

Innovation Brief

New Assessment Tools for Water Vulnerability

Overview

Water increasingly presents a global security concern. Because of water's central societal role, the failure of nations to address water vulnerability can lead to civil disruption and unrest. Water is essential not only for basic human existence, but for agricultural and industrial production. In many countries, hydropower also is a major source of energy. Population increases and economic growth can generate disputes among water sectors and geographic regions, deplete groundwater aquifers, and collide with physical limits on available water. Droughts and other perturbations in water supplies can similarly disrupt economic activities, generate disagreements among water users, and displace populations. Researchers, for example, have concluded that Syria's severe drought from 2006 through 2009 helped contribute to the 2011 civil uprising.

Identifying countries facing significant water vulnerability is therefore critical. By pinpointing nations and regions of concern, international aid and assistance can be better directed to avoid the problem of water vulnerability. Security officials also can take steps to reduce the risk that water stress will lead to more general civil strife or unrest.

Problem Statement

Tools to identify regions that face a risk of water-related conflict or disruption are still rudimentary. The most common approach to analyzing water risks has been the calculation of *water stress*, determined generally as the percentage of an area's water supply currently being withdrawn or consumed for human use. More sophisticated models are needed to fully understand the regional and country by country risks of water vulnerability by taking into account factors such as infrastructure and governance.

The Facts

Water crises are increasingly recognized as representing a new set of security challenges for the world. Over the past 50 years, the global population has doubled while the total volume of water withdrawn for human use has nearly tripled. The World Resources Institute calculates that approximately three dozen countries suffer from *extremely high* levels of water stress, which it defines as withdrawing more than 80 percent of available water for agricultural, domestic and industrial uses.

The problem with most approaches to identifying regions facing water vulnerability is that the approaches generally examine only one or a small handful of factors that determine whether a nation can adequately address issues of water vulnerability that arise. Maps of water stress, for example, show only current demand as a function of supply – ignoring water dependency, precipitation variability, available

infrastructure and institutional capabilities. By focusing on only one or two characteristics of water vulnerability, such approaches risk suggesting that some highly vulnerable countries are safe from disruption, and that some countries with minimal risk are the source of major concern.

Recognizing the deficiencies of traditional measures, scientists at Stanford have developed and tested a new assessment tool for global freshwater supply vulnerability. As shown in Figure 1, the assessment tool examines 19 different characteristics of freshwater vulnerability, including measures of both consumptive and ecological water demand, freshwater endowment and variability, infrastructure and institutional capacity to regulate water use and correct deficiencies.

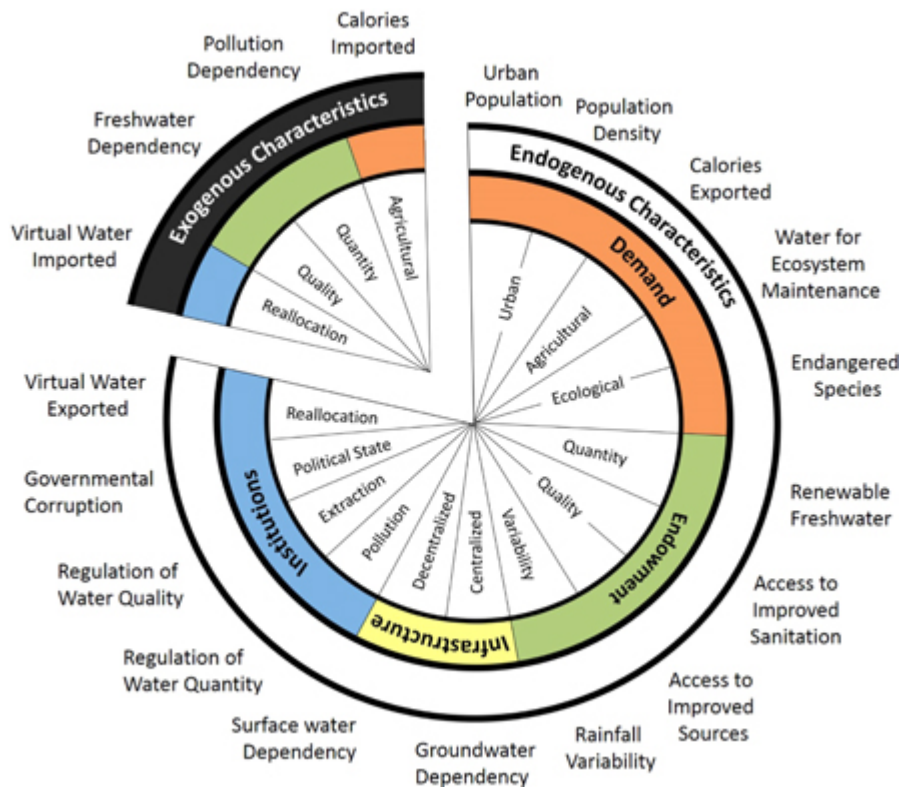


Figure 1. Characteristics of freshwater vulnerability. Four major characteristic categories (demand, endowment, infrastructure and institutions) are identified. Characteristics can be endogenous or exogenous. We evaluate 19 characteristic values (displayed radially) to determine a region's vulnerability. Greater vulnerability pushes a characteristic value towards the circle's outer boundary, whereas a value with low vulnerability falls near the center.

Rather than combining these disparate factors into a single vulnerability score, the analysis produces spider diagrams that highlight a nation's deficiencies in addressing freshwater vulnerability (see Figure 2). The assessment tool uses commonly available information and therefore can be used to examine risks without collecting significant new information.

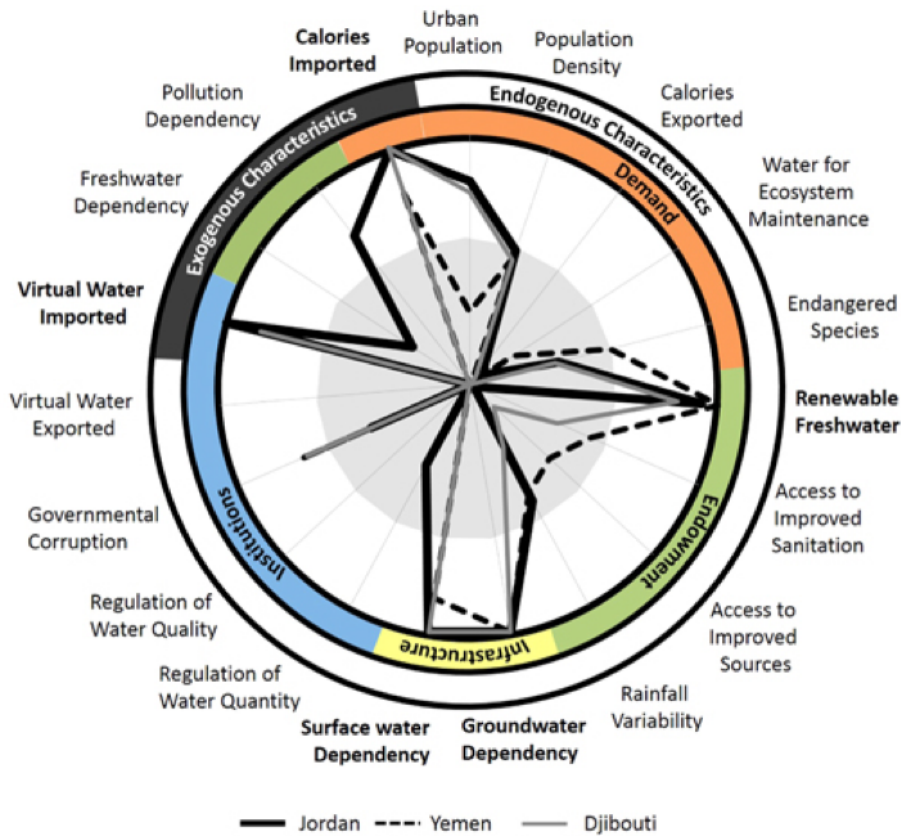


Figure 2.

Applying the analysis to 119 countries or territories without high per-capita incomes, the Stanford researchers found that 41 countries (or over a third) had five or more vulnerable characteristics, and 23 were *moderately vulnerable* in all four of the basic categories (demand, endowment, infrastructure and institutions). While many of the most vulnerable countries were arid (e.g., Egypt), others were in water-rich areas that would not be identified as vulnerable under traditional and unidimensional water-stress analyses (e.g., the Solomon Islands, Belize and the Republic of Congo). The Stanford analysis found that Jordan faces the greatest vulnerability concerns, followed by Djibouti and Yemen. Demonstrating the importance of a multidimensional analysis, the Stanford study also found that institutional factors present the most common source of risk.

The Challenges

- The United State must do a better job of identifying and addressing problems of water vulnerability around the world;
- Traditional tools for measuring water vulnerability are too limited in scope, focusing solely on supply and demand;
- New approaches to reducing regional risks of water vulnerability must also address a broader set of factors, such as institutional considerations, that can determine whether water stress leads to unrest and disruption.

The Recommendations

The United States should develop and utilize new, more comprehensive tools for identifying nations and regions facing serious risks of water vulnerability. The Stanford approach provides a path to such identification by considering not only water demand and supply, but also infrastructure and institutional factors. As the Stanford study shows, one of the major factors contributing to water vulnerability is the lack of adequate institutions to manage water resources. The United States should take steps to (1) provide adequate institutions to manage international bodies of water, and (2) help nations develop internal institutions sufficient to minimize water vulnerability.

This brief is based on research and findings by Barton “Buzz” Thompson, Senior Fellow and Founding Perry L. McCarty Director, Stanford Woods Institute for the Environment; Robert E. Paradise Professor in Natural Resources Law