103629

WORLD BANK water — Learning Events

The Zimbabwe Water Forum provides a platform for Government and Development Partners to share international best practices in the water sector between Zimbabwe and other countries. The forum was formed through a partnership between the Ministry of Environment, Water and Climate, the Multi-Donor Trust Fund and the World Bank and is hosted by the World Bank's Zimbabwe Country Office and the Urban WSS Thematic Group.

Climate Change and Water Resources Planning, Development, and Management in Zimbabwe

This policy note summarizes the issues paper on Climate Change and Water Resources Planning, Development and Management prepared at the request of the Ministry of Environment, Water, and Climate of Zimbabwe. The issues paper was intended to help highlight the potential impacts of climate change on the hydrological cycle and to strengthen the water-related aspects of the National Climate Change Response Strategy (NCCRS). Rafik Hirji, World Bank, provided the overall technical leadership and coordinated consultant inputs for its preparation with support from the Analytical Multi Donor Trust Fund (AMD TF) under the Flexible Technical Assistance for the Water Sector in Zimbabwe managed by Michael Webster of the World Bank office in Harare. The paper's principal authors are Richard Davis (Senior Water Resources consultant) and Rafik Hirji (Senior Water Resources Specialist). Consultant inputs were provided by Professor Amon Murwira and Dr. Richard Owen of the University of Zimbabwe and Mr. Zebediah Murugnweni, a senior water resources expert in Harare.

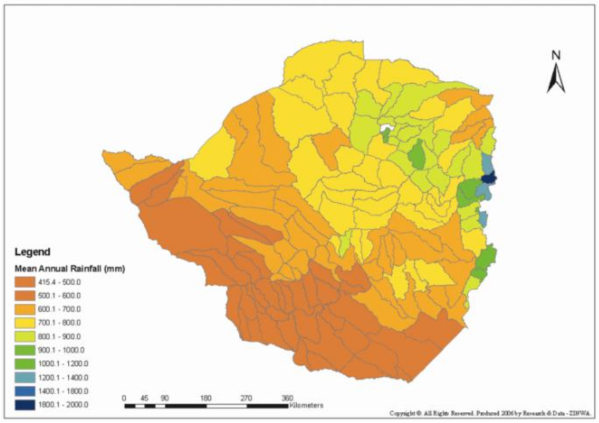
Water, Climate, and the Economy

Zimbabwe has embarked on a long-term process of rebuilding its economy following a period of economic decline and breakdown of social services during the 2000s. Clean water, the safe disposal of sewage, irrigation, and hydropower are among the services in urgent need of rehabilitation and expansion. One challenge that has yet to be factored into the recovery plans is the effect of climate change on the country's water resources and its implications for planning, design, and management of these resources.

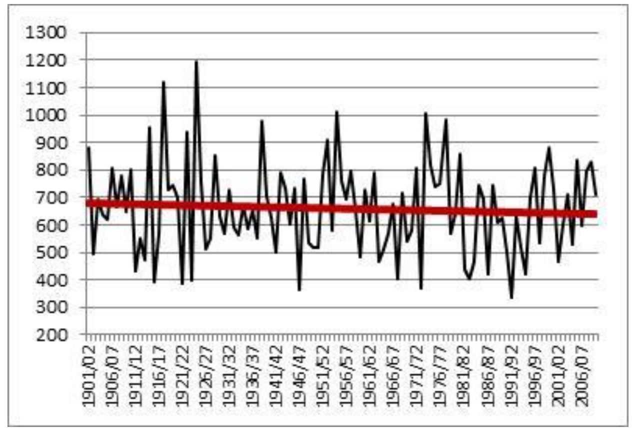
Water is central to the economy of Zimbabwe and to its people's livelihoods and wellbeing, but the availability and reliability of water resources are dependent on highly variable climatic conditions. Climate change has already had an impact on water resources in Zimbabwe, and the effects are projected to become more severe over the next century.

The climate in Zimbabwe is highly variable both spatially and temporally. Mean annual precipitation (MAP) is 657 millimeters; there is a distinct precipitation gradient from the drier south to the wetter north of the country. The wet season usually extends from October to April, with most rain falling between December and February. Rainfall varies considerably from year to year, particularly in the northern plateau where inter-annual precipitation can vary by almost 50 percent. Zimbabweans can expect drought to occur between one and three years every decade. The nation is also prone to floods driven by cyclones. Some 80 percent of Zimbabweans are farmers or are engaged in agro-industry, and the economic damage and human suffering caused by extreme weather events can be very high; impacts include water and food shortages, the spread of disease, economic losses to farmers, and the destruction of infrastructure.

Distribution of precipitation across Zimbabwe



Average Seasonal Precipitation (mm) 1901–2010



While precipitation is the main factor influencing the availability of water resources, rates of runoff and groundwater recharge can have a more direct effect on livelihoods. More than 70 percent of the population of Zimbabwe relies on wells and bore-holes for their drinking water, yet there have been few studies of rates of recharge or depletion of these resources. Surface water plays a critical role in urban and rural water supply as well as for irrigation and electricity production, but there is considerable uncertainty about the current state of Zimbabwe's surface water resources and their use. Mean Annual Runoff (MAR) is dependent on precipitation, but other factors such as silting, land clearance, and recharge and infiltration rates can also affect runoff, making it particularly sensitive to environmental change.

Climate change will affect water resources

This study used limited modeling (using the CSIRO Mk3 global circulation model and the A2a and B2a scenarios) to examine the potential impacts of climate change on precipitation and runoff in Zimbabwe's seven catchments. A2a is a business-as-usual scenario that assumes high population growth, increased energy use, conservative technologies, and significant land use changes. B2a is an ecologically aware scenario that assumes that local solutions are sought for environmental challenges, population grows more slowly, technology adapts to new conditions, and changes to land use are more gradual. The years 2050 and 2080 (consistent with the NCCRS) were used to develop projections for rainfall, runoff, and recharge.

Under both scenarios, MAP is projected to decrease significantly by 2050 and 2080 in all catchments, except for Manyame where it could increase slightly under the ecologically aware scenario. The most affected catchments are in the south of Zimbabwe—Mzingwane and Runde catchments—where MAP could decline by 12 to 16 percent by 2050 and by 12 to 25 percent by 2080. Precipitation is likely to remain relatively constant in the northwest of the country (Manyame and Mazowe catchments). MAP could stabilize or start to recover in the more affected catchments—Gwayi, Mzingwane, Runde, Sanyati and Save—between 2050 and 2080 under the ecologically aware scenario, although it would continue to decline in almost all catchments if population growth and technology continue at the current rates.

The uncertainties in the assumptions used in these models mean that the projected changes to precipitation may vary in scale, but the overall pattern of a decrease in MAP across western and southern Zimbabwe to 2050—with continuing precipitation declines to 2080 if emissions of greenhouse gases are not curbed—should be regarded as a reliable conclusion. In spite of the overall declines in precipitation, greater climate variability is expected to create higher risks of extreme climate events including drought and flood.

Estimated current, 2050, and 2080 MAP (mm) by catchment

Catchment	Current		2050 Business as usual scenario (A2a)	2050 Ecologically aware scenario (B2a)	2080 Business as usual scenario (A2a)	2080 Ecologically aware scenario (B2a)
	Observed	World Climate Data				
Gwayi	599	605	545 (10%)	576 (5%)	515 (15%)	587 (3%)
Manyame	709	785	769 (2%)	795 (-1%)	757 (4%)	800 (-2%)
Mazowe	824	915	854 (7%)	907 (1%)	864 (6%)	899 (2%)
Mzingwane	547	506	430 (15%)	447 (12%)	379 (25%)	445 (12%)
Runde	606	706	592 (16%)	622 (12%)	534 (24%)	616 (13%)
Sanyati	635	738	684 (7%)	716 (3%)	655 (11%)	723 (2%)
Save	815	915	784 (14%)	839 (8%)	756 (17%)	832 (9%)

Note: Percentage decreases in MAP are shown in brackets. A negative percentage indicates an increase in rainfall.

The Mean Annual Runoff (MAR) was calculated using the MAR and MAP relationships developed by ZINWA for all catchments. As was found in other climate studies, there is a proportionately greater decline in runoff due to climate change than in precipitation in all Zimbabwe. This multiplier effect on runoff means that even small declines in MAP can have significant impacts on water availability. For example, Manyame catchment is projected to face only a 4 percent decrease in precipitation by 2080 under business as usual, but this could result in a 10 percent decline in MAR. But river flows in Gwayi and Mzingwane catchments could decline significantly if greenhouse emissions are not controlled. Even more dramatically, a 3–7 percent decline in precipitation in Sanyati catchment by 2050 will result in a 10–23 percent decline in runoff. Given the simplicity of the method, there is considerable uncertainty about the extent of the decreases in river flow, but the general prediction of a drier climate with considerably less river flow across southern and western Zimbabwe and much smaller impacts in Manyame and parts of Mazowe catchments, is a reliable conclusion.

Estimated current, 2050, and 2080 MAR (Gl) by catchment

Catchment	Current (World Climate data)	2050 Business as usual scenario (A2a)	2050 Ecologically aware scenario (B2a)	2080 Business as usual scenario (A2a)	2080 Ecologically aware scenario (B2a)
Gwayi	2,088	-	1,047 (50%)	-	1,432 (31%)
Manyame	4,496	4,244 (6%)	4,661 (-4%)	4,046 (10%)	4,736 (-5%)
Mazowe	5,665	4,825 (15%)	5,559 (2%)	4,974 (12%)	5,443 (4%)
Mzingwane	1,082	-	379 (65%)	-	356 (67%)
Runde	3,530	1,967 (44%)	2,343 (33%)	1,311 (63%)	2,271 (36%)
Sanyati	6,905	5,314 (23%)	6,248 (10%)	4,483 (35%)	6,471 (6%)
Save	8,010	5,455 (32%)	6,558 (18%)	4,970 (38%)	6,414 (20%)

Note: Percentage decreases in MAR are shown in brackets. A negative percentage means runoff is predicted to increase.

Groundwater recharge rates as well as the impact of climate change on recharge rates were estimated using expert knowledge rather than field measurements for each catchment. Overall, decreases in precipitation will lead to proportionate decreases in groundwater recharge, but this effect is likely to be different in the geologically different aquifers in Zimbabwe. Unconfined, shallow aquifers that receive direct recharge from rain are the most susceptible to the effects of drought as well as the most subject to the increased evapotranspiration expected with the higher temperatures projected under climate change. These types of aquifers are concentrated in the western regions of Zimbabwe, and farmers there who depend on groundwater for irrigation and drinking water could face declines in yields or even crop failure. In addition, reduced precipitation and runoff are expected to increase people's dependence on groundwater, exacerbating groundwater depletion.

Reductions in groundwater recharge are expected to range from 2 percent (Manyame) to 16 percent (Runde) by 2050 and to 4 percent (Manyame) to 25 percent (Mzingwane) by 2080. A recent regional study estimates that the percentage of population at very high risk of groundwater drought in Zimbabwe could rise from 32 percent to 86 percent without measures to adapt to the effects of climate change.

Estimated groundwater recharge (Gl/yr) by catchment

Catchment	Recharge as % MAP	Current	2050 Business as usual scenario (A2a)	2050 Ecologically aware scenario (B2a)	2080 Business as usual scenario (A2a)	2080 Ecologically aware scenario (B2a)
Gwayi	3%	1596	1438 (10%)	1520 (5%)	1359 (15%)	1549 (3%)
Manyame	6%	1907	1868 (2%)	1932 (-1%)	1839 (4%)	1944 (-2%)
Mazowe	6%	1918	1791 (7%)	1901 (1%)	1811 (6%)	1844 (2%)
Mzingwane	2%	632	537 (15%)	558 (12%)	473 (25%)	556 (12%)
Runde	5%	1449	1215 (16%)	1277 (12%)	1096 (24%)	1265 (13%)
Sanyati	5%	2750	2549 (7%)	2668 (3%)	2441 (11%)	2694 (2%)
Save	6%	2660	2279 (14%)	2439 (8%)	2197 (17%)	2418 (9%)

Note: Percentage decreases in recharge are shown in brackets. A negative percentage means that recharge is predicted to increase.

Climate change will profoundly impact Zimbabwe's economy

This preliminary modeling suggests that climate change could have major impacts on Zimbabwe's water resources. Water supply to urban and rural areas in the south and west of the country could be seriously affected, and reductions in groundwater could undermine the livelihoods of rural communities.

When the reduction in runoff and groundwater recharge expected under climate change is coupled with projected high rates of population growth, the amount of water available per person could decrease to critical levels. Even with relatively low population growth, national per capita water availability is projected to decline by 38 percent; medium or high population growth scenarios could move Zimbabwe from the UN's "water stress" to the "absolute water scarcity" category.

The impacts of the reduced precipitation and increased temperatures expected under climate change on the economy of Zimbabwe could be severe, particularly in the agricultural and energy sectors. Although agriculture contributes only 14 percent of GDP, it employs 60 to 70 percent of the population; reductions in yields from climate change could have a dire impact on the livelihoods of these farmers, particularly in the south and west of the country. In addition, the manufacturing sector relies heavily on agricultural produce, so that the ripple effect of scarce resources and higher prices could be significant. The projected reductions in runoff could also decrease the efficiency of the country's hydropower plants, which currently provide over 80 percent of Zimbabwe's electricity.

Reduced precipitation and increased evaporation in southern and western parts of Zimbabwe, as well as more frequent droughts and floods, will make it more difficult to manage the country's water resources. Existing dams built for water supply and irrigation may become less reliable, and new infrastructure will need to be designed to be more resistant to extreme climate events. Reduced precipitation and runoff will likely lead to increased reliance on groundwater because it is shielded from evaporative losses and better buffered against increased climate variability than surface water, but currently most water management plans in Zimbabwe do not include groundwater.

Adaptation should be coordinated across sectors

Anticipating the potential effects of climate change should become a normal part of operational thinking in water management and planning. There are many opportunities for the water sector to adapt to climate change.

Adaptation in advance of climate change will allow water to be captured and used more efficiently in the face of declining availability, and will encourage managers and water users to respond flexibly to increased variability. Management will need to address both supply and demand: the amount of available water can be increased through reuse of wastewater, rainwater harvesting, controlling pollution, and reducing unaccounted for water in supply systems while the amount of water used can be decreased through rational pricing and revised water allocation systems. Plans for the rehabilitation and expansion of Zimbabwe's water infrastructure will also need to include the effects of climate change, and the design standards for dams, bridges, and levees should be reassessed to withstand increased flooding. The destructive force of floods could also be reduced by better protection and management of floodplains and wetlands to absorb floodwaters.

In order to adapt efficiently, it will be important to collect better information about the effects of climate change on the country's water resources and to communicate that information to communities and administrators. Surface water monitoring has deteriorated sharply over the past 20 years, and groundwater monitoring is virtually nonexistent. Without a better understanding of current resources, it will be impossible to accurately project and plan for the future.

Adapting to climate change will require coordination between water managers at every level of government. Currently the management of water resources spans the responsibility of a number of ministries. Various policy instruments (for example, the NWP and the Environmental Management Act) promote coordination, but it has been difficult to translate these principles into action. Local responses will be critical; catchment councils are the most efficient way to ensure that local needs are met and local knowledge is exploited, but ZINWA will need to support these efforts by helping councils revise and update River System Outline Plans to meet the challenges of climate change.

All the proposed measures to adapt to climate change are no-regrets options: wiser water use, increased information gathering and dissemination, and improved coordination in water management will serve Zimbabwe well no matter what the future holds. The reality of climate change increases the urgency to take action now.

Recommendations

This study illustrates the need for better scientific information if Zimbabwe is to develop a comprehensive strategy for climate change adaptation in the water sector. This includes: better data on climate and water resources gathered through comprehensive monitoring programs; better understanding of groundwater resources and use; predictive models of surface and groundwater systems; accurate assessment of current and future uses of water; and a more comprehensive exercise to model the potential impact of climate change on water resources than was possible here. This study recommends the development of a comprehensive Climate Change Adaptation Strategy for the water sector based on better information and modeling in order to implement some of the adaptation opportunities identified in this report.

The formation of the Ministry of Environment, Water, and Climate, which merges the mandates of the three key areas—environment, water, and climate—under the new cabinet, provides an excellent opportunity to re-align and work out effective coordination at the policy, regulatory, and institutional levels to systematically address climate change adaptation in the water and water-related sectors.

The Zimbabwe Water Forum Policy Notes Series

Between 2011 and 2014, at the request of the Government of Zimbabwe, through the Ministry of Water Resources Development and Management, and with support from the Zimbabwe Analytical Multi-Donor Trust Fund, the World Bank has undertaken a series of analytical studies and technical assistance in the water and sanitation sector. These studies are captured in the Zimbabwe Water Forum Policy Note Series. The task team leader for the studies is Michael Webster, Sr. Water and Sanitation Specialist in Harare (mwebster@worldbank.org) with support from Priscilla Mutikani (pmutikani@worldbank.org). All notes have been edited by Rolfe Eberhard and Hilary Gopnik.

- *Policy Note 1: A 24/7 water supply is possible for Harare and other cities: Lessons on what it takes from water manager Neil Macleod*
- *Policy Note 2: Modeling the water sector in South Africa and Zambia*
- *Policy Note 3: Zimbabwe's new National Water Policy: Responding to Challenges to Create a Foundation for Sustainable Growth*
- *Policy Note 4: The Future of Sanitation in Harare and Other Cities: Perspectives on Possible Pathways to Recovery*
- *Policy Note 5: The Beitbridge Emergency Water Supply and Sanitation Project: Lessons Learnt*
- *Policy Note 6: Zimbabwe Urban Water Tariff Study*
- *Policy Note 7: Improving the operations of Harare's water and wastewater treatment plants*
- *Policy Note 8: Zimbabwe Dam Safety Study*
- *Policy Note 9: Zimbabwe Infrastructure Policy Review*
- *Policy Note 10: Enhancing Water and Sanitation Services through Performance Contracts: Lessons from Africa*
- *Policy Note 11: Climate Change and Water Resources Planning, Development, and Management in Zimbabwe*