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**Worldwide: Countries Likely To Expand Weather-Modification Efforts** (b)(3)

ECONOMIC SECURITY CENTER

**More governments probably will employ weather-modification technology to counter the perceived effects of climate change—despite the risks associated with greater use—following the latest example where Indonesia publicly claimed that its use in January and February of cloud seeding prevented some flooding in Jakarta.**

scientific experts have warned that the risk of societal disruptions from weather and climate extremes, such as droughts and floods, is likely to increase during the next few years—challenges that governments may assess weather-modification efforts can mitigate.

- **Weather-modification efforts are generally designed to enhance precipitation in chronic drought areas, suppress destructive hail, or disperse disruptive fog cover. According to the US National Research Council and press reports, the number of countries with weather-modification programs during the past decade has increased from 24 to 42, with at least 150 active programs worldwide as of 2012.**

- **Indonesian officials in March said that they plan to expand the use of weather modification to other parts of the country next year, according to Indonesian press reporting. Jakarta in early January suffered flooding that killed at least 36 people and displaced more than 46,000 residents, but Indonesian officials claimed that cloud seeding off the coast had reduced the amount of rain that would have fallen on the city later that month and in February.**

- **According to press reports, China, which spends more than \$100 million on weather-modification projects annually, started four new cloud-seeding programs in 2011 as part of its Five Year Plan to increase precipitation across the country after it suffered the worst drought in a century. Chile last year announced a cloud-seeding program as part of its drought-mitigation strategy.**

**Effectiveness of Weather Modification Uncertain** (b)(3)

**Scientific experts and those conducting weather-modification operations disagree about the effectiveness of the programs. The US National Research Council, World Meteorological Organization (WMO), and scientists have expressed skepticism over claims of success, cautioning that additional research is needed to show a causal link between cloud seeding and rain, although they concede the practice could contribute to climate mitigation.**

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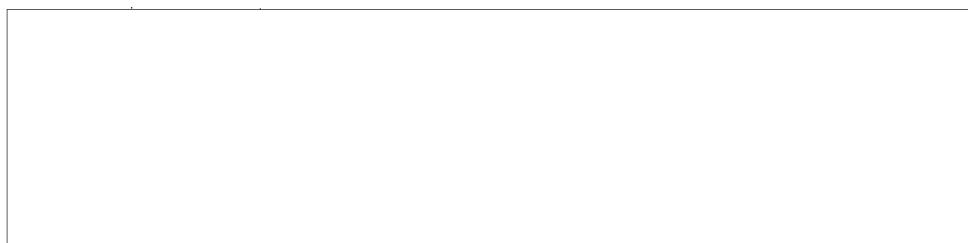
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- Cloud-seeding firms and governments engaged in the practice claim cloud-seeding techniques can increase seasonal precipitation rates by 5 to 20 percent, according to press reporting. (b)(3)
- The scientific community criticizes weather-modification operations, like the one in Indonesia, for failing to collect control data to determine how much rain would have fallen without the operation. (b)(3)
- According to the WMO, financial support for scientific weather-modification research since the 1980s has decreased worldwide, while more countries have moved directly into operational projects. (b)(3)

**Greater use of weather-modification technologies and the potential for unintended weather effects to extend beyond borders could lead to disputes over resources or damages and calls for global standards and monitoring.** For example, India and Pakistan have a long history of bilateral disputes over water rights that have been resolved through the Indus Water Treaty; however, weather-modification efforts—or perceived efforts—that alter the water supply across the border could exacerbate tensions.

- The 1977 Convention on the Prohibition of Military Use of Environmental Modification Techniques is the only formal international legal mechanism related to weather modification, but its scope is limited to prohibiting the use for military applications. (b)(3)
- The United Nations Environment Program (UNEP)'s Provisions for Cooperation Between States in Weather Modification could provide a basis for future legal agreements. According to academic literature, UNEP recommended guidelines that states considering weather-modification operations first conduct assessments of the environmental impact, notify and consult with states potentially affected, and register with the WMO.

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## **Worldwide: Extreme Weather Events Likely To Heighten Interest in Weather Modification Efforts**

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A projected increase in extreme weather events—including droughts, heat waves, wildfires, desert and arid-region expansion, greater variability in the timing of monsoons, higher precipitation levels, and tropical storms and cyclones—probably will encourage countries to develop and use weather modification technology. Extreme weather events<sup>a</sup> resulting from rising global temperatures are projected to increase in frequency during the next decade.

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More than 40 countries have a history of experimentation with weather modification, primarily by employing precipitation enhancement, hail suppression, and fog dispersal techniques.<sup>b</sup> Other countries vulnerable to extreme weather probably already are pursuing weather modification efforts or will soon do so because the barriers for experimentation are low.

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Countries with a history of weather modification efforts are also vulnerable to extreme weather events during the next 10 years.<sup>c</sup>

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<sup>a</sup> An extreme weather event is defined as a one-in-30-year event—a 3.3-percent chance of occurring—based on a period of historical observations. The temperature and precipitation analyses used more than 60 years of observed record data as the baseline for the projections.

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<sup>b</sup> Precipitation enhancement, hail suppression, and fog dispersal involve a similar technique, whereby clouds are seeded—usually by airplane—with aerosols, such as silver iodide, or a cooling agent, such as dry ice or liquid propane.

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The chemicals stimulate coalescence of water molecules and then create raindrops, snow, or less damaging hail by prompting early rainout or freeze water droplets to disperse fog.

<sup>c</sup> Regional and country-specific trends in climate extremes during the next decade are more difficult to project with certainty than larger geographical regions and multidecade time scales. Dot symbols indicate a convergence of evidence across multiple scientific sources, and we assess the changes are significant enough to merit attention.

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