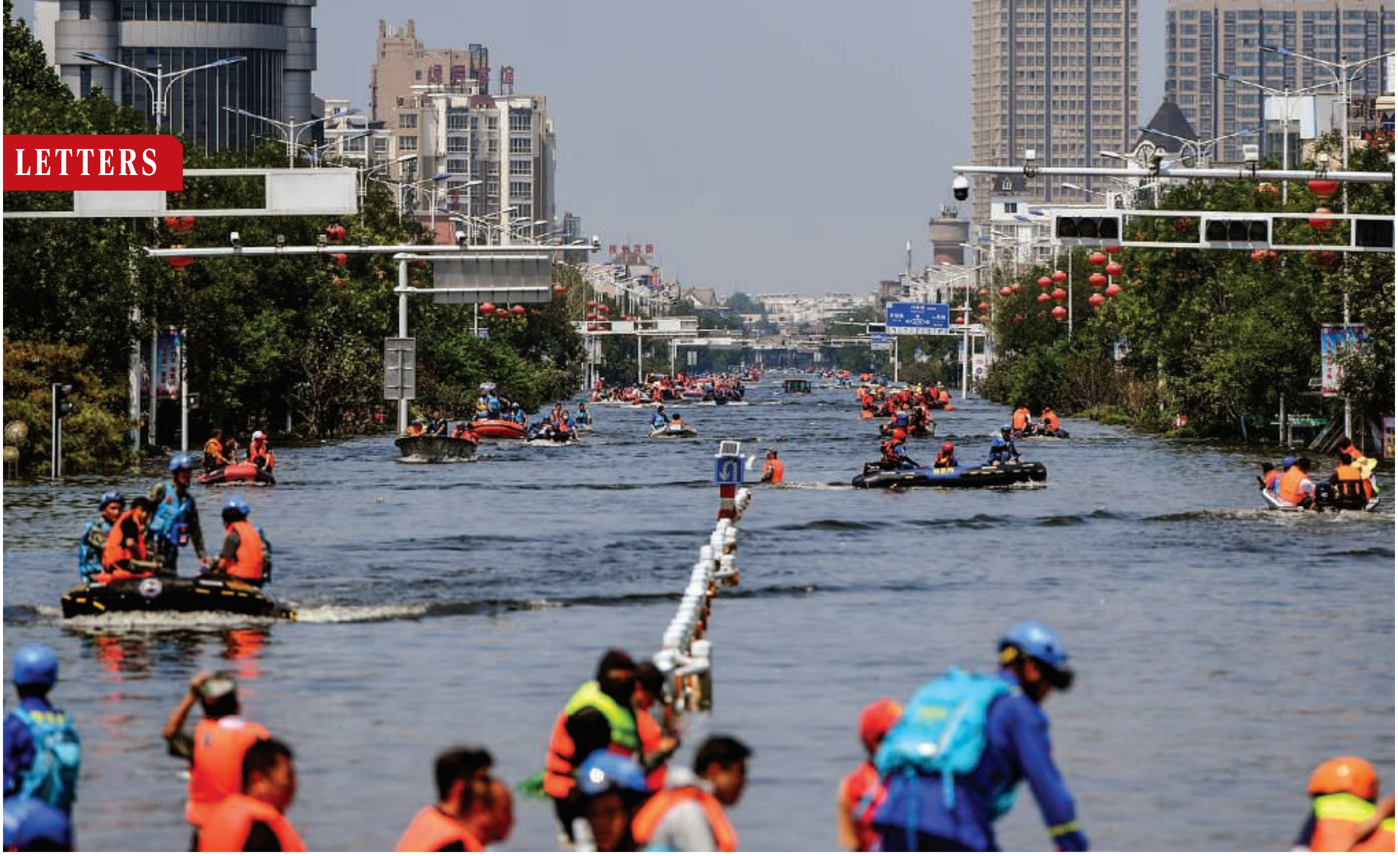
Improving the response to inland flooding

Science

Guo, Xiaona; Zhu, Annah; Li, Qiang; Chen, Ruishan

https://doi.org/10.1126/science.abm7149

LETTERS



Rescuers evacuate stranded people in the waterlogged urban area of Weihui City in central China's Henan Province, 27 July 2021, after a heavy rainfall.

Edited by **Jennifer Sills**

Improving the response to inland flooding

Extreme precipitation across China, Europe, and the United States led to unprecedented flood disasters this year, with hundreds of people killed and billions of dollars in losses. Thousand-year flood events in China and Europe and a 100-year flood event in the United States devastated inland regions not typically subject to extreme floods (*1*). The flooding in China, largely in Henan province, affected more than 14 million people, killing over 300 and inundating 16 million hectares of crops with direct economic losses of US$20.69 billion and indirect costs magnitudes greater (*2*). While climate change has been viewed as the primary culprit of these disasters (*3*, *4*), these inland regions' extreme lack of preparedness for such flooding events compounded the losses (*5*).

The damages and human cost of the flooding this summer resulted in part from human choices and activities. In Henan, the meteorological observatory issued no fewer than seven red alerts calling for staying at home before the flooding occurred (*6*), but the warnings were not taken seriously by municipality government or citizens (*7*). Metro passengers, as well as those trapped in the flooded Jingguang tunnel, did not know how to proceed in the face of such an emergency, resulting in 14 and 6 lives lost, respectively (*2*). The loss of green spaces, compounded by outdated and poorly maintained drainage systems, increased the region's flood risk (*6*).

In Europe, the situation was similar, with the European Flood Awareness System sending more than 25 early warnings to public authorities across the affected river basins, none of which led to meaningful action on the ground (*8*). In New York City, the death toll was not the greatest in coastal areas, but rather inland where flooding basements and subway lines, according to Mayor Bill de Blasio, were "catching people unaware" (*9*). Across all three flood events, lack of communication and cooperation between emergency management agencies within cities and between upstream and downstream river system authorities created further difficulties.

Transformative climate adaptation based on lessons from previous disasters can help mitigate future impacts as formerly safe regions increasingly face unprecedented conditions (*4*). Improving monitoring, forecasting, and warning systems by weather and hydrological agencies—or leveraging climate services already provided by insurance companies—can greatly reduce risks (*10*). Enhancing flood drainage systems and applying nature-based solutions such as protecting green spaces and lakes can reduce waterlogging in cities (*11*). Strengthening water infrastructure on medium and small rivers is also necessary to control floodwaters (*12*). Establishing a coordination mechanism for multiple departments and river basins will allow meteorological, transportation, communication, and emergency authorities to respond more promptly to hazards. Designing detailed emergency plans will help evacuate people more quickly, and improving public awareness will decrease casualties. Implementing a reward and punishment system to stimulate government agencies to react swiftly to combat flooding is also critical for disaster prevention and mitigation. Lastly, flood maps should be developed and distributed so that policy-makers, planners, and citizens better understand flood risk.

Xiaona Guo[1], Annah Zhu[2], Qiang Li[3], Ruishan Chen[1]*
[1]Shanghai Jiaotong University, Shanghai 200040, China. [2]Wageningen University, 6706KN Wageningen, Netherlands. [3]Henan University, Kaifeng 475000, China.
*Corresponding author.
Email: chenrsh04@gmail.com

REFERENCES AND NOTES

1. J. Sclafani, R. Falconer, "Deadly Northeast floods: More than 40 killed by Hurricane Ida's remnants," *Axios* (2021).
2. Henan Provincial Government, "Henan held its 10th news release conference on flood control and disaster relief," *The State Council Information*

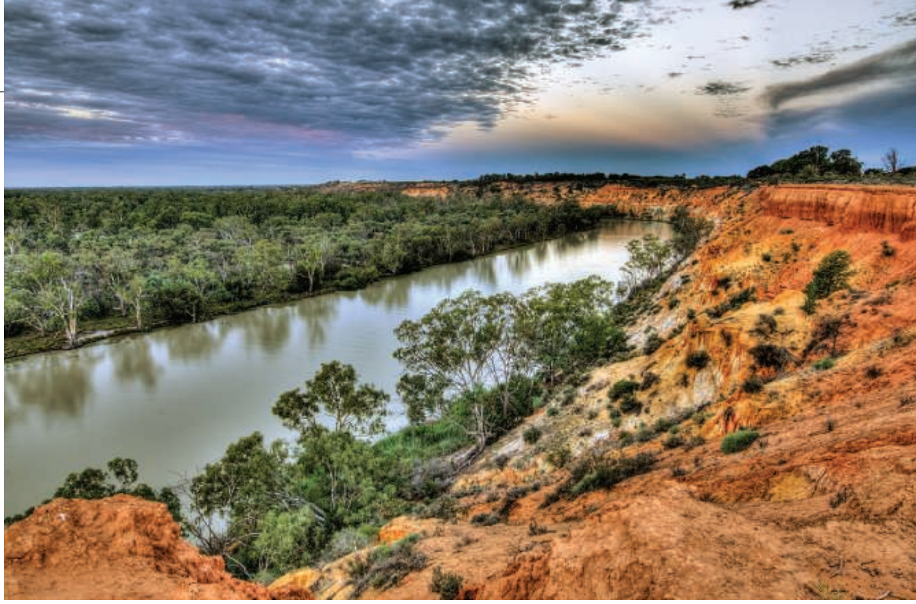
Office of the People's Republic of China (2021); www.scio.gov.cn/xwfbh/gssxwfbh/xwfbh/henan/Document/1710343/1710343.htm [in Chinese].
3. D. Carrington, "Climate crisis made deadly German floods 'up to nine times more likely,'" *The Guardian* (2021).
4. L. Shi, S. Moser, *Science* **372**, eabc8054 (2021).
5. K. Bradsher, S. Lee Myers, "How record rain and officials' mistakes led to drownings on a subway," *The New York Times* (2021).
6. S. Feng, "Rethinking Zhengzhou after the flood retreat: How did this 'natural disaster' happen?," *China Business News* (2021); www.yicai.com/news/101125402.html [in Chinese].
7. J. Chen, "The examination and advice of Zhengzhou 7.20 flood to solve 17 world-class problems," *Kunlunce* (2021); www.kunlunce.com/e/wap/show2021.php?classid=183&id=154143 [in Chinese].
8. K. Mathiesen *et al.*, "Europe's floods: How a modern warning system was overwhelmed," *Politico* (2021).
9. J. McKinley *et al.*, "The storm warnings were dire. Why couldn't New York be protected?," *The New York Times* (2021).
10. W. Cornwall, *Science*, 10.1126/science.abl5271 (2021).
11. J. Du, "In Gorakhpur, India, citizens use nature to prevent floods," World Resources Institute (2019); www.wri.org/insights/gorakhpur-india-citizens-use-nature-prevent-floods.
12. W. R. Travis, *Climatic Change* **98**, 1 (2009).

10.1126/science.abm7149

Environmental "nonuse rights" warrant caution

In their Policy Forum "Allow 'nonuse rights' to conserve natural resources" (27 August, p. 958), B. Leonard *et al.* argue that conservation—not just extractive activities—should be a valid form of land use and that such "nonuse rights" should be granted to natural resources to enable their conservation through trading in environmental markets. We offer a cautionary tale from Australia's water markets, where nonuse rights appear useful but offer limited environmental benefits. These limitations arise from both rent-seeking behavior and regulatory capture, through which decision-making in the public interest is co-opted by vested interests (*1*).

Nonuse rights for water in Australia's one-million-square-kilometer Murray-Darling Basin were introduced in 2012 to protect water-dependent downstream ecosystems from overextraction (*2*). A combination of open-tender water trading (where owners sell to the highest bidder) and reverse auctions (where owners bid to one buyer) allowed the transfer of entitlements between users and the purchase and retirement of entitlements by governments. The measures were implemented with the intention of returning water to the basin for environmental purposes while ensuring that remaining rights to extract water flowed to their most profitable use. Murray-Darling Basin water markets are now seen as among the world's most successful (*3*) in terms of trading volumes, which is most likely true (*4*).



Efforts to conserve Australia's Murray-Darling Basin have been undermined by commercial interests.

However, the legitimacy of environmental allocations remains contested, and the effectiveness of the cap-and-trade approach built into market design has been undermined (*2*, *5*). Sustained lobbying from irrigation representatives has led to water purchases for the environment shifting from open tenders to particular sellers—usually large-scale water rights holders—being invited for "targeted" purchases of water. One purchase, shrouded in commercial confidentiality, totaled A$78.9 million, more than 25% above market rate, and the nature of the water entitlement acquired is not exclusively secured for the environmental flow (*1*).

Regulatory reform and improved market design in the Murray-Darling Basin could, in principle, address some of these issues. The question is whether reforms that allow private conservation actors to purchase and retire water entitlements would improve environmental outcomes without negatively affecting legitimate objectives of social and economic wellbeing. The answer is likely no. Few, if any, conservation organizations, not-for-profit actors, or First Nations peoples or groups are likely to have the capacity to outbid commercial water users. Moreover, the retirement of water entitlements that governments have made available for consumptive use could undermine the aspirations of First Nations people and the viability of rural communities. Markets dominated by commercial users or a small number of large conservation nongovernmental organizations can also prioritize tangible ecosystem goods at the expense of intangible ecological and cultural services (*6*).

To include nonuse forms of value, decision-makers must deliberate with stakeholders who have noncommercial interests in the resource area, which includes First Nations' cultural, social, and economic interests. Environmental markets can be better served if they are underpinned by democratic processes, such as thorough public deliberation, so stakeholders perceive them to be legitimate and equitable (*4*). Nonuse rights are no exception.

Patrick Lucas[1]*, Megan C. Evans[1], Stewart Lockie[3], Katie Moon[1,2]
[1]School of Business, University of New South Wales, Canberra, ACT 2600, Australia. [2]Centre for Ecosystem Science, School of Biological, Earth, and Environmental Sciences, University of New South Wales, Sydney, NSW 2052, Australia. [3]The Cairns Institute, James Cook University, Cairns, QLD 4878, Australia.
*Corresponding author.
Email: p.austin.lucas@gmail.com

REFERENCES AND NOTES

1. R. Q. Grafton, J. Williams, *Int. J. Water Resour. Dev.* **36**, 484 (2020).
2. Y. Chen, M. J. Colloff, A. Lukasiewicz, J. Pittock, *Mar. Freshw. Res.* **72**, 601 (2021).
3. B. Richter, "Water markets can support an improved water future" (2016); https://blogs.worldbank.org/water/water-markets-can-support-improved-water-future.
4. S. Lockie, *Failure or Reform? Market-Based Policy Instruments for Sustainable Agriculture and Resource Management* (Routledge/Taylor & Francis Group, ed. 1, 2020).
5. J. Williams, R. Q. Grafton, *Australasian J. Water Resour.* **23**, 78 (2019).
6. K. Moon, D. Marsh, C. Cvitanovic, *Conserv. Lett.* **14**, e12767 (2021).

10.1126/science.abm4324

Protect elephants from tuberculosis

Both African elephants (*Loxodonta africana*) and Asian elephants (*Elephas maximus*) are Endangered (*1*, *2*). About 415,000 African elephants, including both savanna and forest elephants, remain on the African continent (*3*); fewer than 48,000 Asian elephants remain globally (*4*). Poaching for the ivory is the main cause of rapid decline in population of African elephants (*3*), whereas the survival of Asian elephants is also threatened by habitat fragmentation and human-elephant conflict (*5*). In addition to these challenges, tuberculosis (TB) has emerged as a potential threat to both African and Asian elephants.

TB in elephants is mostly caused by *Mycobacterium tuberculosis*, a human form of TB that can be fatal in elephants (*6*), and by *M. bovis*, a form of TB that infects bovine species (*7*). TB has been widely reported in captive elephants globally (*7*). In some countries, captive elephants are treated with anti-TB drugs, but there are no tools to confirm whether the TB treatment is successful. The elephants' thick skin makes taking x-rays difficult (*7*). Captive elephants in range countries intermingle with wild elephants in protected areas during grazing in pasture, elephant rides, and other activities, providing an opportunity for TB transmission at the captive-wild interface.

Since 2014, *M. tuberculosis* infection has been reported in five wild Asian elephants from Sri Lanka and India (*7*). More recently, TB has been confirmed in free-ranging African elephants in Kruger National Park in South Africa, one of which was infected with *M. tuberculosis* (*6*) and two of which were infected by *M. bovis* (*8*). The bovine TB cases could be evidence of spillover transmission, given that it has been reported in more than 24 wildlife species in the park (*9*). The long-term effects of TB in elephant populations remain unknown, but in African buffaloes, bovine TB affects both survival and fecundity in adults and has reduced the rate of population growth (*10*).

Surveillance and monitoring of TB in wild elephants are challenging (*11*), and the currently available methods for diagnosing TB in captive elephants are difficult to use in wild elephants due to challenges in sample collection. Given the multiple potential routes for transmission and the negative effects seen in other species, it is imperative to design early diagnostic tools and to increase the surveillance of TB in these species using serological, bacteriological, and molecular techniques. Genomic studies of the TB isolates in elephants can clarify transmission patterns and sources of infection of TB in elephants. To help conserve these endangered elephant species, we must minimize the threats they face.

Yogendra Shah[1]* and Sarad Paudel[2]
[1]National Zoonoses and Food Hygiene Research Center, Kathmandu, Nepal. [2]Department of Pathobiology and Diagnostic Investigation, College of Veterinary Medicine, Michigan State University, East Lansing, MI 48824, USA.
*Corresponding author.
Email: yogendra.90@gmail.com

REFERENCES AND NOTES

1. K. S. Gobush *et al.*, *Loxodonta africana* (amended version of 2021 assessment) (The IUCN Red List of Threatened Species, 2021); www.iucnredlist.org/species/181008073/204401095.
2. C. Williams *et al.*, *Elephas maximus* (The IUCN Red List of Threatened Species, 2020); www.iucnredlist.org/species/7140/45818198.
3. C. R. Thouless *et al.*, in *Occasional Paper Series of the IUCN Species Survival Commission, No. 60*, IUCN/SSC Africa Elephant Specialist Group, Ed. (IUCN, Gland, Switzerland, 2016).
4. P. Fernando, J. Pastorini, *Gajah* **35**, 15 (2011).
5. R. Sukumar, *Int. Zoo Yearbook* **40**, 1 (2006).
6. M. A. Miller *et al.*, *Front. Vet. Sci.* **6**, 18 (2019).
7. S. Paudel, S. Sreevatsan, *Tuberculosis* **123**, 101962 (2020).
8. M. A. Miller *et al.*, *Emerg. Infect. Dis.* **27**, 990 (2021).
9. N. Bernitz *et al.*, *Front. Vet. Sci.* **8**, 588697 (2021).
10. A. E. Jolles *et al.*, *Ecology* **86**, 2258 (2005).
11. S. Paudel *et al.*, *Science*, **363**, 356 (2019).

10.1126/science.abm5609

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Science, 374 (6569), • DOI: 10.1126/science.abm7149

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