## **Developing empirical insights into irreversibility in nuclear arms control and disarmament**

**Dr Hassan Elbahtimy**

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This is the second special issue on the topic of irreversibility in nuclear politics. The first special issue established that irreversibility, despite its frequent mention in arms control and disarmament discussions, was understudied and needed further exploration. By grouping together six articles, the previous issue aimed to develop a conceptual foundation for the topic, emphasizing the relative nature of irreversibility and focusing on the technical and political pathways to re-armament (Elbahtimy 2023). Contributions drew on various perspectives, including Science and Technology Studies, Law, and Nuclear Studies, and provided valuable insights into the importance of nuclear weapons complexes for irreversibility (Ritchie 2023; Elbahtimy and Peel 2023) the inherent paradoxes in negotiating arms control and disarmament treaties (Rodgers and Williams 2023), how verification and legal withdrawal provisions impact the application of irreversibility (Muti, Christopher, and Stott 2023; Hajnoczi 2023; Fleck 2023).

This special issue shifts the focus from the conceptual to the empirical. It aims to explore how dynamics linked to irreversibility have played out in practice by examining arms control and disarmament efforts in South Africa, Kazakhstan, the Democratic People’s Republic of Korea (DPRK), and US-Soviet/Russian contexts. This introductory article begins by outlining new research and developments related to irreversibility. It then reflects on the approach taken in developing the empirical cases. Finally, it introduces the contributions made to this special issue, highlighting some themes that emerge from the analysis provided in each article.

## **Irreversibility: an expanding conversation**

Discussions about irreversibility in nuclear politics have expanded since the publication of our first special issue on the topic last year. Plans are underway to produce new diplomatic outputs during the current NPT review cycle, drawing on the valuable conversations taking place in research, non-governmental, and diplomatic circles. In multilateral diplomacy, two documents reflecting this renewed interest in nuclear irreversibility stand out. The first is the UK-Norway working paper submitted to the last NPT review conference.[[1]](#footnote-1) The second is a joint statement delivered by Norway on behalf of itself, Austria, Mexico, and the UK on August 3, 2023.[[2]](#footnote-2)

New and expanded research activities on the topic have also emerged. Readers of this journal may be familiar with the Irreversibility Research Consortium (2022-2023), which included the Centre for Strategic and International Studies (CSIS), the European Leadership Network (ELN), VERTIC, and the University of York, led by King’s College London. Some early outputs from the consortium were published as a special issue in this journal (Elbahtimy 2023). With the end of the research consortium, various institutions initiated new research projects and partnerships to study different aspects of irreversibility. For instance, Nick Ritchie at York University developed a project mapping the UK nuclear weapons complex through the lens of irreversibility.[[3]](#footnote-3) The Open Nuclear Network and VERTIC formed a partnership exploring irreversibility through the prism of latency.[[4]](#footnote-4) VeSPoTec and the Vienna Center for Disarmament and Non-Proliferation (VCDNP) organized a tabletop simulation focusing on the link between irreversibility, verification, and nuclear safeguards.[[5]](#footnote-5) VERTIC and NPS Global engaged Latin American countries in dialogues on irreversibility.[[6]](#footnote-6) Additionally, International and British Pugwash hosted a meeting in Rome that explored ‘resilience’ as a framework for irreversibility, drawing lessons from chemical disarmament and nuclear arms control.[[7]](#footnote-7)

Wilton Park conferences continue to serve as a forum for policy and research communities to engage with this topic. To date, three well-attended conferences have been organized, fostering conversations between policymakers and researchers. These took place in March 2022, 2023, and 2024. In these meetings, research on the conceptual and empirical aspects of irreversibility was integrated with the experiences of diplomats and the priorities of multilateral fora. In the early conferences, the discussions were exploratory and open-ended, aiming to capture and develop existing perspectives on the concept based on broad-based support.

By the latest Wilton Park conference in 2024, the conversation had evolved significantly, with a growing consensus on the need to take irreversibility more seriously. While there remains broad-based support for the concept, diverse views have also emerged. In the context of a crisis in arms control and disarmament, the nuclear shadow of Russia’s war in Ukraine, and the challenge of upholding international norms amid the conflict in Gaza, questions about the practicality and timing of a new push for irreversibility have arisen. Another key debate centers on whether arms control and disarmament practices require adaptation to integrate irreversibility standards or if such adaptations are unnecessary.

## **Thinking about irreversibility empirically**

This special issue comprises four articles, each exploring irreversibility within distinct disarmament and arms control contexts. These articles delve into nuclear disarmament in Kazakhstan and South Africa, efforts to constrain North Korea’s nuclear program, and the history of arms control agreements between the US and the Soviet Union, now Russia, spanning several decades and continuing, albeit with challenges, to this day.

The examination of these cases intentionally avoided rigid frameworks, allowing authors the flexibility to explore and evaluate the dynamics of irreversibility within their respective contexts. This approach provided researchers with the freedom to direct their focus and shape conclusions not only within the specific cases studied but also on what irreversibility might mean in the various contexts. This flexibility also enabled the articles to uncover dynamics and pose questions that may not have been previously addressed or captured in the conceptual literature on the topic.

Authors were guided by a foundational definition of irreversibility developed early in the project. (Elbahtimy 2023). Drafts of the articles were workshopped at King’s College London on March 7, 2023, facilitating interaction and feedback among authors across different empirical cases and between conceptual and empirical themes.

While authors were provided with initial guidance through a defined concept of irreversibility and its characteristic features, there remained ample room for them to explore various new facets of the concept. This open-ended approach was particularly beneficial given the relatively undertheorized nature of irreversibility; the under theorization is also a feature of disarmament more broadly.

Looking forward, a promising avenue for advancing research on irreversibility involves leveraging new empirical insights to inform and enrich existing conceptual frameworks. This integrative approach would aim to foster a more comprehensive understanding of irreversibility, bridging empirical findings with theoretical concepts to deepen scholarly insights into disarmament dynamics.

## **The DPRK**

In their article, Matt Korda and Eliana Johns examine and evaluate international efforts to constrain the DPRK’s nuclear programme. These efforts, that spanned three decades, were the product of negotiations sometimes taking the form ofthat alternated between bilateral talks and broader forums like the Six-Party Talks. Rather than providing a survey of this lengthy timeline, the authors focused on a series of measures, , that constituted either ‘technical freezes’ or ‘political moratoria’ that were applied at various historical junctures. Specifically, they analyze the effectiveness of technical freezes at the Punggye-ri nuclear test site, the Sohae launch complex, and the Yongbyon nuclear complex. The article also explores why these measures, among others, ultimately failed to sustainably address the DPRK’s nuclear ambitions.

Their analysis highlights several key themes. The authors conceptualize and categorize technical freezes and political moratoria—collectively termed 'halting measures'—designed to temporarily constrain aspects of the DPRK’s nuclear program. These measures were intended as transitional steps with the expectation that future actions could build upon them, leading to substantial reductions in North Korea's nuclear capabilities over time.

Regarding technical freezes, the authors offer a largely positive assessment despite the inherent reversibility of these measures. Their analysis reveals instances where North Korea managed to reverse these measures sooner than anticipated. Nevertheless, these freezes serve as viable proof of concept, suggesting that with longer and more coordinated implementation, coupled with additional measures, they could have had a more significant impact.

The authors are less positive about 'political moratoria', which differ from technical freezes in that they represent high-level political commitments to cease specific activities such as missile launches or weapon tests for a set period. These declarations often lacked tangible impact on the ground and in retrospect appear as superficial gestures, or even deliberately deceptive allowing North Korea to continue advancing its capabilities.

In examining the shortcomings of negotiated efforts to impose sustainable and meaningful constraints on the DPRK’s nuclear program, the authors attribute much of the failure to political factors that curtailed any chance of momentum that could have achieved higher levels of irreversibility. These include conflicting objectives, disagreements over sequencing and terminology, and the influence of domestic politics, which at times hindered political support for engagement efforts.

## **US-Soviet/Russia arms control**

Amy Woolf analyzes U.S.-Soviet/Russian arms control agreements through the lens of nuclear irreversibility. She offers a detailed catalogue of bilateral treaties and agreements that mark key milestones in arms reductions. In tracking these agreements, Woolf explores the physical measures implemented to ensure irreversibility. She also reflects on the challenging journey of arms control, including its ups and downs, and discusses what that reveals about the factors that influence the long-term durability of these agreements.

Several important themes emerge from Woolf’s analysis. First is the question of whether arms control and disarmament provide radically different contexts for considering irreversibility. In other words, does irreversibility follow a different logic in treaties that limit rather than eliminate all nuclear weapons? Woolf’s careful analysis of irreversibility in arms control suggests a fundamental difference between these two contexts, and this idea deserves further engagement and exploration.

Second, an examination of various arms control agreements reveals a number of measures, called ‘technical procedures,’ that specify how weapons above a certain limit are disposed of or otherwise managed. The more these measures lead to physical destruction, the more difficult it is, particularly in terms of cost and time, to reconstitute these weapons. These technical procedures vary from one treaty to another, and this variation does not follow any single trajectory.

Third, the overall value of the technical procedures is tied to pathways left open beyond the limitations stipulated by the treaty. These pathways can provide backdoors to replenishing capabilities while still complying with the letter of the agreements.

Finally, the durability of arms control agreements rests on the political commitment that parties invest and maintain in these agreements. As all agreements, whether time-limited or indefinite, have provisions for withdrawal, the spectre of leaving the treaty and being free from its constraints is embedded in the legal structure of these arrangements. This was fully displayed in the case of the INF Treaty, which was long considered one of the biggest arms control successes of the late Cold War, yet crumbled in 2019 as relations deteriorated between the U.S. and Russia amid accusations of non-compliance and changing strategic priorities.

## **South Africa**

South Africa stands out as one of the most remarkable cases of nuclear disarmament. Nuclear weapons were built during South Africa’s Apartheid regime, and then a decision was made to dismantle them in the final years of that regime. Post-apartheid governments stayed the course and remained committed to a South Africa free from nuclear weapons. Joelien Pretorius offers a compelling narrative of South Africa’s nuclear journey and introduces new analytical concepts whose significance to the study of irreversibility goes beyond their application to this specific case.

The paper analyzes the origins of South Africa’s nuclear program and tracks the decisions to develop and ultimately abandon it. The country's nuclear policy trajectory is traced across a broad timeline, demonstrating continuity in support for disarmament across successive administrations. Additionally, the paper examines the significance of South Africa retaining Highly Enriched Uranium (HEU) while advocating for global nuclear disarmament.

Several themes emerge from Pretorius's analysis. Conceptually, she introduces the concept of ‘path dependency,’ providing a fresh lens for understanding irreversibility. The article draws on literature on path dependency to provide an analytical lens capable of capturing critical junctures and inflection points. It also develops utilitarian and normative models to illustrate the logics that influence decision-making processes and shape the ensuing path.

Reflecting on South Africa’s nuclear history, the pivotal decision to relinquish its nuclear weapons is identified as a transformative moment for disarmament. However, Pretorius’ narrative more accurately portrays this as an ongoing process that requires deliberative political action to maintain the commitment amidst internal political dynamics and external pressures. It is true that post-apartheid governments were presented with a fait accompli, but their decision to continue on the non-nuclear path should not be taken for granted. External factors and internal politics were crucial in shaping outcomes at both the formative and transformative junctures of the disarmament trajectory.

Identity and role conception emerge as pivotal factors in South Africa’s adoption and reinforcement of a position against nuclear weapons. Pretorius also identifies utilitarian considerations alongside normative ones in shaping this stance. Ultimately, this leads to the reproduction and further entrenchment of the non-nuclear position, which becomes normalized through being part of a variety of international and regional agreements as well as by taking a leading role as a disarmament advocate on the international stage. South Africa’s retention of HEU under IAEA safeguards reflects the complexities of maintaining a strong anti-nuclear weapons stance while navigating frustrations over the lack of progress toward global disarmament and a more equitable nuclear order.

## **Kazakhstan**

Kazakhstan’s abandonment of nuclear weapons is widely recognized as a robust example of a commitment to nuclear disarmament. In her article, Togzhan Kassenova examines key aspects of Kazakhstan's denuclearization and its connection to nuclear irreversibility. She traces the decision to abandon Soviet nuclear weapons, explains the historical legacy of nuclear testing on Kazakh attitudes towards nuclear weapons, and shows some unique features of how the decision to abandon nuclear weapons was implemented. These elements significantly enhance the chances of irreversibility in Kazakhstan’s case.

Examining this case highlights three key themes. First, the disarmament decision was driven by strong domestic political incentives and a commitment to the image of a non-nuclear state. The anti-nuclear sentiment has deep historical roots, linking nuclear weapons to structures of racial supremacy and hierarchy under Soviet nuclear policies. Despite the Soviet Union's rhetorical commitment to egalitarian principles, its policies often revealed Russian supremacy. In the nuclear field, this meant that ethnic Russians held dominant positions in the nuclear program, while other ethnicities were marginalized. The starkest manifestation of this racial hierarchy was the selection of the Kazakh Steppes for Soviet nuclear testing, conducted without regard for the human toll or environmental impact. This galvanized Kazakh national identity and shaped nuclear attitudes following the achievement of national sovereignty. In addition, there was also a drive to join the international community as a non-nuclear weapon state and from that position contribute to fostering norms and standards against nuclear weapons.

Once the decision was made to follow a non-nuclear path, Kazakhstan adopted a highly transparent approach to implementing its disarmament. It cooperated with Russia, the U.S., and international organizations, including the IAEA, to dismantle silos, address the historical legacy of the Semipalatinsk nuclear test site, and eliminate weapons-grade material. The openness and transparency Kazakhstan displayed, along with its collaboration with multiple international stakeholders, provided additional assurances of its solid commitment to a non-nuclear path. Its proactive international conduct, support of anti-nuclear norms, and prominent role in establishing the Central Asian Nuclear-Weapon-Free Zone further cemented this decision and its commitment to nuclear disarmament.

## **References**

Cliff, D., H. Elbahtimy, and A. Persbo. 2011. *Irreversibility in Nuclear Disarmament: Practical Steps Against Nuclear Rearmament*. VERTIC. https://www.vertic.org/media/assets/Presentations/ Irreversibility\_Launch\_Presentation.pdf

Elbahtimy, H. 2023. “Approaching Irreversibility in Global Nuclear Politics.” *Journal for Peace & Nuclear Disarmament* 6 (2): 199–217. https://doi.org/10.1080/25751654.2023.2295595 .

Elbahtimy, H., and R. Peel. 2023. “Nuclear Weapons Production Complexes in a Disarmed World.” *Journal for Peace & Nuclear Disarmament* 1–29. https://doi.org/10.1080/25751654. 2023.2292348 .

Fleck, D. 2023. “Irreversibility in Nuclear Arms Control and Disarmament Law?” *Journal of Conflict and Security Law* 28 (3): 423–466. https://doi.org/10.1093/jcsl/krad013 .

Hajnoczi, T. 2023. “Legal Reflections on the Irreversibility of Nuclear Disarmament.” *Journal of Peace and Nuclear Disarmament*.

Ritchie, N. 2023. “Irreversibility and Nuclear Disarmament: Unmaking Nuclear Weapon Complexes.” *Journal for Peace & Nuclear Disarmament* 1–26. https://doi.org/10.1080/25751654.2023.2282737 .

Rodgers, J., and H. Williams. 2023. “The Irreversibility Paradox: What Makes for Enduring Arms Control and Disarmament.” *Journal for Peace & Nuclear Disarmament* 6 (2): 244–262. https:// doi.org/10.1080/25751654.2023.2292812 .

1. NPT/CONF.2020/WP.16 [↑](#footnote-ref-1)
2. <https://www.reachingcriticalwill.org/images/documents/Disarmament-fora/npt/prepcom23/statements/3Aug_Irreversibility.pdf> [↑](#footnote-ref-2)
3. <https://www.york.ac.uk/politics/research/current-projects/irreversibilityandnucleardisarmament/mappingtheuknuclearweaponscomplex/> [↑](#footnote-ref-3)
4. <https://www.vertic.org/programmes/vm/irreversibility-of-nuclear-disarmament/> [↑](#footnote-ref-4)
5. <https://vespotec.rwth-aachen.de/2024/04/15/nuclear-safeguards-and-irreversibility-in-the-reduction-and-elimination-of-military-nuclear-stockpiles-three-key-questions-/3608/> and <https://vcdnp.org/nuclear-safeguards-and-irreversibility-in-the-reduction-and-elimination-of-military-nuclear-stockpiles-three-key-questions/> [↑](#footnote-ref-5)
6. <https://www.vertic.org/programmes/vm/irreversibility-of-nuclear-disarmament/> [↑](#footnote-ref-6)
7. <https://britishpugwash.org/pugwash-meeting-on-irreversibility-in-the-nuclear-domain/> [↑](#footnote-ref-7)