

Climate in the 21st Century: A Macroeconomic Model of Fair Global Warming Benefits Distribution to Grant Climate Justice Around the World and Over Time

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ABSTRACT: Climate justice accounts for the most challenging global governance goal. In the current post- COP21 Paris agreement climate change mitigation and adaptation efforts, the financialization of the ambitious goals has leveraged into a blatant demand. In the weighting of the burden of global warming, the benefits of a warming earth have been neglected since recently. Following the introduction of the gains from climate change (Puauschunder 2017), this article proposes a model to distribute the benefits of a warming earth in a fair way based on which countries are losing and which countries are winning from a warming earth until 2100. A macroeconomic cost-benefit analysis thereby aids to find the optimum solution on how to distribute climate change benefits and burden within society. When unidimensionally focusing on estimated GDP

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growth given a warmer temperature, over all calculated models assuming linear, prospect or hyperbolic gains and losses, the world will be gaining more than losing from a warming earth until 2100. Based on the WL index of 188 countries of the world, less countries (n=78) will gain more from global warming until 2100 than more countries (n=111) will lose from a warming earth. Based on the overall WLTT index factored by GDP per inhabitant, global warming benefits are demanded to be redistributed in a fair way to offset the costs of climate change loser countries for climate change mitigation and adaptation efforts and to instigate a transition into renewable energy. Adding onto contemporary climate fund raising strategies ranging from emissions trading schemes (ETS) and carbon tax policies as well as financing climate justice through bonds as viable mitigation and adaptation strategies, climate justice is introduced to comprise of fairness between a countries but also over generations in a unique and unprecedented tax-and-bonds climate change gains and losses distribution strategy. Climate change winning countries are advised to use taxation to raise revenues to offset the losses incurred by climate change. Climate change losers could raise revenues by issuing bonds that have to be paid back by taxing future generations. Regarding taxation, within the winning countries, foremost the gaining GDP sectors should be taxed. Climate justice within a country should also pay tribute to the fact that low- and high income households share the same burden proportional to their dispensable income, for instance enabled through a progressive carbon taxation. Those who caused climate change could be regulated to bear a higher cost through carbon tax in combination with retroactive billing through inheritance tax to map benefits from past wealth accumulation that potentially contributed to global warming. Deriving respective policy recommendations for the wider climate change community in the discussion of the results is aimed at ensuring to share the burden but also the benefits of climate change within society in an economically efficient, legally equitable and practically feasible way.

KEYWORDS: Climate Change, Climate Change Bonds, Climate Change Gains, Climate Change Losses, Climate Justice, Europe, Macroeconomic Modelling, Tax-Bonds-Transfer Strategy, Taxation, United States, World

1. Introduction

Climate justice has been discussed in the focal point of law, economics and governance (Puaschunder 2016c). The implementation of climate stability accounts for the most challenging contemporary global governance predicament that seems to open an abyss of world inequality regarding differing times and degrees to enjoy benefits of a warming earth around the globe (Puaschunder 2017). As a novel angle towards climate justice,

this article proposes a well-balanced climate gains global governance distribution based on micro-, meso, and macroeconomic analyses results.

Overall the following paper investigates the nature of climate justice imbalances from an economic and a legal perspective in order to ensure economic justice solutions for advancing global climate stability. The structure of increasingly fragile environmental conditions will be captured in order to derive real-world relevant implications how to improve the overall global environmental conditions for humankind on a global scale but also over time. Through the understanding of climate change gains and losses, climate gain redistribution strategies will be presented. Shedding light on fair global warming gains distribution is meant to aid market economies to be brought to a path consistent with prosperity and sustainability. A preliminary literature review revealed a missing focus on climate change gains (Puaschunder 2017). Holistic global systemic risk analysis centered around fragility of the global environmental systems dominates the focus of contemporary climate justice discussions. Addressing these biases in order to gain a holistic climate change picture, innovatively the gains of a warming mother earth were recently measured in order to prepare for a well-tempered climate stability policy mix recommendations financed through a right, just and fair global warming gains distribution strategy (Puaschunder 2017).

The following paper combines theoretical and empirical research to review climate change gains in order to propose a right, just and fair strategy to implement climate justice around the globe. Outlining the benefits of a warming earth raises the demand for a fair asset allocation in order to offset the costs arising from climate change mitigation and adaptation strategies around the world. The paper thereby targets at gaining an in-depth understanding of how to alleviate climate change risks and implement climate change stability in the international arena by the help of fair global warming benefits distribution. Theoretical legal arguments capturing international climate stability mandate interdependencies are thereby innovatively coupled with quantitative global warming asset analyses in order to retrieve a fair and feasible climate stability implementation proposal. The overall goal of the paper is to develop our understanding of climate stabilization through the analysis of global warming gains distribution. Legal studies as well as economic calculus enhanced will produce public policy recommendations following the greater goal of developing a multidisciplinary analysis of global climate alleviation.

The paper is organized as follows: After a climate stability risk overview (Part 1.2), a qualitative legal analysis aims at gaining climate change benefits and burden sharing strategies. Quantitative modelling of global warming gains focus on finding a fair

distribution of global warming gains based on international climate interdependencies (Part 2.). Global warming benefits transfers will be proposed on a global and temporal scale in the discussion of an unprecedented tax-and-bonds-transfer strategy. In its entirety, the paper offers a unique combination of the laws and economics of global warming gains including a nomenclature creation, literature reviews and quantitative modeling in order to derive public policy directions for global governance experts and institutions pursuing a real-world relevant worldwide fair climate stability strategy.

2. Climate change

Climate change accounts for one of the most pressing problems in the age of globalization as for exacerbating more complex risks than ever before. As never before in history since the birth of the earth, there is an environmental sensitivity to economic growth (Centeno & Tham 2012; The World Economic Forum Report 2015). While classic economics portrayed balancing the interests of different generations as ethical problem of competitive markets requiring governance for intergenerational transfers and some economists even opposed discounting of future utilities (Allais, 1947; Harrod, 1948; Ptaschunder, 2015a; Ramsey, 1928); climate change has leveraged intergenerational equity as contemporary challenge of modern democracy and temporal justice an ethical obligation for posterity (Ptaschunder 2016e, 2017).

Global warming has become reality in temperature anomalies, extreme weather events, unprecedented hurricane seasons and up to 50 inches sea level rise predicted until the end of the century. History has also been made in reaching an iconic agreement on global warming mitigation at the UN Paris climate change conference. Literature on the topic centers around the economics of climate change, on causes of climate change, mitigation policies – such as cap and trade and carbon taxation – regulatory measures, and on adaptation. Substantive climate coverage through the IPCC research but also international conferences on climate change and global warming abatement stress the currently most urgent need for climate change mitigation and adaptation policies. The most recent research attempts address in particular the funding a burden sharing of climate policies in the international compound raising challenging questions about the burden sharing in between countries and over generations.

2.1. Climate justice between countries

The legal argumentation about climate stability touches on different fields of law, ranging from common goods to private property to human rights. While climate was historically understood as a common good,¹ which is non-excludable and non-

rivalrously shared and beneficial for all world members, this original perception is currently challenged by climate change. If climate becomes less stable, climate may not be considered as common good any more. For instance, if climate instability impacts certain world areas by weather extremes – such as sea level rise, flooding, droughts, desert formation, storms, and hurricanes – more severe than other parts of the world that may even benefit from a warmer climate (e.g., consider Russia's and Canada's access to natural resources when ice is melting in their Northern territories), a quest for living in a beneficial area of the world may leverage a favorable climate as a quasi-luxury. Living in a part of the world with a beneficial climate may become an exclusive privilege that is rivalrously contested. Under these circumstances, climate would not be considered as classical common good. But also take the example of rising sea levels. If climate gets warmer, sea levels rise and drown landscape under water, the common good of climate directly impacts on private property. Predictions of Venice disappearing and Manhattan being almost by half under water in 200 years² if we continue on a business-as-usual path, underline the direct impact of the common good climate on private property rights. If temperature rises, private property will be destroyed or more expensive to maintain than before.

Climate justice concerns thereby directly touch on human rights (Puaschunder 2016c, 2017). The greater goal of ensuring climate justice is that not one generation creates irreversible lock-ins for future generations. The claim for a human right of access to a stable climate stems from intergenerational fairness demands, which is a natural behavioral law or a human-imbued cue that has been practiced ever since (Puaschunder, 2011). Climate justice is thereby traced in human rights and sustainable development is a quest to safeguard the rights of those affected by climate change. Connecting a stable climate to human rights has become a blatant demand in the light of a changing sea levels. Yet to this day, climate refugees are not treated under the Geneva Convention³ as long as their rights are not directly connected to a human right. From the Arctic to the Indian Ocean to the South Pacific, small island states and coastal lines have therefore nowadays become home to the most vulnerable communities, whose rights are not fully protected by contemporary legal frameworks. The threat of rising sea levels in the wake of climate change pushes populations to relocate to safer areas. Contemporary legal frameworks do not recognize and protect the rights of these novel climate migrants as climate refugees do not fall under Geneva Convention⁴ protectorate as long as climate justice is not considered an eternal human law and right. Climate justice may thus be leveraged as a human right in the years to follow. Subsequent legislation should set out to ensure a decent standard of living of those affected by global climate warming. As the destabilization of climate will

directly destroy, damage or intensify maintenance costs of private property and a decent living; the climate stabilization efforts therefore also have entered private property and standard of living financialization considerations.

In the financing of climate stabilization, private market rational have been proposed following World Bank and United Nations approaches to price natural resources. These financialization and commodification of nature efforts, however, have just started. In the commodification of climate, economic rational should be applied but with the caution of legal oversight. The basic economic rules of supply and demand suggest that an over-demand of climate elevates the price of a stable climate. Legal rational following the quest for justice between countries subsumes the rising price of a stable climate to those countries that benefit more from a stable climate, should also be paying a higher price for climate stabilization. Fair climate change burden sharing between countries could therefore comprise of two argumentations: First, those countries who benefit more from a stable climate, hence those with a larger landscape or higher population, who have more access to climate than others and hence a greater summed up utility over all their individual nationals derived from a stable climate, should also bear a higher degree of the burden of climate change mitigation and adaptation efforts. Second, those countries who benefit more from global warming and reap benefits from a warmer earth temperature should redistribute some of the wealth accumulation due to climate change to offset the costs arising from global warming at other countries of the world that suffer from a decline in living conditions due to rising temperatures.

The legal foundation for different country approaches toward climate mitigation and adaptation cost sharing can be found at the heart of sustainability having been declared as one in which countries have 'common but differentiated responsibilities,'⁵ which was first discussed in Principle 7 of the Rio Declaration at the first Rio Earth Summit in 1992.⁶ New to this argument, however, is that the benefits of global warming – which are real and exist, for instance, in melting ice allowing unprecedented access to below surface resources and larger arable landscape – should be shared globally to offset costs and harms produced from a higher temperature in other parts of the world. In addition, building on case and international law, those countries that have better means of protection or conservation of the common climate should also face a greater responsibility to protect the earth. The legal basis for this argument stems from an inverted subsumption of the argumentation whether climate stability is a common good or impacts on private property and draws on historical cases of legally-justified expropriation.

Private property rights are some of the starkest legal claims existent around the world. Private property rights hold through time, distance and space. If a neighbor goes on vacation, one cannot simply move in his home and claim oneself as new owner. But there is one interesting case in history, where private property rights could be neglected for the sake of common goods. In history, the private property claim of a country was legally-justified negligible if (1) those who owned a good were not alive anymore and direct attribution of the owner non-existent; (2) the former private property was turned into a common good; and (3) the new owner had better means of protection and conservation than the good had experienced before.

Take historical examples such as the Stone of Rosetta but also other cases such as the 'Elgin' Parthenon Marbles as part of the Athenian Acropolis (Downs, 2008). Historically the stone of Rosetta was discovered by Napoleon Bonaparte in 1799 in the small town of Rosetta in Egypt, and is now exhibited in the British Museum for more than 200 years. There are several arguments for not restituting former private property to the countries of their origin as in the case of the Stone of Rosetta: (1) The actual former owner are not alive anymore and unknown, which naturally transposes any direct individual property claim to the international law domain, hence the country Egypt contests the country Great Britain over ownership and possession. Great Britain claims (2) to turn the former private property to a common good through granting a large and diverse group of people access, hence creating a larger summed up utility. London – as a vibrant metropolitan hub with a vast array of visitors – is a better stage to explain the meaning of the stone to a broader public than if the stone were still in Rosetta, a small town near Alexandria in Egypt. The display of the stone in a museum adds additional value: (3) The British Museum has better means of protection, preservation and conservation of the stone than if it were displayed by itself in a desert town benefiting not only from the political stability of Great Britain but also the strong culture of heritage awareness and valuation as a Royal mandate. (4) The surrounding in a museum grants the stone meaning and a Gestalt bringing to life the mysteries of the ancient Egypt and the stone's importance as a historical artefact in deciphering Greek, Hieroglyphs and demotic Egyptian (Downs 2008). The stone's connection to history truly becomes apparent in the wealth of other displayed objects that grant the stone a certain collective Gestalt bestowing upon it an additional value. The sum of objects in a museum is worth more in its entirety than its sole pieces standing alone.

What can we learn from the historic case of expropriation for the future of climate justice? Instead of asking whether ancient colonial claims have still today the right to retain misplaced cultural heritage, these standard argumentations for expropriation

– on which the justification for these items to remain in former colonial powers' territories to this day lies – could be subsumed to the novel and contemporary case of climate justice. In the arguments whether the first and the second world should bear the same burden of climate change mitigation and adaptation efforts brought up foremost by China arguing to have a right to economic growth by the same – unfortunately climate-change causing – means of economic transition as the first world had in previous centuries⁷, one could subsume from the above case of expropriation for the sake of common goods creation: (1) That climate change will potentially infringe on private property rights of future owner who are currently unknown. (2) Those countries should bear a higher burden of climate change mitigation and adaptation efforts, who have more access to climate, hence those with larger gains from a warming earth but also a larger landscape and/or those with a larger population; (3) but also those countries who have better means of protection, preservation and conservation, hence the first world or GDP strong countries, have to take on a greater responsibility in averting climate change (Puaschunder 2016c, 2017). (4) Overall, there is a natural Gestalt over time regarding climate. Over time, the sum of a stable climate over time is more precious than the individual generation's costs incurred to maintain a favorable climate. Shedding light at these deficiencies underlines the need for considering climate justice a natural law over time that connects our common humankind's past to our future (Puaschunder 2016d, 2017).

2.2. Climate justice between generations

Society as a whole outlasts individual generations. Pareto optimality for society over time differs from the aggregated individual generations' preferences. As the sum of individual generations' preferences does not necessarily lead to societally favorable outcomes over time (Bürge nmeier 1994; Klaassen & Opschoor 1991), discounting based on individual generations' preferences can lead to an unjust advantage of living generations determining future living conditions. In the climate domain, intertemporal questions arise whether to invest in abatement today – in order to prevent negative effects of global warming – or to delay investment until more information on climate change is gained (Rawls 1971). In general, resources are balanced across generations by social discounting to weight the well-being of future generations relative to those alive today. Regarding climate justice, current generations are called upon to make sacrifices today for future generations to cut carbon emissions to avert global warming (Sachs 2014). In general, intergenerational balance is therefore accomplished through individual saving decisions of the present generation (Bauer 1957). Policies curbing preferences and taxes distributing welfare between the present and

future generation, however, decreases economic growth. But this climate change mitigation at the expense of lowered economic growth creates intergenerational predicaments. Costly climate change abatement prospects are currently hindering necessary action on climate change given a shrinking time window prior to reaching tipping points that make global warming irreversible (Oppenheimer, O'Neill, Webster & Agrawal 2011; Puaschunder 2016a, 2017).

As an innovative angle in this debate of economic growth versus sustainability that pits the current generation against the future, a novel climate change mitigation approach with bonds funded through debt and taxation imposed on future generations is proposed. In order to avoid governmental expenditure on climate change hindering economic growth but also to instigate immediate action on climate change abatement (Barro 1990); Sachs (2014) introduced to fund today's climate mitigation through an intertemporal fiscal policy mix backed by climate bonds and carbon tax (Marron & Morris, 2016). Bonds are debt investment in which investors loan money to an entity, which borrows the funds for a defined period of time at a variable or fixed interest rate. Bonds are primarily used by companies, municipalities, states and sovereign governments to raise money and finance a variety of future-oriented long-term projects and activities. In this debt investment strategy, investors loan money to an entity, which borrows the funds for a defined period of time at a variable or fixed interest rate (Puaschunder 2016c). A climate bonds financing could subsidize the current world industry for transitioning to green solutions as a real-world relevant means to tap into the worldwide USD 80 trillion-bond market in order to fund the incentives to a transition to a sustainable path (Puaschunder 2016b; World Bank 2015).

Carbon tax can also help financing a well-tempered climate change mitigation and adaptation mix as carbon taxes can raise substantial revenue until the economy is largely decarbonized (Marron & Morris 2016). In Sachs (2014) 2-period model, climate change mitigation is financed by debt to be repaid by tax revenues on labor income in the future. Leaving the current generation with unchanged disposable income allocates the burdens of climate change mitigation across generations without the need to trade off one generation's well-being for another's. While today's young generation is left unharmed, the second period young generation is made better off ecologically. Taxes on later generations are justified as for the assumed willingness of future generations to avoid higher costs of climate change prevention and environmental irreversible lock-ins. Shifting the ultimate costs of climate change aversion to later generations leverages climate stability into a Pareto improving strategy for mankind.

Overall, in this tax-and-transfer mitigation policy all generations are better off with mitigation through climate bonds as compared to the business-as-usual (BAU)

non-mitigation scenario (Sachs 2014). While future generations enjoy a favorable climate and averted environmental lock-ins; the current populace does not face drawbacks on economic growth. Sharing the costs of climate change aversion between and across generations appears as powerful strategy to instigate immediate climate change mitigation through incentivizing emission reduction and provide adaptation. Although intergenerational burden sharing on climate change appears as viable real-world relevant emergent risk prevention; we currently lack an analytical understanding of the impact of climate mitigation through bonds on economic growth, the coordinated implementation of climate change burden sharing bonds as well as the model's long-term effects.

A literature review and preliminary studies have to be undertaken on the current discussion on sustainable finance and the diverse methods of funding of mitigation and adaptation policies. Particular emphasis was given to the already existing literature, experiences and practices of issuing climate bonds and its relation to carbon tax (Puaschunder 2017). The issue of sustainable financing of climate policies was found to be less developed. Regarding creative financing strategies, a focus group was staged during August 2016 at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg Austria with 39 young scientists representing diverse disciplines, well-balanced gender composition and differing nationalities from around the globe (Puaschunder 2016c). The focus group revealed primary interests in the novel climate change bonds financing strategy (Puaschunder 2016c). Questions were raised about the legal and policy frameworks to enact the bonds; feasibility, efficiency and pricing of bonds; multi-dimensionality and incentive concerns of the general bond financing strategy idea; international differences in climate change mitigation and adaptation attempts as well as justice between countries to share the benefits and burdens of global warming equally. In addition, several sustainable development financing approaches were discussed during the 2016 Alpbach Retreat comprising of open source investment platforms, innovative public-private partnership plans as well as self-financing tools to create constant revenue streams to settle expenses long-term (Puaschunder 2016a).

Uncertainty arising in assessing economic growth in relation to climate change creates an unprecedented predicament for scientists and global governance technocrats. International questions are posed as to which countries should be paying to invest in abatement today – in order to prevent negative effects of global warming around the globe (Rovenskaya 2008). In general, resources are balanced across the globe by social discounting to weight the overall well-being. Regarding climate justice, current climate change beneficiaries are called upon to make sacrifices today to cut carbon emissions to avert global warming (Sachs 2014). The implementation of climate change avoidance,

and the adaptation against the coming climate risk was previously described as to pit today's climate change winners and losers against each other in the trade-off of economic growth versus sustainability (Puaschunder 2016b, 2017; Sachs 2014).

In this framing, the problem of climate change is therefore mainly associated with risks and burden sharing costs, which may have caused a lethargy on action (Puaschunder 2016a). Climate change burden sharing strategies have been thermalized alongside mitigation and adaptation policies against climate risks (Puaschunder 2016b). Recent IPCC research, international conferences on climate change and fund raising activities to combat global warming stress that it is advisable now to pursue both mitigation as well as adaptation. While climate justice will require both, climate change gains and losses should be analyzed concurrently (Puaschunder 2017). Yet, no macroeconomic model exists to date on the transfers of global warming benefits a warming earth will bring in the short term to areas that need funding to offset the losses of climate change.

2.3. Research question

The empirical part features a stylized model to introduce intergenerational burden sharing financed through distributing the contemporary global warming gains around the world. The discussion will then focus on the actual implementation of climate justice through the idea of issuing climate bonds coupled with a taxation solution. Empirical analyses will help revealing the model's viability in order to derive suggestions for global governance policy makers to efficiently herald climate justice in the 21st century.

Shedding unprecedented light on the advantages of global warming will help to retrieve real-world relevant climate justice implementation recommendations. Contrary to negative connotations of burden sharing on climate change, outlining the benefits of global warming will draw attention from agnostic market actors. As a positive incentive, gains raise awareness for the issue at stake and ensure that the positive advantages of a warming earth can be distributed based on right, just and fair ethical principles. Without knowledge and quantification of the gains of climate change, climate inequality may become unnoticed (Chancel & Piketty 2015). Only by the sound understanding of who will gain what on a warming earth, justice can be established – as to the entire world benefitting from the gains of a warming globe in a just way. Knowledge of the concrete benefits based on contemporary finance and growth models maximizing utility over the world can thereby lead the implementation of climate justice between countries but also over time. The measurement and description of the short-term winners and losers of a warming earth is an innovative and novel angle towards accomplishing climate justice that is introduced in order to find a behavioral economics solution to steer action through positive incentives. The following empirical

part therefore elucidates climate change gains around the world in order to find right, just and fair benefit sharing strategies and mechanisms, which will be proposed in the following discussion section based on a tax-and-bonds diversification strategy.

As the very first preliminary attempt in the benefits distributions direction, the article provides real-world relevant means how to implement climate justice on a global and long-term scale. Outlining the distribution of benefits of climate change is key in determining redistribution strategies for vulnerable cities, communities and countries to protect them from the variegated climate change risks (Nordhaus 1994). The prospective results of a climate change gains analysis will therefore help multivariate stakeholders achieving compensation for climate change mitigation, adaptation and a transition into renewable energy for sustainable development. The climate model helps analyze how global governance experts can distribute the gains of a warming earth around the globe. Working with insights on the benefits of climate change appears as novel, feasible and easily-implementable solution to gain interest from the very many contemporary stakeholders we need to address the issue of a warming earth but also nudging overlapping generations towards future-oriented sustainability follows the greater goal to make the world a fairer place in the access to stable climate for this generation and the following.

3. Method

3.1. Overall model assumptions

Building on Ptaschunder (2017) economic output was measured under projected conditions of a warming earth. For 189 world countries the Gross Domestic Product (GDP) agriculture, industry and service sector composition was retrieved from the Central Intelligence Agency (CIA) World Factbook.⁸ Contemporary climate change projections estimate a mean temperature rise of approximately 4.24 degrees Celsius. The cardinal temperature C per GDP sector was related to the projected temperature in 2100 per country. From the current world temperature mean per country and the estimate of a 4.25-degree Celsius climate change until 2100, the closeness to cardinal temperature per sector was calculated for each country by using the following formula 3.1:

$$T_A = C_A - T_e \quad (3.1)$$

Whereby T_A represents the closeness to the optimum cardinal temperature for agriculture calculated by the cardinal temperature for agriculture C_A , which equals to 28.5 degrees Celsius, subtracted by T_e as the temperature estimated for the year 2100

per country. The result for the distance to the optimum temperature for each sector for each country was then multiplied by the GDP contribution percentage of the sector using the following formula 3.2-3.4:

For the agricultural sector, formula 3.2 reads

$$WL_A = T_A * GDP_A \quad (3.2)$$

whereby WL_A stands for the climate change winner and loser index for agriculture per country comprised of the distance to the optimum cardinal temperature per GDP sector T_A multiplied by the percentage of agriculture contributing to the overall GDP indicated by GDP_A .

For the industry sector, formula 3.3 reads

$$WL_I = T_I * GDP_I \quad (3.3)$$

whereby WL_A stands for the climate change winner and loser index for industry per country comprised of the distance to the optimum cardinal temperature per GDP sector T_I multiplied by the percentage of industry contributing to the overall GDP indicated by GDP_I .

For the service sector, formula 3.4 reads

$$WL_S = T_S * GDP_S \quad (3.4)$$

Whereby WL_A stands for the climate change winner and loser index for service per country comprised of the distance to the optimum cardinal temperature per GDP sector T_S multiplied by the percentage of the service sector contributing to the overall GDP indicated by GDP_S .

The overall Winner-Loser WL_T index was calculated per GDP sector leading the sector-specific Winner-Loser indices WL_A for the agriculture sector, WL_I for the industry sector, and WL_S for the service sector, that were then added up into the Winner-Loser total index WL_T based on the following formula 3.5:

$$WL_T = WL_A + WL_I + WL_S \quad (3.5)$$

Whereby WL_A denotes the Winner-Loser index for the agriculture sector, WL_I the index for the industry sector and WL_S the index for the service sector. All indices were calculated per country for the year 2100 business-as-usual projection. To account for gain loss-prediction model differences, Puaschunder (2017) outlined three model

variants over gain and loss perspectives. A linear model included gains and losses based on formula 3.6 and 3.7:

$$W = T^1 * GDP \quad (3.6)$$

For the losers' index L a linear growth is assumed by calculated by formula 3.7 for each respective sector:

$$L = -T^1 * GDP \quad (3.7)$$

per country and per GDP sector, which were then added up into the Winner-Loser total index WLT based on the formula 3.5.

A prospect model included concave gains and convex losses based on formula 3.8 and 3.9:

$$W = T^{0.5} * GDP \quad (3.8)$$

For the losers' index L a linear growth is assumed by calculated by formula 3.9 for each respective sector:

$$L = -T^2 * GDP \quad (3.9)$$

per country and per GDP sector, which were then added up into the Winner-Loser total index WLT based on the formula 3.5.

A hyperbolic model included gains and losses based on formula 3.10 and 3.11:

$$W = T^2 * GDP \quad (3.10)$$

For the losers' index L a linear growth is assumed by calculated by formula 3.11 for each respective sector:

$$L = -T^2 * GDP \quad (3.11)$$

per country and per GDP sector, which were then added up into the Winner-Loser total index WL_T based on the formula 3.5.

The overall Winner-Loser **WL** index was calculated per GDP sector leading the sector-specific Winner-Loser indices WL_A for the agriculture sector, WL_I for the industry sector, and WL_S for the service sector, that were then added up into the Winner-Loser total index WL_T based on formula 3.5. The mean overall Winner-Loser **WL** index was retrieved from summing the WL_T indices for the linear, prospect and hyperbolic models per country divided by $n=3$.

Overall, a positive **WL** index result would indicate a long distance to the optimum, whereas a negative index would be considered as negative prospect. Basically the more positive the index, the longer time the country could expect to be having a favorable climate for agriculture, industries or service production until peak condition and the

more negative the index, the sooner the country would (have) run out of efficiency time. In sum, the Winner- Loser index is an indicator how much cool time a country still has ahead in prospect of an optimum GDP productivity temperature and the assumption that the earth is warming. For a detailed explanation of the WL_T index creation please see Puaschunder (2017).

3.2. Modelling climate change gains and losses distribution

In order to estimate a fair climate change gains and losses distribution, first for each model variants the gains and losses were calculated (Puaschunder, 2017).

3.2.1. Linear model

When unidimensionally focusing on estimated GDP growth given a warmer temperature and estimating a linear growth of losses and wins, overall the world will be gaining more than losing until 2100. Based on the WL index of 198 countries of the world and under the assumption of linear gains and losses in light of climate change, less countries ($n=79$) will win more from global warming until 2100 than more countries ($n=119$) will lose from a warming earth. In particular, 79 countries of the world will gain $WL_L=78139.08$ in GDP output, whereas 119 countries of the world will lose estimated $WL_L=-52061$.

3.2.2. Prospect convex losses and concave gains model

When unidimensionally focusing on estimated GDP growth given a warmer temperature and estimating an exponential growth of losses and concave wins, overall the world will be losing more than gaining until 2100. Based on the WL index of 188 countries of the world, more countries ($n=113$) will lose more from global warming until 2100 than less countries ($n=75$) will win from a warming earth. In particular, 75 countries of the world will gain $WL_p=22717.161$ in GDP output, whereas 113 countries of the world will lose estimated $WL_p=-353175.32$.

3.2.3. Hyperbolic model

When unidimensionally focusing on estimated GDP growth given a warmer temperature and estimating a hyperbolic growth, overall the world will be gaining more than losing until 2100. Based on the WL index of 188 countries of the world, less countries ($n=79$) will gain more from global warming until 2100 than more countries ($n=109$) will lose from a warming earth. In particular, 79 countries of the world will gain $WL_H=1037192$ in GDP output, whereas 109 countries of the world will lose estimated $WL_H=-352088$.

3.2.4. Total estimate

The total Winner-Loser WL index was calculated per country based on the mean of the overall Winner-Loser index WL_L for the linear model, the overall Winner-Loser index WL_p for the prospect model, and the overall Winner-Loser index WL_H for the hyperbolic model that were then added up into the Winner-Loser total index WL_{TT} based on the following formula 3.12:

$$WL_{TT} = (WL_L + WL_p + WL_H) / n \quad (3.12)$$

whereby WL_L denotes the Winner-Loser index for the linear model, WL_p the index for the prospect model and WL_H the index for the hyperbolic model and $n = 3$. All indices were calculated per country for the year 2100 business-as-usual projection.

3.3. Global warming winners and losers around the world

When unidimensionally focusing on estimated GDP growth given a warmer temperature, over all calculated models assuming linear, prospect or hyperbolic gains and losses, the world will be gaining more than losing until 2100. Based on the WL index of 188 countries of the world, less countries ($n=78$) will gain more from global warming until 2100 than more countries ($n=111$) will lose from a warming earth. In particular, 78 countries of the world will gain $WL_G=354039,6345$ in GDP output, whereas 111 countries of the world will lose estimated $WL_L=-232613,188$.

Puaschunder (2017) investigated the relation between GDP growth prospects in light of climate change. Based on the WL_{TT} index, which measures the distance to cardinal temperature per GDP sector in 188 countries of the world, the world separates into climate change winners ($n=77$) and losers ($n=111$) are outlined in graph 1 (Puaschunder, 2017).

Insert graph 1 about here

Based on a country ranking, graph 1 highlights the top one-third countries with longest time prospect in green color and the one-third countries that have run out of time in red color.

Based on a WL_{TT} estimate, graph 2 highlights all world countries with highest gain perspective in green color and the one-third countries that lose the most in red color.

Insert graph 2 about here

Graph 3 shows only wins in Europe from climate change until the year 2100 based on the WL_{TT} estimate.

Insert graph 3 about here

Graph 4 reveals only wins in North America from climate change until the year 2100 based on the WL_{TT} estimate.

Insert graph 4 about here

The relation between GDP growth prospects in light of climate change and percentage of GHG for ratification was studied based on the total and percent of greenhouse gas emissions communicated by the Paris COP 21 Parties to the Convention retrieved in their national communications, GHG inventory reports as of December 2015 (Puaschunder, 2017).⁹ Over a sample of 181 countries of the world, a highly significant correlation of $r_{\text{Pearson}}(181) = .215, p < .004$ between the WL index over all models and the self-reported percentage of GHG emissions for ratification was found. As a cross-validation check, the percentage of GHG emissions for ratification was significantly positively correlated $r_{\text{Pearson}}(181) = .178, p < .016$ with self-reported GHG emissions per country (Puaschunder 2017).

This result leads to the conclusion that those countries that emit more GHG are the ones with a positive GDP prospect on the warming earth until 2100. The more time countries seem to have in a favorable climate for production, the more they are also likely to emit GHG and hence contribute to global warming. All these results outline the need for attention to climate justice.

3.4. Fair climate change gains distribution

In order to offset the losses from climate change based on the overall WL_{TT} index, global warming benefits are redistributed in a fair way to offset climate change loser countries for climate change mitigation and adaptation efforts and to instigate a transition into renewable energy.

To ensure a fair benefit transfer strategy, the difference of $\Delta WL = 121426,447$ should be distributed based on following criteria: To ensure a fair benefit transfer strategy in between countries, the per-country contributions to alleviate the losses caused by global warming should only come from those countries that win from a warming earth, hence 78 nation states. The winning countries' contribution in relation to the other winning countries' contribution, hence as share of all wins, were be calculated based on the percentage of wins and losses based on the formula 3.13 and 3.14.

In order to account for country differences in offsetting global warming through GDP growth (especially on the winners' side) and the country differences in their ability to transfer into renewable energy, the overall GDP per inhabitant was factored into the transfer equation as outlined in formula 3.13:

$$R^W = \left(\frac{PW}{WL_G} \right) * \left(\frac{GDP_c}{I_c} \right) \quad (3.13)$$

whereby R^W denotes the total transfer of climate change wins obligation per winning country, P_w is the country specific GDP win divided by all wins $WL_G = 354039,6345$ from a warming earth for the year 2100 business-as-usual projection in order to derive the percentage fraction of wins per country. GDP_c equals the per country GDP estimate per inhabitant I_c per country for the year 2016.

Losses were calculated based on formula 3.14:

$$R^L = \left(\frac{PL}{PL_T} \right) * \left(\frac{GDP_c}{I_c} \right) \quad (3.14)$$

whereby R^L denotes the total transfer of climate change compensation, P_L is the country specific GDP loss divided by all losses $WL_L = -232613,188$ from climate change for the year 2100 business-as-usual projection in order to derive the relative fraction of losses per country. GDP_c equals the per country GDP estimate per inhabitant I_c per country for the year 2016.

The overall transfers R^T equate with the sum of contributions from the countries benefiting from global warming and the losses incurred by the countries that lose from global warming until 2100. Overall all transfers R^T derive from R^W and R^L , which must be equal based on the following formula 3.15:

$$R^T = R^W + R^L \quad (3.15)$$

whereby R^T denotes the total transfer of wins for compensation of losses.

3.5. Country contributions

3.5.1. Climate change transfers

Based on the WL_{TT} index, which measures the distance to cardinal temperature per GDP sector in 188 countries of the world, all 77 climate change transfer grantor countries and 109 climate change transfer beneficiary countries are outlined in graph 5.

Insert graph 5 about here

Graph 6 features the countries with most time to a favorable climate weighted by overall GDP and their overall transfer burden. The top 19 transfer grantor countries are WL_{TTB} . Canada ($WL_{TTB} = -7299.04$), Russia ($WL_{TTB} = -6999.3$), Mongolia ($WL_{TTB} = -5032.75$),

Kyrgyzstan ($WL_{TTB} = -4154.31$), Tajikistan ($WL_{TTB} = -4089.42$), Iceland ($WL_{TTB} = -3887.91$), Finland ($WL_{TTB} = -3798.36$), Norway ($WL_{TTB} = -3708.43$), Sweden ($WL_{TTB} = -3644.39$), Latvia, ($WL_{TTB} = -2465.58$), Georgia ($WL_{TTB} = -2452.19$), North Korea ($WL_{TTB} = -2428.53$), Switzerland ($WL_{TTB} = -2394.05$), Estonia ($WL_{TTB} = -2342.77$), Liechtenstein ($WL_{TTB} = -2318.88$), Lithuania ($WL_{TTB} = -2188.99$), Nepal ($WL_{TTB} = -2131.26$), Austria ($WL_{TTB} = -2103.02$), Belarus ($WL_{TTB} = -2077.12$), and Kazakhstan ($WL_{TTB} = -2039.07$).

Insert graph 6 about here

All global warming transfer beneficiary countries are outlined in graph 7. The major transfer beneficiaries are Qatar ($WL_{TT} = 2911.69$), Bahrain ($WL_{TT} = 2793.87$), Brunei ($WL_{TT} = 2591.98$), United Arab Emirates ($WL_{TT} = 2446.67$), Kiribati ($WL_{TT} = 2370.55$), Mauritania ($WL_{TT} = 2311.14$), Tuvalu ($WL_{TT} = 2228.85$), Djibouti ($WL_{TT} = 2140.24$), Senegal ($WL_{TT} = 2091.74$), Burkina Faso ($WL_{TT} = 2009.04$), Maldives ($WL_{TT} = 2008.46$), Trinidad and Tobago ($WL_{TT} = 1997.28$), Mali ($WL_{TT} = 1922.99$), Equatorial Guinea ($WL_{TT} = 1875.88$), Sri Lanka ($WL_{TT} = 1855.24$), Palau, ($WL_{TT} = 1838.85$), Seychelles ($WL_{TT} = 1775.79$), Saint Vincent and the Grenadines ($WL_{TT} = 1772.60$), Samoa ($WL_{TT} = 1760.75$), and Guinea ($WL_{TT} = 1753.07$).

Insert graph 7 about here

Based on the WL_{TT} index weighted per GDP and per inhabitant, which measures the distance to cardinal temperature per GDP sector in 186 countries of the world, all 76 climate change transfer grantor countries and 110 climate change transfer beneficiary countries are outlined in graph 8.

Insert graph 8 about here

Graph 9 features the highest grantor countries weighted by GDP and per inhabitant. The top 20 transfer grantor countries are Liechtenstein ($WL_{TTB} = -10.34$), Canada ($WL_{TTB} = -8.88$), Norway ($WL_{TTB} = -7.65$), Iceland ($WL_{TTB} = -6.35$), Switzerland ($WL_{TTB} = -5.67$), Luxembourg ($WL_{TTB} = -5.52$), Finland ($WL_{TTB} = -3.77$), Monaco ($WL_{TTB} = -3.41$), Denmark ($WL_{TTB} = -3.19$), Austria ($WL_{TTB} = -3.03$), United States ($WL_{TTB} = -2.87$), Ireland ($WL_{TTB} = -2.18$), Germany ($WL_{TTB} = -2.15$), United Kingdom ($WL_{TTB} = -1.80$), Belgium ($WL_{TTB} = -1.44$), New Zealand ($WL_{TTB} = -1.41$), Estonia ($WL_{TTB} = -1.38$), France ($WL_{TTB} = -1.18$), Latvia ($WL_{TTB} = -1.15$), and Slovenia ($WL_{TTB} = -1.15$).

Insert graph 9 about here

All global warming transfer beneficiary countries are outlined in graph 10. The major transfer beneficiaries are Qatar ($WL_{TT} = 19.06$), United Arab Emirates ($WL_{TT} = 9.33$),

Singapore ($WL_{TT}=7.90$), Brunei ($WL_{TT}=6.06$), Bahrain ($WL_{TT}=5.90$), Kuwait ($WL_{TT}=3.94$), Trinidad and Tobago ($WL_{TT}=2.98$), Saudi Arabia ($WL_{TT}=2.92$), Mauritania ($WL_{TT}=2.51$), Seychelles ($WL_{TT}=2.39$), Equatorial Guinea ($WL_{TT}=2.29$), Palau, ($WL_{TT}=2.27$), Oman ($WL_{TT}=2.00$), Antigua and Barbuda ($WL_{TT}=1.99$), Barbados ($WL_{TT}=1.70$), Venezuela ($WL_{TT}=1.29$), Saint Kitts and Nevis ($WL_{TT}=1.28$), Panama ($WL_{TT}=1.27$), Grenada ($WL_{TT}=1.26$), and Malaysia ($WL_{TT}=1.24$).

Insert graph 10 about here

Graph 11 provides an overview off all climate change winning transfer grantors in green and yellow colors and all climate change loser country transfer beneficiaries in pink and red colors.

Insert graph 11 about here

4. Discussion

The implementation of climate stability accounts for the most challenging contemporary global governance predicament that seems to pit world countries but also today's generation against future world inhabitants. For enacting climate justice current world nation states of the current world population are called upon to make sacrifices today for future generations to cut carbon emissions to avert global warming (Sachs, 2014). Climate change mitigation at the expense of lowered economic growth seems to pit the current generation against future ones. Costly climate change abatement prospects are thus hindering currently necessary action on climate change given a shrinking time window prior to reaching tipping points that make global warming irreversible (Oppenheimer et al. 2011).

In a trade-off of economic growth versus sustainability, a broad-based international coalition could establish climate stability. As a novel angle towards climate justice, the attention to global warming gains and losses being distributed unequally around the globe allows proposing a well-balanced climate mitigation and adaptation public policy mix guided by micro- and macroeconomic analysis results. This paper offers a new way of funding climate change mitigation and adaptation policies but also the transition to renewable energy through broad-based climate stability bonds-and-tax-transfer-mix that also involve future generations (WorldBank 2015). Contemporary climate stability financing strategies are discussed in order to derive recommendations how market economies can be brought to a path consistent with prosperity and sustainability. Finding innovative ways how to finance climate abatement over time coupled with future

risk prevention as well as adaptation to higher temperatures appears as an innovative and easily-implementable solution to nudge overlapping generations towards climate justice in the sustainability domain (Rawls 1971).

Having shed light on the gains of a warming earth demands for the redistribution of climate change benefits to those areas of the world that will be losing from a warming earth. In the implementation, a climate change bonds but also taxation strategies are recommended. Having found that there are gains from a warming earth demands to partially transfer benefits into areas of the world that will be primarily losing from climate change. In order to avoid governmental expenditure on climate change hindering economic growth (Barro 1990); the climate transfers should be enacted through bonds and taxes.

First Jeffrey Sachs (2014) proposed an intergenerational burden sharing idea by presenting a 3-model climate change burden sharing through fiscal policy with bond issuing in order to reflect the implementation regarding contemporary finance and growth models with respect for maximizing utility of the model. In an overlapping-generations type model, climate change abatement and mitigation policies financed through climate gains re-distribution could lead to a fairer solution across the globe and over generations. Thereby the current generation mitigates climate change and provides infrastructure against climate risk financed through climate bonds to be paid by future generations. Since for future generations the currently created externalities from economic activities – the effects of CO₂ emissions – are removed, this entails that the current generations remain financially as well off as without mitigation while improving environmental well-being of future generations. As Sachs (2014) shows, this intergenerational tax-and-transfer policy turns climate change mitigation and adaptation policy into a Pareto improving strategy. Shifting the costs for climate abatement to the recipients of the benefits of climate stability appears as novel, feasible and easily-implementable solution to nudge many overlapping generations towards future-oriented loss aversion in the sustainability domain (Puaschunder 2016b).

One of the most prominent forms to create revenues for public long-term investment causes are taxes. Taxation is codified in all major societies and a hallmark of democracy. Aimed at redistributing assets to provide public goods and ensure societal harmony, taxation improves societal welfare and fairness notions within society. Tax compliance is a universal phenomenon based on cooperation in the wish for improving the social compound. Taxpayers voluntarily decide to what extent to pay or avoid tax that limit the personal freedom. In a social dilemma, individual interests are in conflict with collective goals. From a myopic economic perspective, the optimal strategy of rational individuals would be to not cooperate and thus evade tax. Short-term the single civilian

tax contribution does not make a significant difference in the overall maintenance of public goods – if only a few taxpayers evade taxes, public goods will not disappear or be reduced. If a considerable number of taxpayers do not contribute to tax over time, common goods are not guaranteed and ultimately everyone will suffer from suboptimal societal conditions (Dawes 1980; Stroebe & Frey 1982; PNAS 2015b). Contemporary economic research has focused on costs and risks of tax evasion (Tyler & De Cremer 2006). Coercive means – such as audits and fines – were found to crowd out tax morale and ultimately result in greater non-compliance as people feel controlled and not being trusted (Cialdini 1996; Feld & Frey 2002; Frey, 1992; Hasseldine 1998). In the last decade, researchers have started to recognize the importance of incorporating morals and social dynamics in economic theory on tax behavior (Andreoni, Erard & Feinstein 1998). When analyzing tax behavior, recently behavioral economics insights have drawn attention to social influences (PNAS 2015b).

Behavioral economists widen the lens of incorporating sociological and socio-psychological notions of fairness stemming from social comparisons regarding tax burdens could be positive drivers of tax compliance to overcome the ‘burden of taxes’ and associations of losses. The cases of voluntary, self-chosen tax ethics and situational influences on social tax compliance norms have just recently been covered by behavioral approaches towards public administration. In general, social comparisons determine social norms that define internalized standards how to behave. Yet internalized social norms are based on comparisons with others that may determine tax morale (Frey, 1997; Mumford, 2001; Schmolders, 1960). Social norms elicit concurring behavior when taxpayers identify with the goals of a group but also if they feel being treated in a fair manner by that group. Social fairness considerations in a tax reference group may further taxpayer compliance. Fairness is believed to decrease egoistic utility maximization leveraging trust and reciprocity as interesting social norms building factors (Kirchler 2007). Social perceptions of fairness as underlying social norms are therefore potential tax ethics nudges. But psychological facets of fairness for the formation of social norms have been left out. If taxpayers believe that non-compliance is a widespread and socially-accepted, then it is more likely that they will not comply as well. Non-compliance may stem from the notion of unfairness in how the tax burden is weighted heavier on some parts of society.

The respective bonds-and-tax climate stability financing strategy therefore proposes to bear the burden of climate in a right, just and fair way around the globe. In the climate change winner countries, taxation should become the main driver over financing climate stability strategies. Foremost, the industries winning from a warming climate should be taxed. The Winner-Loser-index is based on the cardinal temperatures for

all GDP contributing sectors. Based on the cardinal temperatures for the three GDP components agriculture, industry and service, the taxation should be enacted for those sectors having most time ahead. The underlying rationale is thereby that these sectors will be gaining the most from a warming earth and will therefore be flourishing.

Regarding concrete climate taxation strategies, a carbon tax on top of the existing tax system should be used to reduce the burden of climate change and encourage economic growth through subsidies (Chancel & Piketty 2015). Within a country, high and low income households should face the same burden of climate stabilization adjusted for their disposable income. First, climate justice within a country should pay tribute to the fact that low- and high income households share the same burden proportional to their disposable income, for instance enabled through a progressive carbon taxation. Finding the optimum balance between consumption tax adjusted for disposable income through a progressive tax scheme will aid to unravel drivers of tax compliance in the sustainability domain. Those who caused climate change could be regulated to bear a higher cost through carbon tax in combination with retroactive billing through inheritance tax. But also developed and underdeveloped countries as well as various overlapping generations are affected differently. Besides progressive taxation schemes to imbue a sense of fairness in climate change burden sharing, inheritance taxation is also a flexible means to reap past wealth accumulation, which potentially caused environmental damage. The burden of climate change mitigation and adaptation could also be allocated in a fair way within society through contemporary inheritance tax in order to reap benefits of past wealth accumulation.

If climate taxation is perceived as fair and just allocation of the climate burden, this could convince tax payers to pay one's share. A novel 'service-and-client' atmosphere could promote taxpayers as cooperative citizens who are willing to comply if they feel their share as fair contribution to the environment. Taxpayers as cooperative citizens would then be willing to comply voluntarily following the greater goal to promote taxpayer collaboration and enhance tax morale in the environmental domain. International comparisons of tax behavior also reveal tax norms being related to different stages of institutional development of the government, which is an essential consideration in sharing the climate change burden in a fair manner between countries. A completely novel approach is to shed light on the benefits of a warming earth in order to derive fair climate gains distribution strategies around the world (Puaschunder 2017).

Introducing financing climate change mitigation through bonds to be paid back by future generations through taxation is an additional means to raise funds for offsetting the losses of global warming. As a novel means to amend individual saving preferences in favor of future generations, Sachs (2014) proposes to mitigate climate change by

debt to be repaid by tax revenues on labor income in the future. In a 2-period model, one generation works in period 1 and retires in period 2. Part of the disposable wage income is saved for consumption in the second period. CO₂ emission mitigation imposes immediate costs onto current generations and reduces wages. Greenhouse gas concentrations in period 2 are determined by the emissions in period 1. Wages of the young in the second period are reduced by climate change dependent on greenhouse gas levels. Disposable labor income of the young equals market wage net of taxes. Leaving the current generation with unchanged disposable income allocates the burdens of climate change mitigation across generations without the need to trade off one generation's well-being for another's. While today's young generation is left unharmed, the second period young generation is made better off ecologically.

The bonds solution should primarily be pursued in climate change loser countries, in order to offset the costs for climate change in a more intergenerationally harmonious way. Since there are no profiting entities and industries in the losing countries, future generations should be serving as last resort to pay for climate stability. All generations are better off with mitigation through climate bonds as compared to the business-as-usual (BAU) non-mitigation scenario (Sachs 2014). While future generations enjoy a favorable climate and averted environmental lock-ins; the current populace does not face drawbacks on economic growth (Puaschunder, 2017). Governments in loser countries should receive tax transfers in the present from the winning countries. Since here borrowing equals loans or issuing of bonds to be paid back by future generations, the government must pay back debt plus interest payments by raising taxes on later generations. This strategy is justified as for the assumed willingness of future generations to avoid higher costs of climate change prevention and environmental irreversible lock-ins. Overall this tax-and-transfer mitigation policy is thus Pareto improving and overall fair solution across the world and generations.

5. Conclusion

As a novel alternative to raise funds to instigate climate change mitigation and adaptation, the results yield at funding today's climate stabilization efforts through an international benefits transfer backed by climate bonds and carbon tax. Sharing the costs of climate change aversion between countries and across generations appears as important strategy to instigate immediate climate change mitigation through incentivizing emission reduction and provide adaptation funding opportunities.

While the proposed climate change benefits transfer strategy through bonds and taxation is a novel economically and socio-psychologically superior strategy to nudge people into action and real-world relevant emergent risk prevention means; we currently lack information on the concrete impact of financing climate change mitigation and adaptation as well as transition to renewable energy. The concrete benefits a warming earth and interconnectedness with climate change losses in light of interdependencies and lurking tipping points are unknown, yet hold crucial insights on the model's sustainability over time.

Overall, the paper thereby provided the first attempt to find a behavioral economics solution to nudge people into necessary climate action based on positive incentives. Positive signals of gain prospects may help engage the many we need for instigating action now on climate justice. This novel, feasible and easily-implementable solution to steer many stakeholders towards climate action is only presented in order to help to derive mitigation policies and communication strategies for a fairer climate stability solution. All these endeavors may lead to a fairer strategy to respond to global warming and hopefully provide a real-world relevant means how to implement climate justice across the globe and over time.

In deriving information on climate justice implementation and management strategies, future research should investigate what institutions and regimes could guide benefits distribution. This information is essential in order to craft institutional climate justice management strategies and define feasible market structures to issue and policies to support climate justice on a global scale. In addition, the fiscal sustainability of climate justice distribution over time should be evaluated in order to estimate real-world relevant climate change mitigation and adaptation market strategies in the finance sector based on future global climate prospects. In this line of research, a more nuanced investigation should follow on what sector-specific gains are expected to flourish as well as what GDP sectors will likely see growth and which ones will likely see a reduction due to changing climate conditions. Further, climate instigated migration should become prospected based on the findings of global climate change winners and losers as well as prospective findings of sector and industry specific climate change-induced growth. Further insights gained could lead to mapping climate induced migration streams and a climate refugee asylum strategy in countries winning from a warming earth. These insights on climate-induced migration could become the backbone of acknowledging climate refugees under the Geneva Convention (Ferreira, forthcoming). The preliminary findings of beneficial climate change is aimed at paving the way to more solid investigations on the optimal policy mix to combat climate change financed through the distribution of global warming benefits. The established fact of short-

term benefits of climate change should thereby orchestrate the financialization of climate stability. Climate change mitigation and adaptation infrastructure should be derived from balancing the global warming gains around the globe and over time. Future research endeavors should help multiple stakeholders shape economic growth with respect for sustainable development on the basis of climate change burden sharing through global warming benefit transfers enacted through bonds and taxation in between countries and in between generations. All these endeavors target at serving the greater goal of unfolding climate justice in the 21st century.

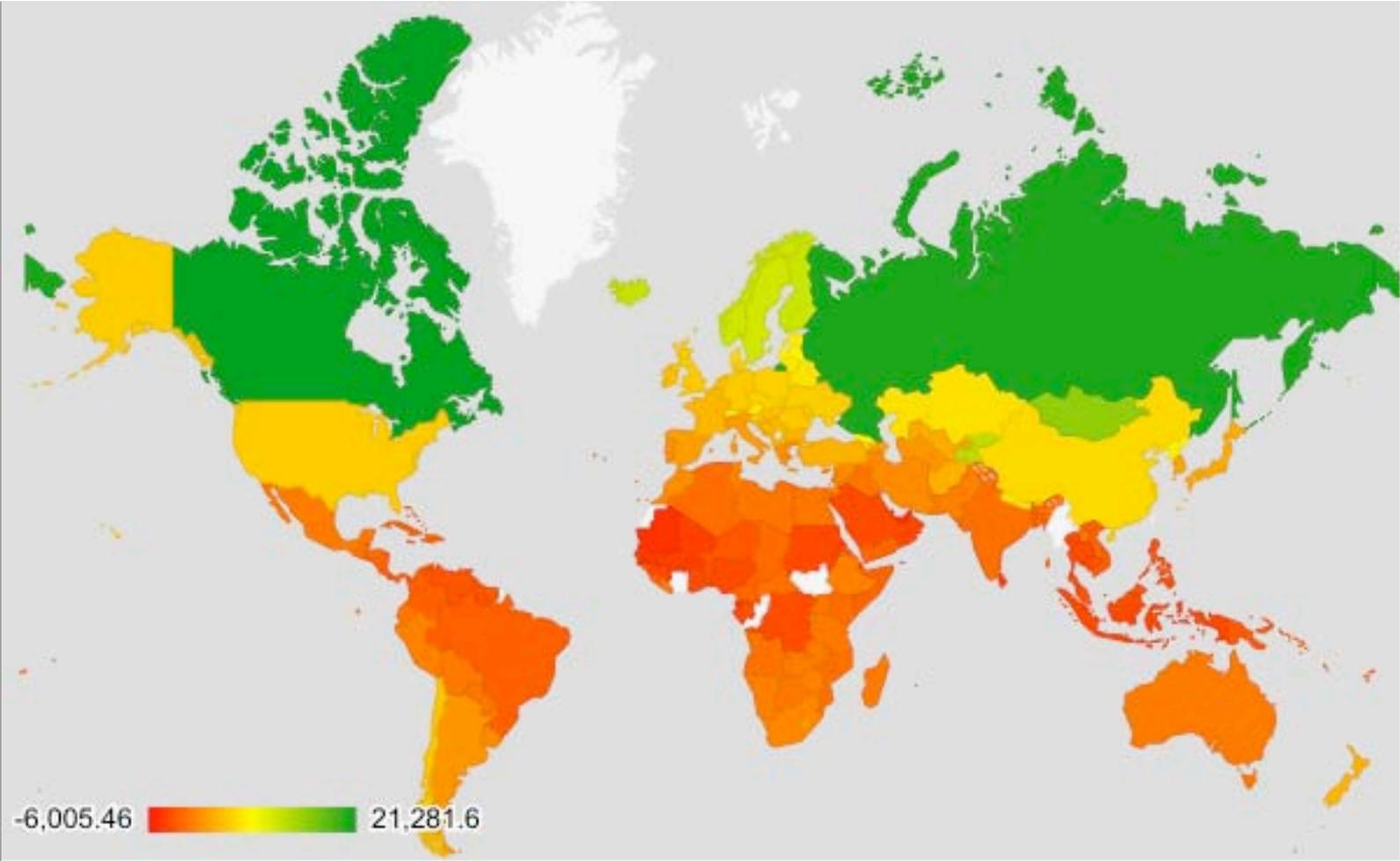
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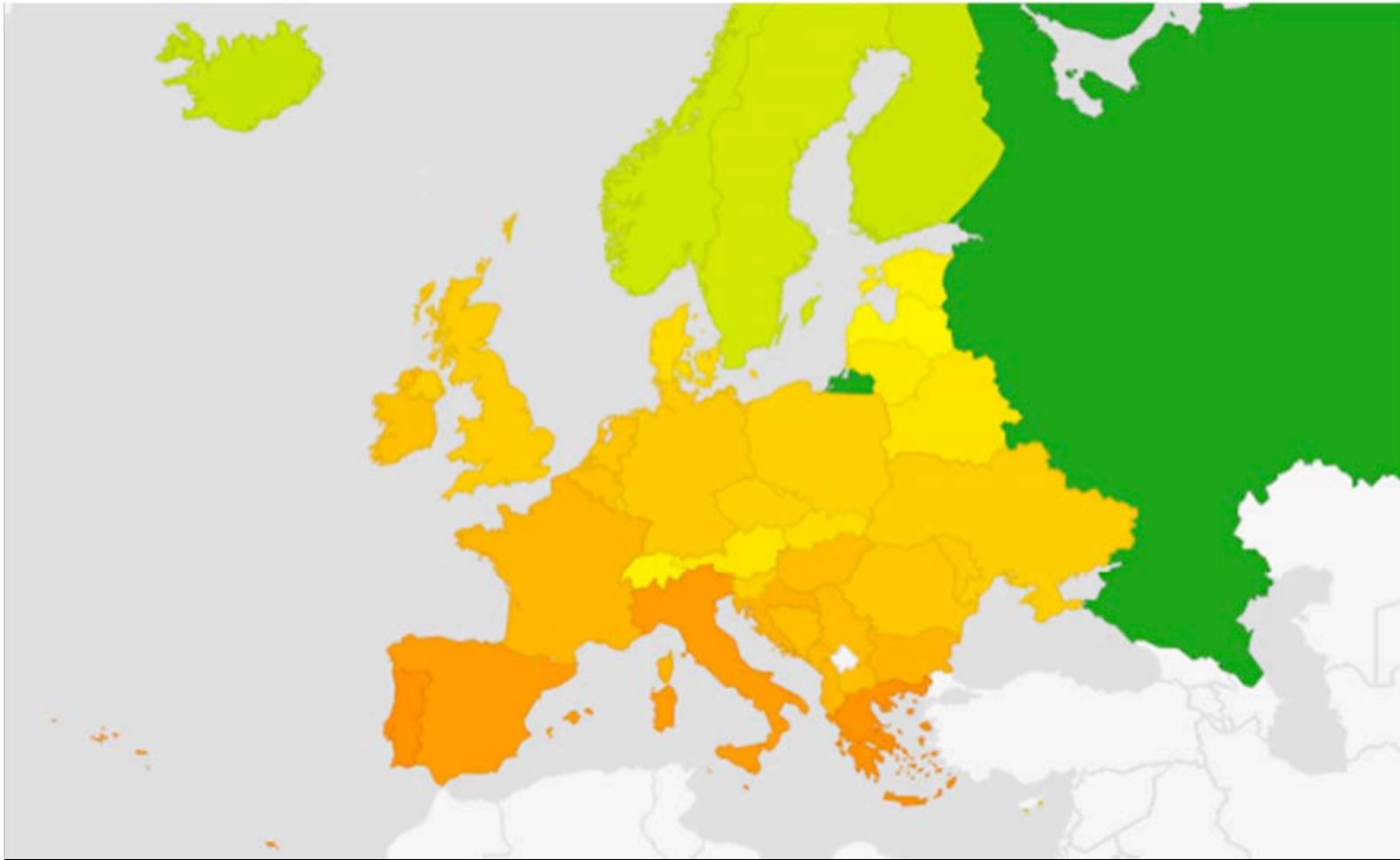
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Graph 2: Climate change winners and losers around the world



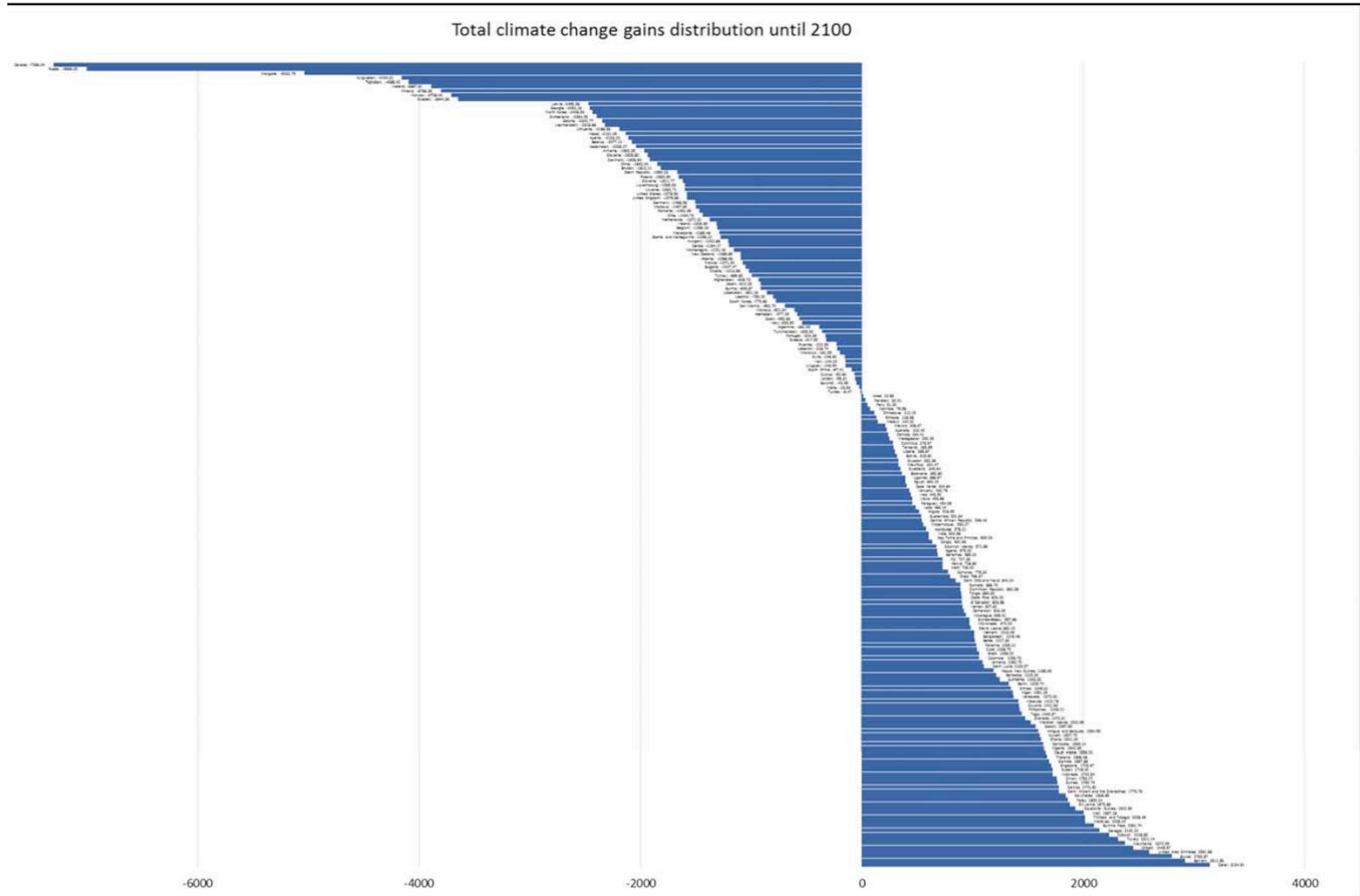
Graph 3: Climate change winners in Europe



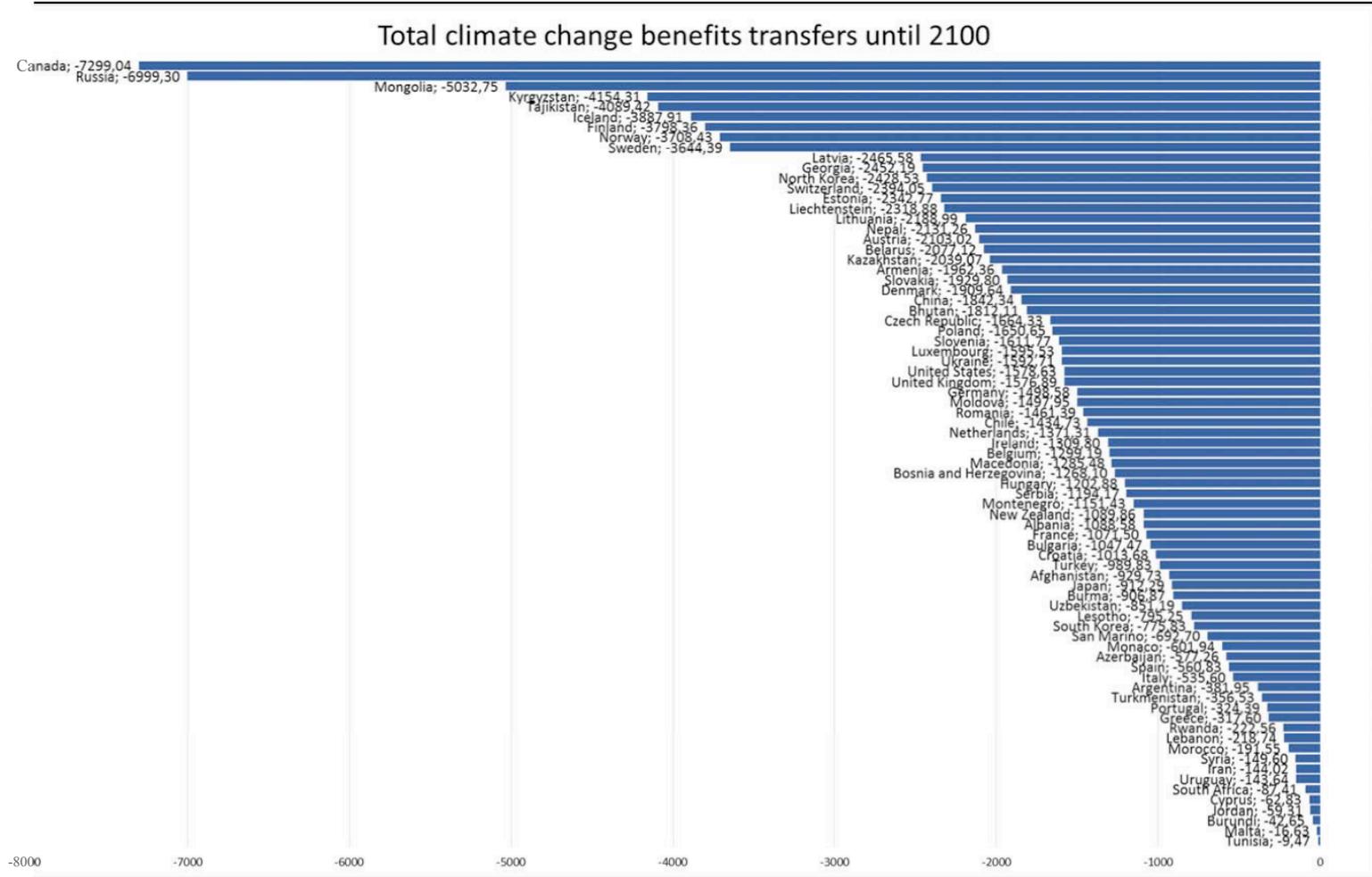
Graph 4: Climate change winners in North America



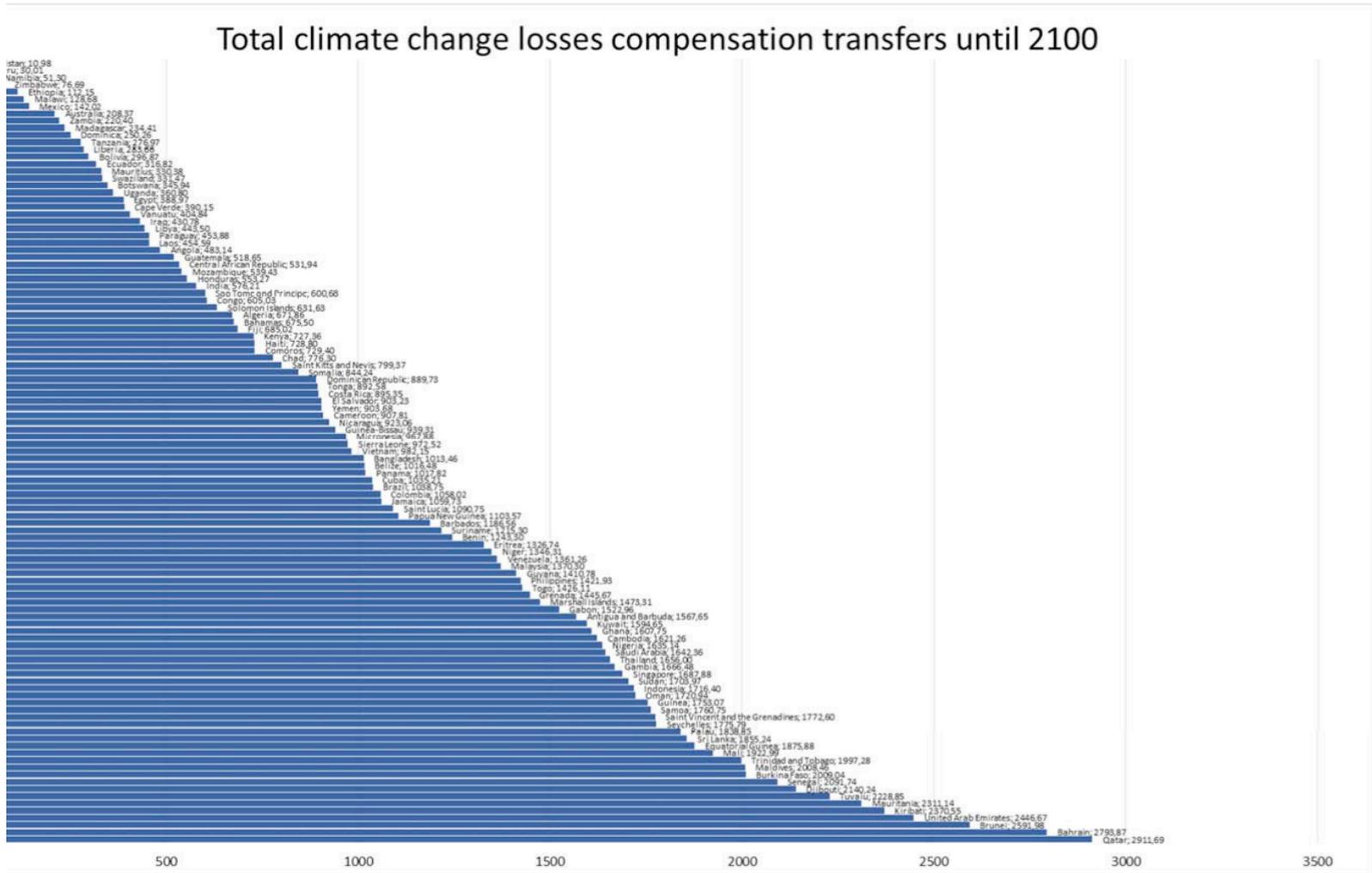
Graph 5: Total climate change transfers until 2100



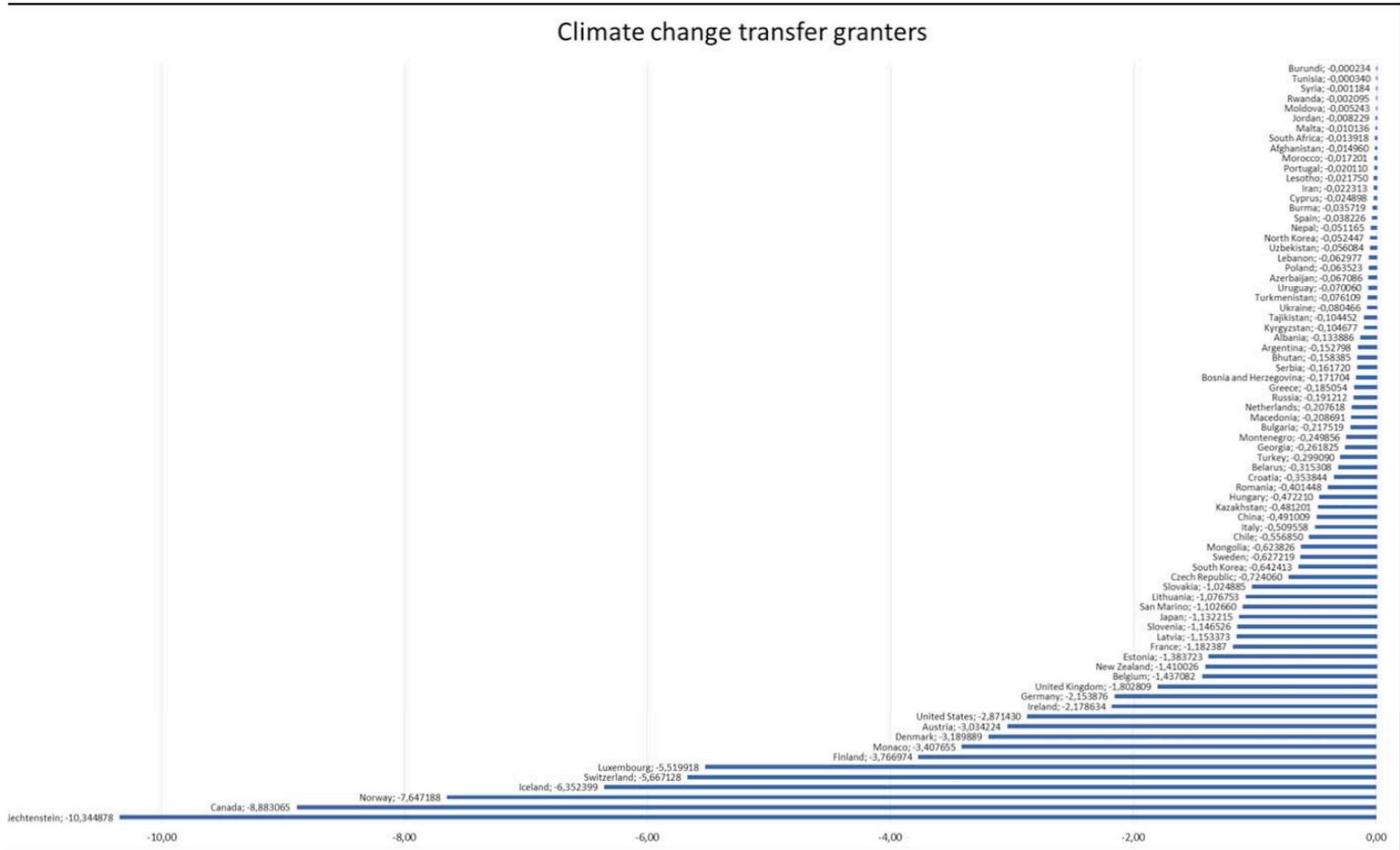
Graph 6: Total climate change benefits transfers until 2100



Graph 7: Climate Change Winners



Graph 9: Climate change transfer payers weighted by GDP per inhabitant



Graph 11: World climate change benefit transfers, green=highest benefit transfer countries, yellow=medium benefit transfer countries, light red=medium beneficiary countries, red=highest beneficiary countries

