Global Security - Howard H. Baker Jr. Center for Public Policy

Tracking China and Russia's Nuclear Diplomacy Activities in Africa

Report for the Y12 National Security Complex

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Executive Summary

Numerous African countries could benefit from nuclear power, given rising rates of economic development, population growth, and consumer electricity demand. In light of these needs, China and Russia have expanded cooperation in the development of civilian nuclear energy on the African continent over the last two decades. This report draws on an original quantitative data tracking trends in Chinese and Russian nuclear diplomacy activities in Africa between 2000 and 2021. We find diverging trends in these two countries' nuclear diplomacy: China engages in a higher number of nuclear outreach activities overall, but they tend to be at lower levels of development. By contrast, Russia engages in fewer activities but they tend to be at higher, more sophisticated levels of development. We conclude with recommendations for U.S. policy: As Chinese and Russian influence expands on the African continent through nuclear diplomacy, the United State has—thus far—chosen to take the back seat. It may be missing opportunities to influence and build support among African leaders, who want to encourage their countries' economic development by pursuing civilian nuclear energy programs under IAEA safeguards.

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1. Introduction

The Cold War's end led to a decline in the power and influence of both the Soviet Union and China. Both states, propagators of Communist political and economic systems, saw their global influence wane amongst other states of the international community. Yet since 2010, both Russia – the Soviet Union's successor – and China have striven to reestablish if not expand their influence on and control over other states, especially in the developing world. These two superpowers have pursued this strategy to increase their global influence by extending cooperative agreements and programs – including in a variety of different economic, technical, and scientific policy areas – to developing countries.

This report examines one understudied policy area where Russia and China are seeking to expand their influence, peaceful civilian nuclear energy. Both Russia and China, acting through their state-owned nuclear energy companies, have sought to aid developing countries in undertaking technical and scientific activities to build a nuclear power infrastructure and prepare their power grids for nuclear power. On one hand, developing countries benefit from these arrangements, as they often need foreign expertise and support to advance their civilian nuclear energy programs. On the other hand, however, Russia and China gain potential diplomatic and political sway – what the political scientist Joseph Nye termed "soft power" – over the domestic and international politics of the developing countries with which they establish these arrangements.[1] In particular, this report analyzes China and Russia's activities in nuclear energy cooperation on the African continent. Africa, a continent with mega-cities such as Cairo and Lagos, rapidly growing populations, and quickly developing economies, could benefit from nuclear energy. Nuclear energy could help meet exponentially increasing energy needs. Yet, African countries could experience drawbacks from working with Russia and China in seeking to achieve this aim. Moreover, broader implications also emerge for U.S. foreign policy. The United States may be missing opportunities to engage with African governments around the development of peaceful nuclear energy. China and Russia are seeking to fill this gap, at a possible cost to less U.S. influence on the African continent.

The remainder of this report proceeds as follows. First, it summarizes the main programs and activities undertaken by China and Russia in Africa related to civilian nuclear energy, what we term 'Chinese and Russian nuclear diplomacy.' We categorize and track these activities according to the International Atomic Energy Agency's (IAEA) three-phase 'milestones' approach. This IAEA approach identifies the three major phases any country undertakes when it chooses to pursue building a nuclear power plant (NPP). Second, we illustrate these trends in Chinese and Russian nuclear diplomacy through originally collected statistical data from open-source media accounts. We show what commonalities exist in these trends, and how they differ between China and Russia, respectively. The statistics show where, what types, and the intensity and depth of Chinese and Russian nuclear diplomacy activities in Africa. After using this data to show how broad trends across different countries on the African continent evolved over time (between 2000 and 2021), we quantitatively explore the attributes of countries more likely to become partners to China or Russia's nuclear diplomacy activities. We use regression analysis to identify the correlates of which countries in Africa have received greater (or fewer) activities from China or Russia, respectively. Finally, the report presents qualitative case studies. It toggles down to examine nine crucial case studies: Egypt, Libya, Tunisia, Algeria, Morocco, Ghana, Nigeria, the Democratic Republic of the Congo (DRC), and South Africa. These case studies detail more precisely China and Russia's nuclear diplomacy activities undertaken in each

country. Finally, the report concludes with a discussion of broader implications for U.S. policymaking in the area of nuclear energy cooperation.

2. General Trends: Tracking Chinese & Russian Nuclear Diplomacy from 2000 to 2021

This study relies on an original dataset that covers 54 sovereign countries on the African continent. To collect the data, the research team undertook a series of steps. For each country, the research team used Lexus-Nexus to identify and download every article discussing Chinese and Russian nuclear diplomacy or related activities in each country per each year between 2000 and 2021. This time periodization was selected due to its contemporary nature, and thus relevance for U.S. policy-making in the area of nuclear cooperation. Lexus-Nexus is an open source search engine, which accesses and scans over 17,000 different English language newspapers and news websites. In addition, we examined news stories drawn from several nuclear energy industry specific media sources, such as *NucNet* and *Bulletin of Atomic Scientists*. Once these articles were downloaded, we developed a form to systematically code and classify each activity according to the IAEA's three-phase milestone approach each state must undertake when it decides to construct a nuclear power plant (NPP).

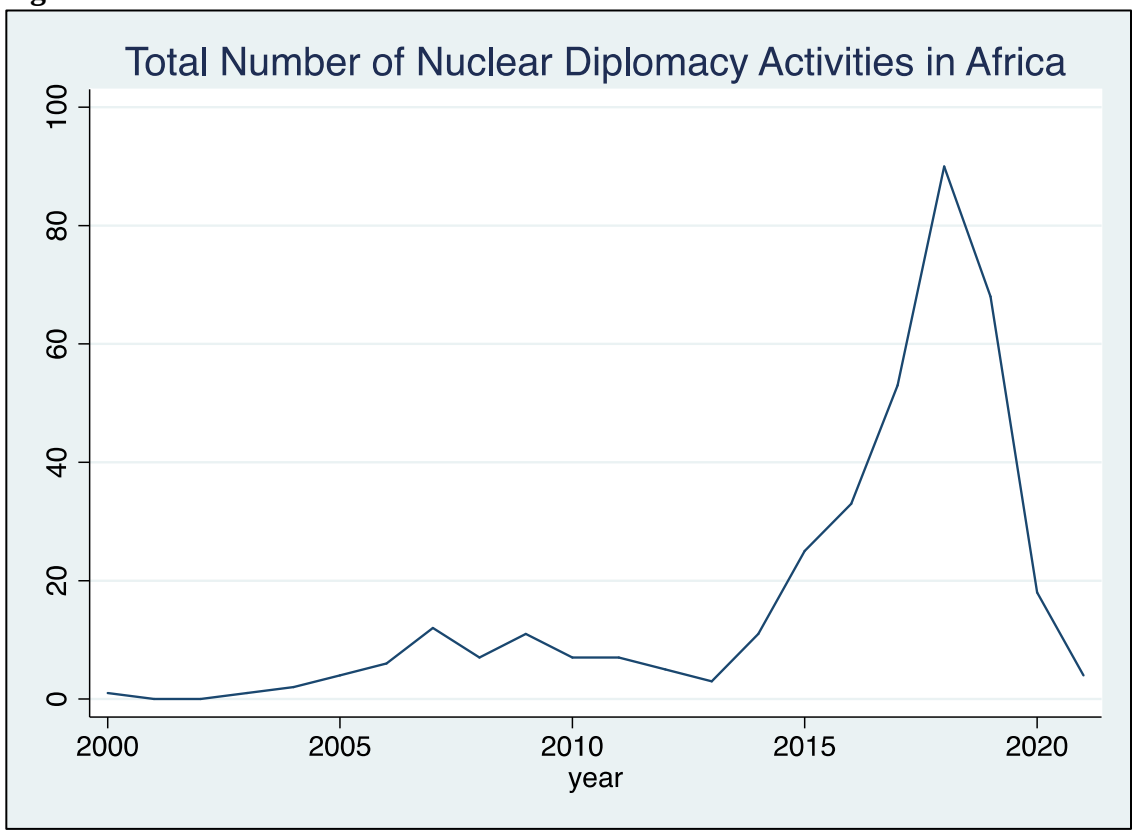
Developed by the IAEA, this three-phase process of NPP construction entails the following activities. In phase one, a policy decision to pursue building a NPP has not yet been finalized. During this phase, policymakers in the country considering building a NPP often hold high-level meetings with foreign partners (e.g. Chinese or Russian officials, in this study) to discuss the possibility and feasibility of nuclear energy. They try to assess their scientific, legal, regulatory, and financial readiness for a civilian nuclear program and future NPP construction. These high-level discussions with foreign partners are often not specifically on nuclear energy alone, but may be embedded within discussions on a variety of other indirectly related policy topics (other types of energy opportunities, uranium mining, infrastructure development, economic aid, etc.). Phase one may also include the improvement of indirectly related infrastructure—like the enhancing of ports, roads, or railways—necessary for transporting heavy equipment for constructing the NPP. Many developing countries do not have sufficient infrastructure to import and transport heavy industrial materials and equipment necessary to build a NPP, so these are considered pre-planning activities before NPP construction. In phase two, policymakers in the country have already taken an affirmative decision to pursue building a NPP. In this phase, policymakers often sign formal memorandums of understand (MOUs) with foreign partners, like Russia's state-owned nuclear energy company (i.e. Rosatom), confirming their willingness to support the building of a NPP. In this phase, technical goods and knowledge have not yet been transferred and formal contracts or tenders have not been completed. In phase three, the state building the NPP receives technology, training or other 'hard' technical support from the collaborating country.

Results from the statistical analysis show clear trends in Chinese and Russian nuclear diplomacy in Africa. As a first step, this report conveys basic descriptive statistics. Between 2000 and 2021, China and Russia engaged in 368 different nuclear diplomacy activities in Africa. China practiced 195 nuclear diplomacy activities, while Russia engaged in slightly fewer, at 173 activities. These activities occurred in nearly all 54 different countries on the African continent. Algeria and Egypt had the highest numbers of total interactions with these two counties, at 41 and 24 activities, respectively. Only a handful of countries—Eswatini (formerly Swaziland), Guinea, Guinea Bissau, Mali, Mauritius, and Mozambique—had zero or

one activity with either China or Russia between 2000 and 2021. Many countries fell somewhere in the middle of those two poles, experiencing between 4 to 10 different activities between 2000 and 2021. The mean number of activities was 6.81 as an average across all 54 countries. The average number of Chinese activities across all countries stood at 3.6, while the average number of Russian activities came in at 3.2.

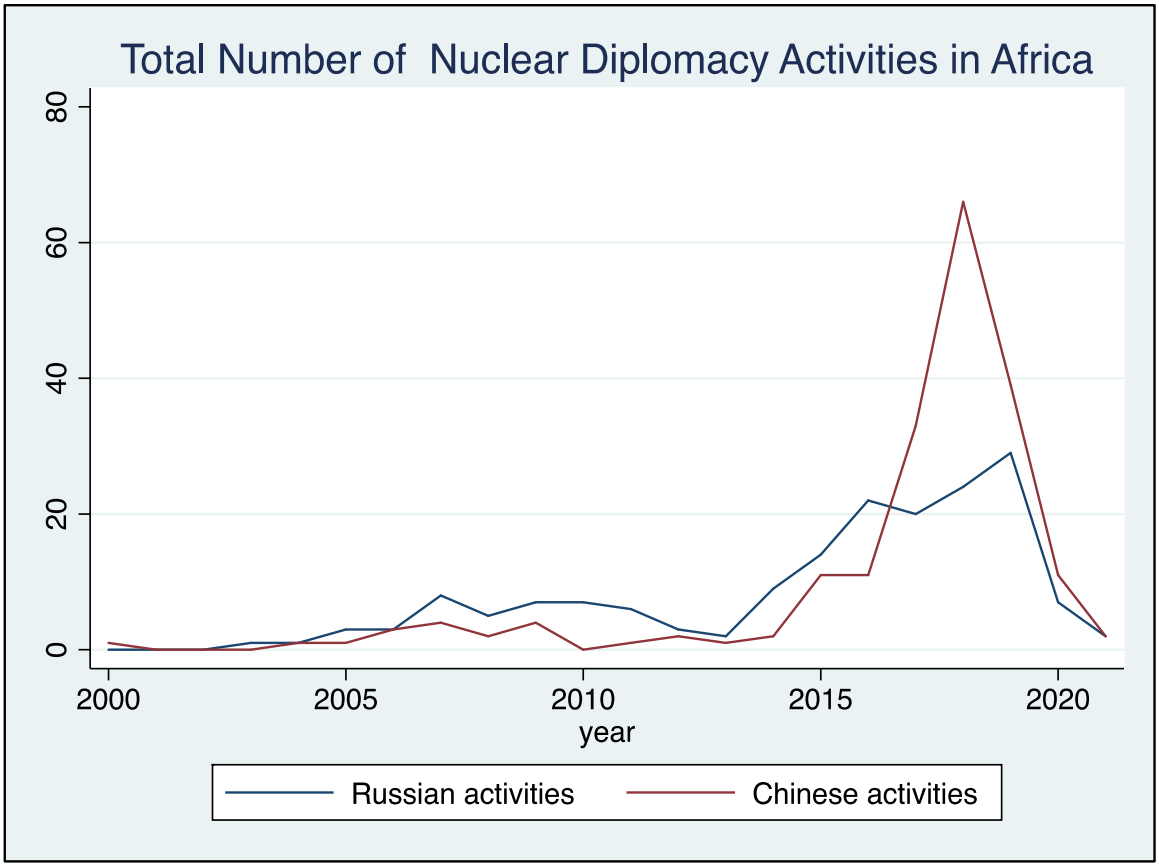
As Figure 1 demonstrates, a large uptick in the number of nuclear diplomacy activities carried out by China and Russia on the African continent occurred after 2015. The number of total activities jumped from under 10 in 2013 to over 30 by 2015, and increased dramatically each year until 2017 (nearly 90 activities at maximum). Figure 1 also shows how—given the Covid-19 pandemic—the number of nuclear diplomacy activities in Africa declined rapidly in 2020 and 2021, likely due to restrictions on international travel and the associated economic downturn.

Figure 1



Next, Figure 2 examines Chinese and Russian nuclear diplomacy activities, respectively. As figure 2 below shows, China has had a more dramatic and sudden growth in the number of its outreach activities to African countries, especially after 2015. Chinese activities reached their peak around 2017, when over 60 different activities occurred on the African continent. This trend likely relates to the launching of the Belt and Road Initiative (BRI) after 2013, when the Chinese government offered substantial economic aid to a variety of developing countries in Africa and elsewhere in the world in order to increase trade connectivity and investment in their natural resource industries. Russia, similarly, also launched a higher number of activities after 2013, yet has had a more consistently steady growth curve between 2000 and 2021.

Figure 2



Figures 3 and 4 disaggregate Chinese and Russian nuclear diplomacy activities, respectively, by the IAEA's milestone approach within its three phases of NPP construction. Figure 3 looks at China's activities, showing that it has engaged in a far greater number of preliminary phase one activities, but fewer phase two or phase three activities. Indeed, the number of China's phase one activities spiked to over 40 in 2017. Yet, for the entire period between 2000 and 2021, China's number of phase two and phase three activities has remained ten per year or fewer. In fact, for most years between the year 2000 and 2014, China's number of phase two and phase three activities hovered between zero and five. In sum, China has practiced a considerable number of preliminary phase one activities on the African continent—those related to working with host states in early stage planning for nuclear power and associated prerequisite infrastructure development—but has not engaged in more sophisticated nuclear diplomacy activities. This finding suggests that China may have interest in transitioning its phase one activities in the future into phase two or phase three activities, yet this development has not yet occurred as of 2021.

Figure 4 displays Russia's nuclear diplomacy activities, per the IAEA's milestone approach. By comparison with China's activities in Africa, Russia has successfully pursued far more sophisticated forms of nuclear diplomacy. Although Russia overall has engaged in fewer activities than China, it has done far more phase two and phase three activities that involve signing formal memorandums of understanding, engaging in contracting for NPP construction,

and the transferring of nuclear technology and training. While Russia had engaged in phase two activities even as earlier as 2006, they reached a peak around 2019 at nearly 20 activities within a year. Although fewer in number, Russia's phase three activities also spiked around 2017 at six activities within one year. On the aggregate, Russia has engaged in fewer phase one activities than China in Africa, yet they also increased to their maximum of seven within one year in 2017. In sum, although Russia has done less outreach in Africa than China around issues of the development of nuclear power, what activities it has launched tend to become more developed and sophisticated beyond the pre-planning operations within phase one.

Figure 3

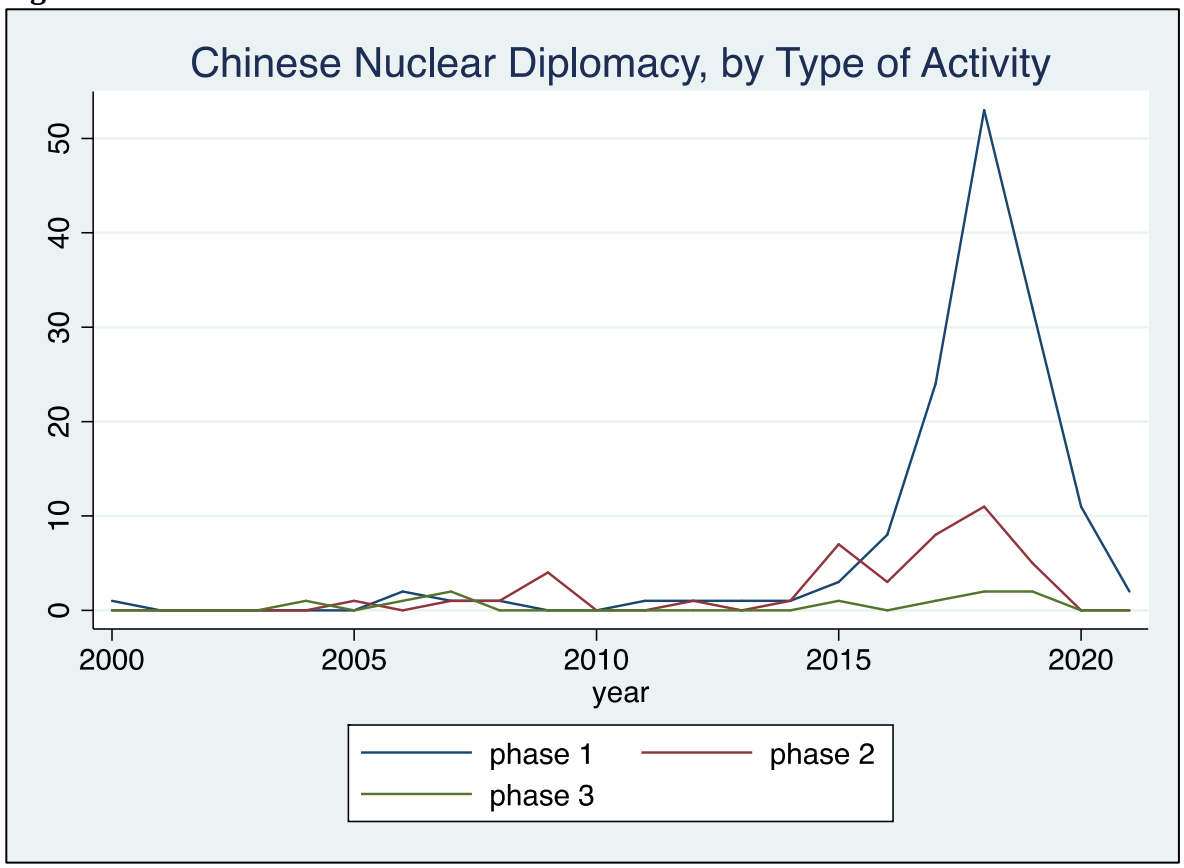
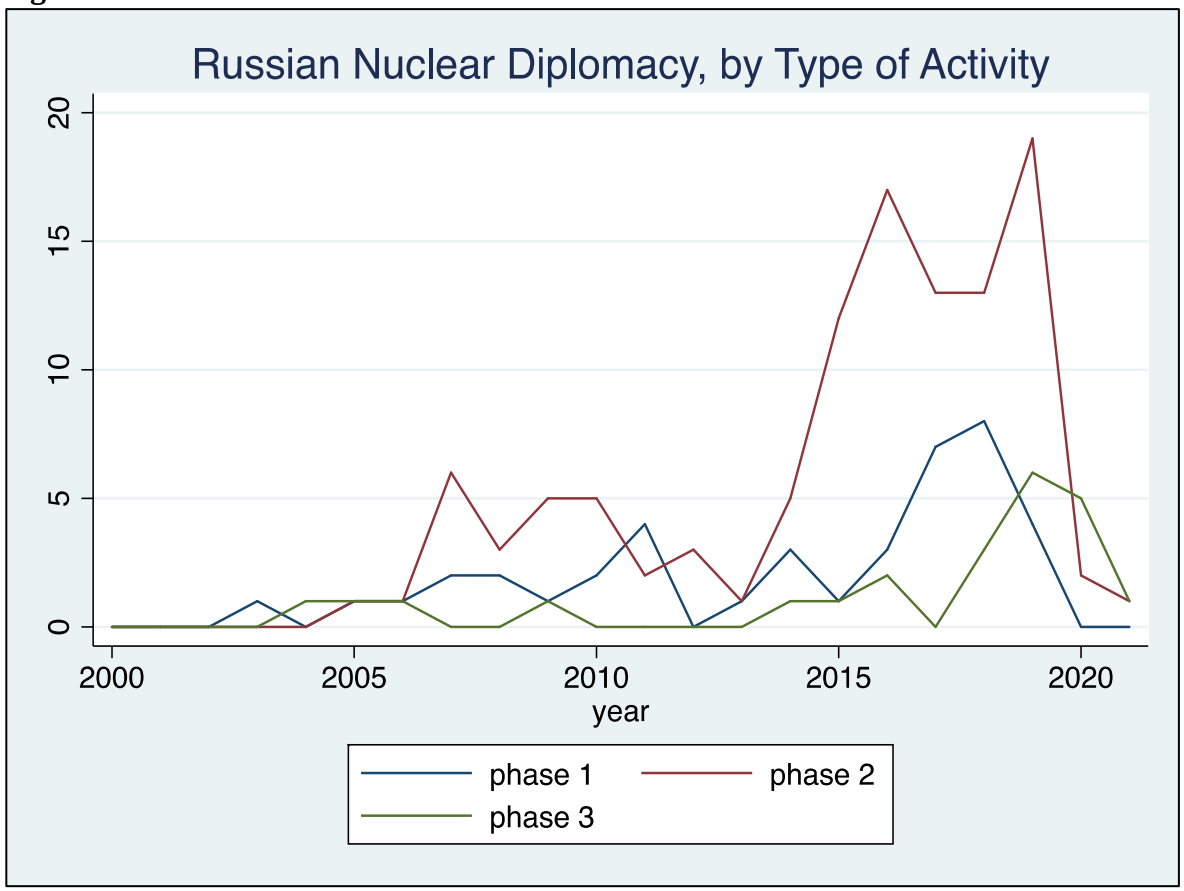


Figure 4



3. The Attributes of China & Russia's Nuclear Partners in Africa

This report has shown how China and Russia's nuclear diplomacy activities have evolved on the African continent over time, between 2000 and 2021. Yet, a natural follow-up question concerns the most common attributes and traits of the countries that have received a greater amount of such Chinese and Russian outreach efforts. The next empirical analysis uses regression models to identify the determinants of variation in how many nuclear diplomacy activities an African state receives. Theoretically speaking, several different variables could potentially predict which African states have received greater (or fewer) number of nuclear diplomacy activities from China and Russia, respectively. Next, we detail each of these variables, describe how they were coded, and finally present results from regression models showing which variables were statistically significant in predicting greater levels of Chinese and Russian nuclear diplomacy.

For our regression analysis, we broadly categorize variables predicting either higher (or lower) levels of nuclear diplomacy into the following categories: A country's level of economic development, its Cold War and contemporary alliance status, its regime type, and its colonial legacy. A country's level of economic development indicates its degree of prosperity. Yet, this variable can be measured in multiple ways. We track two specific metrics: each country's Gross Domestic Product (GDP) per captia and its Human Development Index score. The GDP per capita records a country's overall domestic productivity annually and divides it by its number of inhabitants. The Human Development Index, a score developed by the United Nations, is

calculated by combining a country's overall wealth (including *both* its domestic productivity and receipt of foreign monies, such as overseas immigrant remittances)[2], a citizen's average life expectancy, and a citizen's average number of years of schooling. By combining these financial metrics with life longevity and education metrics, the United Nations has deemed that the HDI provides a broader, more holistic measure of a country's overall level of economic development. Typically, when a citizen on average has a longer lifespan or a greater average number of years of schooling, it suggests a country's government has invested greater tax resources into building health and educational institutions to develop society. These public investments are not easily accounted for in examining a country's annual GDP alone. Similarly, it could be hypothesized that countries scoring higher on the HDI—given their greater investment in educational institutions and infrastructure—also likely have a larger domestic community of scientists and engineers able to undertake projects related to establishing an indigenous civilian nuclear energy program and constructing a NPP with the aid of China or Russia. To code a state's varying levels of economic development in the dataset, each one was coded for its reported annual GDP and HDI scores with the most recent annual data.

Another factor potentially shaping variation in whether a country receives Chinese or Russian nuclear diplomacy activities may relate to its historic and current alliance status. During the Cold War, the Soviet Union built diplomatic alliances with numerous countries on the African continent—some of the most prominent included Algeria, Angola, and Mozambique. Before the signing of the Camp David accords in 1979, Egypt also had close relations with the Soviet Union. Given these African states' socialist and Marxist-inspired ideologies and governing systems, both the Soviet Union and China tended to have closer diplomatic ties with them than other African states. In light of the historically amicable relations between these states, it is theoretically possible that, today, China and Russia may practice more nuclear diplomacy activities with them than other states. In the dataset, each African state that was previously a Soviet ally during the Cold War was coded one, while the remainder were coded zero.

Contemporary alliances may also matter for predicting which African state may receive more (or less) nuclear diplomacy from China and Russia. In today's politics, the United States, China, and Russia have troops and active military bases in several countries on the African continent. African governments, as a component of hosting these troops, develop close diplomatic relations with these superpowers. If an African government has close relations with the United States, by hosting its bases or troops, then perhaps it could be theorized that it is less likely to have close relations with either China or Russia—rivals of the United States. Thus, we coded for the presence of U.S. bases and U.S. troops and hypothesize that these states may be less likely to receive nuclear diplomacy activities from either China or Russia.[3] Although China and Russia have far fewer bases and troops on the African continent than the United States, they do have a foothold in several countries. Thus, we also coded for the presence of Chinese and Russian troops and bases, hypothesizing that those countries willing to host Chinese and Russian military forces may have closer relations with these countries and thus more likely to receive their nuclear diplomacy activities.

Another important variable could relate to an African country's regime type. By regime type, we mean its internal system of government and level of democracy. A body of scholarship from international relations predicts that democracies are more likely to work with other democracies in the international community, and are less likely to experience conflict with them. By contrast, we might hypothesize that China and Russia—as non-democracies—might be less

comfortable working with democracies, due to their greater transparency and popular control over politics. They may find working with non-democracies more familiar, as politics works in similar ways in their own polities with less transparency and popular control. Thus, it could be hypothesized that African states with more democratic systems of government may be less likely to receive nuclear diplomacy from either China or Russia. To code for an African country's level of internal democracy, we used Freedom House's Freedom in the World Index, which ranks each country on a scale of zero (least democratic) to 100 (most democratic). Considerable variation exists in Africa on this variable, with the least democratic country scoring two on Freedom House's index (Eritrea and South Sudan) and the most democratic scoring 92 (Cabo Verde).

A final important variable—also of a historic nature—could relate to each country's colonial legacy. Colonialism left varying institutional legacies on the African continent. Great Britain and France, generally speaking, left deeper and more developed institutions than other European powers, notably Belgium and Portugal who were the other major colonial powers on the continent. Italy, Spain, and Germany also had a minor colonial presence in Africa. Germany lost most of its colonies after WWI, and Italy retained influence in Somalia, Libya, and Eritrea. Spain held minor influence some areas of Morocco, and also in Equatorial Guinea. Given their minor role in Africa's colonial history, our analysis does not examine these European countries but focuses on the four most important colonial powers—Great Britain, France, Portugal, and Belgium. It could be hypothesized that African countries with a legacy of French or British rule may be more likely to receive Chinese or Russian nuclear diplomacy activities, because of their generally higher and more developed scientific institutions and economic infrastructure to begin a civilian nuclear power program. By contrast, since Portugal and Belgium left less developed scientific and economic institutions and infrastructure in their former colonies, they would be less likely to receive Chinese or Russian nuclear diplomacy activities. Below, map 1 displays European colonial presence on the African continent.

Map 1

Given that this study's two dependent variable were interval (number of Chinese and Russian nuclear diplomacy activities, respectively, per country), we used a standard ordinal least-squares (OLS) model. Table 1 presents results. Column one displays all independent variables included within models one and two—related to a country's level of economic development, historic and contemporary alliances, regime type, and colonial legacy. VIF tests were run for both models, showing that none of the independent variables suffered from multicollinearly (VIF scores ranged between 1.1 and 3.0 below the standard threshold of 5.0). Column two displays the most robust correlates of African states that received higher amounts of Russian nuclear diplomacy activity. Column three reports the most robust correlates of African states that received higher amounts of Chinese nuclear diplomacy activities. Statistically significant variables are largely consistent across the two models, though at different p-level thresholds. Consistent with research practices in social sciences, results below are reported p-levels ranging from $p<0.1$ to $p<.001$.

Results were largely consistent across the two models predicting which African countries receive greater amounts of Chinese or Russian nuclear diplomacy activities, respectively. For both models one and two, a country's level of economic development—as measured by the United Nation's Human Development Index (HDI)—mattered for whether or not it was more likely to be a target of nuclear diplomacy. The coefficient (44.619) was far stronger for Russian nuclear diplomacy than for Chinese nuclear diplomacy (16.591). Figures 5 and 6 below show

the general positive correlation between a country's higher HDI and its higher likelihood of receiving greater numbers nuclear diplomacy activities, from either China or Russia. As hypothesized, a higher HDI level likely implies greater state investment in scientific and educational institutions and infrastructure, and this likely predicts why states possessing these attributes are more likely targeted for nuclear diplomacy. Further supporting this finding, a country's higher GDP—which focuses on wealth alone, without reference to investment in educational institutions—is very slightly negatively correlated with greater number of nuclear diplomacy activities.

Figure 5

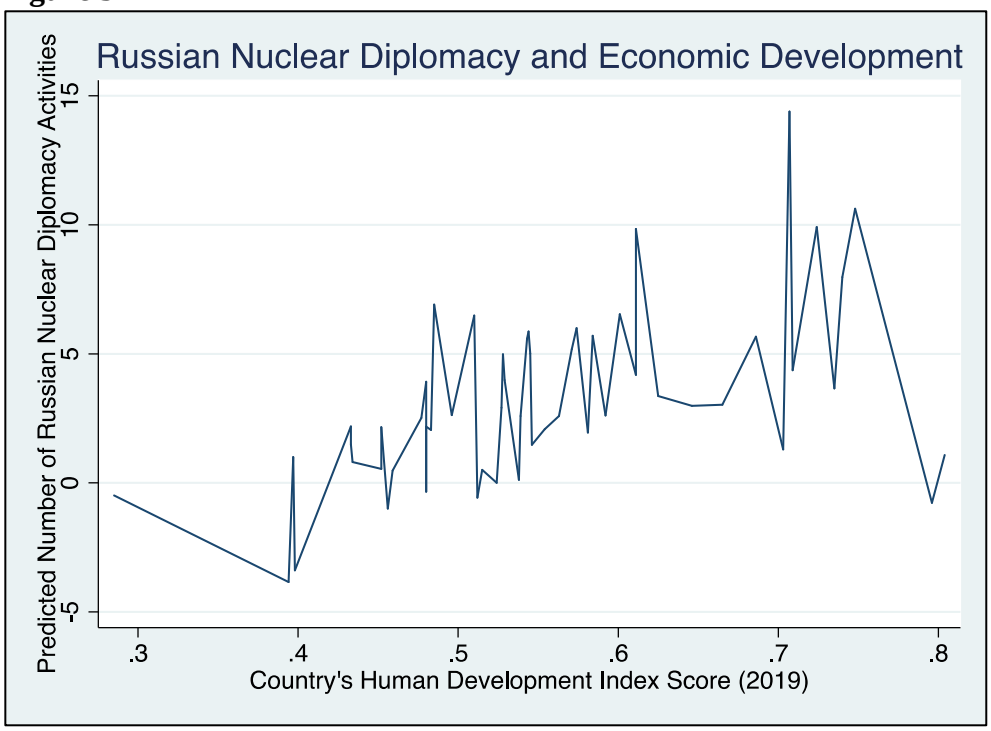
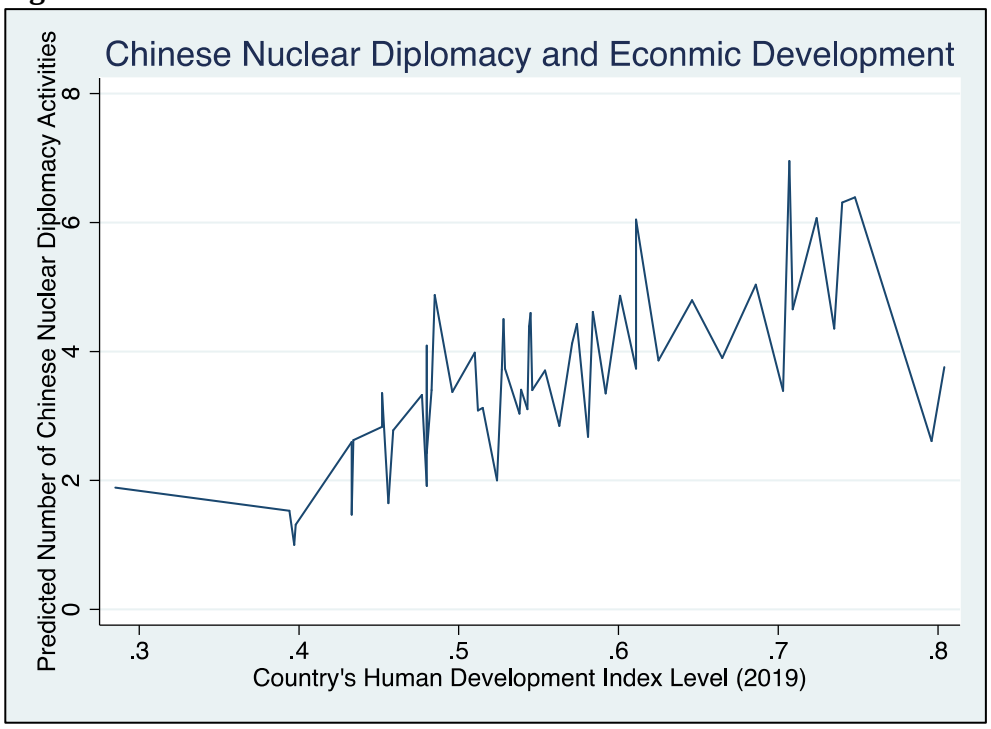


Figure 6



Several other variables were also statistically significantly correlated with greater (or fewer) numbers of nuclear diplomacy activities. In model 1, examining Russia's nuclear diplomacy, former Soviet allies during the Cold War were more likely to receive higher numbers of nuclear diplomacy activities. This variable did not manifest as statistically significant for higher numbers of Chinese nuclear diplomacy activities, however. Further, for both models one and two, Russia and China were less likely to engage in nuclear diplomacy activities in African countries that had been former Portuguese colonies. A number of influences likely explain this trend. First, Portuguese colonialism, in general, left weaker educational and scientific institutions than other forms of European colonialism, so those countries may be less capable of leading successful nuclear energy programs. Second, many former Portuguese colonies—notably Guinea-Bissau, Cabo Verde, São Tomé and Príncipe—are small geographically. In fact, the latter two are small island nations. Thus, leaders in these countries may not believe that their countries have sufficient territory for the safe construction and siting of a future NPP. This situation could change, however, if Russia's pilot floating nuclear power plants program achieves technical success. Currently, this program remains in pilot stage in testing grounds of the Russian artic, but may give island nations new options to pursue nuclear power. Other variables—such as contemporary diplomatic alliances and a state's regime type (level of democracy) did not seem to shape whether or not a country received higher (or lower) levels of nuclear diplomacy from either China or Russia.

TABLE 1. Frequency of Russian or Chinese Nuclear Diplomacy Activities in Africa

	Model 1	**Model 2**
Dependent Variables: Number of Total Nuclear Diplomacy Activities	*Russian Activities*	*Chinese Activities*
Level of Economic Development		
Human Development Index	44.619*** (7.989)	16.591*** (5.733)
Gross Domestic Product pc	-.0012*** (.000)	- .0004* (.000)
Cold War Alliance Status		
Soviet Ally	3.959** (1.279)	.977 (.918)
Regime Type		
Democracy	-.022 (.025)	.005 (.018)
Former Colonial Legacy		
British	- .407 (1.709)	- .861 (.1.226)
French	- 3.482† (1.73)	- 1.422 (1.244)
Belgian	.0175 (2.720)	- 1.758 (1.952)
Portuguese	- 6.574** (2.416)	- 2.988† (1.734)
Contemporary Alliances		
U.S. base/troops	.789 (1.199)	.262 (.860)
Russian base/troops	3.969 (.4.065)	-.360 (2.917)
Chinese base/troops	.215 (3.962)	- .654 (2.843)
N	54	54
cons	- 17.168	- 3.894

*** p< 0.001; ** p<0.01; * p<0.05; † p<0.1
Positive coefficients denote higher number; standard errors in parentheses.

4. Case Studies: Examining Chinese & Russian Influence in Nine African Countries

Now that this report has revealed, cross-nationally, the attributes of African states more likely to receive higher numbers of Chinese and Russian nuclear diplomacy activities, it toggles down to look qualitatively at nine crucial case studies. The Y12 National Security Complex has identified the nine countries constituting these case studies as of utmost importance in terms of nuclear security, proliferation concerns, and also the likelihood of future Chinese and Russian nuclear diplomacy efforts. These countries of concern are Africa's five Arab states—Egypt, Libya, Tunisia, Algeria, and Morocco—and also several sub-Saharan African states, Ghana, Nigeria, the Democratic Republic of the Congo, and South Africa. Next, this report proceeds country-by-country in examining each state's growing civilian nuclear program, and how China and Russia have sought to engage it through nuclear diplomacy especially during the 2000 to 2021 period.

4.1 Africa's Arab states

4.1a Egypt

Given Egypt's belief that Israel possessed nuclear weapons, and the conflict the two countries experienced in the mid-20th century, many scholars such as Maria Rost Rublee and Gawdat Bahgat speculated that Egypt would seek to develop a military nuclear program.[4] In reality, however, the Egyptian government has not followed these scholars expectations, spending much more time, political capital, and resources pursuing civilian nuclear energy programs to meet its high energy needs due to considerable recent population and economic growth. For instance, Egypt undertook multiple attempts at establishing a civilian nuclear program, which occurred throughout the 1950s and 1960s.[5] The most substantial attempt occurred in 1958, when Egyptian president Gamal Abdel Nasser received a two-megawatt reactor from the Soviet Union.[6] Still operating today, the Insha site currently contains two research reactors, a pilot plant for manufacturing low-enriched uranium, a pilot scale conversion plant, an accelerator, a heavy-water laboratory, and a cyclotron. Most recently, a 2015 agreement between Egypt and Russia's Rosatom company launched a project to build a nuclear power plant in El-Dabaa. At this site, officials plan to maintain four light-water reactors, each with a 1200-megawatt output, and to complete the project by 2028 or 2029.[7] In 2020, Egypt's Nuclear Power Plants Authority announced the expected date for obtaining a permit for construction of this site to be late 2021.[8]

Besides this 2015 agreement, Russian has had heavy involvement in other areas of the Egyptian civilian nuclear program. For instance, besides helping to construct and establish a nuclear power plant in Egypt, Russia has agreed to finance the project with a $25 billion loan.[9] Further, in 2019, Russian agencies provided Egypt with both nuclear fuel components for the ETTR-2 reactor,[10] and with training to some of the country's nuclear physicists through the Rosatom Technical Academy[11] at Tomsk Polytechnic University. In terms of Chinese involvement, agreements in both 2014[12] and 2015[13] demonstrate interest in deepening cooperation in the area of nuclear energy. However, other than Egypt officially signing a Memorandum of Understanding to join China's Belt and Road[14] initiative and the ceremonial inauguration of a Belt and Road Research Center in Egypt in 2019,[15] concrete exchanges of scientific personnel or nuclear technology have not yet occurred.

4.1b Libya

Starting as early as 1969,[16] Libya's nuclear program remained a heavily guarded secret until Mu'ammar al-Qadhafi's declaration to discontinue the program in 2003 under pressure from the United States, Great Britain, and other international partners. Within this time frame, however, Libya managed to develop the Tajoura Nuclear Research Center in 1982,[17] with aid from the Soviet Union. In 1984, Libyan officials received an offer from the A.Q. Khan network to buy the technology for gas centrifuges,[18] although the technology was not received until 1995. A.Q. Khan (1936-2021) was a Pakistani nuclear physicist who led a nuclear proliferation network that secretly sold nuclear technology to countries outside of IAEA safeguard procedures. Much of the centrifuge technology that he sold to other countries originated from designs he stole from an Urenco facility where he had worked in the 1970s. Following the interception of a gas centrifuge technology on route to Libya,[19] al-Qadhafi's 2003 declaration allowed the International Atomic Energy Agency to begin investigating and implementing safeguards. In 2006, Libya and France signed a nuclear cooperation agreement around support for the development of peaceful civilian nuclear power.[20] Libya currently maintains a ten mega-watt, light water research reactor at its Renewable Energy and Water Desalination Research Center (i.e. the Tajoura Nuclear Research Center).

Throughout its program's history, Libya has expressed interest in both Chinese and Russian support in its program's development. For instance, in the 1970s, Libya reached out to both China and the Soviet Union for aid in developing the initial program.[21] Further, as part of a deal between the United States and Russia, nuclear fuel for proposed research reactors was transported from Russia to Libya in both 2005[22] and 2006.[23] Additionally in 2007,[24] Libya and Rosatom signed a memorandum of understanding focused on cooperating in the peaceful use of nuclear energy, with a further agreement to explore the design and construction of nuclear reactors the following next year.[25] Besides its slight involvement in the 1970s, China has maintained a high level of interest in Libya due to its volumes of oil and natural gas, yet it has not launched any formal agreements to cooperate in the area of nuclear energy.[26] Libya did, however, join in 2018 the Chinese Belt and Road Initiative, which opens opportunities for future cooperation on nuclear energy development.[27] Given the present civil war in Libya, the future of the country's civilian nuclear program is unclear, yet it does have a basic scientific infrastructure and some interest in developing this energy source.

4.1c Tunisia

Although Tunisia does not possess nuclear power stations or research reactors, the country has had an interest in developing a civilian nuclear program extending as far back as 1982.[28] In addition, the country's National Center for Nuclear Science and Technology was established in 1993 to focus on research for a civilian nuclear program.[29] The state has taken several steps to begin the establishment of civilian nuclear program program. For instance, in 2006, Tunisia signed a nuclear cooperation agreement with France, focusing on both nuclear power and desalination. According to the International Atomic Energy Agency,[30] Tunisia initiated some Phase 1 activities for nuclear development in 2008, some Phase 2 activities in 2012, and even some Phase 3 activities in 2016. Tunisian leaders had hoped to establish a full nuclear reactor for energy production by 2020,[31] but newer estimates place this date in 2024.

In terms of Russian involvement, Tunisia signed a memorandum of understanding with Rosatom in 2015,[32] which focused on cooperation around the peaceful use of nuclear energy and on developing the proper technological infrastructure for these activities. Further, in 2016,[33] Russia and Tunisia signed a bilateral cooperation agreement in which they discussed the design and construction of nuclear reactors, desalination plants, and accelerators. With regard to China, Tunisia formally joined the Belt and Road Initiative in 2018,[34] and also signed an agreement with the China National Nuclear Corporation on nuclear cooperation.[35]

4.1d Algeria

Algeria's interest in nuclear energy can be traced back as far as the 1980s. The country's fifteen-megawatt research reactor in Es-Salem, supplied by the Chinese and discovered in 1991, remains in use to this day.[36] Additionally, Algeria hosts two other nuclear research entities within its borders: the one-megawatt Nur reactor from 1984 and a Nuclear Fuel Fabrication Plant developed in 1999.[37] While these research reactors and facilities were established in the 1980s and 1990s, Algeria signaled in 2000s more interest in developing a full-scale nuclear power plant and a robust civilian nuclear program. For instance, in 2006, Algeria encouraged its legislature to develop a draft bill for regulating and permitting nuclear energy.[38] Currently, all known nuclear facilities and research facilities of the Algerian program fall under International Atomic Energy Agency safeguards, though the country was slower than other regional neighbors to adopt some nuclear treaties.

Whereas Russian involvement in the Algerian nuclear program began in 2007, Chinese involvement in the Algeria can be seen as early as the 1980s with both the Es-Salem reactor and other technological aid. Chinese involvement ultimately culminated in the signing of numerous nuclear cooperation agreements between these two states: two agreements signed in March of 2008 focused on the use of nuclear energy for peaceful purposes,[39] a 2015 cooperation agreement with China National Nuclear Corporation focused on the practical side of cooperation for nuclear power,[40] and the 2018 upgrade to the Algerian Brine Reactor garnered assistance from the China Institute of Atomic Energy[41].

Though not as heavily involved before 2000, Russian influence can be traced back to January 2007 when the first memorandum of nuclear cooperation between the two states was signed.[42] Algeria's memorandum with Russia covered cooperation at all stages of the nuclear energy chain, and established joint working groups for the development of a civilian nuclear program.[43] Additionally, in 2014, Algeria signed an agreement with Russia's Rosatom focused on the design, construction, operation, and maintenance of a nuclear power plant[44] and established a twelve-year plan for a water-powered reactor.[45] In October 2014, Rosatom began negotiations and consultations for the construction of a nuclear power plant. Further, in 2016, officials would sign an agreement, which focused on a joint nuclear power station and nuclear education and training[46]. Most recently, another agreement between Russia and Algeria focused on opening and facilitating further cooperation and experience sharing to benefit Algeria's civilian nuclear program.[47]

4.1e Morocco

Morocco's civilian nuclear program has origins stretching back to the 1950s,[48] and it has benefited tremendously from international assistance and expertise. For instance, in 1996, Morocco submitted a request to the International Atomic Energy Agency for a feasibility study on nuclear desalination,[49] with an INIR mission being completed only two years later.[50] Morocco has signed numerous nuclear cooperation agreements and memorandums of understanding with nuclear energy corporations hailing from France,[51] Russia,[52] China,[53] Spain,[54] and the United States.[55] With its close adherence to nonproliferation treaties and robust international support, Morocco nuclear program has successfully build and maintains the TRIGA Mark II[56] research reactor, aiming to integrate full-scale nuclear power into its energy portfolio by 2030.[57]

Although less important than U.S. or European nuclear assistance, Russia and China have sought to influence Morocco's civilian nuclear energy program. Specifically, Russia's Atomstroyexport and Rosatom and China's China National Nuclear Corporation have historically played the largest roles. Between 2006 and 2010, for example, Russian representatives from Atomstroyexport and Rosatom met with Moroccan officials on three separate occasions—2006,[58] 2007,[59] and 2010[60]). Additionally, Rosatom developed a 2017 memorandum of understanding with Morocco's Ministry of Energy, Mines, and Sustainable Development focused on long-term cooperation in the nuclear energy sphere.[61] Similarly, the China's China National Nuclear Corporation and Morocco's government concluded a nuclear cooperation agreement in 2018[62].

4.2 Africa sub-Saharan states

4.2a Ghana

An initiative of Ghana's first president, Kwame Nkrumah, the country's civilian nuclear program has been active and growing for over five decades (since it commenced in 1961).[63] Although the Soviet-sponsored initial nuclear reactor project, the "Kwabenya Nuclear Reactor Project" failed to reach fruition in the 1960s, the Soviet Union played a large and important early role in training Ghanaian nuclear engineers and others scientists. Many traveled in the 1960s to the Soviet Union in order to learn nuclear protocols, techniques, and mechanics.[64] In the 1990s, renewed interest in Ghana's nuclear program emerged, especially with growing population numbers within the country and thus higher energy demands. This interest culminated in a 1994 agreement with China to purchase a 30 mega-watt research reactor for training and research purposes.[65] As Ghana's increased energy demands evolved into an energy shortage crises, Ghanaian policymakers would, in 2007,[66] announce its intention to focus heavily on developing nuclear energy technology and building nuclear power plants to diversify the country's energy sources. As such, Ghana ultimately signed a 2015 agreement with Russia's Rosatom to build the first nuclear power plant in the country. As of 2017, the International Atomic Energy Agency had completed its INIR mission to assess the Ghana's phase 1 developments of a nuclear program[67]. In addition, reports by government officials have claimed that Ghana aims to begin producing nuclear energy by 2029.[68]

Both China and Russia have had considerable influence on the emergence, growth, and development of Ghana's civilian nuclear program. For instance, besides the 1994 agreement

between Ghana and China, a 2016 meeting between the leadership of Ghana's Atomic Energy Commission and the chairman of the China National Nuclear Corporation led to the promise of future cooperation in regard to the micro reactor low-enrichment renovation project and nuclear energy utilization.[69] Additionally, in 2018 the China National Nuclear Corporation and Ghana signed another agreement focused on maintaining and deepening the cooperation of the two countries within the sphere of civilian nuclear energy.[70]

Russia's Rosatom and Ghana have signed several agreements to cooperate within the field of civilian nuclear energy in 2012,[71] 2015,[72] and 2019.[73] Per these agreements, Rosatom and Ghana have agreed to focus on the construction of a nuclear power plant, which will accommodate a Russian-designed 1000-1200 mega-watt reactor. Russia will provide direct support for infrastructure construction and maintenance of the reactor. In addition, in 2019,[74] Ghanaian scientists were able to study at Russia's Tomsk Polytechnic University in collaboration with the Rosatom Technical Academy. In 2020, furthermore, Russia's Tomsk Polytechnic University and three Ghanaian universities forged an agreement to initiate programs to advance the studies of Ghanaian graduate students focusing on nuclear engineering and nuclear security.[75]

4.2b Nigeria

In the 1970s, the Nigerian nuclear program experienced a shift from an initial interest in weaponry to that of peaceful civilian energy production.[76] For an exact origin date, sources cite the establishment of the 1976 Nigerian Atomic Energy Commission[77] and the founding in 1978 of two nuclear energy research centers.[78] These two centers are the Center for Energy Research and Development and the Center for Energy Research and Training respectively. Due to Nigeria's high energy demand, Nigerian government in 2009 decided to develop a roadmap toward producing 5 mega-watts of nuclear energy by 2030,[79] though this objective has since faced setbacks. Within Nigeria's current program, it operates a 30 kilo-watt, Chinese-designed miniature neutron source reactor which was donated to the state by the International Atomic Energy Agency in 1994.[80] In addition, Nigeria is currently in the design stages for a 2-5 mega-watt research reactor,[81] and is working with the International Atomic Energy Agency to achieve that 4000 mega-watt output.[82]

Currently, Russia and Nigeria have signed over five agreements to cooperate in the field of nuclear technology and energy. For instance, in 2009,[83] Russia's Rosatom and the Nigerian Nuclear Regulatory Authority agreed to cooperate for infrastructure development, research, and uranium prospecting. Nigeria's most recent 2017[84] agreement has gained Russian commitment to construct and operate both a nuclear power plant and a multipurpose nuclear research center. Further, from 2014[85] onward, institutions like Tomsk Polytechnic University and the Rosatom Central Institute for Continuing Education and Training will organize lessons, training seminars, and education programs for Nigerian nuclear scientists and graduate students.

Besides the Chinese-designed 30 kilowatt reactor currently operating in Nigeria, Chinese influence over the program mainly stems from more recent developments. Nigeria officially signed to join China's Belt and Road Initiative in 2018,[86] subsequently the China National Nuclear Corporation agreed to provide low enriched uranium fuel to Nigeria for use in the conversion of the state's miniature neutron source reactor fuel type from high to low.[87] More recently, in both 2019[88] and 2020,[89] the Chinese state nuclear companies pledged both assistance and investments into the development of nuclear energy infrastructure in Nigeria.

4.2c Democratic Republic of the Congo (DRC)

Desire to develop a civilian nuclear program for the Democratic Republic of the Congo can be seen as far back as the 1950's. Indeed, the Democratic Republic of the Congo became the first country in Africa to build a nuclear reactor.[90] In this vein, the Democratic Republic of the Congo currently maintains two research reactors within its territory: the TRICO 1, which has been permanently decommissioned; and the TRICO II, which is expected to be restarted in the near future.[91] Nuclear expertise in the Congo has been increasing, however, with scientists in 2017 using techniques from the nuclear program to help to identify a new outbreak of the avian flu[92]. Within the same year, the Democratic Republic of the Congo also became a signatory to the Treaty on the Prohibition of Nuclear Weapons in the same year. In addition, in December of 2019, officials from both the International Atomic Energy Agency and the Democratic Republic of the Congo met in order to discuss enhancing the country's nuclear legal framework so it meets international standards.[93]

Recent Russian activity and influence over the Democratic Republic of the Congo's civilian nuclear program heavily outweighs that of the Chinese. Nevertheless, a 2018 meeting between officials of the Democratic Republic of the Congo and of the China Nonferrous Mining Corporation did cite an interest including the country in the Belt and Road Initiative going forward,[94] with possible future nuclear cooperation from other Chinese organizations. Regarding Russian involvement in Congo's nuclear program, a 2011 meeting between officials[95] occurred. Yet this meeting focused on increasing cooperation for access to "deposits of mineral resources," and potentially acts only as a precursor to the 2017 signing of two memorandums of cooperation[96] between the countries. The first memorandum involved Russia's education and training of Congolese nuclear scientists and other personnel, and the second memorandum concerned encouraging Congolese positive public support for the development of nuclear energy.

4.2d South Africa

Originating in the 1970s,[97] South Africa's nuclear program is one that became fully capable of producing a nuclear weapon and yet was dismantled just a few years later. In this regard, this highly secretive weapons-focused program[98] benefitted from nuclear trade and cooperation from the United States,[99] France, West Germany, Israel, and Iran. Before it was dismantled in 1991, the South African program succeeded in manufacturing six nuclear devices by 1989.[100] After 1991, the state shifted to focus on developing a peaceful, energy-focused program with its two functioning nuclear power stations at Koeberg.[101] South Africa examined using Pebble Bed Modular Reactors in both 1999[102] and 2007[103].

Notably, in 2014, South Africa looked into using the Integrated Resource Plan for an additional 9000 mega-watt output of nuclear energy for its electric grid.[104] With this plan, South Africa opened bidding for a contract for six reactors of which both China and Russia have shown interest. In this regard, Russian involvement in the program can be seen again in 2010 with a deal between South Africa and Russia's Techsnabexport.[105] The Russian company agreed to supply South Africa with uranium enrichment services for its 1800 mega-watt reactor at Koeberg. In addition, in 2014,[106] Russia agreed to provide both nuclear energy technology and training for the construction of a third reactor in South Africa as well as a large-scale nuclear power plant being provided by Rosatom. Further, in 2015,[107] the two states agreed to allow South African students specializing in nuclear engineering to be trained in Russia.

In terms of China, involvement can be seen as far back as 2009[108] with a memorandum of understanding between the states to develop Pebble Bed Modular Reactors technology. Further, in 2014[109] China's General Nuclear Corporation and the State Nuclear Power Technology Corporation signed an agreement with South Africa to fund skills development at Chinese institutions for South African students. In addition, in 2019,[110] China began to heavily invest in South African basic infrastructure indirectly related to nuclear technology development.

5. Policy Implications & Takeaways

This report concludes with a number of general findings and broader implications for U.S. policymakers and nonproliferation specialists. According to the original data collected herein, the African continent has witnessed a dramatic recent rise in the number of Chinese and Russian efforts at nuclear diplomacy. These efforts increased, particularly, after 2015 especially with the launching of China's Belt and Road Initiative. These activities have broad geographic scope, with nearly every African country experiencing some form of either Chinese or Russian nuclear diplomacy. Our data also show that, although Chinese nuclear diplomacy activities have been more numerous, Russia's activities have in fact been more developed and sophisticated. Russia has engaged in far more phase two and phase three nuclear cooperation activities with African partners, which involve the signing of formal memorandums of understanding, contracting the building of NPPs, and the transfer of nuclear technology and training. China has similarly shown interest in these more sophisticated activities of cooperation in the arena of nuclear energy, yet most of their nuclear diplomacy up to now has been limited to more preliminary phase one activities. Importantly, our data herein also show that Russia and China tend to target countries in Africa for nuclear cooperation when they have higher levels of economic development, as measured by the United Nation's Human Development Index. Higher scores on the United Nation's HDI suggest that a country has invested more tax monies in developing its educational and scientific infrastructure and institutions, making it a more reliable and likely successful potential partner in the sphere of civilian nuclear energy. Simpler measures of economic development that do not account for such investment in educational and scientific institutions—such as a country's overall Gross Domestic Product—do not show similar trends, further strengthening our finding. Russia also, generally speaking, seeks to enter relationships of nuclear cooperation with states that were its allies during the Cold War—former Soviet allies before the collapse of the Berlin Wall. Arab states that had formerly allied with the Soviet Union, notably Algeria and Egypt, are two of their key partners in nuclear energy development.

Given these findings, U.S. policymakers face a series of important decisions. As Russian and Chinese influence expands on the African continent, by way of nuclear diplomacy, the United State has—thus far—chosen to take the back seat. It may be missing opportunities to influence and build support among African leaders, who want to encourage their countries' economic development and energy security through building nuclear power plants and developing robust nuclear energy programs under IAEA safeguards. The United States, should it choose to try and match Russian and Chinese efforts, will need to take further steps in order to encourage and expand its policies and programs related to peaceful nuclear cooperation in Africa in the years to come.

Notes

[1]Joseph S. Nye, *Soft Power: The Means to Success in World Politics.* New York: Public Affairs, 2004.

[2] Large percentages of populations of several African countries—notably Tunisia, Algeria, Morocco, and Ethiopia—constitute migrant worker communities in Western Europe and also North America. Moroccan and Tunisian migrant workers' remittances, for example, make up 6.6 and 5.4 percent of each respective country's annual GDP. The HDI incorporates this wealth in ways the GDP alone does not.

[3]In constructing this variable, we also coded Egypt, Morocco, and Tunisia as U.S. allies, even though none of these countries actively hosts a U.S. base or troops. They have, however, signed major non-NATO ally treaties (similar to South Korea and Australia) with the United States, and thus are considered close U.S. allies in contemporary politics.

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