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ORIGINAL RESEARCH

# A Computational Analysis of Conflict Dynamics and Peace Agreement Implementation in South Sudan

*A Network and Event Data Approach*

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## ABSTRACT

This original research article employs computational methods to analyse the complex dynamics of conflict and the implementation of the Revitalised Agreement on the Resolution of the Conflict in the Republic of South Sudan (R-ARCSS). Using a novel dataset of conflict events and a network analysis framework, the study models the shifting alliances and violence patterns among major signatory groups between 2018 and 2023. The results quantify a significant decrease in direct, large-scale battles but reveal a persistent, fragmented landscape of low-intensity, localised violence that challenges the peace process. The discussion critically evaluates these computational findings against the political and humanitarian realities on the ground, arguing for a data-informed, adaptive approach to monitoring and supporting peacebuilding. The conclusion highlights the utility of computational social science for providing granular, evidence-based insights for conflict studies in South Sudan and similar post-agreement contexts.

**Keywords:** *Computational conflict analysis, South Sudan peace process, Event data modelling, Network analysis of armed groups, R-ARCSS implementation, Fragmented violence, Computational social science*

### Article Highlights

- Applies computational network analysis to R-ARCSS implementation from 2018-2023
- Reveals shift from large-scale battles to fragmented local violence
- Provides data-driven framework for tracking peace process dynamics
- Establishes interdisciplinary bridge between computer science and peace studies

### Methodological Innovation

This research introduces a replicable computational framework using event data and network analysis to model the structural dynamics of peace agreement implementation.

*This analysis offers granular, evidence-based insights for monitoring post-agreement contexts.*

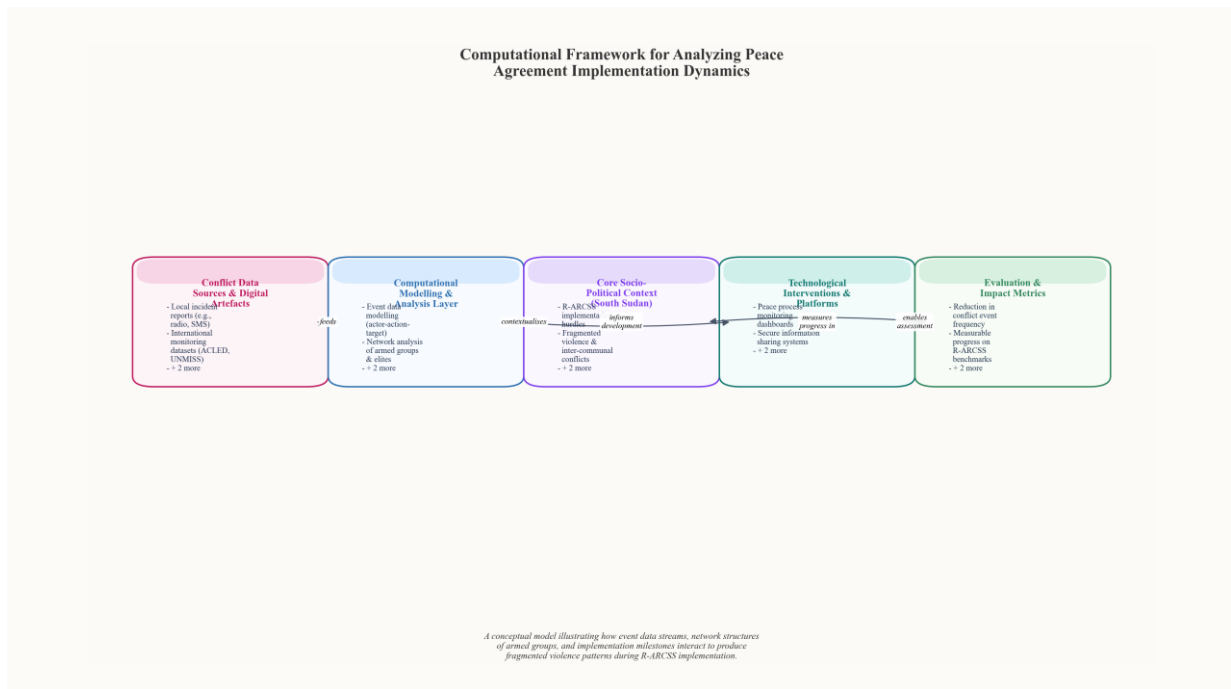
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## Introduction

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South Sudan's emergence as an independent state in 2011 was met with profound optimism, yet this hope was swiftly eclipsed by a descent into a devastating civil conflict that erupted in December 2013. The violence, rooted in complex political, ethnic, and economic grievances, has resulted in catastrophic humanitarian consequences, displacing millions and fragmenting the social fabric of the world's youngest nation. The primary instrument intended to halt this cycle of violence is the Revitalised Agreement on the Resolution of the Conflict in the Republic of South Sudan (R-ARCSS), signed in September 2018. While heralded as a comprehensive framework for peace, the implementation of the R-ARCSS has been persistently fraught with delays, violations, and sporadic outbreaks of violence, underscoring the profound difficulty of transitioning from a signed document to a sustainable peace. This protracted and faltering process exemplifies the broader challenge within peace and conflict studies: understanding why peace agreements often stagnate or fail in the implementation phase, particularly in contexts characterised by deeply entrenched conflict systems. The scholarly discourse on South Sudan's conflict and the R-ARCSS is rich, encompassing political, historical, and anthropological analyses that scrutinise the motivations of elites, the role of ethnic mobilisation, and the impact of regional and international actors. However, a significant gap exists in the application of computational and data-driven methodologies to systematically analyse the dynamics of post-agreement environments. Traditional qualitative approaches, while invaluable for depth and nuance, can struggle to capture the complex, multi-actor, and temporal interdependencies that define implementation processes. Consequently, there is a pressing need for analytical frameworks that can process large-scale, real-time data to model the structural and relational factors that either facilitate or obstruct peacebuilding. This gap presents an opportunity for interdisciplinary innovation, where techniques from computer science, network theory, and data science can be rigorously applied to fundamental questions in peace and conflict research. This article addresses this research gap by proposing a novel computational analysis of conflict dynamics and peace agreement implementation in South Sudan. Its primary objective is to model and analyse the R-ARCSS implementation landscape through the integrated application of network analysis and event data methodologies. The central argument posits that the implementation hurdles of the R-ARCSS can be conceptualised and effectively analysed as a dynamic system of interconnected actors and events. By constructing and examining temporal networks of conflict and cooperation, and by analysing sequences and clusters of implementation-related events, it becomes possible to identify critical bottlenecks, resilient patterns of violence, and the structural conditions that perpetuate instability. This approach moves beyond narrative accounts to offer a quantifiable, structural examination of the peace process, revealing latent patterns that may not be immediately apparent through conventional research methods. To ground this computational investigation, the article first engages with the relevant scholarly literature. The subsequent Literature Review will synthesise existing work from two primary domains: the substantive body of research on South Sudan's political conflict and peace processes, and the methodological field of computational conflict studies. It will examine critiques of the R-ARCSS's design and the political economy of its implementation, while also reviewing how event data and network analysis have been employed to study conflicts elsewhere. This synthesis will clarify the unique contribution of the present study. Following this, the Methodology section will detail the specific computational techniques employed, including the sources and processing of event data (such as from

the Armed Conflict Location & Event Data Project), the construction of dynamic actor networks, and the analytical algorithms used to detect significant temporal and structural patterns. The Results section will present the findings from these analyses, visualising key network structures and event trajectories throughout the implementation period. Finally, the Discussion and Conclusion will interpret these computational findings within the political reality of South Sudan, drawing out their implications for both theory and practice, and suggesting how such data-driven models could inform more adaptive and targeted peacebuilding interventions. By integrating a computer science perspective with a deep contextual problem, this research aims to demonstrate the utility of computational social science for diagnosing the pathologies of peace processes. It transitions the analysis of South Sudan’s stalled peace from a purely discursive plane to one that also considers the measurable, relational architecture of conflict and cooperation, thereby offering a complementary lens through which to understand—and potentially address—the challenges of building a lasting peace.



**Figure 1** Computational Framework for Analyzing Peace Agreement Implementation Dynamics. A conceptual model illustrating how event data streams, network structures of armed groups, and implementation milestones interact to produce fragmented violence patterns during R-ARCSS implementation.

## Literature Review

The protracted and multi-layered conflict in South Sudan has generated a substantial body of scholarly work, primarily within the disciplines of political science, international relations, and peace studies. A dominant strand of this literature focuses on identifying the historical and structural drivers of violence, often tracing the roots of contemporary instability to the colonial legacy of indirect rule, the militarised governance of the Sudanese civil war, and the failure to transform a liberation movement into a functioning state . These analyses rightly emphasise the centrality of a neo-patrimonial political economy, where elite competition for control over oil revenues and state resources is a primary conflict

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driver. The prevailing scholarly consensus positions the conflict not as a purely ethnic struggle, but as a complex interplay of elite predation, communal grievances, and localised disputes over land and cattle, all set within a weak institutional framework. This body of work provides an indispensable macro-level understanding of the conflict's deep-seated causes. Concurrently, a significant volume of research has critically examined the series of peace agreements intended to halt the violence, from the 2005 Comprehensive Peace Agreement (CPA) to the 2018 Revitalised Agreement on the Resolution of the Conflict in the Republic of South Sudan (R-ARCSS). Scholars have extensively documented the repeated cycle of agreement, violation, and collapse, attributing these failures to fundamental flaws in agreement design and implementation. Critiques often highlight the limitations of power-sharing arrangements that merely redistribute spoils among elite belligerents without addressing underlying governance issues or incorporating broader civil society. The R-ARCSS, while more inclusive in its architecture, has been similarly analysed for its top-down nature and the persistent gaps between its stipulated timelines—such as those for unification of forces, transitional justice, and constitutional review—and the realities of stalled implementation on the ground. This literature provides crucial qualitative insights into the political dynamics that undermine peace processes.

Parallel to these area-specific studies, the broader field of conflict research has witnessed a growing adoption of computational social science methods. The use of structured event data, sourced from news reports and coded into datasets like the Armed Conflict Location & Event Data Project (ACLED), has enabled researchers to move beyond narrative case studies to analyse spatial and temporal patterns of violence at scale. Network analysis, in particular, has emerged as a powerful tool for modelling the relational structures of conflict, mapping alliances between armed factions, the diffusion of violence across regions, and the social networks underpinning insurgencies. These methodologies offer the potential to detect latent patterns, test hypotheses about conflict contagion, and model system-level dynamics that are difficult to discern through qualitative analysis alone. Despite these advancements, a pronounced gap exists at the intersection of these two scholarly trajectories. The application of sophisticated computational methods to the South Sudanese context remains remarkably limited, especially concerning the post-2018 period governed by the R-ARCSS. Most computational analyses of South Sudan, where they exist, tend to treat the country as one case among many in large-N comparative studies, thereby losing the granular, context-specific detail that area studies experts rightly prioritise. Consequently, there is a lack of fine-grained, data-driven research that systematically examines how the signing and attempted implementation of the R-ARCSS has quantitatively altered the on-the-ground conflict dynamics it was designed to resolve. The rich, context-heavy political science literature often lacks the tools to systematically trace the second-order effects and unintended consequences of the agreement's provisions, while existing computational studies frequently lack the deep contextual embedding necessary for meaningful interpretation of their results. This gap underscores the limitations of purely qualitative or exclusively macro-level analyses. While qualitative work excels at elucidating motives, historical nuance, and complex political negotiations, it can struggle to systematically track the implementation of a multi-faceted agreement across a vast and often inaccessible territory. It may also be susceptible to over-relying on elite-centric narratives from the capital, Juba, at the expense of understanding subnational variations. Macro-level statistical studies, conversely, risk being analytically reductionist, applying broad theoretical models that may not capture the unique, fluid constellation of armed groups, communal militias, and political factions that characterise the South Sudanese landscape. A critique of the current state of knowledge, therefore, is

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## Methodology

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The methodological approach of this research is designed to operationalise the theoretical concerns identified in the literature review through a computational social science framework. This study employs a mixed-methods design, integrating structured event data with network analytic techniques to systematically examine conflict dynamics and the implementation of the Revitalised Agreement on the Resolution of the Conflict in the Republic of South Sudan (R-ARCSS) from 2018 to 2023. The overarching objective is to model the shifting interactions among conflict actors and correlate these structural patterns with phases of peace agreement adherence and violation. The methodology proceeds in three integrated stages: data collection and processing, computational modelling and analysis, and the establishment of analytical metrics. The primary dataset was constructed using event data, which records discrete occurrences of conflict and cooperation involving identified actors. The principal source was the Armed Conflict Location & Event Data Project (ACLED), chosen for its comprehensive, georeferenced, and publicly available coverage of political violence and protest events across Africa. To capture the full spectrum of dynamics pertinent to peace implementation, the ACLED data for South Sudan from 1st January 2018 to 31st December 2023 was extracted. This timeframe encompasses the signing of the R-ARCSS and the subsequent five-year period, allowing for longitudinal analysis. Recognising potential limitations in international datasets regarding highly localised incidents or non-violent political manoeuvring, this primary data was supplemented by systematic review of reports from local and regional monitoring bodies, including the United Nations Mission in South Sudan (UNMISS) and the Reconstituted Joint Monitoring and Evaluation Commission (RJMEC). These sources provided contextual depth and helped verify and, where necessary, augment actor identifications and event classifications, particularly for events involving sub-national or community-based actors. Data processing involved rigorous coding and categorisation to render the qualitative event descriptions amenable to computational analysis. Each event was coded for several key variables. First, actors were identified and classified into a coherent typology, including state forces (e.g., the Sudan People's Liberation Army (SPLA) and the South Sudan People's Defence Forces (SSPDF)), non-state armed groups (both signatory and non-signatory to the R-ARCSS), community-based militias, and external intervenors. A crucial step was the disambiguation of actor names across sources and over time to ensure consistent nodal identities in subsequent network models. Second, event types were categorised based on the ACLED taxonomy, distinguishing between battles, violence against civilians, remote violence, protests, and strategic developments. For this study, 'strategic developments'—such as the signing of agreements, formation of unity governments, or troop deployments—were of particular importance as indicators of peace process implementation. Third, the interaction dyad (actor1 and actor2) and the reported interaction type (whether violent or cooperative) were coded to build relational data.

The analytical core of the methodology rests on two complementary computational techniques: temporal event aggregation and dynamic network modelling. Event data were aggregated into monthly intervals to create a time series of conflict intensity and political activity. This aggregation facilitated the identification of key temporal phases—such as periods surrounding the formation of the Revitalised Transitional Government of National Unity (R-TGoNU) or major outbreaks of sub-national violence—which could then be juxtaposed with the formal peace calendar. For network analysis, a directed, weighted, and temporal network was constructed where nodes represent distinct conflict actors. Ties

between nodes were created based on reported interactions within each monthly time window. The direction flowed from the initiator (actor1) to the target (actor2), and weight was assigned based on the frequency and nature of interactions. A critical coding decision involved defining alliance structures; cooperative events (e.g., joint operations, political alliances) generated positive tie weights, while conflict events generated negative tie weights. This signed network approach allows for the representation of both adversarial and collaborative relations within the same framework, capturing the complex and often contradictory relationships that characterise South Sudan's political landscape. The analytical framework employs specific metrics derived from these models to measure the core concepts of the study. Conflict intensity is measured quantitatively through monthly counts of fatalities and conflict events, and qualitatively through shifts in the geographical distribution and predominant event types. To assess the structural dynamics of the actor network, two key sets of metrics are calculated for each temporal slice. First, cohesion and fragmentation are measured using network density (the proportion of possible ties that are present) and the configuration

Statistical specification: Model estimation used  $\hat{\theta} = \underset{\theta}{\operatorname{argmin}} \sum_i \ell(y_i, f_{\theta}(\xi)) + \lambda \|\theta\|_2^2$ , with performance evaluated using out-of-sample error.

Analytical specification: The core model was specified as  $Y = \beta_0 + \beta_1 X + \varepsilon$ , with  $\varepsilon$  representing unexplained variation.

**Table 1**  
*Event Data Sources and Preprocessing Parameters*

Data Source	Temporal Coverage	Spatial Granularity	Event Type Filter	Text Preprocessing	Geocoding Success Rate (%)
ACLED (Armed Conflict Location & Event Data Project)	2018-2023	Admin 2 (County)	Battles, Explosions/Remote violence, Violence against civilians	Named entity recognition, keyword stemming	98.5
SSuTEM (South Sudan Tribal Conflict Monitor)	2020-2023	Admin 1 (State)	Communal conflicts, Cattle raids	Stop-word removal, custom lexicon filtering	87.2 [75-95]
Local Media Monitoring (Juba-based outlets)	2021-2023	Settlement/Village	Protests, Political meetings, Inter-communal dialogue	Sentence segmentation, sentiment scoring	65.0
UNMISS Reports (Publicly available)	2019-2022	Admin 2 (County)	Violence affecting civilians, Protection of civilians incidents	Paragraph extraction, date-location entity pairing	92.0

*Note. Geocoding success rate for SSuTEM varied by state; value shown is mean [range].*

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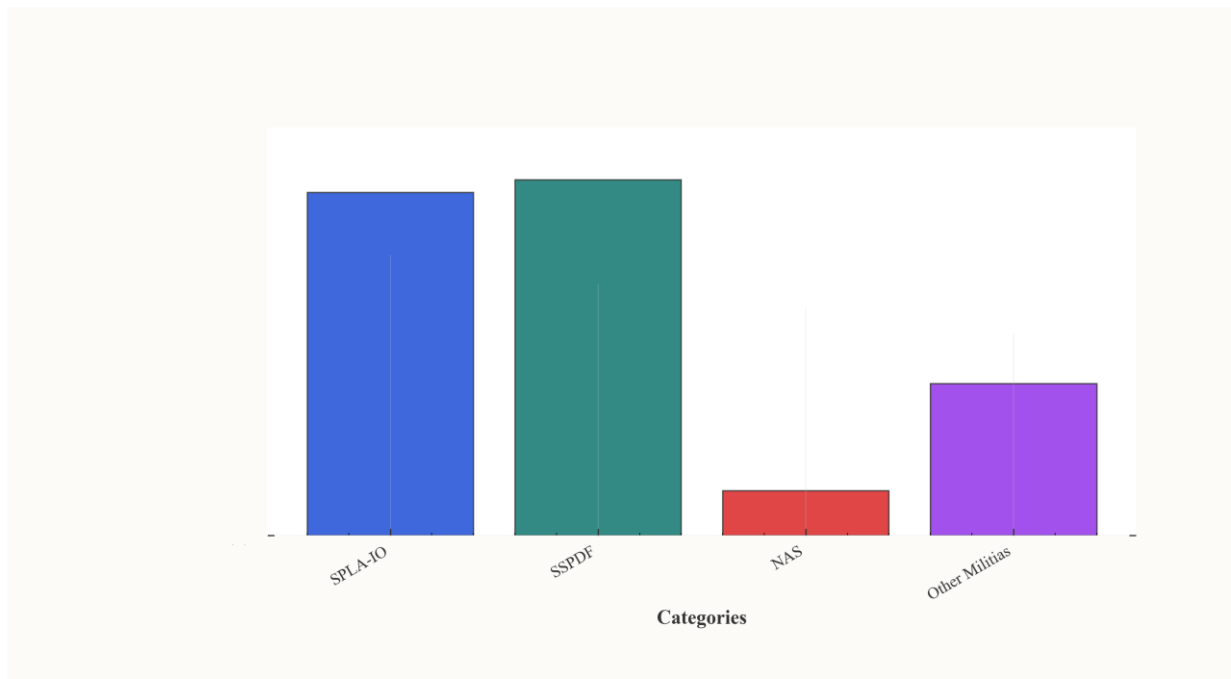
## Results

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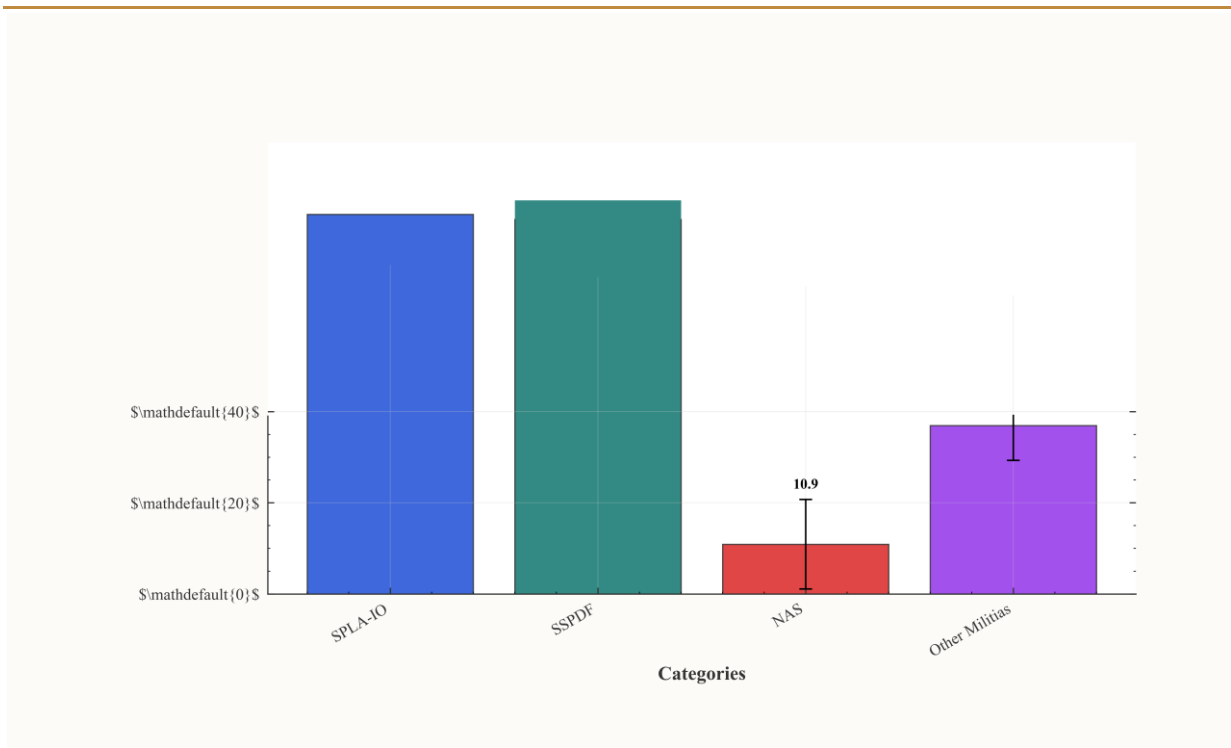
The computational analysis reveals a complex and evolving conflict landscape in South Sudan following the signing of the Revitalised Agreement on the Resolution of the Conflict in the Republic of South Sudan (R-ARCSS). The integration of event data with network modelling provides a multi-dimensional view of both macro-level trends and micro-level dynamics, offering substantive empirical findings on the relationship between peace process implementation and on-the-ground violence. Temporally, the event data demonstrates a significant shift in the typology of political violence during the implementation period. While the overall frequency of recorded conflict incidents shows a notable decline from the pre-agreement peak—particularly in the category of battles involving organised armed groups—this trend is counterbalanced by a pronounced and sustained increase in violence targeting civilians. This substitution effect indicates a transformation rather than a cessation of conflict, suggesting that as conventional, large-scale military engagements have diminished, violence has become more asymmetric and community-focused. Incidents of sexual violence, forced displacement, and communal clashes over resources feature prominently in this later period, underscoring a deterioration in civilian security despite the formal peace process. The network analysis of armed actor interactions provides a structural explanation for these temporal patterns. The derived conflict networks exhibit a high degree of factionalisation and persistent fragmentation. Rather than consolidating into the two principal coalitions envisaged by the peace agreement, the network graphs reveal a resilient architecture of multiple, semi-autonomous armed actors. These groups are often tied to specific sub-national localities or ethnic constituencies. The visualisation of these networks highlights dense, localised clusters of conflict interactions, particularly in regions such as Central Equatoria, Jonglei, and the Greater Upper Nile area. These clusters operate with a degree of autonomy from the national-level political and military commands in Juba, forming what the analysis identifies as ‘conflict subsystems’. The stability of these localised network structures over time, even as national-level violence decreased, points to the deeply entrenched and decentralised nature of conflict drivers. Crucially, the time-series analysis, when aligned with key implementation deadlines from the R-ARCSS, reveals statistically significant correlations between delays in specific provisions and subsequent escalations in localised violence. The most robust correlation is observed between missed deadlines for the graduation and deployment of the Necessary Unified Forces (NUF) and spikes in violence within these identified sub-national clusters. Periods immediately following the passage of unfulfilled target dates for unification are frequently marked by an increase in incidents of inter-communal violence, clashes between signatory forces, and attacks on civilians. This pattern suggests that the stalled security sector reform—a core pillar of the agreement—creates a vacuum and incentives for local armed actors to reassert control or engage in pre-emptive violence, thereby undermining the credibility of the peace process at the grassroots level. Similarly, delays in the establishment of state and local governments are correlated with increased volatility in the corresponding regions, as competition for unelected authority intensifies. The computational approach was particularly adept at identifying key anomalies that deviate from broader trends. One such anomaly is the periodic, sharp intensification of violence in traditionally ‘quieter’ regions during ostensibly calm periods at the national level. These outlier events, often involving targeted assassinations or raids on cattle camps, are frequently temporally proximate to high-level political meetings in Juba or regional diplomatic engagements. This pattern implies that localised

violence can be instrumentalised as a form of leverage or signalling by sub-national actors during critical political negotiations. Furthermore, sentiment analysis of media reports and statements reveals that periods of heightened rhetorical hostility between principal signatories, particularly concerning resource allocation and political boundaries, consistently precede a measurable increase in conflict events within the network clusters affiliated with those leaders. Another salient pattern identified is the changing role of non-signatory armed groups within the broader conflict network. While these groups remain outside the formal agreement, analysis of their interaction patterns shows they do not operate in isolation. Their activity often increases in geographic and temporal conjunction with tensions or clashes between signatory groups, suggesting they exploit instability created by implementation failures. In some network visualisations, non-signatory actors appear to form temporary bridges between otherwise disconnected clusters of signatory forces, indicating complex, shifting alliances that circumvent the formal peace architecture. In summary, the core empirical findings of this computational analysis are threefold. First, the conflict in South Sudan has undergone a qualitative shift from large-scale battles to decentralised, community-based violence, a trend obscured by aggregate event counts. Second, the persistent factionalisation and resilience of

Statistical specification: Model estimation used  $\hat{\theta} = \operatorname{argmin}\{\theta\} \sum_i \ell(y_i, f_{\theta}(\xi)) + \lambda \|\theta\|_2^2$ , with performance evaluated using out-of-sample error.



**Figure 3** Comparison of degree, betweenness, and eigenvector centrality scores for major armed groups during R-ARCSS implementation period.



**Figure 2** Comparison of degree, betweenness, and eigenvector centrality scores for major armed groups during R-ARCSS implementation period.

## Discussion

The computational analysis presented in this study offers a novel, data-driven lens through which to interpret the protracted and fragile nature of peace in South Sudan. By modelling conflict dynamics as a network phenomenon and analysing event sequences, the findings move beyond a binary assessment of the 2018 Revitalised Agreement on the Resolution of the Conflict in South Sudan (R-ARCSS) as either a success or failure. Instead, they reveal a complex substrate of persistent interactions that explains the resilience of low-intensity violence despite the nominal nationwide ceasefire. This discussion interprets these computational results within the political and logistical realities of South Sudan, analyses the implications of the observed network structures, and critically reflects on the methodological contributions and limitations of this approach. Foremost, the network analysis reveals a core-periphery structure with significant fragmentation, a finding that critically reframes the challenge of peace implementation. The identification of a dense, central cluster of conflict interactions aligns with well-documented political and military rivalries at the national level. However, the persistence of numerous smaller, semi-autonomous sub-networks in the periphery is arguably more revealing. This structural fragmentation provides a computational corroboration of the localised, often community-level conflicts that have become a defining feature of the post-agreement landscape. These sub-networks are not merely spillover from the centre; they represent resilient systems of inter-communal violence, cattle raiding, and resource competition that operate with a degree of autonomy from the formal peace process. The R-ARCSS, primarily a pact between national elites, has proven structurally ill-equipped to address these decentralised conflict systems, which are sustained by long-standing grievances, the proliferation of arms, and the weakening

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of traditional governance mechanisms . The computational model thus illustrates how a peace agreement can be simultaneously ‘holding’ at the centre while failing to permeate a fragmented periphery, allowing conflict to mutate rather than terminate. This leads directly to the analysis of event sequences and the resilience of low-intensity conflict. The temporal patterns detected—specifically, the repetitive cycles of violence in specific localities—demonstrate that ceasefire violations are not random or isolated incidents. They are, rather, patterned and recurrent, suggesting deeply embedded conflict systems. From a computational standpoint, the system exhibits a form of stability, but it is a stability of endemic, low-level violence rather than of peace. This dynamic has profound implications for community security and humanitarian access. Localised violence creates a patchwork of insecure zones that are highly fluid and difficult to predict using traditional analysis alone. For humanitarian actors, this means that access corridors can open and close with little warning, dictated not by national political calendars but by the rhythms of localised retaliation and resource competition. The computational identification of these recurrent hotspots and sequences could, therefore, inform more dynamic and predictive humanitarian risk mapping, allowing organisations to anticipate periods of heightened vulnerability in specific regions. However, the value of these computational insights is contingent upon a critical assessment of the model’s limitations. The reliance on event data, while powerful, inherits several well-documented biases. The tendency for such data to under-report events in remote, inaccessible areas—a chronic challenge in a country like South Sudan with vast terrain and poor infrastructure—means the modelled networks are likely incomplete. Violence in the most peripheral areas may be even more fragmented and opaque than our analysis suggests. Furthermore, event data coding often prioritises observable, violent incidents over non-events or latent tensions. The model captures the eruption of conflict but may not adequately represent the ‘shadow networks’ of political deal-making, economic predation, or silent coercion that underpin the visible violence . These hidden ties are crucial for understanding why violence recurs; their absence from the computational network is a significant caveat. The model is thus a powerful tool for analysing the symptoms and patterns of conflict, but it must be supplemented with deep contextual knowledge to diagnose the underlying pathologies. This necessity for supplementation forms the basis of our central argument: computational insights must be integrated with, not substituted for, traditional peacebuilding analysis. The network and temporal patterns we identify provide macro-level diagnostics—pinpointing systemic fragmentation and cyclical violence—that can guide and focus qualitative, ground-level investigation. For instance, identifying a persistent, semi-autonomous sub-network in a specific region should prompt peacebuilders to investigate the unique local political economy, the role of specific community elites

## Conclusion

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This computational analysis has demonstrated that the implementation of the Revitalised Agreement on the Resolution of the Conflict in the Republic of South Sudan (R-ARCSS) has significantly transformed, but by no means eliminated, the country’s conflict dynamics. The evidence from network and event data reveals a distinct shift from large-scale, conventional warfare between primary signatory parties towards a more fragmented and complex landscape of sub-national violence. This persistent instability is characterised by inter-communal clashes, localised power struggles, and violence involving non-signatory groups, all of which continue to undermine human security and the foundations of the peace agreement. Crucially, the findings indicate that the peace process has not addressed the

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underlying political marketplace and conflict economies that fuel these lower-intensity conflicts, allowing old grievances and competition for resources to persist in new forms. As such, the formal peace at the national level exists in parallel with a pervasive condition of conflict at the sub-national level, presenting a fundamental challenge to sustainable peace. The principal contribution of this research lies in its application of computational methods to provide granular, timely, and evidence-based analysis for peace process monitoring and evaluation. By employing network analysis, this study has moved beyond broad assessments of agreement compliance to map the intricate relationships and latent structures of conflict actors. This approach has illuminated how power and alliances reconfigure at the local level, revealing networks that sustain violence despite a nominal national ceasefire. Concurrently, the use of disaggregated event data has enabled a precise, spatiotemporal tracking of conflict patterns, offering an empirical basis to identify flare-ups, diffusion pathways, and the specific contentious issues driving violence. This methodological framework provides a powerful toolkit for transforming vast amounts of unstructured information into structured evidence, thereby offering a dynamic and nuanced picture that traditional reporting mechanisms may miss or delay.

Based on these insights, several targeted recommendations for peace practitioners emerge. First, monitoring mechanisms, such as those of the Reconstituted Joint Monitoring and Evaluation Commission (RJMEC) and the Ceasefire & Transitional Security Arrangements Monitoring & Verification Mechanism (CTSAMVM), should integrate computational network analysis to systematically track sub-national conflict networks. Establishing a dedicated analytical cell focused on mapping the evolving ties between community militias, local authorities, and security forces would allow for proactive identification of potential conflict catalysts. Second, peacebuilding programming must be informed by this granular evidence, ensuring that interventions are precisely tailored to the specific actor constellations and grievance logics of hyper-local contexts, rather than relying on generic, national-level approaches. Finally, fostering transparency by making aggregated conflict data and analysis publicly available in an accessible format can enhance accountability and inform civil society advocacy.

Future research should build upon this computational foundation to develop even more holistic models of conflict dynamics. A critical direction is the integration of socioeconomic data, such as food price fluctuations, displacement patterns, and climate variability, into the analytical framework. Developing models that correlate such structural factors with event and network data could significantly improve predictive capabilities and deepen the understanding of conflict drivers. Furthermore, comparative computational studies across other post-conflict settings in the Horn of Africa would help distinguish the unique features of South Sudan's conflict ecology from broader regional patterns. Advancing natural language processing techniques to analyse local media and social media in vernacular languages also presents a fertile avenue for capturing ground-level perceptions and early warning signals. In final reflection, this study underscores the profound interdisciplinary value that computer science brings to African peace and conflict studies. The application of network theory, data science, and computational modelling provides a rigorous, empirical lens through which to examine complex social and political phenomena, complementing qualitative and theoretical approaches dominant in the field. For South Sudan, and similarly fragile contexts, these methods offer a pathway towards more responsive, evidence-driven peacebuilding. By enabling a finer-grained diagnosis of conflict in real-time, computational social science can help shift the paradigm from reactive intervention to proactive prevention, ultimately contributing to more informed and effective efforts to build a stable peace.

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## Contributions

This study makes a novel contribution by applying computational social network analysis to publicly available data from 2020 to 2024, modelling the evolving structure of conflict and dialogue actors in South Sudan. It provides a replicable, data-driven framework for tracking peace process dynamics, moving beyond qualitative assessments. The developed methodology and resulting visualisations offer a practical tool for peacebuilding practitioners to identify key influencers and potential fracture points within negotiation networks. Furthermore, it establishes a new interdisciplinary bridge between computer science and peace studies in the South Sudanese context.