Spatial-network modeling may offer new path to monitoring political hotspots

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A team of scientists say they have made improvements to an algorithm that might help officials predict movements among political groups during conflicts or potential conflicts. Credit: Unsplash/GeoJango Maps

An improvement to a computer model may help scientists better predict the future moves of political factions and locate where they might interact with other—often rival—groups, according to Penn State researchers. Predicting those moves could provide an early warning system for potential civil conflicts and violence, they added.

In a study of data from a civil conflict in Nigeria, the researchers report that adding a variable, called a dyadic predicted distance, to a statistical model could one day lead to more accurate predictions on the movement of political groups. Dyadic spatial distance refers to the location of two or more parties from each other, as opposed to monadic variable, which refers to the location of a single party and is used in most current models . To build that variable, the team also developed an algorithm that could project the locations of moving actors.

"Researchers have been interested in how we can forecast the movement of the actors in civil conflicts, as well as political conflicts, such as protest events or even more serious situations, such as lynchings and armed conflicts," said Sangyeon Kim, doctoral student in political science and social data analytics, Penn State. "However, there has not been a serious approach on prediction in terms of using both actors—or multiple actors—who are involved in the conflict, so our basic idea was to create a design that could help forecast the location of those actors."

Connecting spatial and network modeling

The study merges both spatial modeling—how people move in space—with network modeling—how people are connected to each other, according to Bruce Desmarais, the professor of political science and Institute for Computational and Data Sciences co-hire.

"Often, people do spatial research, or they do networks research, but we intentionally wanted to combine and integrate those methodological

toolkits in this project," said Desmarais. "I think that became the spark for our team was integrating spatial data and also relational network data, to pull those toolkits together to improve the field."

The researchers, who published their findings in the journal *Political Science Research and Methods*, hope that future work will improve the model. Predicting the movements of rival political factions could then lead to better ways to mediate conflict and allocate supply and aid, said Kim.

"One of the big questions is, "Where would we place aid on the country level, for example, or in the regional level?" said Kim. "That has been a really challenging topic for both academics and practitioners, so maybe using this this methodology could help them find better locations to place aid, for example."

Future research

The researchers said while this preliminary work on their new model only offered a negligible difference compared to a model that used the monadic prediction variable in their current example of application, they do see it as evidence that scientists could use the new model to one day accurately capture how multiple parties might move.

According to Kim, the team tested the variable on its ability to predict the movements of the Christian Militia during the civil conflict in Nigeria, a period of violence that stretched from 2001 to 2016. The data was drawn from media accounts on the militia's movements during the conflict, Kim added.

The use of that data may be one reason for the slim difference between the researchers' model and current ones that use the monadic variable.

"We believe this non-difference is largely due to the measurement level issue: it is very hard to trace the movement of armed groups longitudinally with a high level of accuracy," said Kim.

Future research may also look at alternative data for the model. In the study, the researchers relied on media reports that documented the movements of the political factions, however, most of the civil strife documented in that dataset happened before social media became better accessible.

"It is possible that we could use, for example, social media data," said Kim. "And, if we can show that the dyadic design also improves the predictions of events, that would be really interesting."

The researchers said the model focuses on four key aspects of the groups' location history: their average general location, their recent movements, locations where groups interact, and the number of events occurring in each location.

More information: Sangyeon Kim et al, Spatial modeling of dyadic geopolitical interactions between moving actors, *Political Science Research and Methods* (2022). DOI: 10.1017/psrm.2022.6

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