AT A GLANCE

Weather index insurance can help households recover from extreme weather events

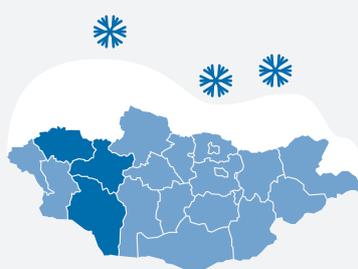**By Kati Kraehnert and Veronika Bertram-Huemmer**

- Study is one of the first to evaluate the effects of a globally recognized weather index insurance to help people cope with the consequences of extreme weather events

- Index insurance payouts are not based on the actual losses suffered; rather, they are triggered if an objective index (regional livestock mortality) exceeds a threshold

- Results show that the Index-Based Livestock Insurance in Mongolia has a clear positive effect on the economic recovery of households after an extreme winter

- Insured households have herds up to a third larger than uninsured households in the initial three years after an extremely cold and snowy winter

- Index insurance can prevent extreme weather events from causing poverty

Herding households in Mongolia which took out a weather index insurance policy have herds almost a third larger than uninsured households two years after an extreme winter


Index insurances do not compensate policy holders based on the actual losses suffered. Instead, an insurance payout is triggered when a predefined value (in this case, for regional livestock mortality) is exceeded. Advantages include lower costs because individual damage assessment is unnecessary.

If an extreme weather event occurs—such as extremely cold and snowy winters in Mongolia—insured households receive an insurance payout.

31 %
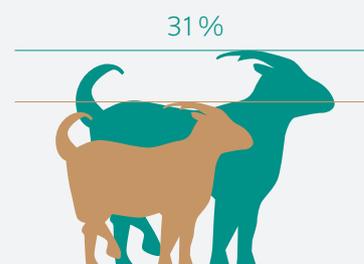
The results show that insured households in Mongolia recover faster from the losses suffered. Two years after the extreme winter they have 31 percent more animals than uninsured households.

Source: Authors' own depiction.

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FROM THE AUTHORS

Households with a weather index insurance policy recover more quickly from extreme weather events, as the example of Mongolia shows. Insurance companies and politicians should take this opportunity to raise awareness of and promote index insurance.

— Kati Kraehnert, study author —

DATA

Between 2012 and 2015, **1,768 households** in western Mongolia were surveyed three times each for this project.

Weather index insurance can help households recover from extreme weather events

By Kati Kraehnert and Veronika Bertram-Huemmer

ABSTRACT

Weather index insurance is considered a promising international climate policy instrument that can help households adapt better to climate change. This is especially true in developing countries where households often suffer severely from the consequences of extreme weather events. This report is one of the first to evaluate the impact of a globally recognized index insurance, Mongolia's Index-Based Livestock Insurance (IBLI). The empirical study is based on econometric methods and uses data from a survey of almost 1,800 households. It shows that index insurance has a clear positive effect on households: in the first three years after an extremely cold and snowy winter, insured Mongolian households are significantly better off than uninsured households in terms of their livestock, which is the key indicator of income and wealth in this context. Two years after the disaster, their herds were almost a third larger than those of uninsured households. In many places, index insurance could be a suitable measure to prevent poverty after extreme weather events.

Climate change is one of the greatest challenges of our time.[1] As a result of climate change, extreme weather events such as storms, heat waves, and heavy rainfall occur more frequently and with greater intensity.[2] Households in developing countries are affected in particular: a large part of the population in these countries is directly or indirectly dependent on agriculture and thus the weather, while the governments there often lack the financial and technical resources to manage climate risks.[3] Accordingly, most households in developing countries must cope with the damages caused by extreme weather events themselves. They face the threat of a vicious cycle of extreme weather events, poverty, and underdevelopment.

Against this background, there is a great need for policy instruments to help households in developing countries to adapt to climate change and reduce their vulnerability to extreme weather events. The Paris Agreement, which was agreed upon at the 2015 United Nations Climate Change Conference (COP 21), set the goal of helping developing countries adapt to climate change, which has become a key goal of Germany's development cooperation as well.[4] Index insurance is an instrument with currently high expectations.[5] During the 2017 United Nations Climate Change Conference (COP23) in Bonn, the Global Partnership InsuResilience was launched under the German G20 presidency, a global partnership which promotes index-based disaster financing

solutions.[6]So far, there are hardly any methodologically robust findings on whether or not weather index insurance achieves the desired goal of increasing household resilience to weather risks. There are two reasons for this knowledge gap: first, there are only a few household surveys in developing countries that would be suitable for evaluating the impact of an index insurance. Second, index insurance is a relatively new instrument. In most of the regions where such insurance has been offered, there have not (yet) been any extreme weather events which would have triggered an insurance payout and thus made an assessment possible.[7]

This report presents the results of a quantitative impact assessment of an index insurance which is highly regarded globally: the Mongolian Index-Based Livestock Insurance (IBLI).[8]

Weather index insurance a highly promising tool for adapting to climate change

Weather index insurance was first tested in the 2000s as a pilot project in developing countries.[9] Unlike traditional insurance products, the actual losses suffered by an insured household do not determine the insurance payouts of index insurances. Instead, insured households receive insurance payouts whenever an index measured at an aggregated level—such as temperatures, precipitation, or wind speeds—exceeds or falls short of a predefined threshold. Ideally, the index correlates strongly with the weather-related losses suffered by the insured household. The insurance payout should help insured households recover from damages after an extreme weather event.
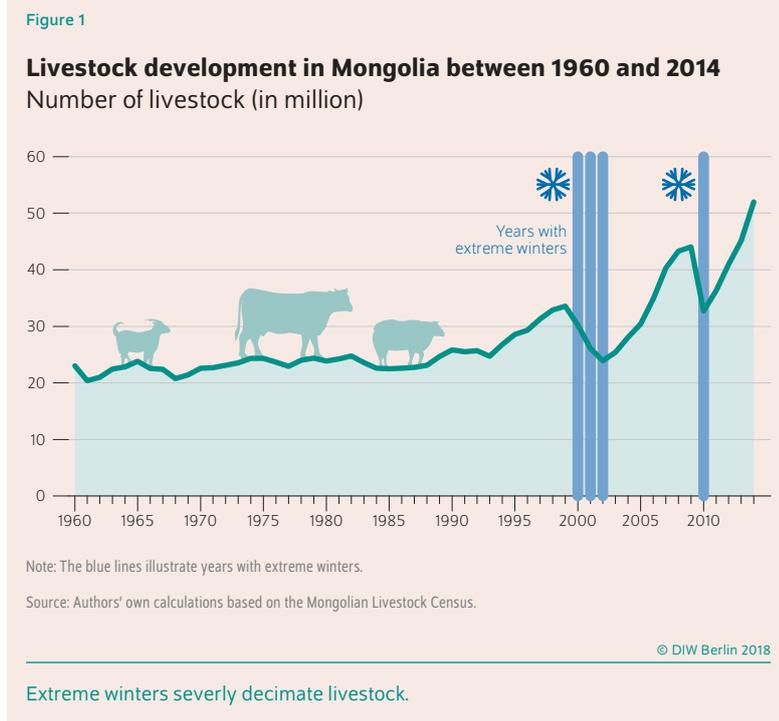
Weather index insurance has several advantages over traditional insurance, which explains why its potential is a current topic of political discussion. The first advantage is that the problem of adverse selection is minimized: because the actual losses suffered by insured households do not determine the insurance payouts, it is not only primarily households with an increased risk from the outset which acquire an insurance policy. Second, the moral hazard problem is avoided: insured households have no incentive to behave in a more risk-averse manner after taking out the insurance policy and to accept losses, as the index alone determines the insurance payout. Finally, because the losses suffered do not have to be proven, transaction costs are significantly

Figure 1

Livestock development in Mongolia between 1960 and 2014
Number of livestock (in million)

Note: The blue lines illustrate years with extreme winters.

Source: Authors' own calculations based on the Mongolian Livestock Census.

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Extreme winters severely decimate livestock.

lower for index insurance compared to traditional loss-based insurance.

Harsh winters lead to significant losses in Mongolia

The focus of the present study is on Mongolia, a country which, similar to many other developing countries and transition economies, is often affected by extreme weather events. In Mongolia, extreme weather events take the form of extremely cold and snowy winters.[10] The consequence of an unusually harsh winter is high livestock mortality. This threatens the livelihood of the rural households which depend primarily on their livestock consisting of sheep, goats, horses, cows, or camels.

Extreme winters decimated livestock drastically nationwide in 1999/2000, 2000/2001, 2001/2002, and 2009/2010 (Figure 1). In the winter of 2009/2010, the highest livestock mortality rate in the past 50 years was recorded: more than ten million animals died nationwide, which corresponds to over 23 percent of Mongolia's livestock. As a result, many rural households no longer had a herd large enough to make a living. This was followed by a mass exodus of impoverished herders to provincial centers and the capital, Ulaanbaatar, where the wage labor sector is poorly developed and poverty is rising rapidly.[11]

6   Cf. Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung, *InsuResilience Global Partnership: Eine globale Partnerschaft im Rahmen der G20 und der V20* (in German; available online).

7   Two exceptions are the studies from Sarah A. Janzen and Michael R. Carter, "After the Drought: The Impact of Microinsurance on Consumption Smoothing and Asset Protection." NBER Working Paper Series 19702, 2013; and Nathaniel D. Jensen, Christopher B. Barrett, and Andrew G. Mude, "Cash transfers and index insurance: A comparative impact analysis from northern Kenya," *Journal of Development Economics* 129, no. 1 (2017): 14–28.

8   Veronika Bertram-Huemmer and Kati Kraehnert, "Does Index Insurance Help Households Recover from Disaster? Evidence from IBLI Mongolia," *American Journal of Agricultural Economics* 100, no. 1 (2018): 145–171.

9   Cf. Jerry R. Skees and Barry J. Barnett, "Enhancing microfinance using index-based risk-transfer products," *Agricultural Finance Review* 66, no. 2 (2006): 235–250; Barry J. Barnett and Olivier Mahul, "Weather Index Insurance for Agriculture and Rural Areas in Lower-Income Countries," *American Journal of Agricultural Economics* 89, no. 5 (2007): 1241–1247; Barry J. Barnett, Christopher B. Barrett, and Jerry R. Skees, "Poverty Traps and Index-Based Risk Transfer Products," *World Development* 36, no. 10 (2008): 1766–1785.

10   There are additional climate factors causing extreme weather events in central Asia, including relatively snowless and thus very dry winters which can also lead to livestock death.

11   Troy Sternberg, "Unravelling Mongolia's Extreme Winter Disaster of 2010," *Nomadic Peoples* 14, no. 1 (2010): 72–86.

The Mongolian Index-Based Livestock Insurance (IBLI)

The Index-Based Livestock Insurance (IBLI) was introduced as a pilot project in three Mongolian provinces in 2006. Demand for IBLI policies quickly rose to over 20 percent and consequently, IBLI was expanded nationwide. IBLI insurance policies have been available in all 329 Mongolian districts since 2012. Policies are currently distributed by six different commercial insurance companies in Mongolia.

Every household decides if it wants to purchase an IBLI policy or not. Households take out IBLI insurance for one year at a time. Policies are sold between April and June every year when neither households nor insurance companies can estimate the intensity of the coming winter. The policy covers the risk of livestock loss in the months of December to June of the following year. If an extreme weather event occurs, insured households receive insurance payouts beginning in August of the following year. Households can purchase IBLI insurance protection for one or more of the five most common animals in Mongolia: sheep, goats, cows, horses, and camels. Furthermore, each household decides the insurance value for each species, which can be between one and 100 percent of the animal's market value. On average they are underinsured, as Mongolian households hedge 30 percent of the market value of their herds.[1] The IBLI premium reflects the local risk of loss and varies depending on the species and district.

The index used is the livestock mortality rate per district and species. The data used to calculate the index is the Mongolian livestock census, which has been conducted annually every December since the 1950s as well as another survey of livestock losses carried out annually every June by the National Statistical Office of Mongolia. Insured households receive an IBLI payout when the loss of a certain livestock species in their district exceeds six percent.[2] In the event of an insurance payout, the amount is based on the actual livestock mortality rate calculated for the respective district. Local banks handle both the premium payment and transferring the insurance payout in the event of an extreme weather event.

In 2009, 21.4 percent of the households in the sample used in this report purchased an IBLI policy. On average, these households insured 102 animals and paid a premium of around 14 euros. The extreme winter of 2009/2010 resulted in a livestock mortality rate exceeding the triggering threshold of six percent in all districts of the survey region. As a result, all sample households that purchased an IBLI policy in 2009 received an insurance payout in 2010. The payout was 232 euros on average.

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1 Project Implementation Unit, *Index Based Livestock Insurance Project Implementation Report 2005–2012* (2012).

2 In some districts, a livestock mortality rate of five percent is the threshold that triggers the IBLI payout.

After Mongolia had been affected by extreme winters for three consecutive years between 1999 and 2002, there was a large need for political instruments which can better support rural households in the event of winter extremes and prevent migration to the cities. On behalf of the Mongolian government, the World Bank developed the Index-Based Livestock Insurance (Box).

New household panel data enable quantitative impact assessment

The data used for the impact assessment of weather index insurance is a household panel survey collected in Mongolia, the *Coping with Shocks in Mongolia Household Panel Survey,* which was conducted together with the National Statistical Office of Mongolia. Altogether, 1,768 households in western Mongolia were surveyed three times between 2012 and 2015. Each household was interviewed a second and third time exactly 12 and 24 months after the first interview. The sample is representative of the rural and urban populations in three provinces, Uvs, Zavkhan, and Govi-Altai (Figure 2). Only sample herding households were used for the impact evaluation presented here.

The household survey covers, among other things, the demographic characteristics of all household members as well as information on assets, income, IBLI policy, and the losses suffered during the extreme winter of 2009/2010. Detailed herd information was gathered: for each household, the survey recorded the herd size at the time of the three survey waves (2012, 2013, and 2014). Additionally, the households reported retrospectively on their herd size in 2011 (shortly after the extreme winter), in 2009 (before the extreme winter), and the extent of their livestock losses in 2010. To check the reliability of the retrospective livestock data, each household was asked for their herd size in 2009 and the losses in the following year twice, in the first and third survey waves. The correlation of the data was 79 and 83 percent; thus, the retrospectively surveyed livestock numbers appear to be very reliable.

Study design takes into account that IBLI is purchased voluntarily

The key question of the study is if weather index insurance helped households recover more quickly from livestock losses caused by the extreme winter of 2009/2010. The analysis investigates whether households that bought an IBLI policy before the extreme winter and received an insurance payout in 2010 had a larger herd in the years after the extreme winter than households that did not purchase an IBLI policy in 2009 and consequently received no payment. A fundamental

Table 1

Comparison of characteristics across insured and uninsured households

	Average		Significance level of the difference
	Insured households (purchased IBLI in 2009)	Uninsured households (did not purchase IBLI in 2009)	
Household head characteristics			
Share without education (percent)	10	13	
Share with primary education (percent)	56	58	
Share with secondary education (percent)	34	29	
Age (years)	45.08	44.64	
Risk preference (0=risk averse; 10=risk loving)	2.59	4.40	***
Household characteristics			
Number of livestock in 2009	349.15	308.01	
Share of goats in herd in 2009 (percent)	33	38	
Number of livestock lost in 2010	130.07	141.36	
Subjective welfare in 2009 (0=amongst the poorest; 10=amongst the richest)	6.10	5.72	*
Share of households living in rural areas (percent)	81	67	**
Sub-district characteristics			
Livestock mortality in 2010 (percent)	31	37	***
District characteristics			
Share of households living in mountain steppe (percent)	20	26	
Share of households living in forest steppe (percent)	15	13	
Share of households living in grass steppe (percent)	27	28	
Share of households living in desert steppe or desert (percent)	37	32	
Cellphone coverage (1=in few areas; 4=in all areas)	2.58	2.75	
Number of transport options to provinical center	1.41	1.53	
Observations	59	608	

Note: significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Sources: Coping with Shocks in Mongolia Household Panel Survey and Mongolia Livestock Census.

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problem of casual analysis must first be addressed to answer this question—namely the fact that only one of the two states can be observed for each sample household: for insured households, only the herd size after the IBLI payout is known, and for uninsured households, only the herd size without receiving an insurance payout.

A further methodological challenge of the impact assessment is that households voluntarily decide to purchase an IBLI policy. Households which purchased an insurance policy in 2009 differ in other respects from uninsured households: for example, insured households are significantly less willing to take risks as uninsured households, they estimated their subjective wealth to be significantly higher in 2009, and they were significantly more likely to live in rural areas and in a sub-district with significantly lower livestock mortality in 2010 (Table 1). In other important features, however, insured and uninsured households do not differ significantly. In particular, there is no significant difference in regards to livestock numbers before and livestock loss during the winter catastrophe: households in both groups had a similarly large number of animals on average before the extreme winter (349 and 308 animals) and suffered similar high livestock losses (130 and 141 animals).[12]

A quasi-experimental econometric regression method—the bias-corrected matching estimator[13]—was employed to determine the causal effect of IBLI payouts on households in order to construct a counterfactual situation. This makes it possible to take into account the fact that insured and uninsured households differ in observable characteristics. The matching estimator relies on the assumption that the two household groups do not differ in unobservable characteristics.[14] A whole series of characteristics serve as control variables (Table 1).

Insured households recover more quickly from losses

The results of the regression analysis show that IBLI helps insured households recover more quickly from losses caused by extreme winters. Insured households which received an IBLI payout in 2010 had a significantly larger herd than uninsured households with comparable socioeconomic characteristics one year, two years, and three years after the extreme winter (Figure 3). The effect of the IBLI payouts is greatest two years after the winter disaster. At that time, insured

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12 Herd size information throughout this article refers to the total number of animals in a household, with the five common species being considered equal, as is usual in Mongolia.
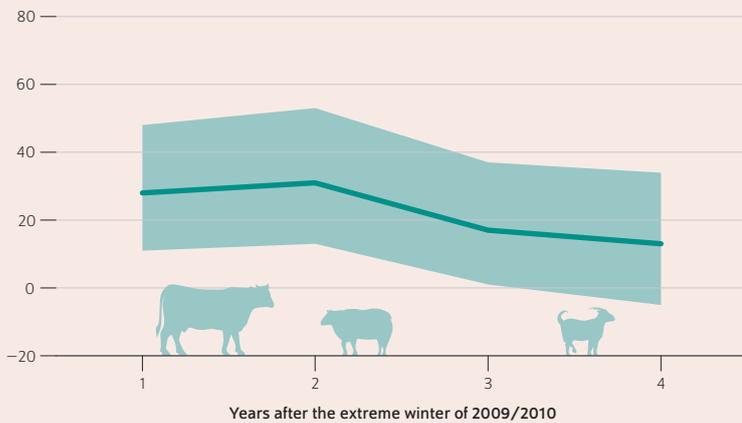
13 Alberto Abadie and Guido W. Imbens, "Bias-Corrected Matching Estimators for Average Treatment Effects," *Journal of Business & Economic Statistics* 29, no. 1 (2011): 1–11.

14 For technical details on the estimation procedure and other estimator assumptions, see Bertram-Huemmer and Kraehnert, "Does Index Insurance Help Households Recover from Disaster?".

Figure 2

Impact of IBLI payouts on the difference in herd size between insured and uninsured households after the extreme winter in 2009/2010
In percent

Sources: Coping with Shocks in Mongolia Household Panel Survey and Mongolia Livestock Census.

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Two years after the extreme winter, insured households own 31 percent more livestock than comparable uninsured households.

To determine which mechanisms of the IBLI payout benefit the insured households, the coping strategies used by households during and immediately after the winter catastrophe are analyzed. A section of the survey asks households to report retrospectively if they used any of the following five coping strategies:

- Borrowing money
- Selling livestock
- Moving livestock during harsh winters
- Organizing additional labor for herding
- Building shelter or fences for livestock

The same bias-corrected matching estimator and control variables were used to make insured and uninsured households comparable in observable characteristics. Nevertheless, in contrast to previous estimates, these results should not necessarily be interpreted causally, since, for example, other factors that could not be taken into account here play a role.

The regression results show that insured households were significantly more likely to borrow money during or immediately after the extreme winter of 2009/2010 than comparable uninsured households (Table 2). This effect is not only statistically significant, but also large. A further empirical observation fits in with this result: in 2012, households which had purchased an IBLI policy in 2009 had a significantly higher amount of outstanding loans than households without an IBLI policy. A logical conclusion to be drawn from these results is that IBLI increases the credit worthiness of insured households and, as a result, facilitates their access to credit. The IBLI policy documents the amount and value of livestock owned by an insured household and can serve as collateral at any bank. In an economy where rural households often cannot prove ownership rights on paper, livestock insurance policies serve as proof of ownership in addition to the insurance coverage.

Insurance likely prevents households from selling livestock

A further result of the regression analysis is that insured households were significantly less likely to have sold animals during or immediately after the extreme weather of 2009/2010 than comparable uninsured households. Such emergency sales are especially unprofitable: when many households sell livestock weakened by an extreme winter, the market prices for livestock sink—and thus the profit for the household selling. Further descriptive statistics reach a similar conclusion: 73 percent of insured households in the household survey stated that they used the IBLI payout to purchase food and other consumer goods for the household. Thus, it appears that insurance payouts help households avoid further decimating their herd by selling or killing them in order to meet their basic needs. With regard to the three other coping strategies—moving livestock, additional labor, and building shelters—insured and uninsured households do not differ significantly.

households had herds larger than uninsured households by an average of 31 percent; this corresponds to around 40 animals. In the fourth year after the extreme weather event, the difference in herd sizes between insured and uninsured households is no longer statistically significant. Thus, the positive effect of an IBLI payout weakens over time.

Similar results are obtained when an alternative propensity score estimator or other control variables are used, or when the sample is reduced to households that match particularly well according to the matching method.[15] This emphasizes the robustness of the result.

Insurance likely works because it frees households from credit constraints

Initially it seems surprising that IBLI payouts have such a large economic effect on the herd sizes of insured households in the years following an extreme event; after all, insured households receive an average payment of only 232 euros. With this amount, households could have purchased 14 goats, ten sheep, two horses, or one camel at market prices in 2010.[16] The difference in herd sizes thus cannot be explained by insured households using their IBLI payouts to purchase new animals.

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15 For regression results as well as further tests, see Bertram-Huemmer and Kraehnert, "Does Index Insurance Help Households Recover from Disaster?".

16 National Statistical Office of Mongolia, *Mongolian Statistical Yearbook 2010* (2011).

Table 2

The impact of IBLI payouts on the households' coping strategies after the extreme winter in 2009/10

	Borrowed money	Sold livestock	Moved livestock during extreme winter	Organized additional labor for herding	Built fences or shelter for livestock
Insured households (purchased IBLI in 2009)	0.377***	−0.159***	−0.085	0.09	0.017
Average of uninsured households	0.286	0.175	0.376	0.207	0.1
Observations	667	667	667	667	667

Note: Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Sources: Coping with Shocks in Mongolia Household Panel Survey and Mongolia Livestock Census.

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Conclusion: weather index insurance can improve recovery from weather extremes

This study is one of the first to prove that weather index insurance can effectively mitigate the negative consequences of an extreme weather event. The example of an extremely cold and snowy winter in Mongolia shows that households with index insurance are significantly better off than uninsured households in terms of their livestock and thus their financial situation. Two years after the extreme weather event, their herds were almost a third larger than those of uninsured households.

The rarity with which extreme weather events occur—although they will occur more frequently in the future due to climate change—is one of the reasons demand for index insurances is relatively low worldwide.[17] The key result of the impact assessment—that payouts from weather index insurance have a positive and significant influence on households' economic recovery after an extreme weather event—can be used by policymakers and in the insurance sector as an opportunity to raise awareness of index-based financial solutions.

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17 Carter et al., *Index-based weather insurance for developing countries*.

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