



Climate change regional review: Russia

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With climate change, an increasingly important focus of scientific and policy discourse, the Russian government has aimed to position the country as one of the leaders of the global process for addressing climate change. This article reviews a breadth of literature to analyze the politico-economic situation in Russia with regard to international climate change negotiations, related domestic policies, societal attitudes, and climatic change impacts on Russia's territory. The analysis demonstrates how Russia has a pivotal role in influencing the future direction of international climate change mitigation and adaptation. Not only is Russia predisposed geographically to the impacts of climate change, but also it is a major emitter of greenhouse gases and a global supplier of fossil fuels, and remains a major force in international politics. This unique confluence of circumstances leaves Russia with a challenging dilemma. It can choose to acquiesce to short-term political and economic considerations, adopt weak mitigation measures, and face potentially significant impacts. Or it can apply its considerable attributes and powers to initiate an epoch of international action to secure a low-carbon climate-resilient future. Although the former will see Russia subsumed into the international malaise on climate change, the latter may both quench the nation's 'thirst for greatness' and fill the void of international leadership. © 2013 John Wiley & Sons, Ltd.

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INTRODUCTION

The urgency and scale of the climate change challenge is reinforced by recent studies illustrating how, despite the global economic downturn, greenhouse gas emissions continue to grow at the highest rates envisaged by the IPCC and well in excess of that necessary to avoid the 2°C characterization of 'dangerous' climate change.^{1,2} Against a backdrop of accelerating increases in emissions, Russia presents an important and interesting case. Although an Annex 1 nation, it witnessed a rapid fall in its emissions as its economy collapsed in the early 1990s. Despite such rapid reductions, Russia remains among the five highest emitting nations, with, since the 2008

economic crisis, its emissions now resuming their upward trajectory. Not only is Russia a major emitter of greenhouse gases, but also it is a leading global supplier of fossil fuels, remains an influential force in international politics, and is predisposed geographically to the impacts of climate change. Russia occupies more than a tenth of the global land area, with nearly two thirds of the country underlain by methane-rich permafrost; consequently the impacts of temperature increases on its territory are likely to have global repercussions.

The global nature of climate change implies that climate-related policies in Russia should link to broader international scientific and political discourses on climate change. Yet, to date, the country's short-term national priorities have taken precedence over international negotiations and the accompanying science, as has indeed been the case in most nations. To better comprehend the development of climate politics in Russia, it is necessary to situate the country's engagement

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within the context of international and national climate-related legislation and institutions, societal participation, and the country's physical-geography characteristics. The influence of broader legislation on the climate may be positive or adverse, with climate-adverse policies driven typically by politico-economic rather than either societal, environmental, or scientific considerations. Yet, there is evidence of improvements in the dialogue between the Russian society and the state,^{3,4} and, as climatic changes intensify, climate science may also gain traction with Russia's policymakers. Exploring aspects of the country's civil society (in terms of its development in general and its engagement with climate issues in particular) as well as aspects of the country's climate (in terms of past and current trends, evident changes and potential impacts) may provide insights for instigating meaningful climate policies in Russia.

Through meta-analysis of scientific works, policy documents, governmental communications, and mass media reports, this article reviews and synthesizes a breadth of literature to deliver insights on the interplay between Russia and the global community around climate change issues. The article comprises three sections. After the introduction, Section "Climate Change Governance" presents legislative and institutional aspects of Russia's climate change governance and how they may affect the climate directly or otherwise. Section "Climate Change and Society" then discusses Russia's climate-focused civil society, public perceptions and mass-media representation of climate change in the country. Having established the socio-political context, Section "Climate Science: Physical-Geography Aspects of Climate Change" proceeds to explore the physical-geography aspects of Russia's climate in the 20th and 21st centuries, summarizing evident and potential climate change impacts and the state of adaptation. The article concludes with a synthesis of the breadth of material covered and reflects on Russia's role in climate change international negotiations.

CLIMATE CHANGE GOVERNANCE

Climate-Related Governmental Institutions

Established in 1834⁵ the Service for Hydrometeorology and Environmental Monitoring (abbreviated as 'RosHydromet'), nested within the Ministry of Natural Resources and Environment, is the main governmental department responsible for climate-related issues in Russia. The inclusion of climatology within RosHydromet's Environmental Monitoring Laboratory occurred in the 1980s, coinciding with the suggestion that the Laboratory could combine all

environment-related departments from different ministries under the umbrella of RosHydromet. The idea was eventually dropped, as was an initiative to protect the environment alongside simply monitoring it. Larin et al.⁶ suggest that the Laboratory failed to pursue active environmental quality control at the behest of its founder and long-standing director Yuri Izrael. His explicit view was that monitoring should be decoupled from active environmental protection.⁶ This culture of 'passive observation' subsequently continued after the Laboratory was renamed as the Institute of Global Climate and Ecology in 1990. The Institute currently retains its focus on monitoring and information provision, but with a more proactive approach evident from its expanded remit to include prevention and adaptation research.

A number of other ministries and agencies contribute to the work of the Institute where their remits match specific activities. A relatively new institutional player in climate change is the Russian Central Bank, acting as the national 'carbon unit operator' for Joint Implementation (JI) projects within the first commitment period of the Kyoto Protocol.⁷ No governmental institution however exists in isolation from the regulatory environment. For the purposes of this article, national legislation is classified into the policies that have the potential to abate emissions and those likely to increase emissions. Abatement, in this research, covers regulations intended to address climate change *directly* (i.e., are climate-focused) and those that have an *indirect* positive effect on the climate (i.e., are synergistic).

Climate-Focused and Synergistic National Legislation

There are two main climate policy decrees in Russia: the Climate Doctrine published in 2009 and the Climate Action Plan passed in 2011. Their combined outcome has been to endorse a number of plausible policies at the highest legislative level. However, neither the Doctrine nor the Plan contains quantitative or definitive, climate change targets. Although the Doctrine acknowledges that "a major part of the Russian Federation is within the geographic area affected by maximum climatic changes, in terms of both observations and predictions",⁸ little has been done to put the suggested policies in place. The reality is often at odds with the written word. For example, out of the four points in the following passage from the Doctrine, only items (a) and (c) have so far received some attention from the government, despite the professed "maximum effort":

The Russian Federation expends *maximum effort* in relation to mitigating anthropogenic

greenhouse gas emissions and increasing their uptake by carbon sinks. The intention is to implement measures aimed at:

- (a) increasing energy efficiency in all sectors of the economy;
- (b) developing and deploying renewable and alternative energy sources;
- (c) reducing market imbalances and realizing financial and fiscal policies to encourage anthropogenic greenhouse gas emission reduction;
- (d) protecting and enhancing the capacity of carbon sinks, including sustainable forestry, forestation, and re-forestation.⁸

More recently (March 18, 2013) the Ministry of Natural Resources and Environment released a draft decree on 'The Level of Greenhouse Gas Emissions' necessary to facilitate the implementation of the Doctrine. The draft announces a national emission 'reduction' target of 25% below 1990 by 2020⁹; in practice, however, this implies a growth in Russia's emissions, as current levels are about 30% lower than they were in 1990.¹⁰ The draft decree also suggests that, within 6 months of it coming into effect, the government is to develop and approve an 'action plan' for achieving the pledged emission 'reduction'.⁹ It is currently unclear whether and how the new 'action plan' will relate to the Climate Action Plan adopted in 2011.

Although the existing Climate Action Plan provides a list of more detailed measures, the largest proportion of the document is focused on adaptation, despite the Doctrine's proclaimed "maximum effort" to mitigate. In particular, the first paragraphs of the Plan (§1–6) address climate change research and awareness; §7–17 center on adaptation and minimizing risks for and impacts on various socio-economic areas—health, forests, infrastructure, and agriculture. Mitigation activities are detailed in §18–23 and include overall political and economic instruments, along with policies for intensive industries, the energy sector, and land transport, to be implemented between 2011 and 2020. A shorter timeframe, 2011–2013, is considered for the buildings sector, consumer white goods and equipment, agriculture, and forestry. The Plan also covers civil aviation and shipping, with both emerging at the end of the document. The document sets no quantitative objectives and identifies no sources of financial or professional support.

About a dozen ministries and subordinate offices share responsibility for implementing the

Plan, with the Ministry of Natural Resources and Environment coordinating most of the adaptation and mitigation work. Some responsibilities are assigned to unexpected departments. For example, the Ministry of Industry and Trade rather than the Ministry of Transport is in charge of improving the fuel efficiency of vehicles and of most other transport-related measures. In contrast, other important agencies, such as the Federal Environmental and Industrial and Nuclear Supervision Service ('RosTekhNadzor') have no explicit roles.

The government's drawing on a host of its departments can facilitate synergies among policies in different sectors. In the context of this article, legislation is termed 'synergistic' if, without overtly addressing climate change priorities, it nevertheless has significant potential to reduce emissions. Although high-level officials briefly acknowledge such synergies,¹¹ there has been no attempt to assess their potential benefits. Such benefits may be considerable, as, for instance, studies conducted in the UK context demonstrate.¹² Examples of synergistic policies in Russia include, among others, the 2009 energy efficiency law, the communal services reform aiming to eliminate fossil fuel subsidies, the introduction of European transport fuel and vehicle standards, the reforestation article of the Forestry Code, and penalties for flaring more than 5% of associated petroleum gas. The scope of this article only allows for a cursory review of the first three synergistic policies; those likely to have the most discernible impact on reducing emissions, particularly, through demand side measures.

The 2009 Energy Efficiency Legislation

The energy efficiency legislation is a flagship energy-demand policy. If successful, it will provide a solid start to challenging the energy system inertia; in contrast, if implemented poorly, it will likely aggravate issues of carbon lock-in. In 2008, President Medvedev pledged a 40% reduction in the energy intensity of the country's GDP by 2020 compared to 2007.¹³ A year later the government adopted the 'Energy Strategy for 2030', followed by the Energy Efficiency Federal Law and a number of related bylaws. The set of policies is ambitious in attempting to cover all sectors and activities where energy is used. Although it lays out specific targets, unlike the Climate Doctrine and the Climate Action Plan, the energy efficiency legislation has implementation difficulties similar to the climate policies. The Scientific Advisory Board of the working group that monitors the implementation of the Law, argues that the current quality of execution, in many respects, does not stand up to scrutiny and that delivering on the 40% pledge within the specified timeframe is very unlikely.¹⁴

The Communal Services Reform in the Residential Sector

The communal services reform, with its market-based residential energy prices, is another important synergistic policy implemented with varying success. A similar reform has already been completed for electricity prices in industry, with natural gas market-based pricing mechanisms to be implemented in 2014, while coal and oil prices have received no subsidies since the mid-1990s.¹⁵ Upon the completion of the residential reform, households are to cover the full costs of housing maintenance and utility services. The original expectation was to increase the share of expenses funded by residents from 35% in 1997 to 100% within 6 years. However, by 2001 it was, at best, 60%, and with benefits and subsidies it was as low as 40%, with the slow progress often explained by the difficult socio-economic conditions of the time.¹⁶ The government later ruled that the share should reach 100% by 2005, with a lower share funded by local governments. However, even in 2012 some municipalities maintain it as low as 50%.¹⁷ Furthermore, although the 'marketization' has succeeded to some extent, experts from the Accounts Chamber of the Russian Federation argue that the reform has hardly improved issues of safety, quality, and security of the service.¹⁸

The government has now rescheduled the elimination of the cross-subsidy in the electricity sector to take place within the next 4 years.^{19–21} One of the suggestions is to develop a 'social quota' for monthly electricity consumption per person, above which the electricity tariffs will be significantly higher.²² Electric energy is the first utility where the government intends to impose a 'social quota', facilitated by high penetration of metering equipment (about 95%, compared with 20 to 40% in heat and water supplies) and the largest cross-subsidization scale.²² A conservative projection of the electricity subsidy for 2013 is 200 billion roubles (6.3 billion USD), up from 135 billion roubles in 2008.²³ These figures are about four times lower than the IEA's estimates (see Table 1 below), a discrepancy explained, in part, by large uncertainties in the data sources.

TABLE 1 | Pre-tax Fossil-Fuel Consumption Subsidies by Energy Source in Russia in 2008–2010.²⁴

Unit: Billion USD	2008	2009	2010
Oil	0	0	0
Gas	28.47	18.57	16.95
Coal	0	0	0
Electricity	23.03	14.40	22.26

Although the scale of heating cross-subsidization is small in comparison, eliminating it may prove harder than reducing the electricity subsidy. During the 2002–2008 electricity reform, the heating sector received little attention, and experts describe its current state as 'a shambles', with the attribution of responsibility unclear for different levels of government.²⁵ Often contradictory decisions have created an atmosphere of uncertainty in the sector, discouraging much needed investment.²⁵ The low level of investor trust and innovation is not dissimilar to the situation in the power industry as a whole.²⁶

European Emission Standards for Vehicles and Transport Fuels

Emission policies in the transport sector have also faced implementation issues. In the mid-2000s, the Russian government committed to adopt a series of progressively stringent European standards for regulating exhaust emissions. The country is currently at the second stage (Euro-2) of implementing the fuel-focused policy. The intention is to phase out Euro-3 fuels by the end of 2014 and Euro-4 a year later.²⁷ However, given the failed attempts by the government to withdraw Euro-2 transport fuels by 2008, experts warn that the policy is unlikely to deliver on schedule, as around half of Russia's 25,000 petrol stations operate independently from the vertically integrated oil companies, and so are likely to have compliance issues.²⁸

The situation is similar with the European emission standards for vehicles. Their introduction has recently been postponed for one year, with Euro-4 cars and engines now allowed to remain until the end of 2015.²⁹ Previously, this policy was suspended from 2009 until 2011 to factor in the financial crisis, whereas the current delay is explained by the need to synchronize the production of vehicles with that of fuel.³⁰ The noncompliance and legislative setbacks, in many respects, stem from Russia's transitional challenges complicated by considerable fossil fuel reserves. Being an indigenous producer is almost certain to affect the country's fossil fuel-dominated energy supply mix^{31,32} and facilitate policies leading to increased emissions. Paradoxically, as some experts have noted, in order to generate revenue for diversifying the economy away from hydrocarbons, Russia will have to heavily invest in its fossil fuel industry³³ driving emissions still higher.

Domestic Policies Likely to Drive Higher Emissions

As Russia continues to undergo significant political and economic transitions, socialist and market-based

ideologies co-exist and, on occasion, merge to provide new policy regimes. The last two decades have witnessed the Russian government increasingly introduce elements of *laissez-faire* capitalism. For example, many state-owned enterprises have been privatized; the prices of most goods and services are now set through the interaction of demand and supply on the market; and a financial industry has been established. However, elements of a centrally planned economy remain, in particular, the re-nationalization of some energy companies and, more importantly, fossil fuel price support.³⁴ As with other nations, maintaining fossil energy subsidies alongside a long-term climate strategy risks the development and implementation of inconsistent policies. Although Russia has gradually raised domestic energy prices since the early 2000s, the transition to a market-based price for energy has nevertheless been slow.³⁴ The World Energy Outlook²⁴ reports that in 2010 Russia still provided a total *pretax* fossil fuel subsidy of 39.2 billion USD (1.2 trillion roubles), which constituted 2.7% of Russia's GDP that year. Table 1 presents the subsidy breakdown by energy source over 2008–2010. Furthermore, the IMF estimates Russia's total *post-tax* energy subsidies at 116 billion USD (3.6 trillion roubles), making it globally the third largest subsidizer of energy, behind the United States and China.³⁵

As regards 'emission-inciting' policies, in January 2012 the Russian government approved a long-term strategy for development of the coal industry. According to the official press-release the investment, planned through to 2030, amounts to 3.7 trillion roubles (119 billion USD), with 251.8 billion roubles (8.1 billion USD) to be direct state-finance.³⁶ The government intends to operationalize new and refurbished coal extraction capacities of 505 million tonnes, which is predicted to result in a 25% higher annual extraction rate by 2030 compared with 2012.³⁷ Some analysts suggest that, to deliver on the coal strategy, domestic consumption of coal will need to be encouraged through lower prices for coal-sourced energy, achieved, in part, by siting new coal power plants adjacent to mineral deposits so as to reduce transport costs.³⁷ The press-release and associated analyses make no mention of carbon capture and storage as an option to 'clean' Russian coal. The failure to consider the impacts domestic policies may have on emission rates, inevitably affects how Russia engages with international climate-related negotiations.

The Kyoto Protocol Developments

Ultimately climate change is a global problem, with national policies insufficient to stay below any

particular temperature threshold; hence the need to coordinate mitigation policies between nations. Amid the global negotiations on climate change in the 1990s, the Russian government remained unconvinced as to the necessity of having an emission target. However, once the negotiations coalesced into the Kyoto Protocol, the government welcomed the near-term nature of the treaty for two principal and related reasons.

First, the fall in Russia's emissions accompanying the economic collapse of the 1990s, as Figure 1 shows, was sufficient to ensure that the short-term emission target could be easily met. Although strong economic growth resumed by the end of the decade, Russia's share of global CO₂ emissions from fuel combustion had fallen to 6.5% in 1999 compared to 10.9% in 1990, with a further fall to 5.4% by 2010.³⁹ The post-2000 decrease was mainly due to the contraction of the Russian economy during the 2008 financial crisis, although its emissions have since resumed their upwards trajectory. Much of the decline in the energy and emission intensity of GDP since 1990 is explained by the decline in industry and a subsequent economic restructuring toward the service sector. A partial switch from coal and oil to natural gas and hydroelectricity in Russia's energy supply fuel mix^{31,32} also accounts for a share of the reduced emission intensity.

Second, following the break-up of the USSR, the relative security and stability of the Soviet system had given way to considerable economic and political uncertainty.⁴⁰ New market activities developed *before* any formal 'rules' such as legislation and accountability were established, triggering widespread corruption.⁴¹ Against this backdrop, the government was not expected to commit to specific policies, and so the limited period of the Protocol, along with the fall in emissions, matched Russia's national circumstances. Moreover, it offered the opportunity for the country to withdraw from any post-Kyoto commitments, should compliance prove too expensive for the Russian economy.

Although the Kyoto Protocol did not initially arouse significant attention within Russia, it later became an important issue dominated by interplay of vested interests.^{42,43} Table 2 summarizes a range of headline considerations evident in the debate around signing and ratifying the Protocol. While some analyses point out a number of hidden motives behind the on-the-record viewpoints,⁵³ this article only refers to publicly declared positions.

Although there was no poll of public views on the Kyoto Protocol specifically, a survey did suggest that,

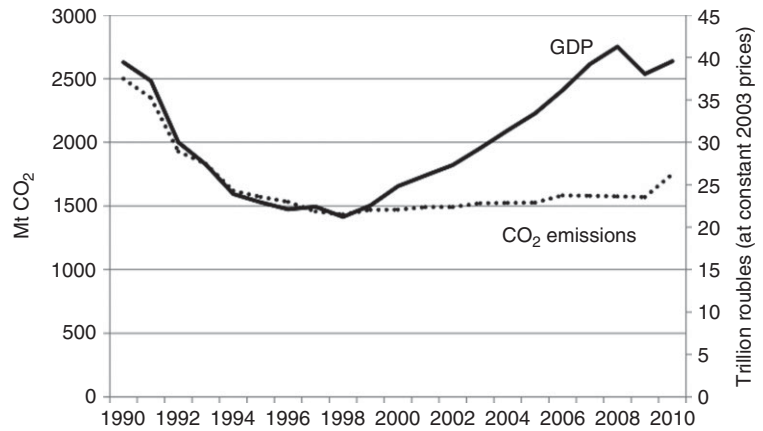


FIGURE 1 | Russia’s CO₂ emissions from energy and industrial processes (left-hand-side axis, dotted line) and gross domestic product (right-hand-side axis, solid line) in 1990–2010.^{10,38}

TABLE 2 | Russia and the Kyoto Protocol: Positives and Negatives as Perceived by Various Stakeholder Groups in Russia Prior to Ratification^{43–52}

Stakeholder Group	Positives	Negatives
President; President’s economic advisor	<ul style="list-style-type: none"> ● Russia was offered support in accessing the World Trade Organization, if it signed and ratified the Kyoto Protocol. 	<ul style="list-style-type: none"> ● Treaty risked stifling economic growth. ● Trading carbon quotas was considered ‘a pure unadulterated myth [...] like trading air’. ● The Kyoto Protocol would be an ‘intergovernmental GULAG’ with ‘interventionism at the level of international governance’. ● Treaty was not based on principles of justice and equality unless signed and ratified by all countries.
Government	<ul style="list-style-type: none"> ● Kyoto Protocol could assist modernization of the economy. ● Selling emission quotas could provide a revenue source for federal budget. ● The treaty implementation could help control power of natural monopolies, supporting competitors via Kyoto flexible mechanisms. 	<ul style="list-style-type: none"> ● Existing environmental regulations were inadequate for monitoring emissions. ● There would be a trade-off between economic growth and Russia’s emission obligation. ● ‘Giving in’ to the European Union during Kyoto negotiations risked impression of Russia’s ‘political weakness’.
Industry	<ul style="list-style-type: none"> ● Big companies could receive funds through flexible mechanisms, for modernization. ● Gas companies would benefit if Europe switched to more Russian natural gas. 	<ul style="list-style-type: none"> ● Importers of Russian oil/coal would decrease their oil/coal consumption.
Scientists and NGOs	<ul style="list-style-type: none"> ● Kyoto Protocol could tighten environmental requirements for production processes, phasing out inefficient industries. 	<ul style="list-style-type: none"> ● There is no link between climate and CO₂; hence Kyoto Protocol a scientific scam. ● Even if Kyoto Protocol is implemented, impact on climate will be insignificant. ● Protocol is part of EU’s conspiracy to increase cost of competitors’ goods via ‘greening’.
General public	No poll or research found on public views on Kyoto Protocol.	

in 1999, 12.3% of the Russian population claimed to be anxious about ‘global climate warming’.⁵⁴ Assuming this adequately captures the broader public concern on climate change, it appears reasonable to infer that a small proportion of the population would have been *actively* in favor of signing and ratifying the Kyoto Protocol.

Another aspect of the Kyoto Protocol process where the Russian government has shown limited progress relates to the Protocol’s Flexible Mechanisms. In July 2010, the Ministry of Economic Development approved 15 JI projects, estimated to reduce emissions by 30 million tCO₂-equivalent by 2012.⁵⁵ This was the first carbon-projects tender and

took place 6 years after the Kyoto Protocol was ratified, despite investors being willing to offer JI projects immediately after the ratification. As a result, potential carbon investments and early emission reductions did not materialize, suggesting inadequate political commitment to climate abatement. As of November 2012, 108 projects were approved with an estimated total mitigation potential of 311.6 million tCO₂-equivalent.⁵⁶ It is worth noting that the majority of Emissions Reduction Units were issued between May and October 2012, suggesting the process overall may have been rushed.

On the face of it, the delays in JI implementation are difficult to explain given the potential benefits of Russia's participation in the Kyoto Protocol spelt out in earlier assessments and largely confirmed by completed JI transactions. Some experts argue that the ratification problems were part of the 'de-ecologization' trend that started in Russia in the late 1990s.^{57,58} Following the collapse of the USSR, the industrial and financial lobby impeded an emerging strong environmental regulation, as an obstacle to exploiting Russia's natural resources.^{57,58} By extension, the same power struggle has probably caused the delays in setting up the JI mechanism. If this is indeed the case, Russia's relatively passive and often ambiguous stance in the current climate negotiations may have similar underlying reasons.

Post-Kyoto International Climate-Related Commitments

Although the Russian government was engaging with the Kyoto negotiations, there was evidence of Russia's 'still terrible thirst for greatness'⁵⁹ in how it exerted control over its abundant energy resources at a time of escalating oil prices.⁶⁰ However, the advent of the Kyoto Protocol suggested, at least to some, that the era of fossil fuel consumption may be cut short, together with Russia's energy supremacy. At the same time, the Protocol offered an opportunity for Russia to demonstrate it was willing to become a key driving force in the abatement of climate change, thereby securing a dominant position in the international climate negotiations. Not only the country's size and resources, but also its share of world emissions¹⁰ and vast cost-effective abatement potential^{61,62} gave it the capacity to play a leading role in international talks.

The leadership considerations Russia may have had during the Kyoto Protocol debate have made little impact on the country's role in more recent negotiations. Although the Russian government did sign the Copenhagen Accord and two subsequent noncommittal agreements between 2009 and 2011,

the country's stance has been undecided. In the run-up to the Conference of the Parties in Doha in 2012, Russian news agencies reported at least three contradictory governmental positions, based on 'confidential sources'. Some observers have likened the ambiguity of Russia's current position to the pre-ratification uncertainty in the early 2000s.⁶³ In December 2012, at the 18th Conference of the Parties to the UNFCCC, Russia officially announced its refusal to participate in the second commitment period of the Kyoto Protocol, putting an end to speculations in the national media. Yet, the language of the statement was less than clear with regard to the country's emission reduction target and a number of other important issues. In particular, Russia's representative stated that, 'the Russian Federation, by remaining a party to the Protocol, will continue to respect all of its current obligations (*except quantitative ones*)'.⁶⁴

Similar equivocation is manifest in Russia's other climate-related international endeavors. For example, in May 2012, Russia signed the Camp David Declaration whereby, in addition to reaffirming the 2°C target commitment,⁶⁵ it agreed to join the UNEP's Climate and Clean Air Coalition to Reduce Short-Term Climate Pollutants.⁶⁵ However, as of April 25, 2013, Russia remained the only G8 nation not listed among the country partners of the Clean Air Coalition.⁶⁶

Russia's recent accession to the World Trade Organization suggests that economic and trade negotiations are associated with less ambiguity than global climate talks, although the implications of WTO membership for energy-related activities are not straightforward to assess. Decreasing import levies and quotas and rising export tariffs are expected to affect all economic sectors except the mineral extraction industry,^{67,68} which is likely to intensify the nation's already heavy dependence on raw material exports.⁶⁷ On the other hand, both households and industry may be persuaded to become more energy-efficient due to higher energy prices and cheaper imports of modern equipment. More importantly, the high-profile international negotiations through the WTO and UNFCCC processes have increased the Russian population's awareness of the issues involved. The climate-focused civil society, in particular, started emerging in the late 1990s when the Kyoto Protocol discussions in the mass media put the issue in the spotlight.

CLIMATE CHANGE AND SOCIETY

The Development of a Climate-Focused Civic Society

The head and machinery of the Russian state have traditionally had a high level of autonomy in

making decisions, with this power and resources used for both uniting a multinational population across a vast territory and remaining resilient to external enemies.⁶⁹ Against this historical backdrop, Russian society has evolved a relatively passive engagement with a paternalistic government and, consequently, has not developed a strong civil society.⁴⁰ For instance, when it came to ratifying the Kyoto Protocol, the initiative was driven by the President rather than scientists, industrialists, or campaigners; and the focus was mostly on advancing Russia's geopolitical interests, regardless of other environmental or financial benefits.^{70–72}

It was not until the mid-2000s that the climate *per se* received more attention in Russia's broader policy circles,⁷¹ this despite Russian scientists being involved in the activities of the Intergovernmental Panel on Climate Change from its inception. Furthermore, interviews with the scientists suggest that they 'did not seem to play a role in deliberative processes leading to key decision-making moments', such as ratification of the Kyoto Protocol.⁷³ Instead, Russia's scientific community and its activities came to the fore *after* the political decision was taken and the climate change issue gained more importance at the national level.

Along with scientists, nongovernmental organizations are an increasingly vocal part of Russia's emerging civil society. In 2009, there were about 360,000 noncommercial organizations registered in Russia, with 136,000 of those active.⁷⁴ For comparison, there are an estimated 1.5 million NGOs in the United States⁷⁵ and 3.3 million NGOs in India.⁷⁶ To date no NGO in Russia is exclusively focused on climate change issues. Instead, such issues are typically piggybacked on other environmental interests, and, since the mid-1990s, it has become common for already established Russian NGOs, such as the Russian Socio-Ecological Union (est. 1988), to embrace climate-related activities.

Despite their growing numbers, the online visibility of environmental NGOs is fairly limited. Salmenniemi et al.⁷⁷ cite an expert opinion that the reputation of and trust toward not-for-profit organizations in Russia is extremely low, which may be attributed to the people's wariness of social institutions in general. Arguably, the social distrust was somewhat mitigated during and after the 2010 heat wave and subsequent wildfires, which catalyzed a more vocal dissatisfaction among the population. Sociologists suggest that the extreme weather event highlighted the inertia and inefficiency of the vertical chain of command and strengthened the socio-environmental movement in Russia.⁷⁸

The social distrust, the centralization of power, and long distances have diminished the involvement of Russia's 'regions' (from Russian: *regiony*—areas outside of Moscow and St. Petersburg) in civil society. In particular, although 'regions' are likely to be significantly affected by the changing climate, they have little influence on climate-related policies. Local and regional citizen representation is in many ways powerless⁴; provincial areas are underdeveloped compared to Moscow and St. Petersburg⁷⁹; and, as a result of top-down publicity campaigns, the trust in local and regional authorities is lower than in the federal government.⁸⁰ These issues have persisted despite recent and slight improvements in the dialogue between Russian civil society and the state,^{3,4} and a surge of climate- and energy-related activities coordinated by regional, national, and international NGOs.⁸¹ Citizens and NGOs have filed petitions to regional and federal authorities, for example, regarding the construction of new hydropower stations without factoring in climate change impacts and adaptation strategies.⁸² A number of formal meetings for discussing regional aspects of climate change have taken place outside of the capital cities.^{83,84}

Yet, no consolidated public effort has transpired so far. Makarova⁴ identifies NGO- and citizen-specific barriers to the interaction between authorities and civic society institutions. Although the study does not specify a policy area, the barriers are nonetheless relevant for the climate change issue. Makarova⁴ attests that NGOs struggle with unstable financial support, little experience in defending their interests, and insufficient professional capacity and expertise. At the same time, citizens tend to prioritize their own problems over those of their city or region, have little trust in authorities, underestimate the significance of their own contribution, and have low awareness of their rights and privileges with regard to resolving local issues.⁴

Public Perceptions of Climate Change

Any views the Russian population may have of climate change have been influenced by successive economic recessions, limited scientific and public discussion of the issue, and the legacy of bureaucracy. Climate change does not feature prominently in Russian public opinion polls, with climate-related questions typically embedded within general environmental surveys. For instance, the website of the Russian Public Opinion Research Centre (abbreviated as 'WCIOM') provides only three survey results that relate to climate change. The surveys enquired, 'What aspects of environmental

TABLE 3 | The Share of the Population Concerned About Climate Change (survey date 13–16 May 2011, sample size 1,600 people)⁸⁶

Russia (Total)	Moscow	City/Town Size (Persons)			Villages
		>500 Thousand	100–500 Thousand	<100 Thousand	
24%	42%	23%	21%	23%	23%

TABLE 4 | Responses to the Question ‘Do you Believe in Global Warming?’ by Age Group and Gender (survey date 7 December 2009, sample size 3,000 people)⁸⁷

Response	By Gender			By Age Group (years)				
	All	Male	Female	18–23	24–29	30–39	40–49	50+
Yes (%)	49	48	51	52	53	48	43	39
No (%)	33	36	30	32	31	34	35	41
Don't know (%)	18	16	19	16	16	18	22	20

degradation, if any, are evident in your place of residence?’ and suggested respondents choose up to five answers. In survey years 2005, 2009, and 2010, respectively 20%, 16%, and 28% of respondents listed climate change as problematic, with it ranking eighth in 2005, and seventh in 2009 and 2010, out of 12 environmental concerns covered by the WCIOM's poll.⁸⁵

In 2011, the Levada Analytical Centre⁸⁶ asked the public, ‘What ecological problems of your city/town/village are you concerned about most?’ and grouped responses by the size of a residential area. The results, summarized in Table 3, demonstrate that the variation across settlements of different sizes is low, with 24% of the population on average anxious about climate change. Moscow stands as an outlier with 42% of its residents listing it as a concern. In August 2012, responses to a slightly rephrased question, ‘What worries you most in the ecological conditions of your city/town/village?’ suggest 22% of Russians are concerned. Despite a 2 percentage point decrease compared to the 2011 Levada poll, climate change is among the top five (out of 14) environmental concerns in 2012, compared to the sixth place a year earlier. The Levada Centre does not report the result breakdown for different residential area sizes in 2012.

SuperJob, one of Russia's largest online recruitment portals, provides more detailed and contextual, if relatively informal, findings. In 2009, SuperJob conducted a ‘global warming’ survey among 3000 economically active adults from across the country, grouping the results by respondents' age and gender (Table 4). In particular, trust in climate science appeared stronger among the young than among the elderly. SuperJob⁸⁷ reports that those

under 30-years old perceived climate change as a side effect of humanity's technological advances, whereas the middle-aged group attributed the phenomenon to natural cyclical processes. In terms of gender, a larger proportion of men than women were inclined to ‘deny’ global warming, but on average nearly half of all respondents ‘believed’ in it.

The respondents were also asked what policy measures can prevent global warming and what specific individual actions they would undertake to help. More than a quarter of the respondents struggled to suggest policy measures for addressing global warming, with most believing that the problem should stay within the remit of science. Many respondents (27%) were certain that no measures would be effective and hence nothing should be done. Similarly, in response to the question on personal action, 24% of the sample could suggest no personal contribution, while about a fifth openly said they were not ready to contribute at all (see Figure 2).

In addition to demographic characteristics (summarized in Table 4), climate change attitudes are influenced by ideological and political preferences of respondents. Ivanova⁵⁴ analyzed a 1999 survey on fears in former Soviet Union countries, classifying respondents as either ‘pro-West’ or ‘traditionalist’ based on their answers to scoping questions. The study reports that pro-West respondents were significantly more concerned about global ecological problems than ‘traditionalists’. Among those problems, ‘global climate warming’ was a concern expressed by 22% of people in the first group and 11% in the second.⁵⁴ In both groups, however, climate change was associated with external and hence less immediate problems, as opposed to domestic problems that were perceived more dominant and urgent.⁵⁴

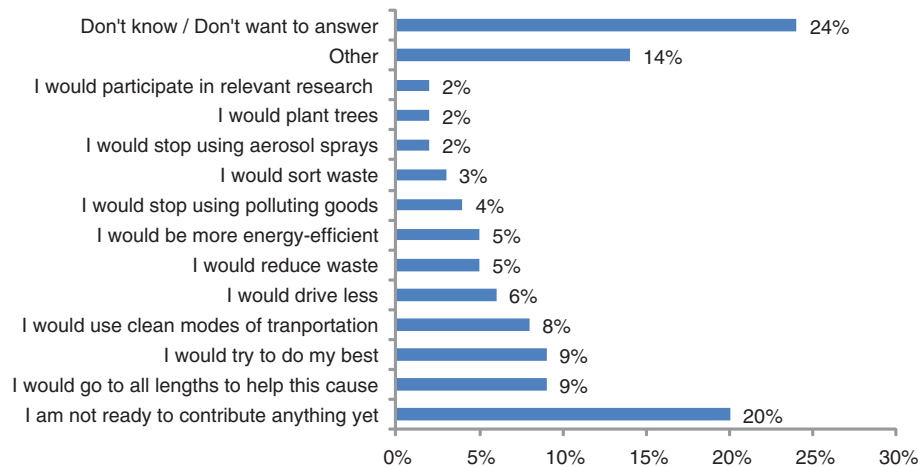


FIGURE 2 | 'What would be your personal contribution to reducing the threat of global warming?' (survey date 7 December 2009, sample size 3,000 people)⁸⁷

Finally, there are a number of climate change surveys undertaken in Russia by foreign organizations. For instance, the BBC conducts an annual Global News poll on the 'most important problems facing the world'. In 2009, 36% of respondents in Russia assessed climate change as a 'very serious' issue, which is significantly lower than the average of 58% across the 23 countries covered in the study.⁸⁸ A year later the proportion of concerned people in Russia increased by 10 points to reach 46%, while still remaining below the global average of 56%.⁸⁹ In a 2010 poll by the World Bank⁹⁰ across 15 countries, a consistently large proportion of Russian respondents chose the 'Don't know/Refuse' option in response to the survey questions, which could imply either a relatively low awareness of, or, a low interest in, climate change issues.

Three of the reviewed surveys have some level of contextualization. Ivanova⁵⁴ classifies respondents by ideological preferences; SuperJob⁸⁷ reports findings by gender and age groups; while the World Bank⁹⁰ covers four dimensions including level of concern, beliefs, attitudes to international cooperation, and the willingness to pay. However, in the absence of high quality and longitudinal survey data it is not possible to draw robust conclusions as to the dynamics of public opinion. Nevertheless and despite numerous uncertainties, the surveys reviewed in this subsection do add to a limited body of research on Russian's public opinion around issues of climate change.

The main differences are evident between survey results from the 1990s and 2000s and between foreign and Russia-led surveys; although the actual number of surveys is insufficient to infer a particular pattern. Overall Russian-conducted surveys in the 2000s show that a fifth to a quarter of the respondents are

concerned about climate change, i.e., approximately double the proportion who had expressed a concern in the 1990s. In contrast, foreign-conducted surveys (by the BBC and World Bank) report that nearly 50% of respondents consider climate change to be a serious issue. However, these higher proportions relate more to questions of 'belief' rather than concern-based framing of Russia-led surveys.

Any results the surveys have so far yielded should be interpreted with caution, as climate change-related questions are often neither contextualized nor matched with respondents' socio-economic profiles, and are usually bundled together with other questions broadly related to the environment. These caveats also make comparisons of results across time and across surveys problematic. Despite the differences, there is some evidence that, compared to the global average, Russian citizens have lower awareness of and concern about climate change. Yet, in the 2000s more people in Russia are concerned about climate change than in the 1990s, whereas more recently the opinions have fluctuated year on year. An increased public awareness of the issue may be explained by a greater prominence of climate change in international politics and recent extreme weather events amplified by wider media coverage.

Climate Change in the Russian Mass Media and Other Communication Channels

According to the Russian Public Opinion Research Centre, 14% of respondents think that it is the mass media that initiate environmental action.⁹¹ Nonetheless, a recent analysis of eco-reporting at the regional level argues that only 2% of all media communications in the studied region cover

environmental issues.⁹² Most communications in that 2% share relate to activities of the regional authorities and are used for strengthening the image of those in power.⁹³ It is reasonable to conclude that, as part of environmental reporting, climate change coverage in regional and local media is inadequate.

At the national level, the situation varies depending on the media type. Yanitsky⁷⁸ argues that, in the Russian mainstream media, ecology-related analytical reviews and public debates have all but disappeared giving way to sensationalism. Television in Russia continues to attract very large audiences, although in 2011/2012, the size of the online audience in Russia overtook the number of television viewers for the 'under 34' age group.⁹⁴ Climate change coverage on television has been limited to occasional and brief extreme-weather-event features on news programmes. A notable exception, duration-wise, relates to a conspiracy-focused and British-made documentary 'The Great Global Warming Swindle' translated and broadcast by Russia's Channel One.⁹⁵

Newspapers, although sometimes prone to sensationalism, are on aggregate more neutral than television, and periodically report 'mundane' details of international climate negotiations, relevant legislation, and viewpoints of stakeholders. However, overall, the coverage is scant even in the most climate-aware and balanced sources. For example, Wilson Rowe⁹⁶ reports that there were 82 climate change-related publications in *Rossiiskaia Gazeta* over 2000–2007. For a leading state-owned daily newspaper, 10 articles per year at the height of public debate on climate change (the pre- and post-Kyoto Protocol ratification discussion) indicate a low importance assigned to the topic.

The Internet is a growing platform for the unfolding climate change debate. A recent survey by the Levada Centre⁹⁷ reports that 57% of adults in Russia use the Internet, up from 42% in 2010. According to Kokhanova,⁹¹ Internet-based environmental reporting in Russia tends to be less sensationalist than traditional mass media. Online authors are usually nongovernmental organizations, who mostly report best practice and success stories as opposed to attention-grabbing negative information. It is argued that, across online sources, there is a noticeable shift toward a more balanced coverage of environmental issues.⁹¹

A recent review of English and German online sources concludes that 'climate and environmental NGOs seem to be the champions of online climate communication'⁹⁸; a situation similar to Russian online eco-reporting.⁹¹ This appears at variance with the alleged 'online backwardness' of Russian NGOs in general, and Mardar's⁹⁹ assertion that they lag behind

online activities of the government and businesses is probably too simplistic. Apart from a recent surge of official communication related to JI projects, it is reasonable to conclude that NGOs are at the forefront of online climate change activities in Russia. Their leading role can be partly interpreted as a response of the civil society to the de-ecologization process and a way to compensate for the deficiency of state environmental institutions.

Despite the relatively active climate-related online presence, environmental NGOs in Russia manifest behavior similar to those of Russian NGOs in general. In particular, the online activities of non-commercial organizations are relatively unassertive, obscure, and often detached from the public,⁹⁹ although this pattern changes significantly during emergency situations. The case in point is the civil society consolidation and an associated flurry of online and other network activities after the 2010 heat wave. Whether a similar degree of consolidation and communication is achievable in support of a proactive, as opposed to reactive, climate debate remains to be seen.

Another important aspect of many NGOs' online presence relates to their financial situation. Several foreign charities have withdrawn from Russia since the mid-2000s, and the dwindling financial support has inevitably reflected on the state of online resources, with some Web sites abandoned.⁹⁹ This trend may intensify if controversial legislation on internationally financed NGOs¹⁰⁰ comes into force in its 2012 edition. The most online-active environmental NGOs (e.g., WWF-Russia, Greenpeace, and the Bellona Foundation) receive foreign funding; hence they are likely to be affected by the repercussions. This complex interplay between the civil society and political forces may be interpreted as adverse; yet, it was politicians who eventually triggered the climate debate in Russia. Despite Russian climate scientists being engaged in international collaborations since the late 1980s, climate change was perceived as a non-issue by broader society in Russia. The politicization of climate discussions at the national level has made climate science more visible than ever before.

CLIMATE SCIENCE: PHYSICAL-GEOGRAPHY ASPECTS OF CLIMATE CHANGE

Climate in the 20th Century^a

Russia is the coldest country in the world with the mean annual temperature of -4.1°C over the 1961–1990 measurement period. Averages, however, fail to reflect the diversity across large territories, and this is particularly true for Russia whose three climatic

zones are divided into 18 climatic regions. Although the warmest areas (the Black Sea coast) enjoy above-zero temperatures in winters, the average winter temperature in the coldest regions (Eastern Siberia) is -40°C . Average summer temperatures across the country vary from $4\text{--}5^{\circ}\text{C}$ in the Far North to $20\text{--}22^{\circ}\text{C}$ in the southern regions.

Two main distinguishing characteristics of the precipitation regime in Russia are the abundance of solid precipitation (e.g., snow, hail, and sleet) and the uneven distribution of rainfall throughout the country. The first characteristic is due to a large number of cold climatic regions; the second one is attributable to the country's vast area. The average annual precipitation is as low as 150 mm on the Arctic Islands and arid valleys of South-East Altai and reaches up to 3200 mm on the Black Sea coast. In contrast to the temperature regime, average monthly precipitation variation is greater in summer than in winter. For example, the Caspian Sea coast sees less than 30 mm of summer rainfall, whereas it measures up to 100–140 mm in Primorsky Krai and the Altai Mountains. Winter precipitation stays at about 20–40 mm a month in most regions.

Another distinct feature of Russia's climate is permafrost. It extends over almost 70% of the country's land area, with the frost penetration in some areas reaching as deep as 1300 m. Permafrost evolution has a major bearing on both climate formation and socio-economic performance in Russia. The maintenance of existing infrastructure and new construction projects are dependant on the state of the frozen ground, particularly, in the northern parts of Western Siberia, Russia's main gas province. Notably, in recent years the areas of intensive gas exploration and production (Nadym and Urengoy) have experienced the highest soil surface temperature increase in the region.¹⁰¹ This and other changes in the climate are expected to intensify over the 21st century.

Climatic Changes and 21st Century Projections

The mean land-surface air temperature in the Russian territory is expected to rise more rapidly than the global average. Temperature projections by the Russian Federal Service for Hydrometeorology and Environmental Monitoring ('RosHydromet') are based on coupled atmosphere–ocean general circulation models and a range of storylines from the IPCC's 'Special Report on Emissions Scenarios', or 'SRES'.¹⁰² The RosHydromet argues that there are only 'minor variations' between outputs of different

scenarios for Russia by the middle of the century.¹⁰³ In particular, the annual mean temperature for Russia is projected to rise $1.1 \pm 0.5^{\circ}\text{C}$ by 2020 and $2.6 \pm 0.7^{\circ}\text{C}$ by 2060, respectively, above a 1990 baseline; with the winter mean surface temperature projected to increase $3.4 \pm 0.8^{\circ}\text{C}$ by 2060.¹⁰⁴ Therefore, Russia would cross the 2°C threshold earlier than the world 'on average' if significant and effective mitigation is not forthcoming. Average warming for the Russian territory for the period 1907–2006 is estimated to have been 1.29°C compared to 0.75°C globally.¹⁰⁴ In a more recent study, Sanderson et al.¹⁰⁵ report that by 2100, at the high end of the SRES A2 scenario family, 'the northern half of Asia', including Russia, is likely to experience a temperature increase of $6\text{--}16^{\circ}\text{C}$, compared to a approximately 4°C global mean temperature increase, relative to preindustrial levels. Simulations by the UK Met Office Hadley Centre, exploring the SRES highest emission scenario family A1FI, demonstrate that the 4°C global average could be reached as early as in 2058 if relatively strong carbon-cycle feedbacks are assumed.¹⁰⁶ Other recent analyses also warn of the global temperature change trending toward 4°C by as early as 2060–2070.^{107–109}

The mean surface temperature in Russia's territory is predicted to change unevenly, with the regions closer to the North Pole experiencing higher temperature increases in winter and lower temperature increases in summer, compared to the south of the country, as Figure 3 illustrates. Similarly, predicted changes in precipitation vary across the country, although RosHydromet¹⁰⁴ expects that winter precipitation will intensify in all Russian regions. In summer, only high and mid-latitudes are likely to experience raised precipitation levels, whereas the southern regions will develop arid conditions. Overall, water resources are expected to increase in water-abundant areas and shrink in drought-prone regions. As to the changes that are already evident, over the past decades there has been some increase in the average annual precipitation country-wide, although there was no definite precipitation trend over the 20th century as a whole.¹⁰⁴

The changes in temperatures and precipitation are likely to raise the probability of droughts in the south of Russia by 2100.¹¹⁰ At the same time, forest flammability is expected to grow throughout the first half of the 21st century,¹¹⁰ as average annual and monthly temperatures continue to climb. Latest data show that 2011 was among the five warmest years since instrumental meteorological observations started,¹¹¹ with 2010 illustrating how temperature anomalies and associated impacts may transpire

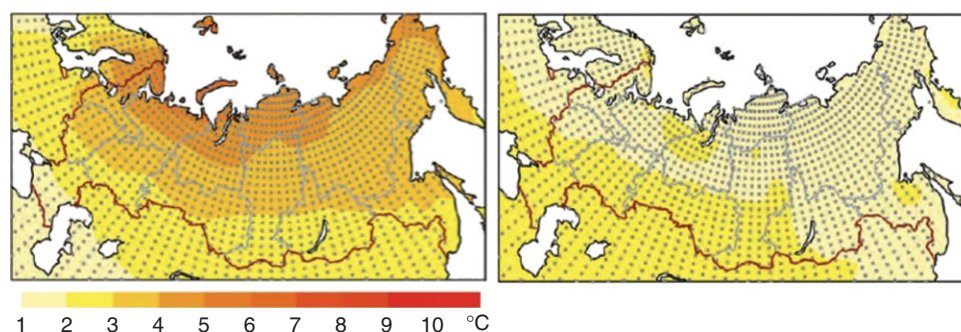


FIGURE 3 | Projected winter (on the left) and summer (on the right) temperature increases in Russia by the middle of the 21st century compared to the 1990 levels, based on the SRES's A2 scenario.¹⁰⁴

in the future if no mitigation action is taken. In the 2010 summer, Moscow experienced the highest monthly average temperatures on record,^{112,113} and a similar situation was observed elsewhere in Russia.¹¹⁴ In addition to temperature anomalies and droughts, several other potential extreme weather events are listed in the bottom row of Table 5.

Climate Change Impacts and Adaptation Strategies

Observing and understanding climatic trends and variation is essential for exploring how they may change and how they may subsequently affect the country's development. This is particularly important for countries with an inhospitable environment that typically locks them into climate-specific infrastructures. Russia has some of the harshest conditions in the world for living and working on much of its territory. Despite the difficulties, the population and institutions have adapted to the environment over the decades of relatively stable climatic conditions. If the scale or the pace of climate change exceeds that of adaptation, the repercussions may be far-reaching and damaging.

The impacts of a temperature increase will be more immediate and detrimental for some regions than others. For example, in the short term, Russia is expected to have an increased vegetation period for crops and fruit trees. At the same time, the variability of weather patterns is predicted to bring about untimely frosts and thaws as well as inadequate protective snow cover during winter that could damage plants.¹¹⁵ Table 5 summarizes climate change implications for Russia as presented in Russian-language literature. The impacts listed in the second column do not assume adaptation and, for the purposes of this article, are ranked as positive (+), negative (−), or uncertain (●). Some impacts and,

consequently, adaptation strategies are unique to particular regions, as is detailed in the first column. For instance, Russia's Arctic and Subarctic territories will likely face the most far-reaching implications compared with other parts of the country in terms of ecological, economic, and human aspects.¹¹⁰ The Northern region is an example of both positive and negative impacts of climate change. For instance, the living and working conditions in the area may improve because of a warmer climate, making it easier to populate the region and extract natural resources. However, the permafrost degradation will make it difficult to maintain existing infrastructures and buildings.^{122,123} Additionally, radioactive waste depositories on one of the Arctic islands, the Novaya Zemlia, are likely to become a major concern as the permafrost weakens.¹²⁴

Studies on Russia typically fail to discuss broader climate change implications, for instance, the issue of climate refugees from neighboring states. Central Asian countries increasingly face water supply shortages and water quality deterioration.^{125,126} This is likely to affect health, ecosystems, and agricultural practices and may result in forced migration to areas more suitable for living, of which Russia is the nearest. Such external pressures may be aggravated by potential tensions *within* Russia linked to water scarcity, dwindling crop yields in certain regions, and populations being displaced by extreme weather events such as floods and mudslides (see Table 5 for more details). In addition, low-frequency high-impact climate change events and their implications are seldom explored (for notable exceptions see Refs 127,128). This research gap is evident in many climate change impact studies, as the risks of catastrophes often become sidelined when the impacts are averaged geographically and temporally.

Regardless of the uncertainties evident in analyses of Russia's climate, the country is likely to be less vulnerable to changes in the climate

TABLE 5 | Potential Climate Change Implications for Russia Summarized from Russian-Language Literature^{110,115–121}

Affected Areas	Impacts	Potential Adaptation
Terrestrial ecosystems (Country-wide)	<ul style="list-style-type: none"> • Changes in borders of vegetation zones (species migration) • Altering regional albedo – Potential extinction of certain plants (particularly, those endemic to Arctic and Subarctic regions) – More frequent and intensive wildfires + Terrestrial CO₂-fertilization 	Land-use and forest management
Cryosphere (Arctic and sub-arctic regions; the Caucasus, the Ural, and the Altai mountains)	<ul style="list-style-type: none"> • Increased sea-ice thickness in some North-West regions (Barents sea, Kara sea) in 2020–2030 – Increased methane emissions from permafrost by 6–10 million tonnes per annum by 2050 – Intensified coastal erosion due to permafrost degradation; consequently, increased risk of subsidence (see 'Infrastructure and buildings') – Declining ice extent and thickness on Arctic islands and archipelagos – Complete melting of certain mountain glaciers in Kamchatka peninsula – Accelerated Caucasus glacier melt and decrease in glacier-derived runoff 	<p>Suspension of new oil field exploration until effective methods of minimizing impact of exploration/extraction in Arctic conditions are utilized</p> <p>Monitoring and development of early warning systems in Arctic areas affected by climate change</p>
Seas (Maritime regions, seas and oceans)	<ul style="list-style-type: none"> • 3–5°C mean sea temperature increase by 2100 for seas of North-East Russia • Increased sea-ice thickness in some North-West regions (Barents sea, Kara sea) in 2020–2030; decreased sea winter ice thickness and extent in other seas • Changes in marine biodiversity • Increased access to energy resources in Arctic – Higher sea level in Southern regions + More accessible navigation routes in Arctic 	<p>Increased attention and diplomatic efforts regarding Arctic region geopolitics</p> <p>Fortification of buildings and infrastructure in regions threatened by sea level rise</p>
Rivers and water resources (Country-wide)	<ul style="list-style-type: none"> • Ecosystem and biodiversity changes along rivers • Extended river shipping season and shorter river 'ice road' season (due to approximately 20 to 27-day shorter river freeze-up and 20–40% thinner river ice) – Decreased river flow by 3% in Southern regions; 10–20% decrease in local water resources by 2040 + Increased river flow by 9–10% in European part of Russia; 4–8% in Arctic regions; 3–11% in Asian part of Russia (by 2040) + Increased electricity production at most hydro-electro stations (except Southern regions) 	<p>Enhanced water supply management: building water reserves; rationed water distribution</p> <p>Increased straightening and deepening of river channels to facilitate river shipping</p>
Infrastructure and buildings (Country-wide)	<ul style="list-style-type: none"> – Shorter service life of buildings/infrastructure with increased temperature variability causing more thaws and cold spells during cold season – Undermined buildings, pipelines and other infrastructure in regions built on permafrost – Increased air-conditioning during warm season + Shorter cold season and lower energy use for maintaining comfortable thermal condition inside buildings 	<p>Implementing energy efficiency measures in buildings sector</p> <p>Fortification of building and infrastructure in Arctic and Subarctic regions; evacuation of population at risk</p>
Agriculture (Country-wide)	<ul style="list-style-type: none"> • Longer annual vegetation periods that might lead to plants damage by early frosts (this risk is forecasted to persist until 2015 when warmer climate establishes itself in Russia) – Risks of new plant pests/diseases/invasive species with increasing aridity and warmer winters – Increased aridity of main crop-producing regions, leading to lower crop yields 	<p>Innovative methods of pest/disease control</p> <p>Water management in potentially arid regions</p> <p>Developing agricultural practices in Northern and Eastern regions</p>

TABLE 5 | Continued

Affected Areas	Impacts	Potential Adaptation
Population and health (Country-wide)	<ul style="list-style-type: none"> +Increased output from marginal lands through reduced variability in temperature in some regions with fertile soil (Urals and Siberia) –Extremely high/low temperatures and large/rapid temperature variations (e.g. a 10°C temperature rise within 24 hours compared to a climatic normality results in 8% morbidity increase) –Potable water scarcity with decreased water flows and higher aridity in South Aggravating air and water pollution problems –Proliferation of climate- and season-dependant allergies and/or vector-, rodent-, and water-borne diseases –Indigenous people and their lifestyle affected by: changing flora and fauna; increasing drowning accidents during hunting/fishing with thinner ice; more frequent food poisoning caused by food conservation problems (as cold outside temperatures fail to serve as ‘refrigerators’) –Ecosystems and population affected by extreme weather events (see below) –Population migration caused by climate change +Developing/populating Arctic/Subarctic regions with better climate conditions/energy resources exploration 	<ul style="list-style-type: none"> Smart urban planning: increased albedo of roofs, planting trees, building shades and so on Improved water storage and supply management Vaccination and other preventive measures for containing diseases Education and development of new occupations for indigenous peoples
Extreme weather events (Country-wide)	<ul style="list-style-type: none"> –Potential increase in frequency/intensity of droughts in South of country (particularly, in Stavropolsky and Krasnodarsky regions) –Increase in frequency/intensity of mudslides (Caucasus) –Potentially increasing risk of avalanches (Caucasus) –Higher risks of wildfires in European part (except North-West), and South of Asian part of Russia +Lower risks of wildfires in North-West and North-East of Asian part 	<ul style="list-style-type: none"> Enhanced water supply management Refined system of predicting and monitoring extreme weather events

•: Uncertain sign of impact; –: negative impact; +: positive impact.

than, for example, nations in the low latitudes.¹²⁹ For some countries, the 2°C threshold is associated with impacts that will threaten their existence *per se*; while for many nations in the high latitudes, holding the temperature increase to 2°C will *avoid* such dramatic impacts.¹³⁰ Evidently the 2°C concept is not static, but rather is contested both temporally and spatially across different countries, with Russia, on the whole, insulated from the most extreme impacts of a global 2°C rise. As a consequence of its vast territory, abundance of water resources, and low population density of its more vulnerable regions, it has the potential to develop a high adaptive capacity compared to many of its neighbors. As Table 6 shows, a doubling of preindustrial CO₂ concentration could result in a 14% decrease of ‘absolutely uncomfortable’ areas compared to 1981–1990.¹³¹ Under the same assumptions, ‘comfortable’ areas are expected to expand. It is unclear from the study how ‘discomfort’

has been measured and whether the results have been normalized by the number of people living in different areas. A climate sensitivity range assumed in the study is not reported either.

Significant monitoring and modeling of climate change with respect to Russia has already been undertaken. RosHydromet has coordinated the majority of this activity including adaptation,¹²⁴ although most of the adaptation projects in Russia have, at least in part, been funded internationally.^{132–134,116,135,136} Although much adaptation research has focused on the Russian Arctic (region-wise) and agriculture (sectors-wise), there already exists a broad base of scientific knowledge necessary for developing and implementing adaptation policies in Russia. At the same time, according to a climate information portal maintained by the Russian Regional Environmental Centre,¹³⁷ the economics of adaptation is one area where research has been scarce.

TABLE 6 | A Share of Russia's Total Area With Varying Degrees of Discomfort in 1931–1960 and 1981–1990 (January) Compared to the Projected Discomfort as a Result of CO₂ Doubling¹³¹

Degree of Discomfort	Share of Russia's Total Area (%)		
	1931–1960	1981–1990	If CO ₂ Doubles
Absolutely uncomfortable	39	33	19
Extremely uncomfortable	22	21	23
Discomfortable	17	14	10
Relatively discomfortable	6	8	9
Comfortable	16	25	38

Effectively, adaptation in Russia is still at the research and planning stage. In this sense, the low level of commitment to addressing the issue of mitigation is exacerbated by the absence of an adequate adaptation strategy. Climate change risks are to some extent considered in various programmes for the development of economic sectors and provinces, but there is no comprehensive and clear set of policies at either national or regional levels. Although Russia's Climate Action Plan emphasizes the importance of adaptation, the level of policy implementation is low. Severe heat waves in the central part of the country during 2010 demonstrated how the Russian government was unprepared to respond to extreme weather events on such a scale. Early assessments of the impacts suggest increased morbidity and mortality, uncontained forest and peat land fires, and acute crop failures.^{138–142} The 2010 heat wave gives rise to serious concern as to how, in the absence of coherent adaptation strategies, Russia would tap its high adaptive capacity to cope with the potential ramifications of a 2°C or more global mean surface temperature rise. One evident political consequence of the heat waves was that the then-President started voicing concerns regarding climate change impacts on Russia. Although the Russian government is often at risk of confusing climate change with weather, such high-level engagement could potentially trigger a more meaningful commitment to the Copenhagen Accord, the 2°C target, and a broad international discussion on climate change.

CONCLUSION

Global greenhouse gas emissions have risen at unprecedented rates since the Intergovernmental Panel on Climate Change produced its first assessment report two decades ago. Despite extensive international negotiations, there is no sign of any major emitting nation dramatically reducing its emissions within the coming decade. As Fatih Birol,

the IEA's chief economist, has put it, 'the [emission] trend is perfectly in line with a temperature increase of 6 degrees Celsius (toward the end of this century)'.¹⁴³ Although a 4°C global mean surface temperature increase is associated with an estimated 6–16°C temperature change across Russia, a 6°C global mean increase would have even more profound implications for impacts and adaptation within the country. Considering that Russia occupies 11% of the global land area, with almost two thirds of the country's territory underlain by methane-rich permafrost, such temperature increases risk triggering global climatic discontinuities. Given such potentially cascading risks, anything short of immediate and internationally coordinated action is likely to result in substantial and irreversible changes across both the Russian territory and much of the globe.

The analysis of national developments shows that within Russia's ruling elite there is considerable resistance to proactive mitigation and adaptation. The government's position is characterized by a number of interrelated geographical, political, and economic factors. A frequently cited reason for inaction is the country's relatively high adaptive capacity, alongside other physical-geography characteristics including large forest carbon sinks and extensive fossil fuel reserves. The latter are not openly declared as an 'excuse' not to mitigate, but rather underlie, first, the sluggish development of renewable energy sources, and second, Russia's influence on importers of its fossil fuels. Arguably, wielding significant control on the international arena and thereby preserving superpower status is an essential part of the government's geopolitical ambition.

Related to international politics are economy-focused arguments against rapid decarbonization. Russia's export-led fossil fuel industry provides the federal budget with an essential revenue stream. In addition, the government has expressed concern that Russia's mitigation action may give an

immediate competitive advantage to other high-emitting economies-in-transition who have no binding emission targets. Among the top echelons of power, little credence appears to be given to the view that decarbonization could benefit the country's economic and geopolitical position in the long run.

Regardless of the government's intention to preserve the status quo at both domestic and international levels, the advent of climate change suggests that the era of fossil fuel consumption may be hastened, together with Russia's energy supremacy. At the same time, the global climate situation has offered Russia an opportunity to realize its leadership potential, wherein an ambitious national emission reduction target could be a first step.

Russia's Climate Doctrine, though currently serving as little more than a rhetorical context and being yet another example of weak policy implementation, may still provide a meaningful framing of climate challenges at a national scale. Complimented with near-term policies, specified targets and longer-term qualitative roadmap, the Doctrine could offer an appropriate umbrella for a coherent programme of mitigation and adaptation. It is, however, important that the Doctrine is aligned with international targets and commitments. Integrating both global and national dimensions of climate change will help to ensure consistent and evidence-based policies, facilitate synergies and abate conflicts. Such integration would be an important step in considering mitigation and adaptation together in the setting of relevant temperature target/s.

Arguably, it is politically easier for Russian policymakers than for many of their colleagues in other industrialized countries to implement stringent temperature and emission targets. The semi-authoritarian policy regime in Russia can more readily impose climate-related policies on the population, with a historically passive civil society further facilitating the top-down approach. On the other hand, despite strong leadership at the national level, it is evident that a limited transparency, unclear attribution of responsibilities, and other aspects of the legacy of bureaucracy continue to stall effective policy implementation. Importantly, recurrent policy setbacks may prevent Russia from taking advantage of its potentially high adaptive capacity. The low level of trust in regional and local authorities further aggravates the situation.

given that adaptation strategies often need to be localized.

The distrust in 'authorities' and the weakness of civil society are a handicap when it comes to long-term national priorities. The culture of 'passive observation' manifest in Russia's principal environmental agency, RosHydromet, for example, partly explains the country's climate change inaction. Yet, the climate-related track record of the government may leave civil society actors as more likely than the ruling elite to emerge as effective and timely 'levers for change'. The level of awareness and concern among the Russian population, albeit comparatively low, is growing steadily. This, combined with worsening extreme weather events (of which the 2010 heat wave was an indication), may yet prompt a wide public discussion of the issues and, ultimately, catalyze national policies and Russia's more constructive engagement internationally. A suggestion for future research is to explore specific mechanisms likely to usher in a more proactive and effective climate policy in Russia, both domestically and internationally.

Along with other 'big emitters', Russia has a pivotal role in shaping the future direction of international climate change mitigation and climate impacts. It remains an influential international force, is a major emitter of greenhouse gases, a global supplier of fossil fuels, and its diverse and extensive territory is both vulnerable and resilient to the impacts of climate change. This unique confluence of circumstances leaves Russia with a challenging dilemma. The country can choose to acquiesce to short-term political and financial considerations, adopt weak mitigation measures, and face potentially devastating impacts. Or it can apply its considerable attributes and powers to instigate an epoch of national and global action to secure a low-carbon and climate-resilient future. Although the former will see Russia subsumed into the international malaise on climate change, the latter may both quench the nation's 'thirst for greatness' and fill the void of climate leadership.

NOTE

^a This subsection draws on RosHydromet's Web site unless otherwise stated. Only temperature and precipitation are covered here, while other elements of the climatic system—cloud cover, solar radiation, wind conditions, waterways—are outside the scope of this article.

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