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The Environmental Change and Security Program's Navigating Peace Initiative, supported by the Carnegie Corporation of New York and led by ECSP Director Geoffrey Dabelko, seeks to generate fresh thinking on the world's water problems in three areas:

- Expanding opportunities for small-scale water and sanitation projects;
- Analyzing water's potential to spur both conflict and cooperation; and
- Building dialogue and cooperation between the United States and China using lessons from water conflict resolution.

THE CHALLENGES OF GROUNDWATER IN SOUTHERN AFRICA

By Anthony Turton, Marian Patrick, Jude Cobbing, and Frédéric Julien

It is impossible to understand the developmental constraints of Africa without grasping the significance of water resources, particularly groundwater. Southern Africa[1] faces potentially severe groundwater shortages, which not only imperil the lives of those directly dependent on it, but also the continued development of the economic engines of the region—South Africa, Botswana, Namibia, and Zimbabwe—all of which face significant constraints on their future economic growth due to the insecurity of water supply. In addition, groundwater resources are the foundation of rural water supplies, which sustain livelihoods for the poorest of the poor communities.

Today's best practice in sustainable water management—Integrated Water Resource Management—focuses on river basins as the units of management. However, this overlooks two fundamental realities in southern Africa:

1. Groundwater aquifer systems, while being an integral part of the overall water resource, seldom correspond with the surface water management unit—the river basin; and
2. In almost all cases, groundwater systems are, by their very nature, transboundary.

While a complex set of agreements govern transboundary river basins in southern Africa, the region lacks international groundwater treaties of similar sophistication and status, which could be a potential cause of future conflict.

The Groundwater Problem in Southern Africa

Water resource management is almost always transboundary. Water resource management in Africa is, like the continent itself, a product of its colonial past. The colonial powers divided the continent into units that tended to be defined by rivers. Within the 53 African countries, 63 river basins cross international borders. Thus, there are more transboundary river basins than sovereign states. These river basins cover two-thirds of the continent's surface area, in which three-quarters of the human population lives, accounting collectively for a staggering 93 percent of all surface water. And significantly, there are

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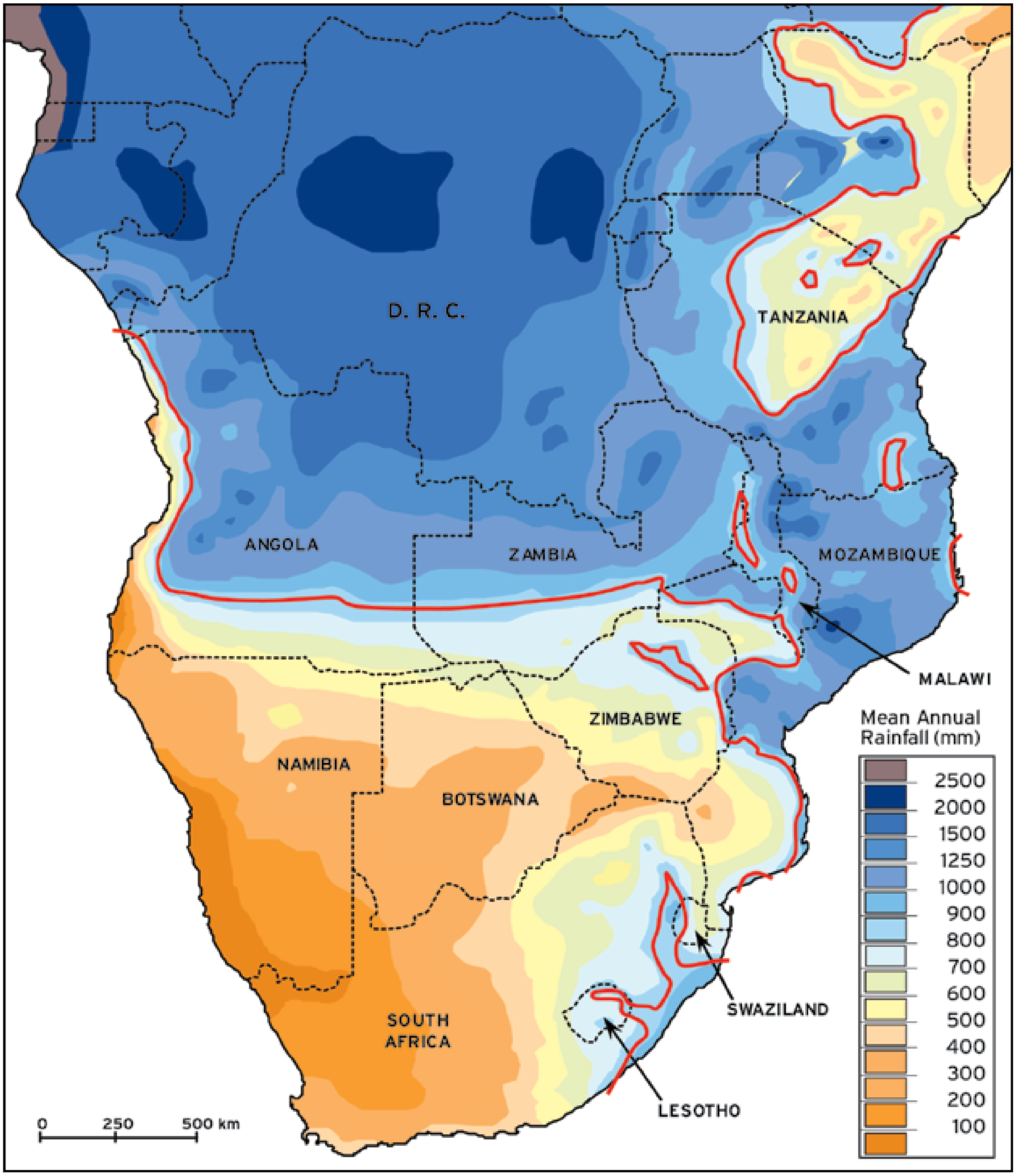
Map 1: Precipitation in Southern Africa



Note: Precipitation in southern Africa is unevenly distributed, with the four most economically developed countries—South Africa, Namibia, Botswana, and Zimbabwe—on the "wrong" side of the global annual average of 860 mm, shown as a red line. Map courtesy of Peter Ashton.

more transboundary aquifers in southern Africa than there are transboundary river basins.

Water is unevenly distributed in both space and time. The four most economically developed countries in the region—South Africa, Namibia, Botswana, and Zimbabwe—are all on the "wrong" side of the global average annual rainfall (see Map 1). Their future economic growth is potentially limited by the insecurity of water supply.

Southern Africa has an inherently low conversion rate of rainfall-to-runoff, which affects both surface water river flows and groundwater recharge. Of the rainfall that falls to earth in an average year, only a small portion is converted to water flowing in rivers. Southern Africa, along with Australia, has the lowest conversion of rainfall-to-runoff in the world. Groundwater recharge is also largely dependent on rainfall, but in a nonlinear fashion: below the critical threshold of 500 mm of mean annual rainfall, a dramatic drop-off in recharge occurs. Therefore, recharge is generally low in southern Africa. Drought-proofing Africa therefore requires a major investment in infrastructure to store the limited streamflow and assure the supply level necessary to provide a stable foundation for a modern industrial economy.

Given the nonlinear nature of groundwater recharge at low levels of rainfall, coupled with the prediction of a hotter and drier future due to global climate change, a reduction in aquifer recharge is a real likelihood. Looking at the scenario considered most likely by mainstream climate change scientists in Africa, southern Africa is the one part of the planet that is expected to become both warmer and drier by 2050.[2] If one accepts this prediction, the groundwater situation in southern Africa is likely to become much worse, with considerable reduction in recharge and hence, an increase in vulnerability of the poor.

Policy Recommendations

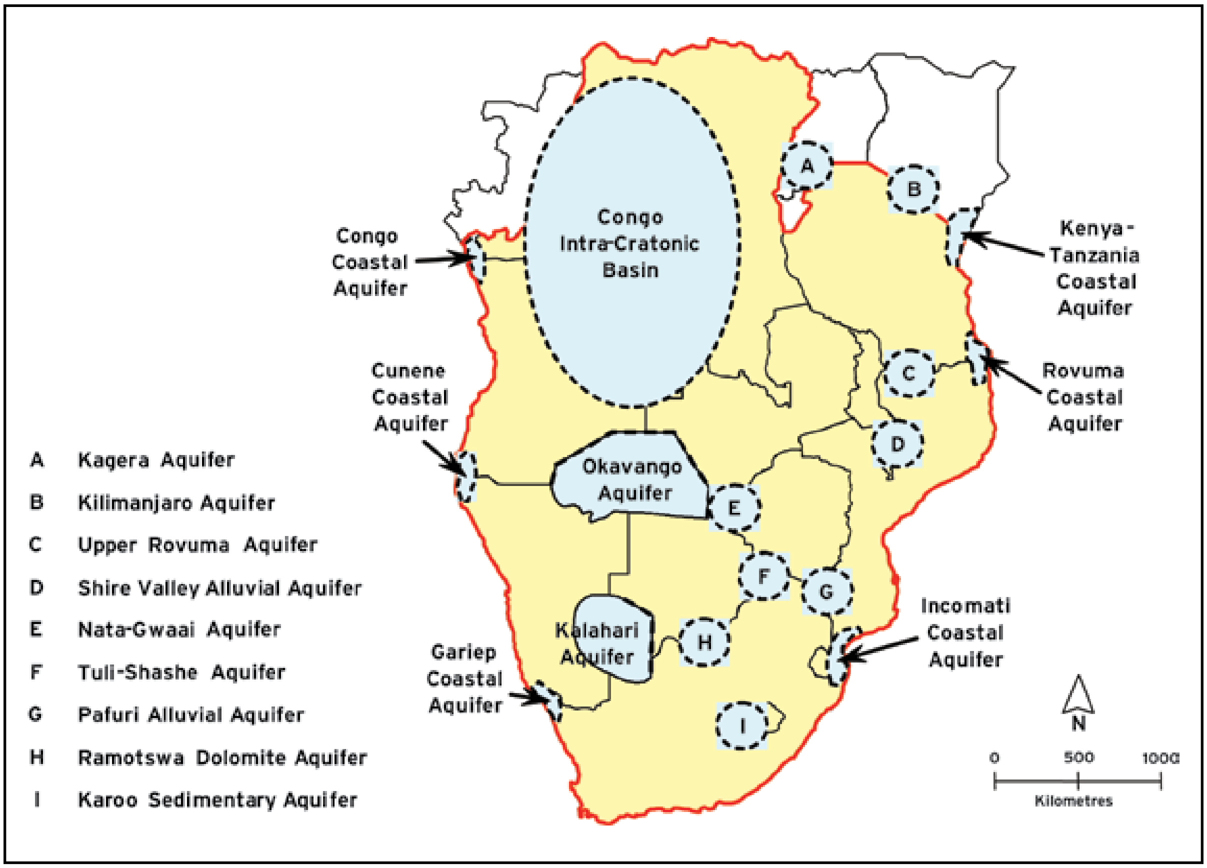
- Although the river basin is the generally accepted unit of management, we must recognize that aquifer systems do not coincide neatly with river basins. Therefore, we need policy-related research on groundwater to assist decision-makers with the management of this complex resource. In addition, we call for support of the Alicante Declaration, which seeks to establish a framework for groundwater management.[3]

- Groundwater is almost always transboundary in nature. Aquifers crossing international political borders pose different problems than river basins. While the Southern African Development Community (SADC) is characterized by a relatively sophisticated set of surface water agreements, it conspicuously lacks agreements dealing specifically with groundwater. The region needs to: (a) more accurately map transboundary groundwater resources (see Map 2 and table); (b) classify such resources in terms of hydrogeological characteristics and future demands; and (c) generate management regimes that are capable of dealing with the problems associated with the resources' specific hydrogeological characteristics.

- Poverty eradication initiatives such as the Millennium Development Goals cannot be successful without recognizing the links between development, water resource management, and global climate change. We must generate consensus on the need to reach agreement on carbon emission targets, and we call upon SADC, Brazil, India, and China (as rapidly industrializing nations) to cooperate in negotiations to this end.

If we are serious about poverty eradication in southern Africa, then we must be acutely aware of the link between transboundary water resource management and changing patterns of resource use. In almost all cases, significant resources—both surface and groundwater—are transboundary in nature. The four most economically developed countries in the region are all approaching limitations on future economic growth and development due to low assurance of water supply. The region's

Map 2: Some Transboundary Aquifer Systems in Southern Africa



Note: Map redrawn and modified from "Water and Security in Sub-Saharan Africa: Emerging Concepts and Their Implications for Effective Water Resource Management in the Southern African Region," by Peter J. Ashton and Anthony R. Turton, in press, in Hans G. Brauch et al. (Eds.), *Globalisation and Environmental Challenges*. Berlin: Springer Verlag. Adapted with permission of the author.

countries share a number of transboundary water resources and all have a vested interest in reaching agreement on their management in a fair, equitable, and peaceful fashion.

Notes

1. Here, southern Africa is defined as the continental countries that are members of the Southern African Development Community (SADC); see http://www.sadc.int.

2. The HADCM3 Global Climate Change model using the IPCC SRES A2 Scenario predicts a hotter and drier southern Africa by 2050; see Scholes, Robert J., & R. Biggs. (2004). *Ecosystem services in southern Africa: A regional assessment.* Pretoria: Council for Scientific and Industrial Research.

3. See http://www.worldwatercouncil.org/fileadmin/wwc/World_Water_Forum/WWF4/declarations/Alicante_Declaration.doc

Table: Known Transboundary Aquifer Systems Shared by SADC Countries

Aquifer / Riparian State	Cunene Coastal	Cuvelai	Congo Coastal	Congo Intra-Cratonic	Gariep Coastal	Incomati Coastal	Kagera	Kalahari	Karoo Sedimentary	Kenya-Tanzania Coastal	Kilimanjaro	Limpopo Granulite-Gneiss Belt	Nata-Gwaai	Okavango	Okavango-Epukiro	Pafuri Alluvial	Pomfret-Vergelegen Dolomitic	Ramotswa Dolomite	Rovuma Coastal	Shire Valley Alluvial	Tuli-Shashe	Upper Rovuma	*Shared aquifers*
Angola	X	X	X	X										X									5
Botswana								X				X	X	X	X		X	X			X		8
Congo (DRC)			X	X																			2
Lesotho									X														1
Madagascar																							0
Malawi																				X			1
Mauritius																							0
Mozambique						X										X			X	X		X	5
Namibia	X	X			X			X						X	X								6
South Africa					X	X		X	X			X				X	X	X			X		9
Swaziland						X																	1
Tanzania							X			X	X								X			X	5
Zambia				X									X	X									3
Zimbabwe												X	X			X					X		4
States sharing	2	2	2	3	2	3	1	3	2	1	1	3	3	4	2	3	2	2	2	2	3	2	

Note: Table adapted from "Unpacking Groundwater Governance Through the Lens of a Trialogue: A Southern African Case Study" by Anthony R. Turton, Linda Godfrey, Frédéric Julien, & Julian Hattingh, 2006, January. Paper presented at the International Symposium on Groundwater Sustainability, University of Alicante and the Spanish Royal Academy of Sciences, Alicante, Spain. Adapted with permission of the author.

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Environmental Change & Security Program

The **Environmental Change & Security Program** (ECSP) promotes dialogue on the connections among environmental, health, and population dynamics and their links to conflict, human insecurity, and foreign policy. ECSP focuses on four core topics:

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- Water; and
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