The Ecological Reserve means the quantity and quality of water required to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource. This is an allocation of water to sustain a river ecosystem so that it continues to provide the desired ecosystem services, such as water supply and quality, flow regulation and aquatic productivity, to society.

4. Future research needs

Research is required to support the development of tools, approaches and case studies that inform water planning for long-term climate change. This includes understanding the way in which climate driven changes in the availability of, and demand for, water resources may constrain or enable different development pathways in different parts of South Africa. Of particular relevance are cross-sectoral implications of the allocation of water resources, including groundwater resources. In addition, it would be valuable to explore the changing long-term hydrological implications of climate change for the ecological reserve (including the appropriate definition of the reserve) and the associated catchment management approaches needed to maintain the ecological reserve in different systems (see Box 5).

5. Conclusion and linkages

Climate change impacts on South Africa are likely to be felt primarily via effects on water resources. There is substantial uncertainty for rainfall scenarios, and thus neither drier nor wetter scenarios can be excluded. Under a drier future scenario, significant trade-offs are likely to occur between developmental aspirations, particularly in terms of the allocation between agricultural and urban-industrial water use, linked to the marginal costs of enhancing water supply. These constraints are most likely to be experienced in central, northern and south-western parts of South Africa, with significant social, economic and ecological consequences through restricting the range of viable national development pathways. Under a wetter future scenario, trade-offs in water allocation between sectors are likely to be less restrictive, providing greater scope for urban-industrial economic growth and water provision for an intensive irrigated agricultural production model. In both wetter and drier futures, a higher frequency of flooding and drought extremes is expected with cross-sectoral effects on human settlements, disaster risk management and food security. There is a need to explore the socio-economic implications of a range of possible climate-water futures to inform key decisions in development and adaptation planning in South Africa in order to build the climate resilience of vulnerable communities and groups. International mitigation action could sharply reduce uncertainty relating to changes in hydrology and water supply in South Africa.

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Photos by Gigi Laider

CLIMATE CHANGE AND THE WATER SECTOR

The project is a part of the International Climate Initiative (ICI), which is supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

The Ecological Infrastructure and the Ecological Reserve

CLIMATE CHANGE SCENARIOS AND ADAPTATION PATHWAYS

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BOX 1. CLIMATE CHANGE WATER QUALITY-RELATED IMPACTS.

- Less irrigation and drinking water could be available due to increasing air and water temperatures.
- Favourable conditions for the incubation and transmission of water-borne diseases may be created by increasing air and ambient temperatures due to increasing water temperatures linked to higher temperatures.
- Increased fish mortality due to reduced oxygen concentrations in dams, wetlands and soil/plant systems from increased water temperatures.
- Increased periods of drought mean less water is available.
- Deterioration in water quality due to increased salt concentrations in dams, wetlands and soil systems from increased evaporation rates.
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- Human health and ecosystem impacts, associated with increased rainfall intensities, flash floods and regional flooding including overflowing sewers due to sewage pipes blocked with washed-off debris, damage to sewerage infrastructure resulting in raw sewage discharges into rivers, scouring and erosion of urban streams, increased sediment and pollutant overflow and damage to low-lying water and wastewater treatment works disrupting drinking water supplies.
- Increased periods of drought mean less water is available to dilute wastewater discharges and irrigation return flows resulting in reduced water quality and associated downstream health risks to aquatic ecosystems.

BOX 2. HYDROLOGICAL MODELLING IN SOUTH AFRICA

- Hydrological modelling is used to understand how changes in precipitation, temperatures and carbon dioxide will affect hydrological processes such as runoff, soil moisture and evapotranspiration.
- South Africa has developed considerable expertise and technology in modeling hydrological processes linked to climate variability and change.

- The Agricultural Catchments Research Unit (ACRU) and the Pilgrim models are two key approaches used for modeling the effects of changes in rainfall and evaporation on the hydrological system in South Africa.
- The approach has particular strengths for understanding the impacts of extreme events at the daily time-scale, and for fine scale sector-specific understanding, while the Pilgrim model approach has strengths relating to broader time and spatial scales and for cross-sectoral integrated assessment.

A key impact of climate change will be changes in runoff across the country. Under a wetter future climate scenario, significant increases in runoff would result in increased flooding, human health risks, ecosystem disturbance and aesthetic impacts (see Box 3). Drier future climate scenarios would result in reduced surface water availability, but would not exclude the risk of extreme flooding events. Projections for national runoff range from a 20% decrease to a 65% increase based on an unmitigated emissions pathway, which reflects substantial uncertainty in rainfall projections. Across the country, this ranges from increases along the eastern seaboard and central interior to decreases in much of the Western and Northern Cape.

Areas showing the highest risk from extreme runoff include Kwazulu-Natal, parts of southern Mpumalanga and the Eastern Cape. Other areas show neutral to reduced risk from runoff, with the exception of the central and lower Orange River region (Figure 1). Specific areas of high risk from increased evaporation, decreased rainfall and decreased runoff include the south-west of the country, the central-western areas and to some extent the extreme north.

If global emissions are constrained to stabilise at 450 ppm CO2, the risk of extreme increases and reductions in runoff could be sharply reduced, and the impacts could be reduced by a 30% decrease and a 20% increase in annual runoff, reflecting sharply reduced uncertainty in rainfall projections.

BOX 3. EFFECTS OF EXTREME CHANGES IN RUNOFF AS A RESULT OF CLIMATE CHANGE

- Increased erosion and sedimentation, causing loss of fertile topsoil and reductions in the fertility and quality of agricultural produce as well as disruptions in aquatic ecosystems.
- Increased transportation of water pollutants (petroleum and hazardous substances/chemicals, herbicides, fertilisers and sediments) through surface water, groundwater and soil systems leading to human health risks, contamination of drinking water, ecosystem disturbance and aesthetic impacts on water resources.
- Increased flooding or drought, resulting in loss of life, livelihoods and assets, damage to infrastructure, contamination and/or limitation of water supplies, loss of crops, and community displacement.

3. Adaptation responses

To build resilience to climate change in the water sector, response strategies that do not foreclose future options, but develop the ability to respond to unforeseen events, monitor indicators so that changes can be observed, and adopt flexible planning to allow appropriate responses as conditions change (see Box 4).

Three types of resilience can be considered for the water sector in the medium and long-term. Development resilience is related to economic and social systems supporting equity and growth. Water resilience builds on integrated planning and is based on water management that responds to hydrological variability. Climate resilience expands on water resilience, but ensures that water management is robust under future climate conditions (Figure 2). Key decisions will benefit from considering the implications of a range of possible climate-water futures facing South Africa. A scenario-based approach is a viable way forward with respect to exploring adaptation options. This is because the current modelling of future climate is uncertain with respect to rainfall variability and seasonality change, but more certain with regard to warming projections.

Adaptation response strategies for the water sector in South Africa can usefully be identified at district governance levels (Figure 3). Coherence and consistency in adaptation planning is required between the national, the water management area or system, and the sub-catchment or municipal scales. However, specific adaptation interventions differ for each level and focus area. For example, water resources management requires effective monitoring, flexible institutional rules and capacitated organisations to observe and respond to changing climate conditions; water resources infrastructure requires robust infrastructure with operational flexibility to perform under different future climate conditions; and water services requires coherent planning with other municipal services, with flexibility in water infrastructure and services under different climate futures.

At national scale, the development of strategic and enabling frameworks for adaptation would help to ensure a coherent national response. At sub-national or system scale, key institutions could usefully engage in prioritising and allocating resources to interventions that take account of adaptation imperatives. At sub-catchment or municipal scale, the design of local implementation actions should respond to local challenges, resources and capacity.