

WATER DIMENSION OF BRICS COOPERATION: NATIONAL CHALLENGES AND JOINT OPPORTUNITIES

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This article examines the evolution and potential of the water agenda of BRICS. The members of this international association of major countries of South America, Eurasia, Asia and Africa are rich in water resources and population. The development of water resources extends beyond their borders to projects in other countries through the activities of a major development institution, the New Development Bank of BRICS. Such conditions suggest some anticipation of a global and comprehensive view on the part of BRICS on the issues relating to water resources. However, the hypothesis of this article is opposite: despite the unique potential of the BRICS water strategy, it remains non-specific, focused on the lower common denominators for the member countries such as cleanliness, sanitation and water management. To account for this, the authors take the position that the bureaucratic logic of basic common interest downgrades strategic vision. This is reflected in the growing gap between the multifaceted nature of the issues related to water resources in the world and the narrowly specialized approach of BRICS association which perceives water de facto without its resource and global function. To study this, the authors analyze the water portfolios of the BRICS member countries and compare the national water agendas based on an analysis of policy documents. They

then systematize water initiatives under the auspices of the BRICS and, finally, calculate virtual water flows and their structure between the BRICS countries using agricultural products trade as an example. The conducted analysis allows the authors to identify a wide gap between the current and potential water agenda of the BRICS. The authors then propose a number of initiatives that can create added value for the BRICS as an association both for its member countries and for developing countries facing water resource challenges. The authors assert that such a new approach, based on a profound understanding of the resource function of water as a commodity with global value, has all the potential to be implemented by BRICS.

Keywords: BRICS; water cooperation; virtual water; water-food nexus.

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Introduction: Local Water with a Global Value¹

Throughout human history, international water basins have always been of political interest to the countries that share these basins. In the second half of the twentieth century, the number of people suffering from water shortages increased many times. Today, it affects more than 2.2 billion people, and in the coming decades their number will rise to 4 billion people.

¹ The paper partially relies on the project “Balance of Water Power,” conducted by the Centre for Comprehensive and International Studies since 2020 (Feb. 25, 2021), available at <https://cceis.hse.ru/water>.

This is how the regional and humanitarian aspects of the global water crisis emerged.

The transition of the water scarcity issue from the regional to the global level is of theoretical and practical interest, especially in the framework of systems analysis. In such cases, Russian scholar Petr Tsygankov suggests turning to Oran Young's concept. At some point, the "breaks in the international system," to use Young's terminology, that determine the characteristic features and models of the interaction of regional subsystems within the international system turn out to be secondary, and the issue becomes important to the entire international system.² This approach demands a clear understanding of the reasons water scarcity has become prevalent around the world, and not only in conflicted regions or areas where large numbers of people are suffering from water stress.

With the advent of globalization, the water component of any state's foreign policy, along with regional ties, begins to be projected globally. Indeed, for the first time in history, once confined local resources have taken on a global dimension that allows the states that control them to project their influence on a global scale.³

Despite regionalization and the evolution of globalization itself, the modern economy remains global and a particular product becomes a valuable resource not just in countries where it is scarce. Countries rich in water use it as a competitive advantage to compete on a global scale. The value of water as a resource is enhanced by the fact that it is one of two key elements for food production, transforming it from a common commodity into a new economic and political resource. And there are no signs of this trend changing soon.

BRICS, as a joint format that unites countries with the largest reserves of renewable water resources on the planet, Brazil and Russia, the world's largest water consumers, China and India, and the African continent with all of its variety of water issues, should be at the forefront of the global water agenda.

However, the hypothesis of this study is the opposite: despite the unique water potential and resources for harmonizing water challenges, both within the BRICS and in relation to BRICS+, the association continues to adhere to the pre-global understanding of the value of water. BRICS reduces the water agenda to a universal basic understanding of water as a resource that must be cleaned, fairly distributed, and conserved in a responsible way.

In order to systemize some opportunities for the promotion of the BRICS water-related agenda, we first retrieve and compare national water portfolios based

² Цыганков П.А. Международное общество с позиций системного подхода: Орэн Р. Янг о «разрывах» в международных системах // Социально-гуманитарные знания. 2000. № 2 [Pavel A. Tsygankov, *International Society from the Position of a Systems Approach: Oran R. Young on "Gaps" in International Systems*, 2 Social & Humanitarian Knowledge J. (2000)]

³ Daniele Cesano & Jan-Erik Gustafsson, *Impact of Economic Globalization on Water Resources: A Source of Technical, Social and Environmental Challenges for the Next Decade*, 2(3) Water Pol. 213 (2000).

on open FAS Aquastat datasets as well as formal water-related indicators. Next, we conduct a structured analysis of official water-related documents, plans, and programs, describing the key pillars of national water management in BRICS countries. This comparison allows us to make recommendations about the agenda-setting process in BRICS, defining the lowest common denominator and potentially conflicting aspects. Finally, we focus directly on the BRICS water agenda and some recent developments related to the Russian chairmanship in 2020. Aside from precedent, this historically logical approach is consistent with Russia's pivotal role in the Clean Rivers of BRICS Program. However, this analysis proves that the BRICS water agenda remains relatively narrow and almost completely disregards a broader understanding of fresh water in the international system.

The current dynamics of the BRICS water agenda, which we will examine in section 2, do not allow us to speak about any steps to position BRICS as a water bloc or to align the economic superpowers of China and India with smaller but water-abundant Brazil and Russia. We believe that a new understanding of the resource potential of freshwater, especially in traded water-intensive goods could provide some impetus here. This logic supports section 3 of this paper's special emphasis on the evaluation of intra-BRICS virtual water-flows. To illustrate these implications, underrepresented at the official level, we provide an evaluation of BRICS virtual water flows in agricultural trade of 2018–2019. A detailed description of the data and methods is provided in section 3.1 and Appendix 1.

In the final section, we propose some suggestions to update the BRICS water agenda. While the purpose of this paper is not to provide a comprehensive list of potential developments in the water-related area of BRICS cooperation, it may be viewed as an argument for a reconsideration of the existing approaches. As the authors have presented some of the possible initiatives in previous works, particularly in the paper on Water Challenge and the Prospects for BRICS Cooperation,⁴ in this paper, we focus primarily on virtual water aspects that could have fairly real and substantial implications.

1. Water Aspect for the BRICS Countries

1.1. Water Portfolios

Table 1 depicts key indicators of the balance of water resources and related socio-economic variables. As the table shows, BRICS countries are in very different positions. Given their vast and globally significant TRWR resources (1 and 2 in the world) and high levels of urbanization (73.5% and 86.9%, respectively), Russia and Brazil have an outstanding position on the water agenda. These two states are primarily concerned

⁴ Anastasia Likhacheva, *Water Challenge and the Prospects for BRICS Cooperation*, 43(6) *Strateg. Anal.* 543 (2019).

with the issues of municipal water use as well as the conservation and maintenance of their freshwater resources.⁵ On the other hand, water is a much more significant issue for India and China, given the size of their populations, economies, and their limited water resources. Yet, South Africa is in the worst possible position as it faces a significant physical deficit of water resources.

Table 1. BRICS Water-Economy-Population Nexus

Indicator	Year	Brazil	Russia	India	China	South Africa
Total Population (mln inhab)	2017	207.8	145.5	1,338.6	1,452.6	57.0
	2019	211.0	144.3	1,366.4	1,397.7	58.5
Urbanization (%)	2017	86.9	73.5	33.6	58.0	65.5
Total Renewable Water Resources (10 ⁹ m ³ /year)	2017	8,647.0	4,525.0	1,911.0	2,840.0	51.3
Dependency Ratio (%)	2017	34.5	4.7	30.5	0.9	12.8
Total Renewable Water Resources Per Capita (m ³ /inhab/year)	2017	41,605	31,096	1,427	1,955	900.7
Total Population with Access to Safe Drinking Water (JMP) (%)	2017	98.1	96.9	94.1	95.5	93.2
Agriculture, Value Added (% GDP) (%)	2017	4.6	3.5	15.6	7.6	2.3
Agricultural Water Withdrawal as % of Total Water Withdrawal (%)	2017	60.0	28.9	90.4	64.4	58.7
Agricultural Water Withdrawal (10 ⁹ m ³ /year)	2017	39.4	18.6	688	385.2	11.3
Water Stress (%)	2017	3.1	4.1	66.5	43.2	62.1

Source: FAO Aquastat Dataset, Knoema

Another factor to consider when analyzing water resources is the vulnerability of states to trans-boundary water conflicts/security challenges. According to this logic, the BRICS countries can be divided into three additional groups based on this factor. Russia and China are almost completely reliant on third countries to ensure water security (dependency ratios of 4.72% and 0.96%, respectively). On the other hand,

⁵ Likhacheva 2019.

Brazil and India rely more on other states for adequate water resources (34.53% and 30.52%, respectively), making the issue of managing transboundary water basins more pressing for them. Finally, South Africa falls somewhere in the middle, with a dependency ratio of 12.84%, indicating it is only somewhat dependent on developing countries, but not as much as Brazil and India. Despite the fact that Brazil and India rely on developing countries for getting water, the BRICS countries are currently able to provide nearly all of their population with access to safe drinking water.

Similarly, as the details show, water stress rates of the BRICS countries are not high. Water stress indicators are almost non-existent in Russia and Brazil (4.1% and 3.1%, respectively). Other countries have much higher rates of water stress (China – 43.2%, India – 66.5%, South Africa – 62.1%), but the figures are still not critical. High water stress levels are most severe in India and South Africa. Moreover, according to the water stress survey,⁶ South Africa's water stress is expected to reach 80% by 2040. Furthermore, it should be noted that water stress can be balanced through policy advice and resource management – a practice that is already being followed in some countries.

Finally, based on the table's indicators, one can conclude that in BRICS, water resources are mostly used for agriculture, which has a significant impact on the natural environment, causes the most water stress, and requires the largest amount of water resources. Though only India is heavily reliant on the agricultural sector (15.62% added value of GDP), other countries with agricultural sectors that play less significant roles in their economies, also use the greatest share of water in agriculture. As a result, India has the highest level of agricultural water withdrawal (90.41% of total water withdrawal), whereas in other countries this sector accounts for around 60% of water withdrawal. One notable exception is Russia, where agriculture contributes little to the economy (and it does not require as much water as South African arid lands). Thus, having mentioned all these factors, one might conclude that BRICS countries do not face any acute water crisis. Nevertheless, indicators vary by country, with India and South Africa experiencing the most acute water problems, while Russia and Brazil enjoy far more favorable and secure water conditions.

1.2. National Water Agendas

In the section below, we attempt to systemize and structure key national water-related challenges in BRICS countries as they are considered at the official level. They are objectively quite diverse, but we categorize them by challenges of allocation of water resources, obsolete or underdeveloped municipal water use, problems of arid regions, water & sanitation, water quality, border water conflicts, and governance of shared water basins.

⁶ Andrew Maddocks et al., *Ranking the World's Most Water-Stressed Countries in 2040*, World Resource Institute (2015) (Feb. 25, 2021), available at <https://www.wri.org/blog/2015/08/ranking-world-s-most-water-stressed-countries-2040>.

As mentioned above, **Brazil** has the most renewable water resources in the world, with 13.8% of the freshwater of the planet⁷ and ranking first within BRICS as well. It uses this competitive advantage as a global exporter of many water-intensive goods like meat, paper, and pulp timber, coffee, soybeans, maize, etc.⁸ Furthermore, water is actively used as a source of energy in Brazil, with hydropower accounting for 92% of renewables-based electricity.⁹

However, Brazil's water resources are distributed unequally among its individual states. The Amazonian region, which is one of the most important from an ecological view point, accounts for 80% of water availability.¹⁰ At the same time, the region is sparsely inhabited (only 5% of Brazil's population) and is poorly connected to the country's economic hubs. As a result, other regions with the majority of the population account for only 20% of water resources.¹¹ Furthermore, precipitation is unevenly distributed, with the majority of rain falling only in two or three places during two or three months of the year, worsening the problem of water scarcity.¹²

Another water issue to consider in Brazil is municipal water use, which refers to the issue of water access in the slums of major Brazilian cities such as Sao Paulo or Ro de Janeiro. Despite significant infrastructure investments, problems with water access issues in the cities remain unresolved, and levels of municipal water and wastewater infrastructure remain unacceptably low in comparison to both international benchmarks.¹³

In terms of water policy, Brazil's National Water Resources Policy (Law No. 9,433 from 1997) recognized water as a "limited natural [resource], endowed with economic value" in 1997 and includes water use charges as one of its instruments.¹⁴ This document defined The National Policy of Water Resources (PNRH) and became the cornerstone of water governance legislation in Brazil, structuring the administration of Brazil's water resources. In 2000, the National Water Agency (ANA) was created to implement the national water policy and to coordinate the National Management System of Water Resources (SINGREH) (which functions as a cooperative mechanism bringing together

⁷ Demetruiis D. da Silva et al., *Integrated Water Resources Management in Brazil in Integrated Water Resource Management* 13 (2020).

⁸ Likhacheva 2019.

⁹ OECD, *Water: Improving Water Resource Government, Brazil Policy Brief* (2015) (Feb. 25, 2021), available at <http://www.oecd.org/cfe/regionaldevelopment/OECD-Policy-Brief-Brazil-Water-EN.pdf>.

¹⁰ da Silva et al. 2020.

¹¹ *Id.*

¹² *Id.*

¹³ Likhacheva 2019.

¹⁴ Law No. 9433 of January 8, 1997 – Brazilian National Water Resources Policy (Feb. 25, 2021), available at <http://www.braziliannr.com/brazilian-environmental-legislation/law-no-9433-brazilian-national-water-resources-policy/>.

water management entities from different levels). The National Water Agency has five official policy instruments: water resource plans, water permits, water quality objectives, water charges, and a system of information on water resources.

The Brazilian government has implemented various programs to improve sanitation conditions, manage water supply and optimize waste water treatment plants, water pollution and river degradation.¹⁵ Yet many issues, such as the water demand/availability ratio in some regions, inadequate investment in water waste technologies, lack of communication between water policy actors and other urban functions, the perception of urban rivers as environmentally unsuitable for use and other such similar problems remain unaddressed.¹⁶

Although **Russia** has the second largest renewable freshwater resources in the world, its position on the international agenda is almost non-existent, with no strategic statements in doctrinal documents. We cannot help but notice the existence of a water problem in Russia, particularly when it comes to the modernization of water management, improvement of water quality for municipal needs, and the preservation of important world reservoirs. However, most of these issues are addressed within the framework of the national agenda.

Since 1997, the country has developed and adopted the Water Code of the Russian Federation,¹⁷ which regulates legal relations in the field of rational use and protection of water bodies, and which has since undergone a number of changes and is now enforceable throughout the territory. The Federal Law of the Russian Federation 'Payment for use of water facilities' is also in effect in the country. Simultaneously, budgetary funding mechanisms are in place in the constituent entities of the Russian Federation to finance more than ten projects for the protection and restoration of water resources.

To complete the priority tasks of socio-economic development by 2020, it was planned to implement the following programs and concepts:

- the Long-term Economic and Social Development Plan of the Russian Federation for the period up to 2020, as approved by the Order of the Government of the Russian Federation in 2008;¹⁸

¹⁵ World Bank Group, *Our Work in Sao Paulo* (2021) (Feb. 25, 2021), available at <https://www.2030wrg.org/saopaulo/our-work/>.

¹⁶ *Id.*

¹⁷ Водный кодекс Российской Федерации от 3 июня 2006 г. № 74-ФЗ // СПС «КонсультантПлюс» [Water Code of the Russian Federation of 3 June 2006 No. 74-FZ, SPS "ConsultantPlus"] (Feb. 25, 2021), available at http://www.consultant.ru/document/cons_doc_LAW_60683/.

¹⁸ Концепция долгосрочного социально-экономического развития Российской Федерации на период до 2020 года (утверждена 17 ноября 2008 г. распоряжением Правительства Российской Федерации № 1662-р) // СПС «КонсультантПлюс» [The Long-term Economic and Social Development Plan of the Russian Federation for the Period up to 2020, adopted on 17 November 2008 by resolution of the Government of the Russian Federation No. 1662-p, SPS "ConsultantPlus"] (Feb. 25, 2021), available at http://www.consultant.ru/document/cons_doc_LAW_82134/28c7f9e359e8af09d7244d8033c66928fa27e527/.

- the Water Strategy of the Russian Federation for the period up to 2020, as approved by the Order of the Government of the Russian Federation in 2009;¹⁹
- the Federal Target Programme “Development of the Water Management Complex of the Russian Federation in 2012–2020.”²⁰

According to the strategy, the main problems were identified as:

- unsustainable use of water resources;
- scarcity of water resources in certain regions due to uneven distribution;
- non-compliance with drinking water quality standards;
- limited access of the population to centralized water supply systems.

The water situation in Russia has been described as a crisis. However, by 2017 the results of the strategy and federal programs showed that overcoming the crisis by 2020 was impossible. Nonetheless, it was still planned to move forward with three tasks: developing the State regulatory system; creating conditions to attract long-term private investment; and modernizing water supply, drainage and waste water treatment systems by supporting regional entity programs.

By the end of 2020, the only thing that could be said is that the priorities that were set were not fully realized. Accurate results and outcomes will be available once the strategy report is published.

One of the main challenges is water pollution in Russia. Annually, about 3,000 cases of high and extremely high levels of pollution are recorded in the country. In the last five years, approximately 320–330 reservoirs have been identified as heavily polluted. In 2020, one of the largest incidents of its kind occurred in Norilsk when the fuel reservoir owned by Russian mining giant Nornickel collapsed, causing damage to the Arctic waterways that will take years to remediate and repair.

In addition, trans-boundary surface water is polluted by the transport of chemicals. According to the study, the most polluted sections of rivers are along the borders of Norway, Poland, Belarus and Ukraine, while the least polluted are those with Finland and Norway.²¹

Another issue in Russia is the country’s uneven distribution of water resources, which can be divided into water-rich and water-scarce regions. The Far East of Russia

¹⁹ Водная стратегия Российской Федерации // Научно-популярная энциклопедия «Вода России» [The Water Strategy of the Russian Federation, Popular Science Encyclopaedia “Water of Russia”] (2012) (Feb. 25, 2021), available at https://water-rf.ru/O_воде_официально/826/Водная_стратегия_Российской_Федерации.

²⁰ Постановление от 19 апреля 2012 г. № 350 «О федеральной целевой программе «Развитие водохозяйственного комплекса Российской Федерации в 2012–2020 годах»» [Act No. 350 of 19 April 2012. On Federal Target Program “Development of the Water Management Complex of the Russian Federation in 2012–2020”] (2012) (Feb. 25, 2021), available at <http://docs.cntd.ru/document/902343713>.

²¹ Министерство природных ресурсов и экологии Российской Федерации, Государственный доклад «О состоянии и использовании водных ресурсов Российской Федерации в 2018 году» [Ministry of Natural Resources and Ecology of the Russian Federation, State Report “On the State and Use of Water Resources of the Russian Federation in 2018”] 290 (2019).

is regarded as the most water-rich region of the country, followed by Eastern Siberia and the northern economic districts, while Central Europe and the Caucasus are considered to be the most water deficient.

Moreover, inefficient use of water is observed in Russia, with total losses estimated at 9–10% in industry and 30% in agriculture due to overuse.

India, the second most populous country in the world, has less water scarcity than China, but the water deficit is still a structural limitation for its socio-economic development. To begin with, India suffers from an uneven availability of water (both spatially and temporally), pollution of the water resources by agricultural and industrial sectors, and an unreliable municipal water supply.²² Furthermore, it should be noted that the modes of consumption of water-intensive goods will be transformed as India enters periods of intense economic growth and profound urbanization (which will further place greater demands on municipal water use).²³ Finally, climate change contributes to the problem, by affecting traditional agricultural (and water use) practices, and destabilizing the water sector through frequent and unpredictable floods and droughts.²⁴

The National Water Policy was adopted in India in 2012.²⁵ However, the water issue was dealt with by a number of ministries, which frequently resulted in a delay in decision-making, inter-sectoral conflicts and problems in governance.²⁶ Recently, India has made some progress in this direction by merging the Ministry of Water Resources, River Development and Ganga Rejuvenation and the Ministry of Drinking Water and Sanitation into the Ministry of Jal Shakti. The new ministry is responsible for developing policy guidelines and programs for the development and regulation of the country's water resources.²⁷ The Ministry is currently implementing several projects, including the "Rejuvenating Ganga" project, flood management programs, programs of research and development in the water sector, dam rehabilitation and improvement programs. Moreover, in 2018 a draft "River Basin Management Bill" was prepared with the goal of establishing river basin management boards.²⁸

China suffers from a water deficit, which is a structural limitation for development and prosperity. In addition, there are ecological problems, pollution of the water

²² Sharad K. Jain, *Water Resources Management in India—Challenges and the Way Forward*, 117(4) *Current Sci.* 569 (2019).

²³ Likhacheva 2019.

²⁴ *Id.*

²⁵ Government of India, Ministry of Water Resources, National Water Policy (2012) (Feb. 25, 2021), available at .

²⁶ Jain 2019.

²⁷ Government of India, Mission, Vision, Function (2021) (Feb. 25, 2021), available at <http://mowr.gov.in/about-us/functions>.

²⁸ The Draft River Basin Management Bill, 2018 (2018) (Feb. 25, 2021), available at https://www.prsindia.org/sites/default/files/bill_files/Draft%20River%20Basin%20Management%20Bill%2C%202018.pdf.

environment, a high frequency of water hazards and an inequitable distribution of water resources. On top of that, national water governance is distributed among twenty central government agencies, which makes coordination to some extent difficult, resulting in increased transportation costs and delays in policy development and implementation.²⁹ As a result, water resources management has become an integrated task for the government.

Nevertheless, three components stand out: the Ministry of Water Resources, which is responsible for the construction and maintenance of its main hydraulic structures as well as the allocation of water resources; the Ministry of Agriculture and Rural Development, which oversees the rural development, irrigation process and production; and, finally, Ministry of Ecology and Environment, which is in charge of management and protection of national ecosystems and water resources. For the longest time, China has based its water management system on a river basin. As a result, there are as many as seven rivers and lakes commissions, but they lack the authority to distribute resources, manage pollution, etc. Despite the fact that this could increase the benefits and efficiency of economic development and environmental protection.

China has constructed a strict water management system that combines basin-specific management with administrative region-based management and is governed by the Water Law of the People's Republic of China. It focuses on the "three red lines" (water development, utilization, water use efficiency and pollutant load control) and four regulations (regulations of water use quantity, efficiency, pollutant load control and accountability and performance evaluation system for water resources management). An integrated assurance system established as a result of that decision guarantees flood prevention, monitoring of logging, concentrated water supply, drainage and pollution control, as well as water protection and management.

Furthermore, the country's policy of water resource allocation contributes to the development of a society whose main objective is the rational use of water. China's water planning system entails the creation of a wide range of specialized plans of various types (as approved by the Council of State the "National Comprehensive Plan on Water Resources," the primary purpose of which is the limitation of national peak water consumption to 700 billion m³ by 2030³⁰). These plans have reduced the imbalance between water demand and supply in the water-scarce northern regions and led to regulatory improvements and greater control over the resources in time and space. Moreover, there are several laws in the framework of the 13th Five Year Plan Period aimed at attaining water consumption volume control and conservation

²⁹ Yonglong Lu et al., *Addressing China's Grand Challenge of Achieving Food Security While Ensuring Environmental Sustainability*, 1(1) *Sci. Adv.* e1400039 (2015).

³⁰ Ministry of Water Resources, People's Republic of China, *Water Resources Management and Protection in China (2020)* (Feb. 25, 2021), available at <http://www.mwr.gov.cn/english/mainsubjects/201604/P020160406507020464665.pdf>.

of water in agricultural and industrial production, as well as in cities with the ultimate goal of building a water-saving society. In this regard, China has encouraged water users to participate in the entire process, has implemented integrated management and clean-up and restoration of water-related ecosystems, and has strengthened integrated groundwater management to prevent overuse.

In 2016, the government launched a project to improve drinking water and sanitation in rural areas. Within the framework of the policy, recommendations for integrated measures for the construction, reconstruction, and modernization of support facilities in the territory of human settlements were provided. Preferential tax incentives for electricity and land use have also been implemented. Thus, by the end of 2016, 80.4% of 260 million rural households were benefiting from the project.³¹

As previously stated, **South Africa** also suffers from a deficit of water resources. Due to the impact of apartheid policies, wide variations in the availability of water sources and infrastructure exist across provinces. For instance, wealthy Gauteng and Western Cape Provinces (which had the largest white population during apartheid) continue to have more reliable water supply, sanitation services, and wastewater treatment plants than other provinces.³² Moreover, the agricultural, manufacturing, and mining industries all contribute to the degradation of water quality.³³

As for water policies, the Department of Water Affairs and Forestry (DWAF) of South Africa is in charge of the water policies of the country. In 2020, it developed a very detailed National Water Security framework for South Africa (before there was a Water Framework for Growth and Development) as part of the National Development Plan (NDP): Vision 2030 to ensure water security.³⁴ Furthermore, the Development Bank of Southern Africa (DBSA) commissioned a number of papers on water security covering several aspects of the issues as perceived at the time.

South Africa's water legislation provides clear guidance on water management, but its implementation has been inadequate, and there is no effective monitoring and evaluation (M&E) system.³⁵ However, there is some progress: water supply has increased, for instance, millions of households have gained access to piped water

³¹ Jialiang Cai, *Water Sustainability: Towards Mutual Benefit and Win-Win Cooperation – Comparative Analysis of Action Plans on Implementation of the 2030 Agenda for Sustainable Development Between the European Union and China*, Report, China Europe Water Platform (May 2018) (Feb. 25, 2021), available at https://www.cewp.eu/sites/default/files/files/CEWP_SDG_report.pdf.

³² Coulibaly Yerema et al., *Differences in Water Policy Efficacy across South African Water Management Areas*, 175 *Ecol. Econ.* 106707 (2020) (Feb. 25, 2021), available at <https://www.sciencedirect.com/science/article/pii/S09211800920300896>.

³³ *Id.*

³⁴ National Planning Commission, *National Water Security Framework for South Africa: Summary, Principles and Recommendations* (2020) (Feb. 25, 2021), available at <https://www.nationalplanningcommission.org.za/assets/Documents/National%20Water%20Security%20Framework%20for%20South%20Africa.pdf>.

³⁵ *Id.*

since 2010.³⁶ Moreover, given the new framework and guidelines, some changes in the area might be expected

Summing up the retrieved priorities (see Table 2 below), we can conclude that national agendas are not limited only to the BRICS countries in the global arena. Similar priorities could be easily found if we analyzed the water agendas of most developing countries, from Thailand and Pakistan to Argentina, Morocco and other water-stressed nations. Furthermore, we see no indications that a more productive and coherent use of water as a globally traded and deliverable resource (in water-intensive goods and services) is being incorporated at a national level among BRICS. Water remains a state interest primarily in and of itself, independent of any water-food-energy-climate nexus.

Table 2. National water priorities of the BRICS countries

Rank	Brazil	Russia	India	China	South Africa
1	Improving water utility, water supply	Rational use and protection of water bodies	Cleaning of Ganga	Water development, water use efficiency and pollutant load control	Water supply and water security
2	Sanitation programs	Water pollution	Flood management, dam rehabilitation and improvement	Flood prevention, monitoring of logging	Even provision of water in all regions (not only wealthy)
3	Water pollution and optimization of wastewater treatment plants	–	Water-related R&D	Improvement of drinking water and sanitation in rural areas	–

Source: Authors' analysis based on national program documents

However, this table may provide insight into the relatively modest ambitions of BRICS as an organization in the water sector. *Water quality and supply in a narrow sense remain a major common ground for all five-member states.* This rather sectoral and industrial focus cannot cause any contradictions when compared to water rich

³⁶ National Water Security Framework for South Africa, *supra* note 34.

Brazil and Russia and water-stressed China, India and South Africa, not to mention transboundary water disputes between China and India and an unclear governance of the Amur and Irtysh river basins that unite Russia and China. The chosen approach of 'lowest common ground' allows us to quickly build joint positions while also heavily resuming the role of BRICS in the water agenda, both in-house and globally. We will present particular implications of this approach in the next section.

2. Water Agenda of BRICS

2.1. Track Record

Though being a very sensible political factor, water has become an issue of international cooperation. First of all, many of the world's most important freshwater basins are trans-boundary, with governance often shifting from the national to the supra-national level. However, what is most important is that international cooperation mainly focuses on providing access to drinking water and sanitation (sustainable access to safe drinking water and basic sanitation is the United Nations (U.N.) Sustainable Development Goal – 6).

In terms of the role of water in BRICS, its members have consistently stressed their commitment to sustainable U.N. goals in various joint statements, memorandums, and during summits. Since 2015, the ministers of the ecology of BRICS member countries have gathered for annual meetings. Water issues play an important role in the BRICS scientific and educational agenda. For instance, 'water resources and pollution treatment' is listed as one of the top five knowledge field priorities in the Memorandum of Understanding³⁷ on the Establishment of the BRICS Network University. Additionally, in 2015 the Moscow Declaration established the Joint Research and Innovation Networking Platform in order to provide a coordinated approach of BRICS to five thematic areas of science and technology cooperation.³⁸ Each of the BRICS countries is responsible for one of the areas; for instance, Russia is in charge of water resources and pollution treatments.

Russia, as the country in charge of water resources, has already established two water forums, among other things.³⁹ In 2016, a program called Clean Rivers of BRICS was presented within the framework of the forum, during which the participants identified three groups of problems related to the issues of water resources management and cooperation of the BRICS countries:

³⁷ Memorandum of Understanding on the Establishment of the BRICS Network University of 18 November 2015 (Feb. 25, 2021), available at https://we.hse.ru/data/2017/09/10/1172330598/MoU_SU_BRICS.pdf.

³⁸ III BRICS Science, Technology and Innovation Ministerial Meeting, Moscow Declaration of 28 October 2015 (Feb. 25, 2021), available at https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKewixkbfT4rDvAhXLuaQKHaitDt4QFjABegQIAhAD&url=http%3A%2F%2Fen.brics2015.ru%2Fload%2F630689&usq=AOvVaw2_g0WEsJn0oc2rtyDKkkSf.

³⁹ The official website of the BRICS Water Forum (2021) (Feb. 25, 2021), available at <http://bricswater.org>.

- development of scientific and technical cooperation of BRICS countries in the field of water resources through interaction and the expansion of financing instruments;
- expansion of technology transfer mechanisms between member countries in the field of water resources;
- exchange of experience in the implementation of strategic documents of the BRICS countries at the national, regional and municipal levels in the field of water resources and scientific and technical policy, as well as assessment of their effectiveness.⁴⁰

Moreover, in 2018 Russia and South Africa signed a Memorandum of Understanding on cooperation in the field of water resources⁴¹ at the BRICS summit. Within the framework of cooperation, a Cooperation Program was developed for the implementation of the Memorandum of Understanding between Governments in the field of water resources for the period 2019–2021.

In addition, within the framework of inter-state cooperation, the project “Development of membrane-based methods to improve the recovery of pure water and valuable products from waste” was launched in 2018 and was supported by the Russian Foundation for Basic Research in collaboration with participating organizations of the BRICS Framework Program in the fields of science, technology and innovation.⁴² The project aims to research five different membrane technologies created by BRICS partners.⁴³

2.2. Russian Chairmanship of 2020

In 2020, Russia took over as chair of BRICS. Among other goals that Russia declared as priorities for its chairmanship were the consolidation of efforts to respond to global and regional challenges, the promotion of cooperation in the field of energy and the encouragement of dialogue on agriculture and food security. Though water issues were not directly stated in the list of priorities, Russia had a basis and an opportunity to propose the development of a water agenda. However, the pandemic disrupted the plans. Nevertheless, some crucial results were achieved.

Under the Russian chairmanship, the 6th BRICS Environment Ministers Meeting took place. During this meeting, the Russian Environment Minister stressed the need for joint efforts in eliminating plastic waste in water under the Russian initiative

⁴⁰ Водный форум БРИКС [The Water Forum (2017)] (Feb. 25, 2021), available at <http://www.izdatgeo.ru/pdf/gipr/2017-1/207.pdf>.

⁴¹ Memorandum of Understanding between the Government of the Republic of South Africa and the Government of the Russian Federation on Cooperation in the Field of Water Resources of 27 July 2018 (Feb. 25, 2021), available at <https://treaties.dirco.gov.za/dbtw-wpd/images/20180726%20Russia%20Water%20Resources.pdf>.

⁴² From waste to Resource (2021) (Feb. 25, 2021), available at <http://brics4water.org>.

⁴³ From waste to Resource (2021) (Feb. 25, 2021), available at <http://brics4water.org/about-project>.

“Clean Rivers of BRICS.”⁴⁴ The minister also stated that Russia would work with the BRICS member countries to achieve the environmental goals of Russia’s National Development Goals 2030.⁴⁵ Furthermore, in September 2020, the New Development Bank approved several infrastructure and development projects, including the USD 100 million loan to the Eurasian Development Bank for the Water Supply and Sanitation Program in Russia. The program aims to support the modernization of water supply and sanitation systems in a number of Russian cities.⁴⁶

As per the Russian chairmanship, on 16 November 2020, joint principles for BRICS Development Financial Institutions adopted joint principles for responsible financing in which they affirmed their commitment to open, inclusive, and sustainable financial practices.⁴⁷ Furthermore, the 5th Meeting of BRICS Ministers of Energy took place in 2020, where the first research reports were approved: the BRICS Energy Technology Report and the BRICS Energy Report, the latter of which briefly looked at the water role in the energy sector.⁴⁸

Nevertheless, Russia had a chance to give impetus to a wider range of water policies. As mentioned above, the pandemic stole the initiative that year. However, at least one mention of broad crucial water issues could have been incorporated into the BRICS agenda in 2020.

- First and foremost, attention could have been paid to transboundary issues (while not all BRICS countries rely on third countries for water resources, transboundary basins still play an important role in the countries’ water agendas).

- Furthermore, programs to support unique water systems in Amazonia, Baikal, and Tibet could have been launched or at least discussed.

- From the economic point of view, programs to reduce non-tariff barriers to the export of water-intensive products could have been introduced, while, in contrast, the international trade arena has become more volatile. This step could significantly contribute to the promotion of real food security based on BRICS cooperation.

- Especially regarding reconsideration of the role of borders, in 2020 cross-border surveillance information systems for river basins could have been discussed at BRICS.

⁴⁴ BRICS Environment Ministers Discuss Prospects of Environmental Cooperation, Russian BRICS Chairmanship (2020) (Feb. 25, 2021), available at <https://eng.brics-russia2020.ru/news/20200731/510024/BRICS-Environment-Ministers-discuss-prospects-of-environmental-cooperation.html>.

⁴⁵ *Id.*

⁴⁶ Press Releases (2020) (Feb. 25, 2021), available at https://www.ndb.int/press_release/ndb-board-directors-held-28th-meeting-approved-infrastructure-sustainable-development-projects/.

⁴⁷ BRICS Development Financial Institutions complete the year of Russian BRICS Chairmanship by adopting joint principles for responsible financing (2020) (Feb. 25, 2021), available at <https://eng.brics-russia2020.ru/news/20201119/1149074/BRICS-Development-Financial-Institutions-complete-the-year-of-Russian-BRICS-Chairmanship-by.html>.

⁴⁸ BRICS Energy Report (2020) (Feb. 25, 2021), available at <https://eng.brics-russia2020.ru/images/114/89/1148985.pdf>.

This could positively contrast with the bilateral agenda that year, marked by intense border incidents between China and India.

Unfortunately, none of these initiatives got an impetus in 2020. Thus, the achievements in the field of water resources during the Russian chairmanship remain quite limited.

Moreover, despite rising speculation of unprecedented turbulence in global food markets, price increases in key commodities, hunger risks and disruptions in food value chains because of the pandemic and quarantines, BRICS continues to keep itself separate from this agenda. The idea of a water calculator based on the water footprint dataset remains an academic exercise instead of a useful tool for strategic planning at BRICS.⁴⁹ However, to illustrate the potential of a broader incorporation of the water agenda into the BRICS agenda, in the next section we will provide calculations of BRICS virtual water flows in agricultural trade.

3. BRICS Water-Food Nexus

We estimate the BRICS water-food nexus through the agricultural trade within BRICS. To do that, we apply the international virtual water (VW) trade flows estimation method from Hoekstra et al. (2012).⁵⁰ It is based on water footprints (WF) of different goods. We multiply the value of an exported product (in tons) with the water footprint indicators (in m³/ton) to calculate it.

3.1. Methodology and Data

The baseline data on products' water footprint is from Mekonnen and Hoekstra (2011, 2012).^{51,52} Although the water footprint statistics are calculated on data from 1996–2005 (in the absence of newer versions of Hoekstra's research), we assume that these indicators have changed slightly due to the lack of breakthrough innovations in water use for crops and animal husbandry. However, water footprint data from Mekonnen and Hoekstra (2011, 2012) lacks indicators for some products.⁵³ To compensate for this shortfall and cover as many agricultural exports as possible, we use numerous assumptions and additional sources (Appendix 1). As a result, we calculate the VW amount to be around 98% of intra-BRICS agricultural trade physical volumes, or 88.5% on average (Table 3).

⁴⁹ Likhacheva 2019.

⁵⁰ Arjen Y. Hoekstra et al., *The Water Footprint Assessment Manual: Setting the Global Standard* (2011).

⁵¹ Mesfin M. Mekonnen & Arjen Y. Hoekstra, *The Green, Blue and Grey Water Footprint of Crops and Derived Crop Products*, 15(5) *Hydrol. Earth Syst. Sci.* 1577 (2011).

⁵² Mesfin M. Mekonnen & Arjen Y. Hoekstra, *A Global Assessment of the Water Footprint of Farm Animal Products*, 15(3) *Ecosystems* 401 (2012).

⁵³ *Id.*

Table 3. Coverage of data on intra-BRICS agricultural exports in 2018–2019

Country	Exports (mln tons)	WF Exports Coverage
Brazil	141.3	99.3%
Russian Federation	6.6	95.3%
India	2.4	80.5%
China	3.7	76.5%
South Africa	1.5	90.9%

Source: Authors' calculations based on U.N. COMTRADE statistics, Mekonnen & Hoekstra (2011, 2012) databases and assumption in Appendix 1

In conducting this research, we use standard footprint classification.⁵⁴

Data on export values is downloaded by *World Integrated Trade Solution (WITS)* tools from the U.N. COMTRADE database. We refer to agricultural export products that fall under HS Chapters 01–24, except for “Fish and crustaceans, molluscs and other aquatic invertebrates” (Chapter 03). We use trade data for 2018 and 2019 on the HS-6 digit level product classification to calculate a countries' virtual water flows.

3.2. BRICS Virtual Water Flows

Table 4 demonstrates that **Brazil** is the leading VW agricultural exporter among the BRICS countries, with 328.7 bln tons exported in 2018–2019 within the BRICS countries. Russia takes second place (27.3 bln tons in 2018–2019), and India ranks third (19.3 bln tons in 2018–2019). It is also worth noticing that Brazil is the smallest agricultural VW importer, while China is the largest. We should mention that even this broad evaluation shows that the allocation of virtual water flows has a positive but not comprehensive relation with freshwater allocation among BRICS countries.

⁵⁴ The Water Footprint Network (2021) (Feb. 25, 2021), available at <https://www.waterfootprint.org/en/water-footprint/glossary/>.

The blue footprint is the volume of surface and groundwater consumed because of the production of a good or service. Consumption refers to the volume of fresh water used and then evaporated or incorporated into a product. It also includes water extracted from surface or groundwater in a catchment and returned to another catchment or the sea. It is the amount of water extracted from groundwater or surface water that is not returned to the catchment from which it was withdrawn.

The green footprint is the volume of rainwater consumed during the production process. It is particularly relevant for agricultural and forestry products. It refers to the total rainwater evapotranspiration from fields and plantations, plus the water incorporated into the harvested crop or wood.

The grey footprint is an indicator of freshwater pollution associated with the production of a product over its full supply chain. It is defined as the volume of freshwater required to assimilate a load of pollutants based on natural background concentrations and existing ambient water quality standards. It is a calculated volume of water required to dilute pollutants to such an extent that the water quality remains above agreed water quality standards.

Moreover, *the leadership varies depending on the VW type*. India exports the most significant blue VW – 1,441.2 and 1,587.9 mln tons in 2018 and 2019, respectively. The reason for this is that the main agricultural product in India exported to BRICS countries is water-intensive castor oil – 1,044.9 and 888.5 mln tons in 2018 and 2019, respectively. Brazil's vast green VW exports are the result of massive soya bean exports (152.6 and 128.5 bln tons in 2018 and 2019, respectively), primarily to China. It is worth noting that rapeseed oil (blue and grey VW) and soya beans (green VW) are the main Russian VW products in 2018–2019. However, we can expect sunflower oil to be the main Russian green VW product in the near future: its exports have increased threefold in 2018–2019, and Russia is gradually intercepting the Ukrainian supply of sunflower to India – one of its largest global markets.

The VW evaluation clearly shows that Russia has yet to find a proper way to some BRICS food markets. Despite this, Russia is the world's largest wheat exporter. However, for BRICS countries, Russia is only the third largest wheat exporter after Argentina and the United States, and BRICS as a whole represents about 2% of Russia's wheat exports – the same as Belarus. This is extremely important due to Russia's potential to position itself as a food security provider within the BRICS. Nevertheless, Brazil and China still import much more wheat from the United States.

Ultimately, we can conclude that intra-BRICS virtual water trade is highly versatile but remains *a buyer's market*. China is the largest BRICS VW importer, importing huge values of water-intensive products such as soya beans and various types of oil, as well as meat. Thus, the intra-BRICS VW trade is primarily driven by Chinese demand.

It allows further research on the BRICS water-food nexus to be strongly linked to domestic Chinese plans on the national food security concept and the ability and interest of key Chinese players to transform the world agro-market and capacities of the New Development Bank of BRICS to profoundly and sustainably support the food industry as one of the strategic sectors for improvement of BRICS cooperation.

Table 4. Intra-BRICS virtual water of agriculture trade in 2018–2019 (mln m³)

WF Type	Brazil		Russia		India		China		South Africa		Total	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Blue			28.1	66.4	83.5	40.2	282.2	404.4	27.7	20.0	421.5	531.0
Green			3,674.4	5,055.0	5,085.0	2,691.2	161,644.8	142,963.7	1,695.8	1,665.0	172,100.0	152,374.9
Grey			68.7	93.8	190.3	102.4	1,313.2	1,290.5	96.0	89.6	1,668.2	1,576.3
Blue	0.8	4.1			11.1	15.1	120.8	218.6	23.8	13.8	156.5	251.6
Green	60.5	263.6			554.9	2,055.7	8,763.9	11,540.8	1,795.6	1,042.8	11,174.9	14,902.9
Grey	2.3	9.3			37.2	66.0	216.9	328.0	67.7	39.3	324.1	442.6
Blue	20.2	15.4	159.3	170.7			1,139.2	1,232.3	122.5	169.5	1,441.2	1,587.9
Green	140.2	127.7	1,067.2	1,102.1			6,011.1	6,118.5	426.7	492.9	7,645.2	7,841.2
Grey	5.2	5.6	72.4	76.7			201.3	280.4	59.5	68.7	338.4	431.4
Blue	9.5	9.8	73.5	76.2	50.6	27.1			8.7	11.6	142.3	124.7
Green	120.7	117.4	919.1	826.1	375.3	195.9			151.1	165.5	1,566.2	1,304.9
Grey	26.6	26.1	275.6	242.0	103.7	68.4			32.0	37.5	437.9	374.0
Blue	0.9	0.3	57.3	31.9	6.7	48.1	76.4	61.7			141.3	142.1
Green	2.6	1.9	73.0	47.5	19.2	1,368	171.9	111.2			266.7	297.2
Grey	0.35	0.25	10.24	5.69	2.90	18.98	17.86	8.62			31.4	33.5
Total VW imports from BRICS countries	390	581	6,479	7,794	6,520	5,466	179,960	164,559	4,507	3,816		

Source: Authors' calculations based on U.N. COMTRADE statistics, Mekonnen & Hoekstra (2011, 2012) databases and assumption in

Appendix 1

The highest amount inline in 2019 – in bold, in 2018 – in italics

4. Prospects for the BRICS Water Factor: Suggestions for Further Discussion

The conducted analysis allows the authors to identify a wide gap between the current and potential water agenda of the organization. While some ambitious initiatives have been mentioned above, we could suggest that this shift should start from pretty clear and consecutive steps. For example, BRICS University could launch a reassessment of the water-food nexus in BRICS and for BRICS+ formats, based on evaluation of virtual water flows. Member states could conduct a parallel assessment of the key tariff and non-tariff barriers for the water-intensive goods and then devise a strategy for gradually lowering the highest ones, which could have a negative impact on food security. BRICS also requires advanced cooperation in water-related issues ranging from the exchange of national experience to joint research and projects, among many others. All these steps could pave the way for the advanced water agenda of BRICS.

Moreover, countries could launch bilateral or other “patchwork” initiatives under the auspices of BRICS to accelerate this process. Similarly, some BRICS+ water-related initiatives could be launched by a pilot project that does not necessarily include all countries simultaneously.

The initiatives listed above correspond to the values of BRICS and can be brought up for discussion, in order to develop the ideas presented at the 2016 Water Forum. However, without the funding from the New Development Bank of BRICS, such initiatives are unlikely to have a profound effect on deepening cooperation within the organization. In the future, this experience could be expanded under the BRICS+ format, especially in light of the turbulent years ahead.

To summarize the analysis, there is a clear gap between the water capacities of BRICS, primarily represented by Brazil and Russia, the severity of the global water challenge and the passive position of BRICS in global and even regional water agenda settings. Bridging this gap in the near future could result in significant profits for both BRICS and its partners and even limit the level of global water stress.

Appendix 1. Assumptions and Sources for WV Evaluation

The main assumption is that if any data on the water footprint for some product in any country is absent, the data on a similar product or world average might be applied. We use it for products:

- 050400 (*Animal products; guts, bladders and stomachs of animals (other than fish), whole and pieces thereof*) – an average of 020110 (*Meat; of bovine animals, carcasses and half-carcasses, fresh or chilled*) and 020311 (*Meat; of swine, carcasses and half-carcasses, fresh or chilled*) is used as a substitute;
- 070310 (*Vegetables, alliaceous; onions and shallots, fresh or chilled*) – all WF types of Brazil, India, Russia and SAR are replaced by world average indicators;

- 071040 (*Vegetables; sweetcorn, uncooked or cooked by steaming or boiling in water, frozen*) – all WF types of Brazil, India, Russia are replaced by world average indicators;
- 071333 (*Vegetables, leguminous; kidney beans, including white pea beans (phaseolusVulgaris), dried, shelled, whether or not skinned or split*) – Chinese blue WF is replaced by world average indicator;
- 080261 (*Nuts, edible; macadamia, fresh or dried, in-shell*) – world average green and grey WF for 080121 (*Nuts, edible; brazil nuts, in shell, fresh or dried*) are used as a substitute for all countries;
- 080521 (*Fruit, edible; mandarins (including tangerines and satsumas), fresh or dried*) – 080520 (*Fruit, edible; mandarins (including tangerines and satsumas), clementines, wilkings and similar citrus hybrids, fresh or dried*) is used as a substitute;
- 080550 (*Fruit, edible; lemons (Citrus limon, Citrus limonum), limes (Citrus auranti-foia, Citrus latifolia), fresh or dried*) – 080530 (*Fruit, edible; lemons (citrus limon, citrus limonum), limes (citrus aurantifolia)*) is used as a substitute;
- 090421 (*Spices; fruits of the genus Capsicum or Pimenta, dried, neither crushed nor ground*) – 090420 (*Spices; fruits of the genus Capsicum or Pimenta, dried, neither crushed nor ground*) are used as a substitute;
- 120242 (*Ground-nuts; other than seed, not roasted or otherwise cooked, shelled, whether or not broken*) – 120210 (*Ground-nuts; in shell, not roasted or otherwise cooked*) is used as a substitute;
- 120510 – blue WF of Brazil, China, Russia and SAR are replaced by world average indicator;
- 120510 (*Oilseeds; low erucic acid rape or colza seeds, whether or not broken*) – 120500 (*Oilseeds; rape or colza seeds, whether or not broken*) are used as a substitute;
- 170114 (*Sugars; cane sugar, raw, in solid form, other than as specified in Subheading Note 2 to this chapter, not containing added flavouring or colouring matter*) – 170111 (*Sugars; cane sugar, raw, in solid form, not containing added flavouring or colouring matter*) are used as a substitute;
- 170290 (*Sugars; n.e.s. in heading no. 1702, including invert sugar*) – 170220 (*Sugars; maple sugar, chemically pure, in solid form; maple syrup, not containing added flavouring or colouring matter*) is used as a substitute;
- 180690 (*Chocolate and other food preparations containing cocoa; n.e.s. in chapter 18*) – 180500 (*Cocoa; powder, not containing added sugar or other sweetening matter*) is used as a substitute, all WF types of China, Russia and SAR, as well as Indian blue WF are replaced by world average indicators;
- 200979 (*Juice; apple, of a Brix value exceeding 20, unfermented, not containing added spirit, whether or not containing added sugar or other sweetening matter*) – 200970 (*Juice; apple, unfermented, not containing added spirit, whether or not containing added sugar or other sweetening matter*) is used as a substitute.

The second assumption is that if there is no world average data, we use estimates provided by recent studies on a product's water footprint.

- 020714 (*Meat and edible offal; of the poultry of heading no. 0105, of fowls of the species Gallus domesticus, cuts and offal, frozen*) – Mekonnen and Hoekstra (2010a)⁵⁵ is used to get all WF types for Brazil, China India, Russia, WF of SAR is taken as the world average;

- 120921 (*Seed; lucerne (alfalfa) seed, of a kind used for sowing*) – green and blue WF for South Africa is taken from Scheepers and Jordaan (2016);⁵⁶

- 151411 (*Vegetable oils; low erucic acid rape or colza oil and its fractions, crude*) – all WF types for all countries are taken as the world average, basing on Mekonnen and Hoekstra (2010b);⁵⁷

- 151800 (*Animal or vegetable fats and oils and their fractions; oxidised, boiled or otherwise chemically modified, (excluding those of heading no. 1516), inedible mixtures or preparations of fats or oils*) – world average WF types for butter, provided by Mekonnen and Hoekstra (2012)⁵⁸ are used as a substitute for all countries;

- 200310 (*Vegetable preparations; mushrooms, prepared or preserved otherwise than by vinegar or acetic acid*) – average green and blue WF are obtained by additional calculations based on data from The Mushroom Council (2017);⁵⁹

- 200899 (*Fruit, nuts and other edible parts of plants; prepared or preserved, whether or not containing added sugar, other sweetening matter or spirit, n.e.s. in heading no. 2008*) – world average WF types for nuts, provided by Mekonnen and Hoekstra (2012)⁶⁰ are used as a substitute for all countries;

- 220720 (*Ethyl alcohol and other spirits; denatured, of any strength*) – average WF types obtained by additional calculations based on data from Popa et al. (2014).⁶¹

The last assumption is that if there is no relevant data on the water footprint of a derived product, it equals to the water footprint of the underlying primary good.

- 200110 (*Vegetable preparations; cucumbers and gherkins, prepared or preserved by vinegar or acetic acid*) – 070700 (*Vegetables; cucumbers and gherkins, fresh or chilled*) are used as a substitute;

- 200290 (*Vegetable preparations; tomatoes, (other than whole or in pieces), prepared or preserved otherwise than by vinegar or acetic acid*) – 070200 (*Vegetables; tomatoes, fresh or chilled*) are used as a substitute;

⁵⁵ Mesfin M. Mekonnen & Arjen Y. Hoekstra, *The Green, Blue and Grey Water Footprint of Farm Animals and Animal Products*, Value of Water Research Report Series No. 48, UNESCO-IHE Institute for Water Education (December 2010) (Feb. 25, 2021), available at <https://www.waterfootprint.org/media/downloads/Report-48-WaterFootprint-AnimalProducts-Vol1.pdf>.

⁵⁶ Morne Scheepers et al., *Assessing the Blue and Green Water Footprint of Lucerne for Milk Production in South Africa*, 8(1) Sustainability 49 (2016).

⁵⁷ Mekonnen & Hoekstra 2011.

⁵⁸ Mekonnen et al. 2012.

⁵⁹ The Mushroom Council, *The Mushroom Sustainability Story: Water, Energy, and Climate Environmental Metrics* (2017) (Feb. 25, 2021), available at <https://www.mushroomcouncil.com/mushroom-sustainability-story/>.

⁶⁰ Mekonnen et al. 2012.

⁶¹ Simona Popa et al., *Water Footprint Assessment of Ethyl Alcohol Production*, 13(8) *Envtl. Eng. Mgmt. J.* (2014).

- 200799 (*Jams, fruit jellies, marmalades, purees and pastes; of fruit or nuts n.e.s. in heading no. 2007, cooked preparations (excluding homogenised), whether or not containing added sugar or other sweetening matter*) – as strawberry jam is the most popular jam type, we used WF for 081010 (*Fruit, edible; strawberries, fresh*), data for India is taken as world average;
- 200870 (*Fruit; peaches, prepared or preserved in ways n.e.s. in heading no. 2007, whether or not containing added sugar, other sweetening matter or spirit*) – 080820 (*Fruit, edible; pears and quinces, fresh*) is used as a substitute;
- 230310 (*Residues of starch manufacture and similar residues; whether or not in the form of pellets*) – 110811 (*Starch; wheat*) is used as a substitute.

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