequestration benefits. (11) The amount of carbon sequestration was estimated by modelling the above-ground and below-ground biomass of the trees. In this model, the quantity of carbon was equated to 45% of the tree biomass. Using this model, the report estimated that, after all the tree harvesting had been completed, 146,885 tons of carbon would have been sequestered over 1142 hectares. (11) In terms of water quality, a study predicted that available water volume would increase because of the CRRP (11), and another report found that water quality in areas with CRRP plantings increased. (12) Surveys of CRRP participants revealed that 70% noticed an increase of wildlife (particularly in terms of birds and small mammals), with 30% noticing a large increase. (10) However, the lack of systematic scientific reports and the reliance on layman observations make it difficult to quantify the impact of the CRRP on biodiversity. Overall, the CRRP demonstrates that community-based reforestation projects can strike a balance between economic gain and environmental benefits in sustainable forestry.

Another example of a community reforestation initiative is the organization called Trees of Life, located in Scotland. Since their inception 25 years ago, Trees for Life has planted almost 2 million trees to restore the Scottish Highlands. (13) This organization focuses on planting native and endangered tree species such as the 'dwarf birch' to restore traditional Scottish ecosystems. The Trees for Life project hopes reforestation will provide support for ecosystems, reduce soil erosion, increase rainfall, sustain local water sources, and help fight climate change through carbon sequestration. (13) There is also an emphasis on sustainability and efforts have been taken to ensure that the restored forests are able to survive and proliferate on their own, enforced primarily through creating sustainable seed sources. The planting of these trees has yielded approximately 40,000 acres of reforested area. This may seem insignificant in comparison to the total 36 billion acres of land area globally, however an acre of forested area can absorb up to 2.5 tonnes of CO₂ annually, meaning the region of reforested land has nontrivial carbon capture and storage capacity. (14)

Local Climate Action Plans for Reducing CO₂ Emissions

A powerful way that local initiatives can impact the climate crisis is through environmental policy implemented by local governments. While climate change is undoubtedly a global issue, its profound impact on communities demands that each unique circumstance be addressed through appropriate and individualized policy.

Local governments may be in a unique position to fight the climate crisis from the bottom-up as they can impact local emissions, can implement catered climate initiatives, and are able to contribute to larger emission and progress tracking. (15) The efficacy of local climate action plans (CAPs) across the world have been assessed through various case studies in the literature, however this section will focus specifically on progress made through this avenue in Copenhagen, Denmark.

Copenhagen has long been considered a leader in forming environmentally conscious cities and a role model for how municipalities are able to nurture a green economy. (17) The City's progress in these environmental

indicators and objectives of its CAPs over the years have reflected this. Copenhagen aims to be carbon neutral, with net zero carbon emissions, by 2025 and has been planning green initiatives for nearly 20 years, adopting its first CAP in 2002. (16) In 2017, an extensive case study examined the implementation of a local climate action plan in Copenhagen and assessed the adherence to and success of the plan. (16) The authors of the study assessed the effectiveness of the implementation of the CAPs through analysis of the Copenhagen 2002, 2009, and 2012 CAPs, which involved compiling municipal Climate Action Plans, greenhouse gas accounts, municipal waste plans and more, as well as conducting interviews with key stakeholders. (16)

The study found that for the 2012 CAP, 6 of the 19 milestones were on target with an additional 6 underway, and 7 remaining with significant difficulties. (16) It was also reported that the majority of the 66 proposed initiatives had begun. This is in stunning contrast with the markers created to analyse progress of the Paris Agreement, none of which have experienced significant progress - in fact many the progress on many of the goals has worsened since the document was ratified in 2015.

Noteworthy initiatives from Copenhagen's CAPs each year include increasing investment in wind power, encouraging use of biomass as opposed to coal in power plants, and incineration of waste. With respect to the reduction of greenhouse gas emissions, the emission target specified in the CAP was not met in 2010, but in 2015, emissions were below target by an equivalent of 480,902 CO₂, which bodes well for the goal of 2025 net carbon neutrality. In Summary, Damso, Kjaer and Christensen (16) conclude that the Copenhagen climate action plans have been effectively implemented and have shown tangible results in terms of emission reduction. These findings indicate an ability for local CAPs to make important contributions to climate change mitigation.

Community Supported Agriculture (CSA)

CSA is a model that offers an alternative method to farming, consuming, and distributing agricultural produce. (18) The Term 'Community Supported Agriculture' was coined and formulated by the Swiss farmer, Jan VanderTuin in 1984, but the concept behind it has existed in Europe since the 1960s. (19) The primary function of CSA is to create agricultural systems which remove the steps between farmers and consumers. Some of the environmental benefits of this method of food distribution include decreased CO₂ emissions from transportation and refrigeration, both of which occur in higher volumes when a farmer supplies their goods to the global market.

Most CSA farms follow a similar structure: near the beginning of each growing season, individuals pay the farmers an agreed upon fee. This allows farmers to avoid relying on conventional funding such as loans or waiting for supermarkets to purchase their produce in bulk. In return, members of the community receive weekly baskets filled with fresh and local produce.

CSA models are not without inconveniences. (20) For individuals and families, much of the customization of choosing what produce is purchased weekly is lost. As a result, there is potential for food waste if the produce delivered is not familiar or preferred. Additionally, CSA is often more expensive than conventional grocery shopping, fortunately some communities can make these sacrifices to reap the social and environmental benefits of CSA. Those issues did not prevent the number of CSA farms from increasing throughout the United States in the past two decades. It was also shown that when more farms adopt the CSA mode, the issues mentioned above begin to resolve themselves organically. This is due to collaborative efforts among neighbouring farms attempting to avoid the shortcomings of the model.

This text focuses primarily on the environmental benefits of CSA, but it should be mentioned that this model has social and economic benefits as well. (20) An example of such economic benefits is the creation of jobs within the community. One of the key characteristics of a CSA farm is that it uses agro-ecological methods, including diverse crop cycling, natural manures and fertilizers, rainwater harvesting, and more to grow produce.

(18) Through a survey in 2003, it was found that 96% of CSA farmers used organic farming methods which have been shown to have fewer negative impacts on the surrounding ecosystems. (21) In a study done on CSAs in China, it was proposed that the new agricultural method offers a solution to China's environmental concerns such as soil pollution (22) because of the ecologically mindful methods followed by the CSA farming methodology.

A strong case for the development of CSA farms can be found in Hungary. The first Hungarian CSA farm was established in 1998, by Mathew Hayes. (23) The first few CSA farms faced some challenges due to the novelty of the model. In 2011, there was a new surge in CSA farms in Hungary. After learning from the mistakes of the programs which Hayes started, new CSA farms were far better equipped to manage the diverse challenges of the market and better compete with conventional agriculture farms. By 2016, CSA farms composed nearly 20% of all farms in the country. Furthermore, due to pressure of communities where this model has been hugely successful, the Hungarian government adopted new policies that support existing CSA farms and encourage conventional farms to adopt this new model. These policies range from exempting CSA farms from following certain regulations, to the allocation of higher national aids relative to conventional farms. This showcases that generating food locally has excellent social, environmental, and economic benefits, and can become the model for a country's farming practices moving forward.

Discussion

The examples discussed above highlight the promise that small scale actions show in creating new solutions to solve existing climate change challenges such as deforestation, the increase of CO₂ emissions, and – the environmentally detrimental – conventional agriculture.

Deforestation is clearly a global issue, but it has dramatic effects on the communities closest to the affected forests. In Scotland, deforestation of the highlands has been a problem for decades, but it wasn't until local groups like Trees for Life chose to take action that a solution was realized. This indicates that the people most likely to offer meaningful contributions to solving specific climate change related challenges are the people in the communities most affected by these issues. For local communities, the issue goes beyond statistics; it is a meaningful challenge to their way of life. The direct impacts of the climate crisis are experienced daily, from mass drought to extreme weather. When sitting in a UN summit debating, it can be difficult to understand the sense of urgency required for climate action, but when you are watching a forest fire creep dangerously close to your home, the gravity of inaction could not be clearer.

Grassroot organizations are so effective simply because the members are personal stakeholders and will be most directly affected. The actions communities take towards reforestation is closely tied to the effects of CO₂ on the environment.

For decades now national governments and international organizations have made pledges and composed treaties promising to lower global CO₂ emissions. A prominent barrier to success with this approach is that it assumes homogeneity in solutions. We live in a highly diverse world composed of unique ecosystems, cultures, and economies; it is unlikely that there is one climate solution that is always relevant. In order to implement meaningful action that will generate positive change, climate policies must come from local governments alongside international movements. Small municipalities and governments are the most aware of their constituents' needs and the challenges their communities face. This places more importance on the voices of individuals and responsibility on the choices of decision makers, as the effect of these policies are immediate, and profoundly evident. The instance of Copenhagen is a clear success, indicating that small government policy has a meaningful effect on the combating extent of Anthropogenic forcing through CO₂ emissions. Through implementing local policies to create CAPs catered to the needs of the community, Copenhagen managed to set an example of what cities can achieve by choosing to create local methods to combat climate change.

A main driver for success in Copenhagen was the city's ability to take charge of its own emissions policies. Every region faces unique barriers to creating sustainable systems, by allowing municipalities to create individualized climate plans, they gain the power to choose the methods that will best suit the needs of their citizens and environment.

City emissions are not the only anthropogenic force that has a major impact on the climate crisis. A large portion of emissions and environmental degradation comes from large-scale agricultural systems. These must change as well. In recent years, the major stakeholders in the agricultural industry have been scaling production and distribution to increase profit without regard for environmental or social consequences. This upscale has created a disconnect between consumers and growers, amongst many ecological issues. Farming is bedrock of a strong community, and just as the argument for reforestation, the individuals most impacted have the potential to create the fastest change. This is why Community Supported Agriculture offers a great alternative to the practices of large farming companies. In Hungary, CAS farms began through communities looking to create a support system for local farms while ensuring they received fresh produce harvested using environmentally conscious methods. Due to the success of this model, regions around the nation chose to incorporate this method of sustainable farming, which ultimately influenced government funding and policy change. This is an excellent instance of inspiring other regions to create successful local systems rather than scaling a system to fit mass demand, losing individuality in the process. With more communities taking similar initiatives, the effects of local action can be noticed throughout the world.

The notion of local initiatives as a method of combating the climate crisis was first proposed by Bennett et al. in 'Bright spots: seeds of a good Anthropocene' (24), where researchers argued that bottom-up initiatives are our best hope for a safe future. This project chose to examine micro-scale climate scenarios as opposed to the standard global analysis. This was done by selecting 100 projects similar to those mentioned above, with the following criteria:

- (i) The three initiatives are attempting to solve highly specific challenges rather than attacking a general vague problem.
- (ii) The three initiatives stem from small communities rather than large organizations.
- (iii) The three initiatives were relatively successful in achieving meaningful change, not only at the local level, but on a larger scale as well.

When examined individually, each movement appears insignificant, but when considered in tandem with one another, a pattern of success begins to form. This is the power of collective action, and it is precisely the method of success for this climate scenario.

Conclusion

Current climate models focus on macro-scale solutions to climate change. We have shown, however, that grassroots initiatives have significant benefits, and can be an effective strategy in the fight against climate change. Community driven initiatives have the added value of being led by the people most affected by the issues they decide to tackle. Creative, local, and successful ideas already exist all around us. The main challenge is to encourage more communities all over the world to act and to fill the world with hope.

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