Scientia Moralitas International Journal of Multidisciplinary Research
ISSN 2472-5331 (Print) | ISSN 2472-5358 (Online) | Vol. 7, No. 2, 2022
DOI: 10.5281/zenodo.7472079

Science Diplomacy Index: Leadership and Responsibility to Act on Climate Change

Julia M. Puaschunder
Columbia University, Graduate School of Arts and Sciences
Julia.Puaschunder@columbia.edu
http://blogs.cuit.columbia.edu/jmp2265
www.juliampuaschunder.com

ABSTRACT: In the age of global warming, pandemics and East-West tensions, the time for science diplomacy has come. To this day, the concept of science diplomacy has never been quantified to highlight the importance and potential of specific countries around the globe to engage in science diplomacy. In the first macroeconomic model of science diplomacy, an index was created including 51 countries around the world ranked on their potential to be spearheading science diplomacy. The presented Science Diplomacy Index integrates (1) the academia quota per country as an indication of scientific excellence based on World Bank Educational Attainment data of at least Bachelor's or equivalent education in the population of a country from 25 years of age as cumulative percent in the population; (2) a modified World Ranking of academic institutions based on the Web of Universities data weighted by the relevance of its academic institutions; and (3) the Lowy Global Diplomacy Index measuring diplomatic relations in embassies, consulates, or other diplomatic representations. The index is then applied to a macroeconomic model on disparate economic impacts of climate change around the world and country-specific CO_2 emission levels, in order to determine what countries have excellent starting grounds but also a heightened responsibility to engage in science diplomacy to reverse the negative impacts of global warming. The results offer invaluable yet quantified information on the importance of science diplomacy in the 21st century.

KEYWORDS: Climate change, Climate change economic impacts, Climate Change mitigation and adaptation, Cultural diplomacy, Global common goods, Global warming, Gross Domestic Product, Macroeconomics, Negotiation, Negotiation Leadership, Pandemic, Prevention, Public policy, Resilience finance, Science diplomacy, Soft diplomacy

Introduction

Today's global challenges in regards to climate change demand for urgent action of the global community. Time windows close on humankind's ability to revert global warming. Global warming impacts have reached unprecedented urgency for attention to finding common-ground driven solutions fast and efficiently.

In the coming together of all nations to solve global issues of concern around global warming, global governance institutions have done excellent work and proved successful leadership in the past decades. Another form of more informal strategies to discuss global crises leaving aside political frameworks and customary law practices is to connect and build a bridge of mutual understandings of global community members via scientific facts.

As early as in the 1930s and at its height during the old Cold War, researchers came together and aligned in order to discuss matters-of-facts and rational findings leaving aside any political agenda and historical denominations. This practice became known as Science Diplomacy. At the forefront of Science Diplomacy stood the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria, which – to-this-day – informs public leaders based on science-driven interdisciplinary findings and interculturally-derived insights.

Science diplomacy had its height during the Cold War era when institutional foundations in global international organizations helped connect scientists via empirical and rational facts in order to solve global issues of concern aside from political realities and country differences. In light of renewed East-West tensions and the urgency of a global warming solution, today's most pressing international challenges in climate change call for a renewed science diplomacy spirit to discuss solutions scientifically without political biases and historic customary practice.

Science Diplomacy builds on 'scientific collaborations…to address common and shared problems' (The Vienna Statement on Science Diplomacy 2022). Science diplomats advocate for 'free and open exchange of scientific ideas and information' (The Vienna Statement on Science Diplomacy 2022). Building on the integrity of research and societal responsibility focus of science, science diplomacy fosters 'freedom of cooperation' (The Vienna Statement on Science Diplomacy 2022). Science can learn from diplomacy tactful communication and respectful appreciation of differences; while diplomacy can benefit from the rationality of scientific facts and the rigor in argumentation over precise quantifications of the natural environment.

With certain world problems being too-big-to-fail requiring global collaboration and fast action, the challenges of our lifetimes appear to only be surmountable if tackled by a rational scientific collaborative approach. The time for Science Diplomacy has therefore come. Yet to this day, no quantification of the concept of science diplomacy exists. The concept of science diplomacy has never been quantitatively studied to highlight the importance and potential of specific countries around the globe to engage in academic discourse for science diplomacy. In particular, we lack information on what countries can lead the world to find a common ground on climate change aversion with science diplomacy advocacy.

The following paper acknowledges today's global challenges in climate change and presents the first quantification of science diplomacy potential around the world. This paper first introduces the concept of Science Diplomacy, drawing from the history of the International Institute for Applied Systems Analysis, to then capture the most pressing contemporary issue of climate change. A macroeconomic index of science diplomacy will be calculated to highlight the individual potential of countries around the world as a global panacea against global warming. In the first quantification of the concept of Science Diplomacy, an Index integrates (1) the academia quota per country as an indication of scientific excellence based on World Bank Educational Attainment data; (2) a modified World Ranking of academic institutions weighted by the relevance of its academic institutions; and (3) the Lowy Global Diplomacy Index measuring diplomatic relations in embassies, consulates, or other diplomatic representations. The paper also applies the

first Science Diplomacy Index (SDI) on the concept of a Responsibility to Act (RTA) on climate change based on a macroeconomic model estimating the economic prospects under the condition of a changing temperature (Puaschunder 2020). The results of the Science Diplomacy Index applied to a macroeconomic model on disparate economic impacts of climate change around the world and country-specific CO_{2e} mission levels determines what countries have excellent starting grounds but also a heightened responsibility to engage in science diplomacy to reverse the negative impacts of global warming (Puaschunder 2020). The discussion informs about future research avenues for deriving inferences about the relation of science diplomacy and macroeconomic correlates to shine light at the positive implications and multiplying variables of science diplomacy.

Science Diplomacy

Science diplomacy uses scientific collaborations among nations to address common problems and build constructive international partnerships for their solutions (The Vienna Statement on Science Diplomacy 2022). As a rather informal and unpaid diplomatic service, scientists are thereby engaging in technical, research-based academic discourse and scientific exchange with the goal of collaborating based on facts to understand and alleviate global concerns.

Originating since the 1930s in concept but practiced vividly during the Cold War, science diplomacy benefitted from the political and financial independence of scientists, who often could exchange information freer from governmental oversight and media scrutiny control than conventional diplomats. Science diplomats were mainly researchers trained to focus on facts and scientific goals rather than promoting national country interests or advocating for stakeholder demands.

Topics of scientific cross-border interests became subject to informal meetings to discuss the emergence of potential global challenges and world community needs. Oftentimes, scientists were the only elite group who was allowed to travel freely under restrictive regimes, granting them a global network in the governance and development of science. Historic examples of scientific collaboration despite political adversities include explorations and

scientific measurement of distance and time as well as grand accomplishments in technology and energy creation. Potential advancements during Cold War that were driven by science diplomacy were the successful closing of the Ozone Layer, cooperative development of nuclear energy, space exploration and technology transfers.

Science diplomacy appears to be practiced by scientists to advise and inform as well as support policy objectives with international impetus and/or global governance focus. Science diplomacy also benefits from attracting a range of scientists who are willing to collaborate and practice heterodox – in terms of unconventional methodology – scientific ethics. Science diplomats' scientific cooperation thereby forms a network of scientific exchange around the world, governmental leaders may turn for maintaining communication channels in times when political and conventional diplomacy are deadlocked (Gluckman, Quirion, Sachs & van Jaarsveld 2022). Science diplomacy is therefore a research collaboration-based informal network of allies that transcends nationalism and political frictions (Gluckman et al. 2022).

Science Diplomacy is considered as a new diplomacy form different from traditional diplomatic ties and a subform of international relations or soft diplomacy (Barston 2014; Bjola & Kornprobst 2018; Constantinou & Sharp 2016; Nye 1990; Sharp 2016; Szkarłat 2020). At the core of science diplomacy rests scientific cooperation and compromise for higher goals of global stability, sustainable development and common security.

Science diplomacy also allows for pooling of diversified viewpoints and a larger range of funding than conventional national scientific endeavors. The international sharing of organizational capacities and historically-grown expertise is bundled with a clear focus on empirically-driven results aside from national-politically-tainted red tape. As a rather unconventional approach to tackle global challenges and mainly focused on often hard-to-understand or inaccessible scientific jargon, science diplomacy collaboration can also benefit from less media scrutiny and market interference.

Historically, Science diplomacy was practiced successfully at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria from the end of the 1960s on throughout the Cold War (Gluckman et al. 2022). On the back-then-neutral country ground Austria, scientists from East and West could discuss and exchange research-based knowledge

and *en passant* build bridges and lasting ties between two blocs that were officially at cold diplomatic tact and rested within politically-distanced camps (Gluckman et al. 2022). Scientists focused on common issues of concern and advancing global progress towards a better future for all and thereby incepted concepts like sustainable development, nuclear disarmament and space exploration cooperation (Gluckman et al. 2022).

Global governance institutions, like the World Bank, International Monetary Fund and United Nations, are building on science diplomacy to this day. Not only in the elevated number of academic-hired Bretton Woods institutions officials. But also in formal ties and open collaborations with universities and scientific organizations, such as National Academy of Sciences. Around the world, science diplomacy appears to come to action and global progress to fruition. Successful examples are the Conferences of the Parties (COP) Intergovernmental Panels on Climate Change (IPCC) reports, which are usually led by scientific investigators and rolled out with the help of global governance institutions, foremost the United Nations. The Sustainable Development Goals of the United Nations but also the Unequal World Conferences of the United Nations have become hallmarks of science diplomacy delivering tangible research output and credible results aside from political agendas.

Most recent notable advancements were the push towards science diplomacy as a soft power during the U.S. President Barack Obama administration. Notable institutional support is – to this day – provided by national Academies of Sciences around the world. The American Association for the Advancement of Science (AAAS) in Washington D.C. houses a Center for Science Diplomacy to bring together 'scientists, policy analysts, and policy-makers' to 'share information and explore collaborative opportunities' (Center for Science Diplomacy of the American Association for the Advancement of Science). The European Union also advocates for science diplomacy in EU-funded projects and international programs, such as the European Master in Law & Economics.

Leaders in science, politics but also the industry have acknowledged the power and influence of science diplomacy beyond traditional governmental efforts and conventional international development. Global challenges that are too-large-to-fail and can only be surmounted by concerted intellectual

effort asides from political agendas call for science diplomacy solutions. Global challenges related to climate change lay at the intersection of science and international relations.

Climate change

The climate change crisis has gained unprecedented urgency in the most recent decade. Scientific estimations give the world community a decade to act on climate change before irreversible lock-ins and substantial tipping points will be reached. The world could end up in an environmentally-hostile state and it will never be possible to bring back stable environmental climate conditions.

Overall, climate change has already led to and will continuously lead to irreversible tipping points and lock-ins that will degrade the common welfare (Kellett, Weller, Faulwasser, Grüne & Semmler 2019). The extraction and use of non-renewable fossil fuels is attributed as one of the main causes of human-made global warming and a highly volatile market endeavor. Global warming can be slowed by limiting the total cumulative global CO2 emissions – but only if this occurs on an international scale and in a globally-concerted action plan.

Historically, the advanced countries have gained welfare and rising living standards by the use of fossil fuel energy and intensive CO2 emissions, while the developing countries have not and appear nowadays as the most burdened with the climate disasters. In the aftermath of the 2020 United Nations Conference of the Parties (COP26) meeting on Climate Change, it has been argued that the advanced countries have an obligation and responsibility to finance the adaptation to global warming of the low-income countries through direct transfers and credit guarantees (Sachs 2021).

Future economic growth depends on national temperature conditions and climate change (Hansen 2014). Climate change risks are manifold and comprise of physical risks in weather extremes, wildfires, landslides, flooding, heatwaves, hurricanes, storms and typhoons, smog and many other forms of environmental damage. Climate-related finance costs are also imbued in transition risks in stranded assets as for causing volatility in financial systems.

Macroeconomically, costs arise as a result of damages that are exacerbated by extreme temperatures and severe weather events (Banerjee 2014). The measurement of the widespread effects of temperature changes includes catastrophes but also response lags and slow feedback in the wake

of environmentally-changing conditions (Bonen, Klasen & Semmler 2014; Hansen & Sato 2016).

In the treatment of risk, economic and non-economic climate risks have to be considered – such as, for example, tipping points and irreversible lock-ins that could cause Greenland ice shields and the Arctic Sea ice to disappear or collapse as well as ocean circulations that cause hurricanes and typhoons (Brock, Engström & Xepapadeas 2014; Keller & Nicholas 2014). Tipping point effects could increase weather extremes and intensify tropical storms, hurricanes, typhoons and cause weather extremes to occur more frequently. Results could be drastic if considering sea level rises, heat waves and desert formations as well as draught impacts on the ecosystem but also human development. Future vulnerability depends not only on climate change but also on the development path, mitigation, adaptation policies and precautionary measures (Hansen & Sato 2016).

Overall, climate change is expected to lead to drastic changes in productivity, food supply and labor working conditions. Tipping points and irreversible lock-ins with long-run changes will require improved climate projections to better inform climate risk management on a global scale (Keller & Nicholas 2014). Mitigation efforts of the international community will be needed that target to avert the global effects of climate change. Adaptation efforts around the world must be concerted to cope with local effects of climate change, such as regional disasters.

In the effort to curb harmful CO2 emissions, problems have arisen historically. The New York Times most recently discussed the disparate impact of climate policies and climate protection attention disparities (Flavelle 2021a, b). Geographically-determined economic prospects in light of climate change reveal vast inequalities in the distribution of future climate-induced economic gain or loss prospects (Puaschunder 2020). While ethical imperatives lead to the claim for redistributing some of the short-term economic gains of global warming into territories that are losing out from climate change the most and the fastest; political realities may hinder efforts to cooperate on an international level to redistribute resources in order to avert climate change. Free rider problems exist, whereby countries that do not take action may benefit from the other countries' efforts. Political historical facts may also deter countries from action on climate change, as

was shown during the Copenhagen Intergovernmental Panel on Climate Change Conferences of the Parties (COP).

Novel policy efforts are now focused on redistribution via taxation and bonds strategies (Semmler, Braga, Lichtenberger & Toure 2021; Puaschunder forthcoming b, c). While a World Bank Report presents a global overview on the current state of climate taxation and climate bonds usage around the globe, it calls for macroeconomic models to inform on the political feasibility of climate gains redistribution strategies and global warming loss burden sharing. Current climate change mitigation and adaptation financing efforts are calling for innovative green investment strategies around the globe.

Alternative market-driven solutions appear in the Cap-and-Trade scheme but also in Socially Responsible Investing (SRI) and market solutions to curb harmful CO2 emissions that can only be effective if implemented on a world-wide scale (Puaschunder forthcoming a). Ethics of inclusion in the environmental domain as a novel climate taxation-and-bonds strategy to redistribute climate change gains can only raise widespread momentum for a transitioning to a zero-carbon global economy if carried by a global community.

An emerging literature and awareness on the economic gains and losses of a warming globe being distributed unequally between countries is the basis of redistribution schemes. In the aftermath of the COP26 annual climate meeting of the United Nations, Jeffrey Sachs (2021) put forward an idea of funds for climate change mitigation and adaptation that should be raised by climate tax-funded grants provided by some countries as transfer payments, while other countries should be recipients of green bonds granted to low-income countries. A refinement in prioritizing which countries should be grantors and which recipients based on macroeconomically-informed criteria, such as expected climate change economic gains and losses as well as CO2 emissions as the cause of global warming. In the political feasibility check of a global redistribution scheme, science diplomacy appears as prerequisite to implement climate change aversion via taxation and bonds strategies. All these strategies will need a scientifically-informed concerted action of all nations of the world, which lets science diplomacy appear as attractive vehicle to push for a common ground. While the country positions on expected climate change economic gains could serve as an indicator to determine the responsibility to act on global warming, science diplomacy

could aid in targeting what countries could lead the world in the collective burden sharing strategy and implementation of a common climate gains redistribution scheme.

Research question and hypotheses

This paper addresses the question, what countries have favorable science diplomacy leadership conditions and heightened responsibility to act on climate change? In order to act on climate change mitigation and adaptation within the shortened timeframe given, a global solution must be found in extraordinary speed. Country leadership of powerful science diplomacy nations appears as necessary conditions to push for cooperation and feasible solutions that are carried by the world community. The following index will thus help determine the countries that have good starting grounds on science diplomacy given their academic skills and scientific institutions as well as knowledge-driven expertise networks.

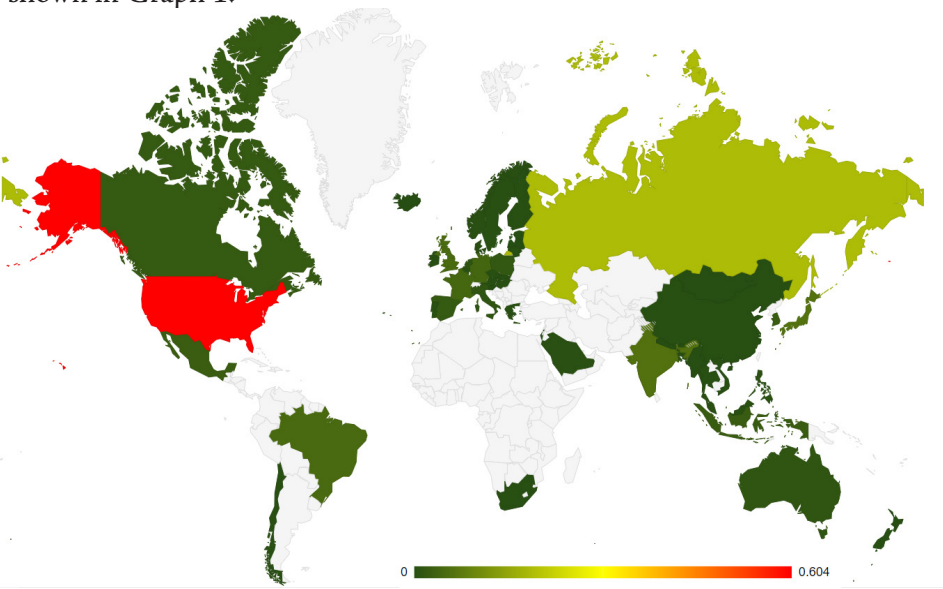
After presenting a scientific quantification of science diplomacy leadership potential, the Science Diplomacy Index will be applied on climate change aversion strategies. Thereby the question arises what countries have an economically better starting ground to protect the earth from global warming and a higher obligation to act on fair climate solutions. In accordance with ethical imperatives derived from Immanuel Kant's (1783/1993) categorical imperative and Hans Jonas (1979) extension on environmental justice, John Rawl's (1971) veil of ignorance, Kaldor's (1961) compensation criteria and Puaschunder's (2020) climatorial imperative, those countries should have a higher responsibility to act to protect the earth from global warming that have relatively better economic outlook conditions in light of climate change as well as those countries that cause the problem of a heating up earth in CO2 emissions.

The underlying hypotheses of the following macroeconomic modeling state that scientifically-skilled and academically-equipped nations with rising economic prospects based on changing temperatures under global warming have favorable redistribution conditions as well as those countries that cause the problem in harmful CO2 emissions have a heightened responsibility to act on climate change with science diplomacy focused on enacting climate justice.

Science Diplomacy Index (SDI)

Method: In the first macroeconomic model of science diplomacy, an index was created including 51 countries around the world ranked on their potential to be spearheading science diplomacy. The presented Science Diplomacy Index (SDI) integrates (1) the academia quota per country as an indication of scientific excellence based on World Bank Educational Attainment data of at least Bachelor's or equivalent education in the population of a country from 25 years of age as cumulative percent in the population derived from the United Nations Educational, Scientific and Cultural Organization (UNESCO) Institute for Statistics data as of June 2022 (World Bank 2022); (2) a modified World Ranking of academic institutions based on the Web of Universities data weighted by the relevance of its academic institutions of the July 2021 edition (Web of Universities 2022); and (3) the Lowy Global Diplomacy Index 2019 Country Ranking measuring diplomatic relations in embassies, consulates, or other diplomatic representations (Global Diplomacy Index 2022).

Results: The Science Diplomacy Index results for 51 world countries are shown in Graph 1.



Graph 1: Science Diplomacy Index world map

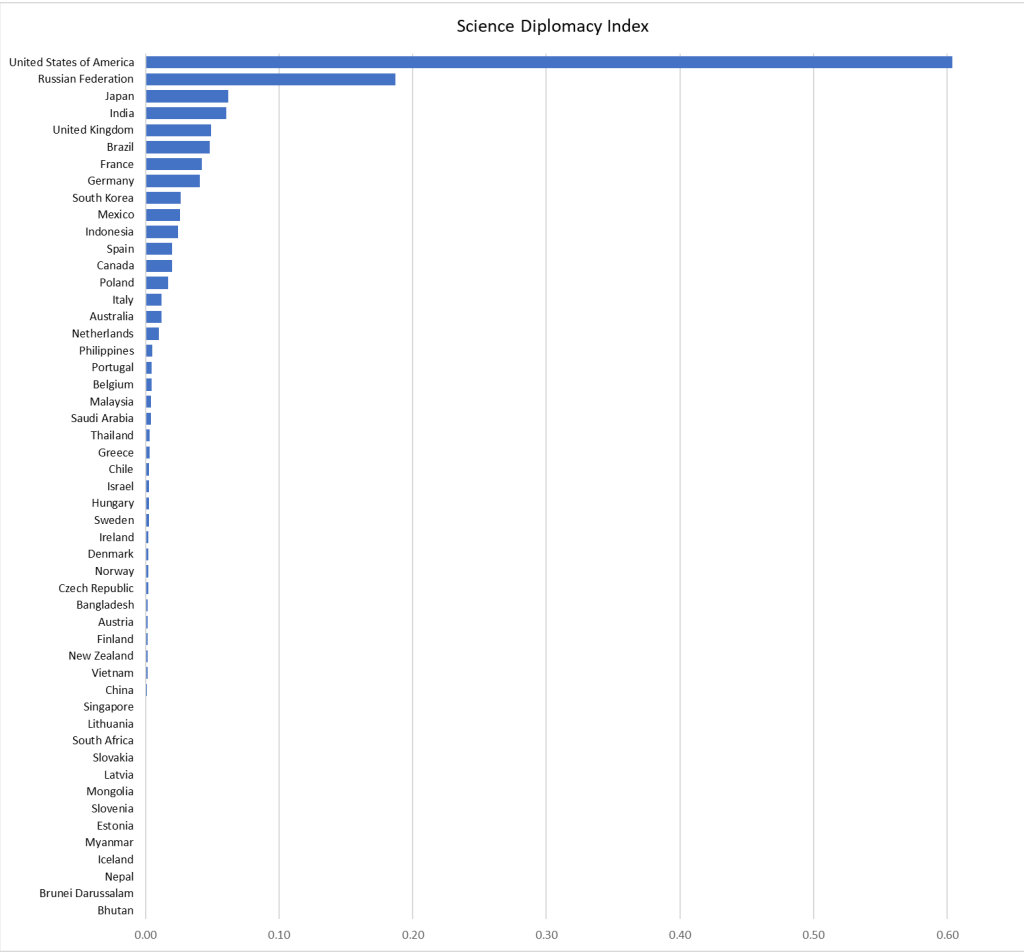
The red country has the best science diplomacy conditions, followed by yellow and light green colored countries. The dark green countries have low science diplomacy preconditions. For white countries no data exists.

The supporting data of the Science Diplomacy Index is exhibited in Table 1.

Table 1: Science Diplomacy Index numerical ranking

Science Diplomacy Index									
Australia	0.012041	Czech Republic	0.002086	Indonesia	0.024474	Myanmar	0.000161	Singapore	0.000921
Austria	0.001633	Denmark	0.002291	Ireland	0.002345	Nepal	0.000010	Slovakia	0.000848
Bangladesh	0.001803	Estonia	0.000313	Israel	0.002615	Netherlands	0.010268	Slovenia	0.000400
Belgium	0.004423	Finland	0.001598	Italy	0.012258	New Zealand	0.001583	South Africa	0.000867
Bhutan	0.000000	France	0.042081	Japan	0.062239	Norway	0.002108	South Korea	0.026350
Brazil	0.048176	Germany	0.040758	Latvia	0.000557	Philippines	0.005180	Spain	0.020001
Brunei Darussalam	0.000002	Greece	0.003227	Lithuania	0.000903	Poland	0.016922	Sweden	0.002562
Canada	0.019878	Hungary	0.002593	Malaysia	0.004031	Portugal	0.004512	Thailand	0.003280
Chile	0.002752	Iceland	0.000038	Mexico	0.026015	Russian Federation	0.187294	United Kingdom	0.049136
China	0.001145	India	0.060416	Mongolia	0.000511	Saudi Arabia	0.003982	United States of America	0.603586
								Vietnam	0.001503

The Science Diplomacy Index for 51 countries of the world indicates that the United States offers best conditions to lead the world on science diplomacy. As visible in Graph 2, Russia as well as Japan and India, the United Kingdom, Brazil, France and Germany have good conditions to establish cooperation through science diplomacy. South Korea, Mexico, Indonesia, Spain, Canada, Poland but also Italy, Australia and the Netherlands play a role in science diplomacy leadership on a global scale. Additional countries of interest to help with science diplomacy are the Philippines, Portugal, Belgium, Malaysia, Saudi Arabia, Thailand, Greece, Chile, Israel, Hungary, Sweden, Ireland, Denmark, Norway and Czech Republic. In addition, capable of science diplomacy are Bangladesh, Austria, Finland, New Zealand, Vietnam and China. Further science diplomacy support can be granted by Singapore, Lithuania, South Africa, Slovakia, Latvia, Mongolia, Slovenia, Estonia, Myanmar, Iceland, Nepal, Brunei and Bhutan.



Graph 2: Science Diplomacy Index bar chart

Discussion: Overall, the results indicate that the U.S. and Russia are key players in science diplomacy. Africa offers science diplomacy leadership potential foremost in South Africa. In Asia Japan and India but also South Korea, Indonesia as well as the Philippines, Malaysia and Thailand, Bangladesh, Vietnam, China, Singapore, Mongolia, Myanmar, Nepal, Brunei and Bhutan play a role in science diplomacy. Australia and New Zealand take a role in science diplomacy as well. Within Eurasia, Saudi Arabia and Israel are key players on Science Diplomacy. In Europe, the United Kingdom, France and Germany lead followed by Spain, Poland, Italy, the Netherlands,

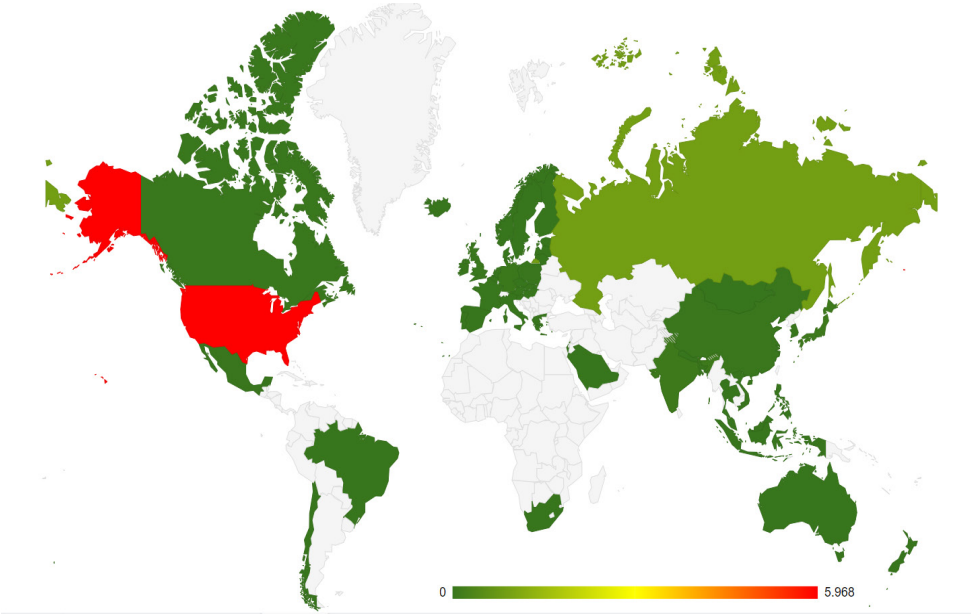
Portugal, Belgium, Greece, Hungary, Sweden, Ireland, Denmark, Norway and Czech Republic, Austria, Finland, Lithuania, Slovakia, Latvia, Slovenia, Estonia and Iceland. In North America, the U.S. leads on science diplomacy but also Canada has potential for academic diplomacy. In South America Brazil, Mexico and Chile have good starting grounds on science diplomacy.

Science Diplomacy Climate Responsibility Index (SDCRI)

Method: Economic research has elucidated the economic impact of climate change on the world and found stark national differences (Puaschunder, 2020). Puaschunder (2020) measured the Gross Domestic Product (GDP) prospect differences under climate change around the world and found exacerbating climate inequalities. Puaschunder (2020) introduced a climate change winners and losers index based on the economic prospects under climate change around the world and over time. The index attributed economic gain and loss prospects based on the medium temperature per country in relation to the optimum temperature for economic productivity per GDP agriculture, industry and service sector and the GDP sector composition per country in order to determine how far countries are deviating from their optimum productivity levels based on temperature on a time scale (Puaschunder, 2020).

The Science Diplomacy Climate Responsibility index is applied to the macroeconomic model on disparate economic impacts of climate change around the world (Puaschunder 2020) and country-specific CO2 emission levels for the year 2019 derived from Our World in Data, in order to determine what countries have excellent starting grounds on science diplomacy leadership but also a heightened responsibility to engage in science diplomacy to reverse the negative impacts of global warming via redistribution of prospective economic gains.

Results: The Science Diplomacy Climate Responsibility Index results for 48 world countries are shown in Graph 3.



Graph 3: Science Diplomacy Climate Responsibility Index

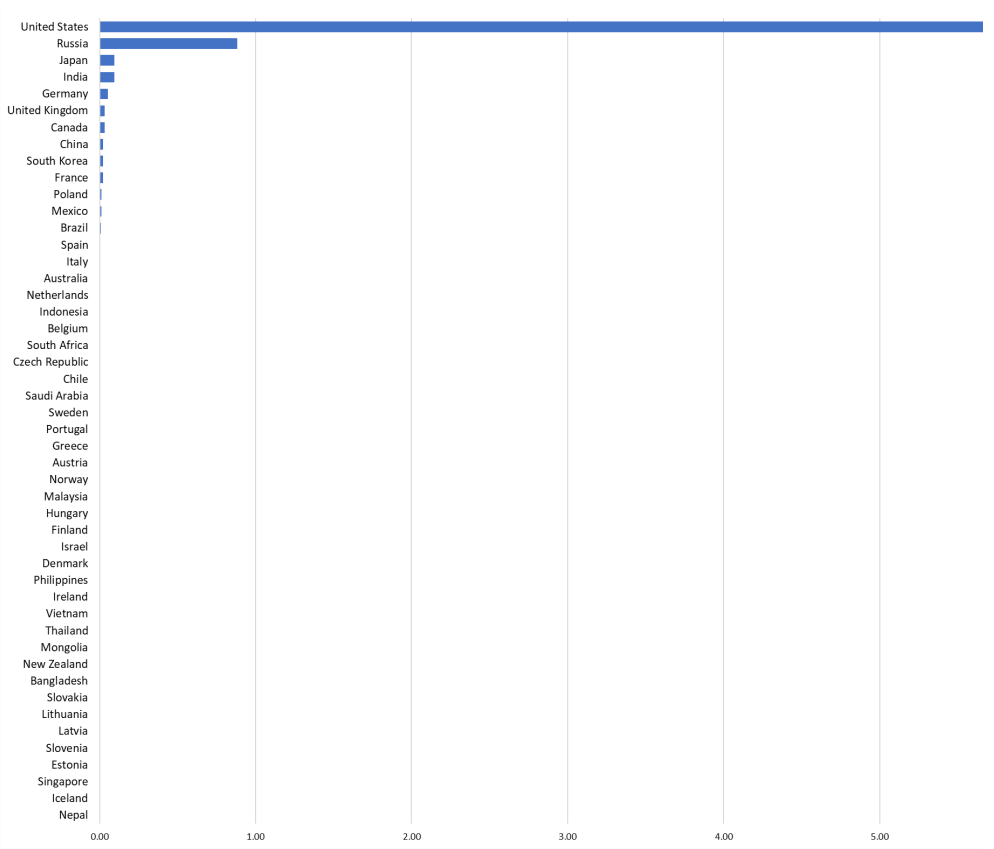
The red country has the best science diplomacy conditions and the highest responsibility to act on climate change, followed by light green colored countries. The dark green countries have low science diplomacy preconditions and relatively-lowered responsibility to act on climate change based on economic prospects given climate change. For white countries no data exists.

The supporting data of the Science Diplomacy Climate Responsibility Index is exhibited in Table 2.

Table 2: Science Diplomacy Climate Responsibility Index numerical ranking

Science Diplomacy Climate Responsibility Index									
Australia	0.004416	Estonia	0.000010	Israel	0.000168	New Zealand	0.000089	South Africa	0.000451
Austria	0.000248	Finland	0.000171	Italy	0.005214	Norway	0.000227	South Korea	0.021213
Bangladesh	0.000064	France	0.020454	Japan	0.096205	Philippines	0.000150	Spain	0.006468
Belgium	0.000740	Germany	0.052112	Latvia	0.000011	Poland	0.010761	Sweden	0.000273
Brazil	0.006980	Greece	0.000259	Lithuania	0.000028	Portugal	0.000266	Thailand	0.000111
Canada	0.032920	Hungary	0.000205	Malaysia	0.000218	Russia	0.882752	United Kingdom	0.033554
Chile	0.000406	Iceland	0.000000	Mexico	0.010328	Saudi Arabia	0.000287	United States	5.968150
China	0.023881	India	0.094465	Mongolia	0.000092	Singapore	0.000004	Vietnam	0.000133
Czech Republic	0.000421	Indonesia	0.001380	Nepal	0.000000	Slovakia	0.000059		
Denmark	0.000153	Ireland	0.000148	Netherlands	0.002743	Slovenia	0.000011		

The Science Diplomacy Climate Responsibility Index for 48 countries of the world indicates that the United States offers best conditions to lead the world on science diplomacy. As visible in Graph 4, Russia as well as Japan and India, Germany, the United Kingdom, Canada, China, South Korea and France have good conditions to establish cooperation through science diplomacy and a heightened responsibility to act on climate change. Poland, Mexico, Brazil, Spain, Italy and Australia should also play a role in science diplomacy leadership for climate justice. Additional countries of interest to help with science diplomacy on global warming are the Netherlands, Indonesia, Belgium, South Africa, Czech Republic, Chile, Saudi Arabia, Sweden, Portugal, Greece, Austria, Norway, Malaysia, Hungary, Finland, Israel, Denmark, the Philippines, Ireland, Vietnam, Thailand, Mongolia, New Zealand, Bangladesh, Slovakia, Lithuania, Latvia, Slovenia, Estonia, Singapore, Iceland and Nepal.



Graph 4: Science Diplomacy Climate Responsibility Index bar chart

Discussion: Overall, the results indicate that the U.S. and Russia are key players in science diplomacy with highest responsibility to act to avert climate change. Africa offers science diplomacy climate stabilization leadership potential foremost in South Africa. In Asia Japan, India and China but also South Korea, Indonesia as well as Malaysia, the Philippines, Vietnam and Thailand, Mongolia, Bangladesh, Singapore and Nepal play a role in science diplomacy with responsibility for climate control. Australia and New Zealand should take a responsible role in science diplomacy for global warming alleviation. Within Eurasia, Saudi Arabia and Israel are key players on science diplomacy with respect for climate mitigation and adaptation. In Europe, Germany, the United Kingdom and France lead on science diplomacy for climate awareness followed by Poland, Spain, Italy, the Netherlands, Belgium, Czech Republic, Sweden, Portugal, Greece, Austria, Norway, Hungary, Finland, Denmark, Ireland, Slovakia, Lithuania, Latvia, Slovenia, Estonia and Iceland. In North America, the U.S. leads on science diplomacy but also Canada has potential for academic diplomacy and a responsibility to protect from the downsides of global warming. In South America Mexico, Brazil and Chile have good starting grounds on science diplomacy for a common climate solution.

Conclusion

Climate change imposes massive environmental challenges and unforeseeable human living condition degradation risks. With rising unpredictable risks and a complex ecosystem challenge as never before being imposed on humankind, the call for science-informed united action against climate change has reached unprecedented momentum.

In all the mentioned contemporary tragedies of our lifetimes, science diplomacy appears as beacon of light and ray of hope to connect the world in a united wish to overcome challenges successfully and grow stronger on externally-adverse shocks. The results offer invaluable quantified information on the importance of specific nations to lead on science diplomacy solutions to overcome the climate change problem.

Advocating for science diplomacy enlightens science as a profession, which is often criticized for being a competitive field with a hostile collegial

climate and negative socio-psychological externalities. Science diplomats would be trained to be socially-versed and diplomatically-fit. Science diplomacy could also help scientists find meaning and additional value in their profession beyond impact factors and could touch the laypeople's everyday life with quality results.

Science diplomacy could also address the call for heterodox scientific methods granting interdisciplinary and international exchange a prominent role in science. Lastly, in the most recent call for heterodox scientific ethics, science diplomacy could serve in genuine support of creative thinking to develop innovative ideas in a protected environment, inspiring others to move traditions forward respectfully, thoughtfully and meaningfully and to allow for breaking hierarchical dynamics in mutual exchange of insights while meeting in collective appreciation for the differences.

As for future research endeavors, to this day, the question remains whether scientist diplomats or diplomat scientists are more effective than conventional modes of governmental and governance diplomacy and international relations. Until today, we have no clear economic model that investigates what science diplomacy ingredients are favorable and how science diplomacy is related to macroeconomic stability and resilience variables.

References

Banerjee, Lopamudra. 2014. "Climate thresholds, weather extremes, and catastrophic losses." In Lucas Bernard & Willi Semmler (Eds.), *The Oxford Handbook of the Macroeconomics of Global Warming*, pp. 567-587. Oxford: Oxford University Press.

Barston, Ronald Peter. 2014. *Modern diplomacy*. Routledge: Oxon.

Bjola, Corneliu & Markus Kornprobst. 2018. *Understanding international diplomacy: Theory, practice and ethics*. Routledge: Oxon.

Bonen, Anthony, Stephan Klasen & Willi Semmler. 2014. "Economic damages from climate change: A review of modeling approaches." Schwartz Center for Economic Policy Analysis working paper 2014-3. Retrieved at https://ideas.repec.org/p/epa/cepawp/2014-3.html.

Brock, William, Gustav Engström & Anastasios Xepapadeas. 2014. "Energy balance climate models, damage reservoirs, and the time profile of climate change policy." In Lucas Bernard & Willi Semmler (Eds.), *The Oxford Handbook of the Macroeconomics of Global Warming*, pp. 19-52. Oxford: Oxford University Press.

Center for Science Diplomacy of the American Association for the Advancement of Science, Retrieved at https://www.aaas.org/programs/center-science-diplomacy.

Costas, M. Constantinou & Paul Sharp. 2016. *Theoretical perspectives in diplomacy*. *SAGE Handbook of Diplomacy*. London: Sage.

Flavelle, Christopher. 2021a. "Billions for climate protection fuel new debate: Who deserves it most." *The New York Times*, December 3. Retrieved at https://www.nytimes.com/2021/12/03/climate/climate-change-infrastructure-bill.html.

Flavelle, Christopher. 2021b. "The climate bill includes billions in funding: Will it be spent fairly?" *The New York Times*, December 8. Retrieved at https://www.nytimes.com/2021/12/03/climate/climate-change-infrastructure-bill.html.

Global Diplomacy Index. Lowy Institute. Retrieved at https://globaldiplomacyindex.lowyinstitute.org/country_rank.html#.

Gluckman, Peter, Rémi Quirion, Jeffrey Sachs & Albert S. van Jaarsveld. 2022. "Scientific diplomacy keeps reason alight in dark times." *Nature 604* (7906): 425.

Hansen, James E. 2021. "Environment and development challenges: The imperative of a carbon fee and dividend." In Lucas Bernard & Willi Semmler (Eds.), *The Oxford Handbook of the Macroeconomics of Global Warming*, pp. 639-646. Oxford: Oxford University Press.

Hansen, James E. & Makiko Sato. 2016. "Regional climate change and national responsibilities." *Environmental Research Letters 11*: 9-17.

Jonas, Hans. 1979. *Das Prinzip Verantwortung: Versuch einer Ethik für die technologische Zivilisation*. Frankfurt am Main: Insel.

Kaldor, Nicholas. 1961. "Capital accumulation and economic growth." In F.A. Lutz & D.C. Hague (Eds.), *The Theory of Capital*, pp. 177-222. New York: St. Martin's Press.

Kant, Immanuel. 1783/1993. *Grounding for the metaphysics of morals*. Cambridge: Hackett.

Keller, Klaus & Robert Nicholas. 2014. "Improving climate projections to better inform climate risk management." In L. Bernard & W. Semmler (Eds.), *The Oxford Handbook of the Macroeconomics of Global Warming*, pp. 9-18. Oxford: Oxford University Press.

Kellett, Christopher M., Steven R. Weller, Timm Faulwasser, Lars Grüne & Willi Semmler. 2019. "Feedback, dynamics, and optimal control in climate economics." *Annual Reviews in Control* 47: 7-20.

Nye, Joseph S. 1990. *Bound to lead: The changing nature of American power*. New York: Basic Books.

Our World in Data. Data on CO_2 and Greenhouse Gas Emissions. Retrieved at https://github.com/owid/co2-data.

Puaschunder, Julia M. 2020. *Governance and Climate Justice: Global South and Developing Nations*. New York, New York: Palgrave Macmillan. Cham, Switzerland: Springer Nature.

Puaschunder, Julia M. forthcoming a. "Funding Climate Justice: Green Bonds and Diversified Interest Rates." In: S. Boubaker & L.T. Han, *Handbook of Environmental and Green Finance: Towards a Sustainable Future*, World Scientific.

Puaschunder, Julia M. forthcoming b. *Responsible Investment around the World: Finance after the Great Reset*. Emerald.

Puaschunder, Julia M. forthcoming c. *The Future of Resilient Finance: Finance Politics in the Age of Sustainable Development*. Palgrave Macmillan.

Rawls, John. 1971. *A theory of justice*. Cambridge, MA: Harvard University Press.

Sachs, Jeffrey D. 2021. "Fixing climate finance." *Social Europe: Politics, Economy and Employment & Labor*, November 17.

Semmler, Willi, Joao A. Braga, Andreas Lichtenberger, Marieme Toure & Erin Hayde. 2021. "Fiscal policies for a low-carbon economy." Washington, D.C.: *World Bank Report*, Retrieved at https://documents1.worldbank.org/curated/en/998821623308445356/pdf/Fiscal-Policies-for-a-Low-Carbon-Economy.pdf.

Sharp, Paul. 2016. *Domestic public diplomacy, domestic diplomacy, and domestic foreign policy: The transformation of foreign policy*. Oxford: Oxford University Press.

Szkarłat, Monika. 2020. "Science diplomacy of Poland." *Humanities and Social Sciences Communications 7* (1): 1-10.

The Vienna Statement on Science Diplomacy, International Institute for Applied Systems Analysis (IIASA), Retrieved at https://iiasa.ac.at/network-with-us/vienna-statement-on-science-diplomacy

Webometrics. Ranking Web of Universities. Retrieved at https://www.webometrics.info/en/distribution_by_country.

World Bank. 2022. Educational attainment, at least Bachelor's or equivalent, population 25+, total (%) (cumulative). Retrieved at https://data.worldbank.org/indicator/SE.TER.CUAT.BA.ZS.