Lesotho: Tackling water insecurity in a changing climate

Water is one of the Kingdom of Lesotho's most valuable resources. The landlocked country's water-rich highlands enable the water sector to contribute about 8–10% to gross domestic product (GDP). The proximity of the Kingdom to major demand centres in southern Africa, along with the altitude and high-quality water, have enabled it to generate revenues through regional transfer schemes.

The country derives about 3% of its GDP from the Lesotho Highlands Water Project (LHWP), a multi-stage infrastructure project that enables the transfer of water from Lesotho to Gauteng, South Africa, a regional economic hub. The LHWP has contributed to the development of hydropower in Lesotho.

Balancing the opportunities afforded by the LHWP with the need to secure water for domestic, agricultural, industrial and commercial use is no small challenge, particularly in the face of uncertainties related to climate change. Despite its abundant water resources, Lesotho remains vulnerable to the impacts associated with regular and recurrent floods and droughts. The floods in 2011 were the largest on record since the 1930s, while the drought in 2015–16 was the most severe on record.

Although Lesotho has one of the highest rates of access to clean water in sub-Saharan Africa – 72% in urban areas and 63% in rural areas – urbanization is straining resources. Agriculture is almost entirely rainfed and therefore highly vulnerable to changes in precipitation, undermining efforts to improve food security. To achieve the government's goal of 100% access to clean water by 2020, Lesotho will need major investments in urban water and sanitation services, particularly in the lowlands, which are home to 75% of the people.

This policy brief summarizes the findings of an assessment that evaluated the performance of Lesotho's water management system and explored adaptation strategies across a range of potential future climate conditions.

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The Katse Dam, on the Malibamat'so River in Lesotho, was completed in 2009, as the centrepiece of the Phase 1 of the LHWP.

Key findings

- Water is one of Lesotho's most valuable resources, so an increasingly unpredictable and variable climate has profound implications for the structure of the economy and future development.
- The water sector contributes about 8–10% to overall GDP, with the Lesotho Highlands Water Project alone having facilitated investments of more than US$3 billion and providing sustained revenues that amount to nearly US$800 million since 1996.
- Lesotho already experiences large natural climatic variations, and the lack of adequate infrastructure exposes the economy and households to a high degree of water insecurity.
- Future climate change is likely to have important implications for water security. All the climate models indicate that average mean surface temperatures will rise, but precipitation projections vary greatly.
- Ensuring the continued sustainable development of Lesotho's water resources requires an integrated and strategic long-term approach to water resources and climate change adaptation.
- Integration of targeted investments, such as those envisaged under the Lowlands Bulk Water Supply Scheme, can increase water security, improve irrigation potential and enhance food security, while sustaining hydropower production without significant reductions in the reliability of water transfers.

Key trade-offs in developing Lesotho's water sector

The value of Lesotho's water resources is derived from its strategic position in the Orange-Senqu River Basin. One of Africa's most economically important rivers, the Orange-Senqu begins in the highlands of Lesotho and flows for more than 2,300 km across South Africa and Botswana before discharging into the Atlantic between South Africa and Namibia.

The LHWP is a binational project between South Africa and Lesotho, governed by a treaty signed in 1986 that envisaged four phases enabling the transfer of up to 70 m^3/s. Water is transferred within the Orange-Senqu River Basin through a series of dams, tunnels and associated infrastructure, and provides opportunities to supply electricity to Lesotho through associated hydropower development.[1]

The project was developed as the least-cost option to secure water for more than 12 million people in the dry Gauteng Province, which generates more than 40% of South Africa's GDP. Phases 1A and 1B have been completed, and Phase 2

1 See http://www.lhda.org.ls.

ACP-EU Natural Disaster Risk Reduction Program
An initiative of the African, Caribbean and Pacific Group, funded by the European Union and managed by GFDRR

With financial support from the European Union (EU) in the framework of the ACP-EU Natural Disaster Risk Reduction Program, managed by the Global Facility for Disaster Reduction and Recovery

was launched in 2014. Separately, Botswana has approached Lesotho to explore options for the transfer of water to Botswana from the highlands through South Africa.

Combined efforts to increase the national coverage for water supply, enhance agricultural development and build out further phases of the LHWP are central to the government's efforts to eradicate extreme poverty and promote shared prosperity. However, it has been challenging to balance the development of water resources for export with the national priority to improve domestic levels of access and enhance economic growth.

Water is a key constraint to economic development. Historically, the supply of water to urban areas in the lowlands has come from river extraction and pumping from underground sources. Increases in the urban population and commercial activity in the lowlands have led to growing demand on these resources and water supply facilities.

In the 1990s and early 2000s, Lesotho developed a strong textiles and clothing sector, driven by foreign investment geared to export markets that was facilitated through the U.S. African Growth and Opportunities Act. These water-intensive industries have boosted formal employment and made substantial contributions to overall GDP. Despite a decline in recent years, the textile industry still accounts for 60% of exports and 80% of the manufacturing work force – more than 30,000 people.

Investments in agriculture, meanwhile, are central to addressing entrenched rural poverty. Only 13% of the total land area is deemed suitable for crop production, but farming provides a lifeline for the majority of Lesotho's population. Yet productivity is low and declining, due in part to the effects of climate variability. Climate change exacerbates the risks to the agriculture and food sectors. Lesotho now imports 70% of its food, and will likely face greater shortfalls as its population grows from the current 2.1 million to a projected 2.5 million by 2030 and 3 million by 2050.[2]

Ensuring that all households have access to clean water, while meeting agricultural, industrial and commercial demands for water, will require major investments in Lesotho's water supply infrastructure. The Lesotho Lowlands Water Supply Scheme (LLWSS) aims to address those needs through a series of investments, including (i) development of new water sources; (ii) treatment of water as necessary; (iii) transfer of water to demand centres; and (iv) bulk storage.

The Metolong Dam and Water Supply Program, the first project to be implemented under the LLWSS, has provided a more secure water supply to Maseru, the capital, and to several surrounding towns. Ensuring a robust regime for sustainable management and further development of water resources will be critical to securing long-term benefits through economic development of these sectors.

Planning for an uncertain future

SEI's Water Evaluation and Planning (WEAP) system was used to analyse Lesotho's water management system in order to explore the role of water and the vulnerability of macro-economic development through to 2050. The project involved close interaction with members of several government agencies, with particular

2 United Nations (2015). *World Population Prospects: The 2015 Revision*. UN Department of Economic and Social Affairs, Population Division, New York. http://esa.un.org/unpd/wpp/.

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Workers at the Shining Century textile company in Maseru. The textiles sector, a major source of urban employment, requires a large amount of water.

focus on exploring the implications of climate change for different water infrastructure investments being considered, to improve water security in Lesotho.

WEAP considers climate, hydrological and water management systems together, to examine key uncertainties and evaluate how potential strategies might affect the reliability of the water supply for each key sector (including, in this case, water transfers to South Africa). The analysis included a detailed characterization of the current situation and future demand scenarios across 121 scenarios for future climatic conditions.

The climate models all show a rise in average mean surface air temperatures (Figure 1), ranging from 0.8°C to 2.9°C. Projections of future precipitation vary widely, however, with 64 scenarios showing drier conditions relative to the historical annual average precipitation (about 760 mm), and 57 showing wetter conditions: from a 20% decrease, to a 20% increase. It is important to note, however, that Lesotho already experiences large natural variations in precipitation year by year.

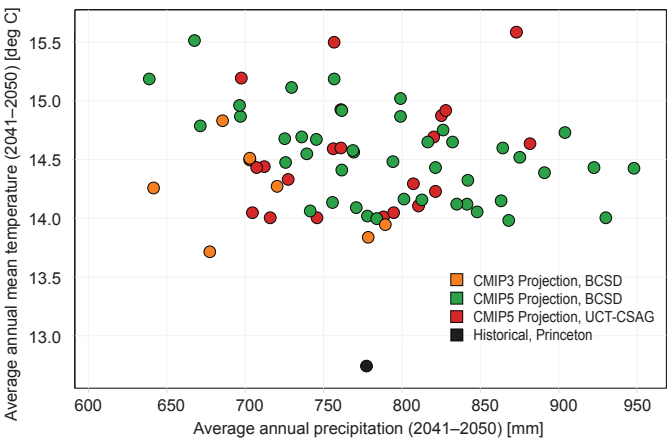

Figure 1: Temperature and precipitation projections for Lesotho, 2041–2050, under 121 climate scenarios modelled.

Lesotho's vulnerabilities and robust solutions

The aim of this project was not only to enable the Government of Lesotho to better account for risks to water resources associated with climate change, but also to help ensure that investments in infrastructure and overall development will be resilient to future shocks. Thus, the modelling process was embedded in a robust decision-making (RDM) framework.

Key uncertainties, management options or adaptations, relationships and interconnections, and key performance measures

were identified through consultation with stakeholders. The analysis does not try to assign probabilities to different scenarios, but rather examines how each strategy performs against each measure, looking for the most robust performance across the range of future scenarios. It also highlights trade-offs. For example, one strategy may perform well against one measure, but poorly against another, while a second strategy may do the opposite. The results can facilitate decision-making even under highly uncertain conditions.

Baseline conditions

The analysis quantified vulnerabilities in the access to water across different sectors, focusing on domestic and industrial use, irrigation, hydropower production and water transfers to South Africa through the LWHP.

As a first step, the analysis considered what would happen if no further infrastructure were developed. Even with average precipitation similar to the historical past, deficits for domestic and industrial demand could be 32–110 million m^3/year. Unmet domestic and industrial demands grow significantly after 2025: by 2050, over half the projections show shortages of more than 15% of demand. Demand in the urban domestic and industrial sectors in Lesotho is not reliably met under any of the climate futures.

Hydropower production under historical climate is highly constant, producing the maximum amount of 674 GWh for all but one year between 2015 and 2050. Production is also at or near the maximum for most years for the other climate scenarios. Only near the end of the 2040s does production fall below the maximum in more than 25% of the scenarios. Meeting water delivery commitments to South Africa, however, becomes increasingly difficult over time in the absence of further LHWP phase and with increasing demand. From 2041 to 2050, transfer deficits occur in 49% of the climate scenarios.

Alternative management options

In addition to the baseline strategy, four other strategies were considered for infrastructure construction and water prioritization that can support the country's development. Two strategies were considered individually: (i) construction of the Polihali Dam under Phase 2 of the LHWP; and, (ii) full development of all future phases of the LHWP (including Polihali). In addition, three combinations were considered:

1. Full development of the LHWP plus the LLWSS;
2. Development of the Polihali Dam plus the LLWSS, along with development of irrigation to support 12,000 ha of agricultural production;
3. Full development of the LHWP, the LLWSS, and development of irrigation to support 12,000 ha of agricultural production.

The vast majority of water resources are allocated to transfers under the LHWP (see Figure 2). Still, the transfer commitments can be met while still supporting development of domestic service provision. The analysis shows that continuing to build out the LHWP – particularly the development of the Polihali Dam under Phase 2 – reduces the risk of failing to meet water delivery commitments to South Africa. Transfer deficits only occur in 13% of the climate scenarios. Hydropower production is also more robust.

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Most of Lesotho's agriculture is rainfed, with low productivity. Another 12,000 ha of irrigated land could boost production by as much as 50%.

Development of the LLWSS would improve the resilience of the domestic sector. Unmet demand still exceeds 15%, but by much smaller amounts than in the baseline case. Importantly, the model indicates that implementing this strategy would not affect the reliability of transfers to South Africa under the LHWP.

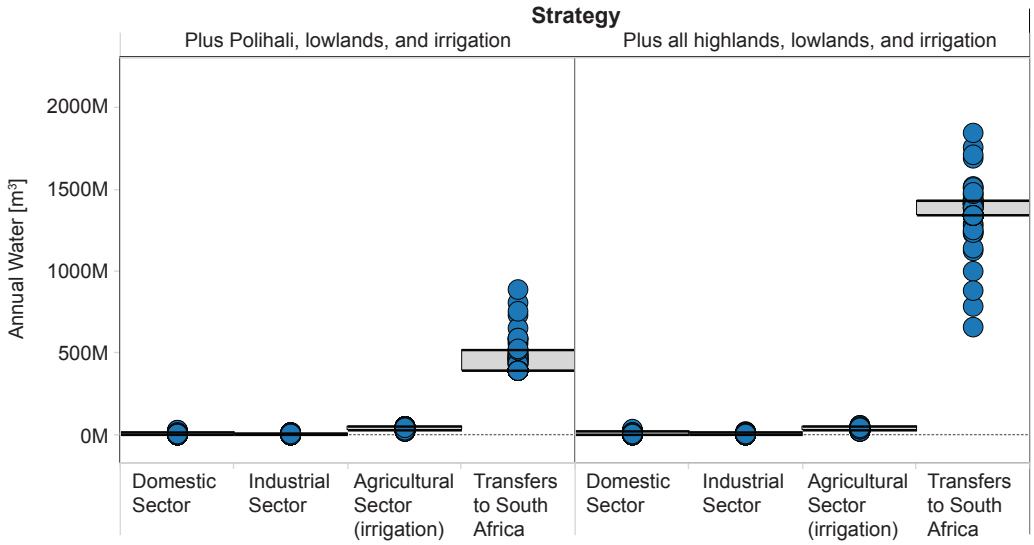

Figure 2: Allocation of additional water supplied by the different strategies in 2050, relative to the baseline, across all climate scenarios.

Implementing the lowlands scheme and expanding irrigation would not jeopardize the reliability of the water transfers to South Africa. The analysis identified both a Plus Polihali, Lowlands, and Irrigation strategy and a Plus All Highlands, Lowlands, and Irrigation strategy. These two strategies both dramatically increase the amount of water exported to South Africa and divert enough water to the lowlands to significantly reduce the projected shortages and increase food production in future decades.

Policy recommendations

• There are dual opportunity pathways to secure national development interests while also maintaining the opportunities and obligations under the LHWP. These opportunities are enhanced through the development of Phase 2. Both objectives can be achieved and are considered robust to changes in climate.

• Continued development of the LLWSS is critical for the domestic and industrial sectors. Exploring interconnections between the LHWP and the lowlands bulk water supply scheme could enhance resilience and balance the opportunities afforded through the regional transfer of water with national priorities.

• Improved data are needed to continue to develop more sophisticated analyses of the complex issues around the country's most important natural resource. Data constraints around agriculture, the economic uses and value of water, climate and hydrology have the potential to undermine future opportunities.

• Sustained capacity development will be needed to enable stakeholders to continue to build on the tools developed and to fully integrate the data, modelling and information into national planning processes.

• Extending the adaptation analysis could provide valuable new perspective. This may include extending the time-frame to the end of the 21st century; modelling water supply and demand on a daily basis; and extending the geographic scope to include demand areas in South Africa that rely on water transfers.

• A more thorough assessment is needed of the implications of climate change for Lesotho's agricultural sector, including the impact of rising carbon dioxide (CO_2) concentrations, rising temperatures, and water stress. This could inform the development of adaptation measures tailored to local conditions.

Investments in expanding irrigation would have significant impacts on Lesotho's development trajectory, increasing incomes and enhancing food security. The addition of 12,000 ha of irrigation could substantially boost production of maize, beans, peas, sorghum, and wheat. The increase could range from 70,000 to more than 100,000 tonnes per year, depending on the climate scenario. While the yields would vary yearly, this would represent an increase of as much as 50% over the current rainfed production.

Conclusion

The analysis does not prescribe a water management strategy for Lesotho, but rather examines how different strategies would affect water availability for different sectors under a wide range of possible future conditions. The results show how different strategies are likely to perform and so provides the tools to empower stakeholders to act with more confidence in the face of uncertainty.

Specifically, the analysis shows that climate change has significant implications for Lesotho's future economic development. Domestic and industrial water security is highly vulnerable even under current climate conditions, but implementation of the LLWSS and other potable water supply infrastructure investments, along with the Polihali Dam, can reduce these vulnerabilities.

Agriculture will remain vulnerable to variations in precipitation in the absence of investments in the development of irrigation infrastructure. However, projected development targets can be met without significantly reducing the reliability of transfers to South Africa.

The analysis also shows that the LHWP can continue to reliably meet transfers to South Africa unless the climatic conditions become drier by 5% or more. Building the Polihali Dam will increase the potential transfers and improve reliability. Full development of the LHWP will increase the transfer capacity and would also support development of water supply and irrigation schemes in the lowlands.

In addition, the assessment suggests that transfers to both South Africa and Botswana could be reliably met under future scenarios in which the climate is about the same, or wetter, than historical trends. Under drier climates, there would be a trade-off between meeting the transfer targets for Botswana and South Africa.

Adapting to future challenges, including climate change, is a long-term process that affords time and opportunities for strategic planning and investments. With this analysis in hand, decision-makers in Lesotho are well positioned to make robust choices to support their country's sustainable development.

This policy brief was written by Annette Huber-Lee, Stephanie Galaitsi and Marion Davis, all of SEI's U.S. Center, and Marcus Wishart and Ijeoma Emenanjo of the World Bank. It is based on the World Bank report *Lesotho Water Security and Climate Change Assessment*, published in August 2016, available at: http://hdl.handle.net/10986/24905.

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