DIW Weekly Report 40 2018

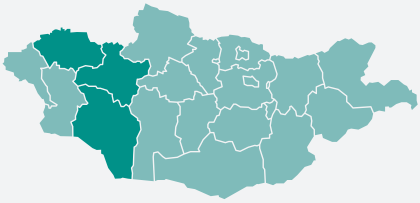
AT A GLANCE

Extreme weather events threaten the livelihood of herding households in Mongolia

By Katharina Lehmann-Uschner and Kati Kraehnert

- Analysis of a household survey examines effects of the extremely harsh winter of 2009/2010 on Mongolian households' livestock
- Extremely harsh winter led to massive livestock death
- Many severely affected households quit herding and moved to the city, their income and wealth suffering considerably as a result
- Extreme winter also has long-term effects for strongly affected herding households: their herds grow more slowly than those of unaffected households
- Rural households require support to be able to adapt to an increasingly extreme climate

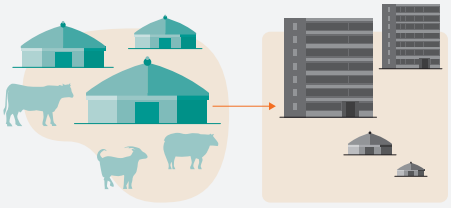
The extremely harsh winter of 2009/2010 had devastating consequences for herding households in western Mongolia



Between 2012 and 2015, 1,768 households in three Mongolian provinces, Govi-Altai, Uvs, and Zavkhan, were surveyed about their past and present livestock numbers, among other things.

43 %

After the extremely harsh winter of 2009/2010 where temperatures reached −40 degrees Celsius, herding households lost 43 percent of their animals on average ...



13 %

... and 13 percent of them gave up herding entirely. Many moved to cities.

Source: Authors' own depiction.

FROM THE AUTHORS

"Livestock is the most important asset owned by the households we studied. After the extremely severe winter of 2009/2010, many animals died—so many that a large number of herding households were unable to continue their livelihood in the herding economy."

*— **Kati Kraehnert**, study author —*

MEDIA

Audio Interview with Kati Kraehnert (in German)
www.diw.de/mediathek

Extremely harsh winters threaten the livelihood of Mongolia's herders

By Katharina Lehmann-Uschner and Kati Kraehnert

ABSTRACT

Households in developing countries are exposed to increasingly extreme weather events that could endanger their prosperity. This study examines the impact of the unusually cold, snowy winter of 2009/2010 on the livestock of Mongolian households. Livestock represents on average more than 90 percent of the value of all assets owned. It is essential for current consumption and—due to the insufficient financial infrastructure—the most important means to provide for the future. The econometric analysis is based on three waves of a household panel survey that the German Institute for Economic Research carried out in collaboration with the National Statistical Office of Mongolia two to five years after the extreme event. The extremely hard winter dramatically depleted the livestock of rural herder households. Many of those affected stopped herding as a result of the extreme winter, settling in cities to earn their wages as hired hands—which in turn had a negative impact on their wealth. Even five years after the event, severely affected households that continued to herd animals recorded lower herd growth than those that were moderately affected, likely increasing inequality further in the future. The findings show that extreme weather events have long-term negative consequences on households and underscore the need for systematic aid for those affected.

As the global climate continues to change, extreme weather events are expected to occur more frequently and with greater intensity. Between 1995 and 2015, weather-related disasters have taken over 500,000 lives worldwide, and four billion people were affected by the consequences of extreme weather events.[1] Extreme events such as storms, floods, and periods of extreme cold typically affect entire regions; hence it is usually impossible to deploy informal response strategies such as loans among (nearby) friends and relatives.[2] In developing countries in particular, the markets for formal insurance often function only partially or not at all. When extreme weather events occur, many of the affected households must fall back on their assets to finance their basic needs, exposing them to a high risk of poverty.

More knowledge on the consequences of extreme weather events is needed in order to support households as they deal with such events. There has been little research on the long-term effects of extreme weather events on households in developing countries—mainly because of the lack of suitable microdata.

Based on a household survey of herders in Mongolia, this study shows how an extreme weather event has long-term negative effects on the households' asset base and asset growth rates. It focuses on the winter of 2009/2010, which caused the highest loss of livestock in the past 50 years in Mongolia.[3]

1 United Nations Office for Disaster Risk Reduction, *The human cost of weather-related disasters 1995–2015*, United Nations Office for Disaster Risk Reduction, Geneva and Centre for Research on the Epidemiology of Disasters, Brussels (2015).

2 Barry J. Barnett, Christopher B. Barrett, and Jerry R. Skees, "Poverty Traps and Index-Based Risk Transfer Products," *World Development* 36 (10) (2008): 1766–1785.

3 The research and data on which this report is based were funded by the German Federal Ministry of Education and Research under the "Economics of Climate Change" funding line (project "Coping with Shocks in Mongolia," research grant 01LA1126A). A detailed version of the events presented here has been published as Katharina Lehmann-Uschner and Kati Kraehnert, "When shocks become persistent: Household-level asset growth in the aftermath of an extreme weather event," *DIW Discussion Paper* 1759 (2018). (Available online, accessed September 26, 2018).

Extreme weather conditions pose challenge to herding

Herding is a key sector of the Mongolian economy. In 2012, 35 percent of the population was employed in agriculture and 19 percent of Mongolians earned a living from herding alone.[4] Mongolian herding households procure meat, milk, and other dairy products from their animals, while the sale of animals and animal products is the most significant source of income for these households. Herders typically possess a mix of sheep, goats, horses, cows, and camels. In order to make a living from herding in Mongolia, owners must have a minimum herd size of between 100 and 150 animals.[5] For most herder households, the animals are the most valuable household asset. In the households of the sample examined here, the value of the animals is equal to approximately 90 percent of their total assets.

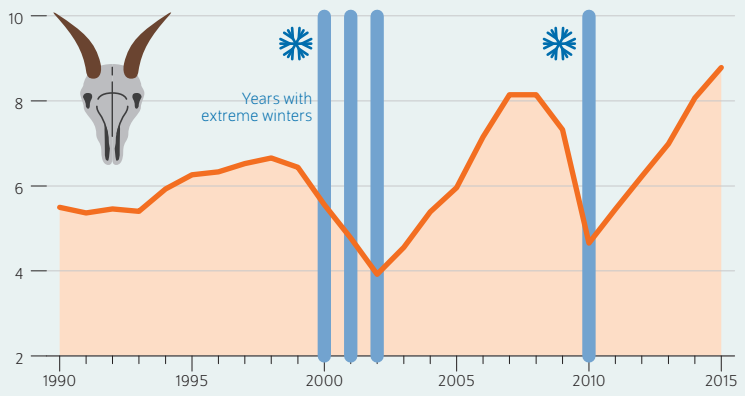
In most regions of Mongolia, the continental climate is unsuitable for cultivating forage crops. For this reason, animals are pastured all year long. Most herding households lead a nomadic or semi-nomadic life, changing pastures with their herd up to 25 times a year. In the process, households typically follow the same migratory movement year in and year out, since a complex system of norms and common law controls access to grazing land.[6]

Unusually harsh winters are the greatest threat that Mongolian herders have to face. Extreme winters—called *dzud* in Mongolian—are caused by a complex interplay of unfavorable weather conditions. They cause the death of animals on a massive scale. Since 1990, there have been four extreme winters in Mongolia (Figure 1). The focus of the present study is the winter of 2009/2010, which caused the greatest livestock depletion in the past 50 years.

A drought in summer 2009 that inhibited the growth of vegetation kicked off a series of unfavorable weather conditions. As a result, animals were unable to create adequate fat reserves for the coming winter. The first snowfall began unusually early, in October 2009, making it difficult for animals to graze. Extremely low temperatures were measured in December 2009 and January 2010. At temperatures below –40 degrees Celsius, many weakened animals froze to death. When the snow melted in May 2010, there was flooding in many regions. This in turn caused more animals to die. In January 2010, the Mongolian government declared a state of emergency.[7]

Figure

Annual number of livestock in western Mongolia[1], 1990 to 2015
In million



1 Uvs, Zavkhan, and Govi-Altai provinces.

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

Extreme winters drastically increase livestock mortality.

Extreme winter of 2009/2010 drastically reduced households' herd size

A household survey in western Mongolia provided the database for the analysis presented here (Box).

On average, the households in the sample lost 43 percent of their herd in 2010.[8] A few households did not lose any animals at all, while a larger group of households lost their entire herd. In order to empirically examine the extent to which the winter of 2009/2010 was responsible for this, the livestock mortality suffered by the sample households in 2010 was regressed on the average livestock mortality per district, determined by the livestock census, plus a large number of control variables. This methodology allows to pinpoint to what extent socio-demographic characteristics, such as experience in herding and response strategies applied by households in the midst of the extreme winter, influenced the death of the animals.

The findings show that the intensity of the extreme winter had a significant and strong effect on the loss of animals suffered by households (Table 1). An increase in livestock mortality per district by ten percent raised household livestock mortality by seven percentage points.[9] On the other hand, the herd size a household owned before the extreme winter did not have a significant influence on the livestock mortality rate: households with smaller herds and those with larger herds lost a similarly high proportion of their animals. Experience in herding did not protect against loss either. Neither the

4 National Statistical Office of Mongolia, *Mongolian Statistical Yearbook 2012*, (Ulaanbaatar: National Statistical Office, 2013).

5 Andrew Goodland, Dennis Sheehy, and Tara Shine, "Mongolia: Livestock Sector Study," *Synthesis Report*, vol. I (Washington, DC: World Bank, 2009).

6 María E. Fernández-Giménez, "Sustaining the steppes: A geographical history of pastoral land use in Mongolia," *Geographical Review* 89 (3) (1999): 315–342.

7 United Nations Mongolia Country Team, *Mongolia 2010: Dzud Appeal*, (Ulan Bator: United Nations, 2010).

8 The loss was higher than the national average since the extreme winter affected the western part of Mongolia more severely. However, other regions of the country recorded even higher losses.

9 A similar finding was obtained when the intensity of the extreme winter was approximated by winter temperature (see Lehmann-Uschner and Kraehnert, "When shocks become persistent").

Box

Database: a household panel survey in western Mongolia

This report uses data from a household panel survey, the *Coping with Shocks in Mongolia Household Panel Survey*, conducted by DIW Berlin in collaboration with the National Statistical Office of Mongolia.[1] The data were collected in three provinces in western Mongolia: Govi-Altai, Uvs, and Zavkhan. A total of 49 of the 61 districts in the survey region were included in the data collection.[2] Both herding households and those without animals were among the 1,768 households in the survey. Based on the population census of 2010, the sample is representative for the rural and urban population in each of the three provinces. Each household in the sample was surveyed a total of three times between 2012 and 2015, exactly 12 and 24 months after the first interview for a second and third time. The study presented here only includes the sample households that possessed livestock in 2009—before the extreme winter of 2009/2010.[3]

The household questionnaire included the demographic and socio-economic characteristics of all household members. The migratory history of all adults was also part of the survey, including their districts of birth and residence in 2009. Further, all adults were asked questions about their employment history and their parents' professions. Households were asked detailed questions about their livestock. For each of the five common types of animals, the number of animals at the time of the three surveys as well as changes in the number of animals in the past 12 months before the interview were documented. There were separate questions on the purchase, sale, and slaughter of animals for personal use, the transfer of animals between households, and unexpected herd depletion. A further module contained questions about the households' past: their number of animals before the shock (in 2009) and their livestock losses in the extreme winter of 2009/2010. This retrospective information was collected twice; in the first and then again in the third panel wave. The two sets of information are practically identical, which reinforces the quality of the data. In addition to the household questionnaire, a district questionnaire was used to record responses regarding infrastructure and population characteristics.

The data of the household survey were merged with aggregated data from Mongolia's historical livestock census. Every year in December since the 1950s, Mongolia's National Statistical Office has collected data on the number of animals and herd depletion over the 12 previous months. Data on each of the five common types of animals is collected separately. Based on this data, livestock mortality per district in 2010 was calculated. This variable measures the difference in the intensity of the extreme winter of 2009/2010 among the districts in the survey region.

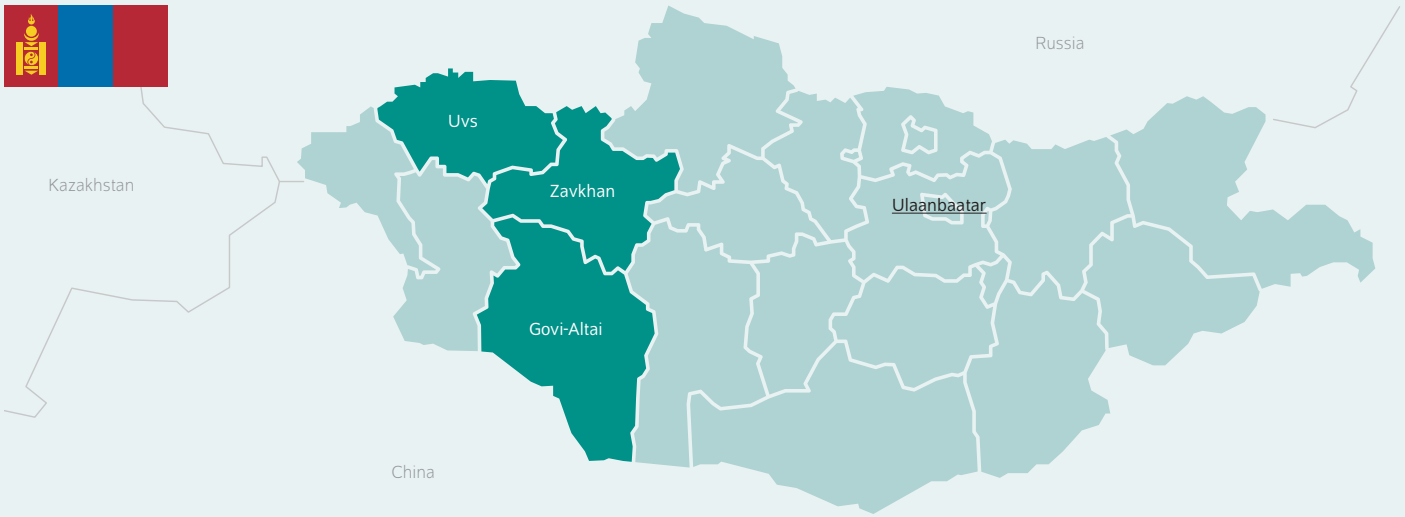
1 Kati Kraehnert, Katharina Lehmann-Uschner, Valeria Groppo and Veronika Bertram-Huemmer, *Coping with Shocks in Mongolia Household Panel Survey*, Wave 1–3, Version 1.0, German Institute for Economic Research and the National Statistical Office of Mongolia (2017).

2 The 49 districts in the survey region have an average size of 4,865 square kilometers and are home to around 1,002 households.

3 The attrition rate—the proportion of households that dropped out of the sample between the first and third waves—is less than three percent. This very low attrition rate is striking because over half of the households in the sample are nomads.

Figure

The provinces of Mongolia



Source: Authors' own depiction.

The household panel survey was conducted in three western Mongolian provinces.

fact that the respondents' parents were herders nor the age of the head of household had a significant effect on the herd depletion suffered in 2010. The response strategies that some households deployed during the extreme winter (additional nomadic migratory movement and the sale of animals) were just as ineffective. Only those households whose head worked exclusively as a herder before the shock recorded lower losses by six percentage points. This could be the result of these households being able to deploy more labor in caring for the weakened animals during the winter months. Households headed by women recorded significantly higher losses. Such households are likely to be disadvantaged when it comes to accessing good pasture land and have fewer coping strategies available than households headed by men.

These findings suggest that neither socio-demographic characteristics nor household behavior during the shock could have reduced the loss of livestock. The spatial intensity of the extreme winter is the most robust explanatory factor for the level of household herd depletion. In view of the significance of livestock for household assets, the livestock mortality suffered by those affected represents a massive drop in assets as a direct result of the extreme winter.

Many severely affected households abandoned herding

Around 13 percent of sample households gave up herding in 2010. In a second step, the analysis examines to what extent the extreme winter caused this. To do so, a binary variable that takes the value one when a household stopped herding after the shock, was regressed on a measure of the intensity of the extreme winter and further control variables at the household and district levels.

The results show that the herd depletion suffered by households in 2010 was by far the single most important predictor for dropping out of herding. (Table 2). A rise in livestock mortality of ten percent increased the probability that former livestock owners would give up herding after the shock by 1.4 percent. A comparable finding was achieved regardless of whether the intensity of the extreme winter was measured by livestock mortality in a district or winter temperature.[10] Some household characteristics also have a significant effect on the probability of giving up herding, but the magnitude of the effect of these socio-demographic variables was much lower than that of the weather's effect.

Mongolia's economic and social structures are facing major challenges because so many households have stopped herding. In the rural sections of the survey region, there are virtually no employment opportunities outside of herding. Many of those who abandoned herding moved to the city to earn their wages as hired hands. Both their gross household income and assets were lower in 2012[11] compared to those of households that continued herding and urban households that did not own any animals before the extreme winter.

Because herders are highly regarded in Mongolian culture, giving up herding also entails diminished social status.[12]

10 See Lehmann-Uschner and Kraehnert, "When shocks become persistent."

11 All assets were added together at their current value here. See Lehmann-Uschner and Kraehnert, "When shocks become persistent."

12 Daniel J. Murphy, "Going on Otor: Disaster, Mobility, and the Political Ecology of Vulnerability in Uguumur, Mongolia," Unpublished PhD dissertation, University of Kentucky, Lexington (2011).

Table 1

Effects of the extreme winter of 2009/2010 on households' livestock mortality

	Dependent variable: Household-level livestock mortality in 2010, in percent
Measure of winter intensity	
Livestock mortality per district in 2010, in percent	0.70***
Household characteristics	
Herd size in 2009 (in log)	0.01
Household lived in rural area in 2009	0.02
Household head was full-time herder in 2009	−0.06**
Spouse of household head was full-time herder in 2009	−0.02
Parents of household head were herders	−0.03
Household head always lived in current district	−0.03
Age of household head	0.00
Household head is female	0.09***
Household head has secondary or higher education	−0.03
Shock coping strategies	
Additional migration during winter of 2009/2010	0.00
Household sold livestock	−0.03
Number of households	1,056

Note: Model estimated as generalized linear model. Significance levels: ** p<0.05, *** p<0.01. Additional variables at the district level and fixed effects at the province level were used.

Sources: Coping with Shocks in Mongolia Household Panel Survey und Mongolia Livestock Census; authors' own calculations.

Table 2

The effects of the extreme winter of 2009/2010 on abandoning herding

	Dependent variable: household gives up herding after winter of 2009/2010
Measure of winter intensity	
Household-level livestock mortality in 2010, in percent	0.14***
Household characteristics	
Herd size in 2009 (in log)	−0.02***
Household lived in rural area in 2009	0.00
Household head was full-time herder in 2009	−0.03***
Spouse of household head was full-time herder in 2009	−0.04***
Parents of household head were herders	−0.04***
Household head always lived in current district	−0.04***
Age of household head	0.00
Household head is female	−0.01
Household head has secondary or higher education	−0.01
Shock coping strategies	
Additional migration during winter of 2009/2010	0.02*
Household sold livestock	0.00
Number of households	1,056

Note: Model estimated with probit. Significance levels: * p<0.1, *** p<0.01. Additional variables at the district level and fixed effects at the province level were used.

Source: Coping with Shocks in Mongolia Household Panel Survey und Mongolia Livestock Census; authors' own calculations.

Years later, herds of affected households are still growing slowly

On average, the households in the sample that continued to herd after the extreme winter possessed the same number of animals in 2014 as they did in 2009, before the shock. However, there are major differences in the extent and speed with which households recovered from the loss they suffered. Around one-quarter of households owned only half as many animals or even less in 2014 as they did in 2009.

To find out how the extreme winter of 2009/2010 affected the livestock of households that continued to herd, annual herd growth after the shock was regressed on an intensity measure of the extreme winter, plus the control variables previously used. Additional control variables are included in the regression, such as whether or not households were exposed to shocks in the previous year (unrelated to the extreme winter of 2009/2010), as those factors may also influence herd growth after the extreme winter. For the econometric estimate, data from all three panel waves are used.[13]

The results show that the extreme winter of 2009/2010 has a negative effect on the herd growth of households—also in the long term (Table 3). Households that suffered high livestock losses due to the extreme winter also show significantly lower herd growth between 2012 and 2015 in comparison to the households less severely affected by the extreme event. A rise in livestock mortality by ten percent in 2010 reduces annual growth rates by an average of 5.2 percent. And households that unexpectedly lost animals in the previous year—due to illness or wild animals, for example—have significantly lower growth rates than those that did not experience any shocks. However, the size of the effect of the recent shock is much smaller—around 33 percent—than the effect of the extreme winter of 2009/2010.

In a final step, the analysis tests whether the strategies that households applied in 2010 to cope with the extreme winter have long-term effects on herd growth. This was not the case (Table 3): neither additional nomadic migratory movement during the winter months nor the emergency sale of animals in 2010 had a significant effect on herd growth. And not only did the livestock of affected households continue to bear traces of the extreme weather event years later—other research has shown that the education and health of the children in affected families suffered significantly, which in turn has consequences on future income and prosperity.[14]

Conclusion

The present study documents that an extreme weather event has a negative effect on the asset base and asset growth rate of herders in Mongolia. On the one hand, extreme weather conditions in winter 2009/2010—very low temperatures and an unusually high amount of snow—led directly to the death of animals on a massive scale. On the other hand, the extreme winter depleted the livestock and with it, household wealth in the longer term. Even five years after the extreme event, the severely affected households recorded significantly

13 For a detailed explanation of the econometric approach, see Lehmann-Uschner and Kraehnert, "When shocks become persistent."

14 See Kati Kraehnert and Valeria Groppo, "Extreme weather events affect many Mongolian children's ability to complete schooling," DIW Weekly Report no. 40 (2018) and Valeria Groppo and Kati Kraehnert, "The Impact of Extreme Weather Events on Children's Height: Evidence from Mongolia," DIW Economic Bulletin no. 12 (2014): 3–9 (available online, accessed September 27, 2018).

Table 3

Effects of the extreme winter of 2009/2010 on post-shock herd growth

	Dependent variable: annual growth rates in herd size between 2012 and 2015		
Measure of winter intensity			
Household-level livestock mortality in 2010, in percent (in log)	−0.52***	−0.48***	−0.44***
Other shocks in previous year			
Household experienced livestock losses in previous year	−0.17***	−0.17***	−0.18***
Shock coping strategies			
Additional migration during winter of 2009/2010		−0.29	
Additional migration x household-level livestock mortality in 2010		0.12	
Household sold livestock			2.10
Household sold livestock x household-level livestock mortality in 2010			−0.29
Constant	−2.68**	−4.65***	−4.70***
Number of households	855	844	844

Note: Model estimated with the Hausman-Taylor estimator. Significance levels: ** p<0.05, *** p<0.01. Additional variables at the district level and fixed effects at the province level were used.

Source: Coping with Shocks in Mongolia Household Panel Survey und Mongolia Livestock Census; authors' own calculations.

lower herd growth than those that were moderately affected. Neither experience nor informal coping strategies were able to mitigate the consequences of the extreme winter as it occurred. A sizable group of households lost the majority of their herd, stopped herding after the extreme event, and moved to cities—typically with negative consequences for their income and wealth. Among the households that continued to herd, inequality increased. While households that were hardly affected by the extreme winter recorded relatively high herd growth in subsequent years, the group of households whose livestock was just above the minimum number of animals required for a livelihood based on herding increased. This group of households is particularly vulnerable to future extreme events.

And in the future, more and more extreme weather events can be expected.[15] Some regions of Mongolia were again exposed to extreme weather conditions in the winters of 2015/2016, 2016/2017, and 2017/2018; and again, the livestock mortality rate rose sharply. Given the circumstances, policy measures that support rural households in their effort to adjust to an increasingly extreme climate and sustainably protect their livestock are advisable.

15 Sonia I. Seneviratne et al., "Changes in climate extremes and their impacts on the natural physical environment." In *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*, eds. Christopher B. Field et al. (Cambridge and New York: IPCC, 2012): 109–230.

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JEL: O12, O13, Q5

Keywords: Assets, extreme weather events, growth rates, post-shock recovery, Mongolia

LEGAL AND EDITORIAL DETAILS

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Phone: +49 30 897 89–0 Fax: –200
Volume 8 October 11, 2018

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Phone: +49 1806 14 00 50 25 (20 cents per phone call)

Layout
Roman Wilhelm, DIW Berlin

Cover design
© imageBROKER / Steffen Diemer

Composition
Satz-Rechen-Zentrum Hartmann + Heenemann GmbH & Co. KG, Berlin

ISSN 2568-7697