

Revealing the Impacts of Dams and Land Cover Change on Luvuvhu River Baseflows

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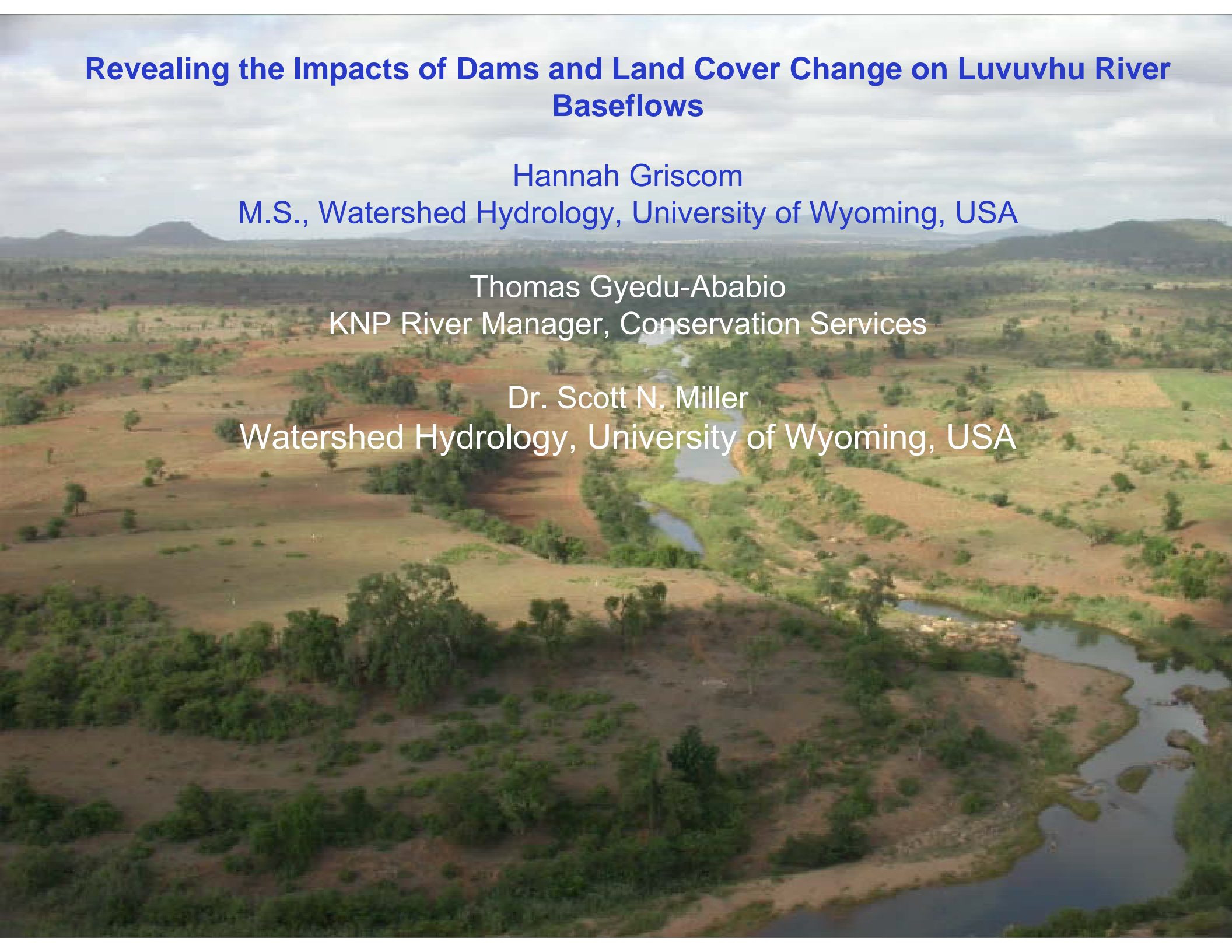
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KNP River Manager, Conservation Services

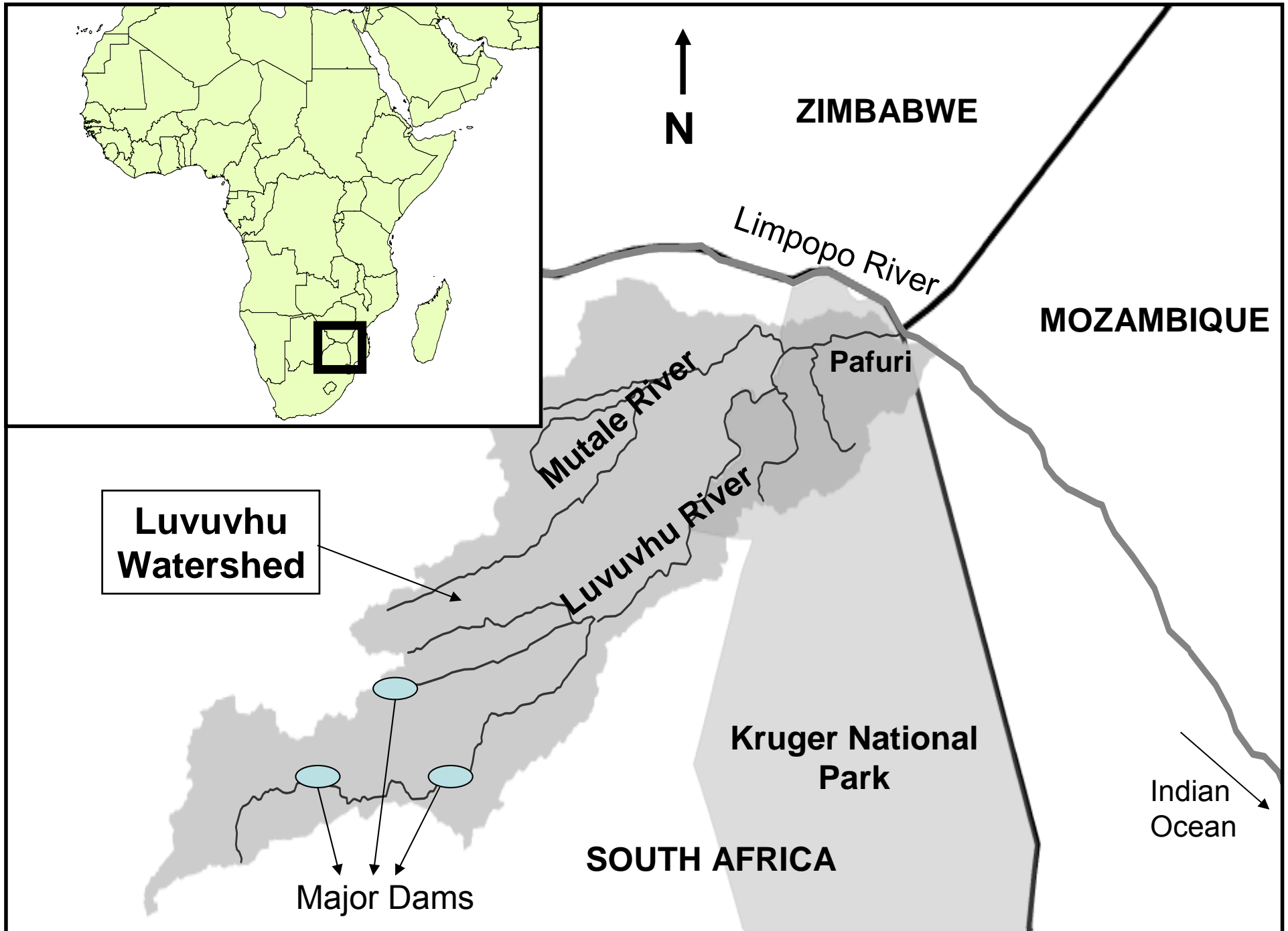
Dr. Scott N. Miller

Watershed Hydrology, University of Wyoming, USA



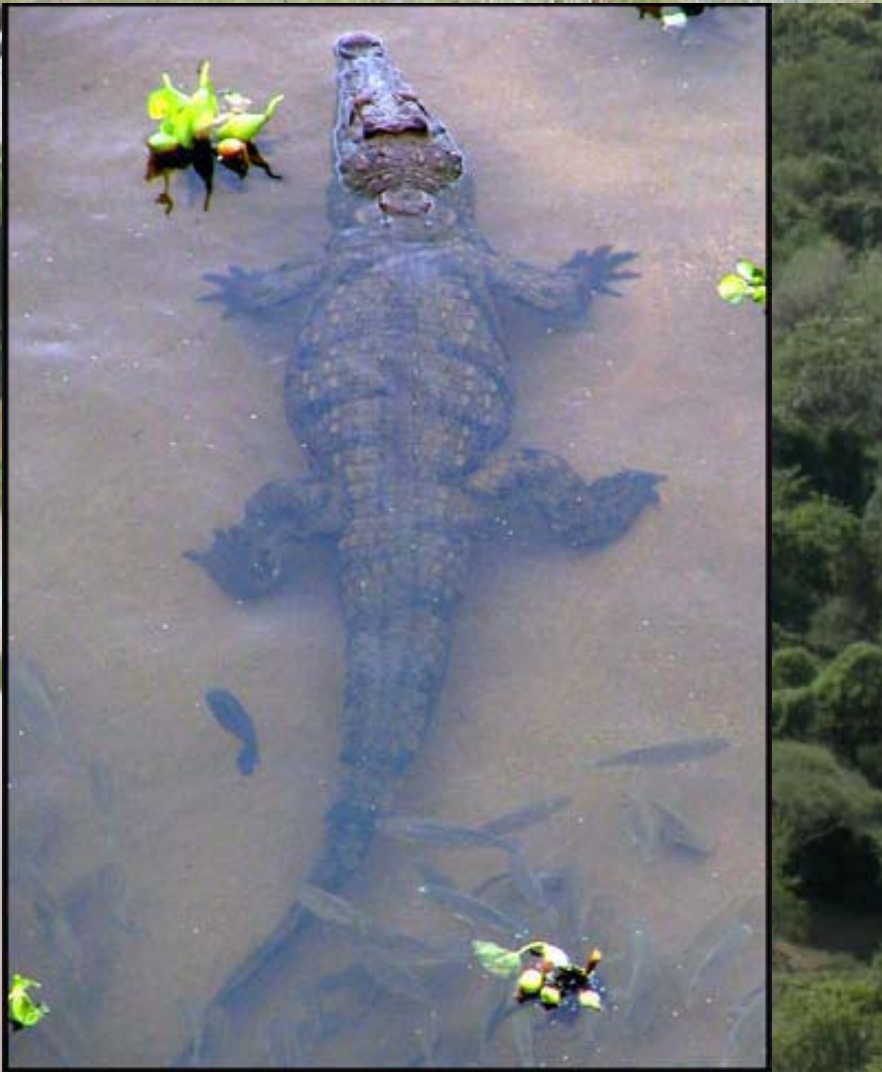
The Luvuvhu Catchment

6,000km²





IVU



A landscape in the Pafuri region showing a mix of green trees and dead, skeletal trees under a clear blue sky. The foreground is dominated by green grass and some small green trees. In the middle ground, there are several dead, skeletal trees with bare branches. The background shows a line of green trees under a clear blue sky with a few small white clouds.

A drying trend in the Pafuri....

- **River dries annually since mid-1960s (some pools remain)**
- **Drought in 1991-1992**
 - **river dried for 10 months**
 - **50% of outer riparian zone trees died**
- **“Dams, extractions, and land cover change” blamed**

Research Questions

- 1. How are land cover change and dams drying the river?**
- 2. Can these factors be separated within a hydrological modelling framework?**
- 3. How can further ecological degradation be avoided?**

Research Questions

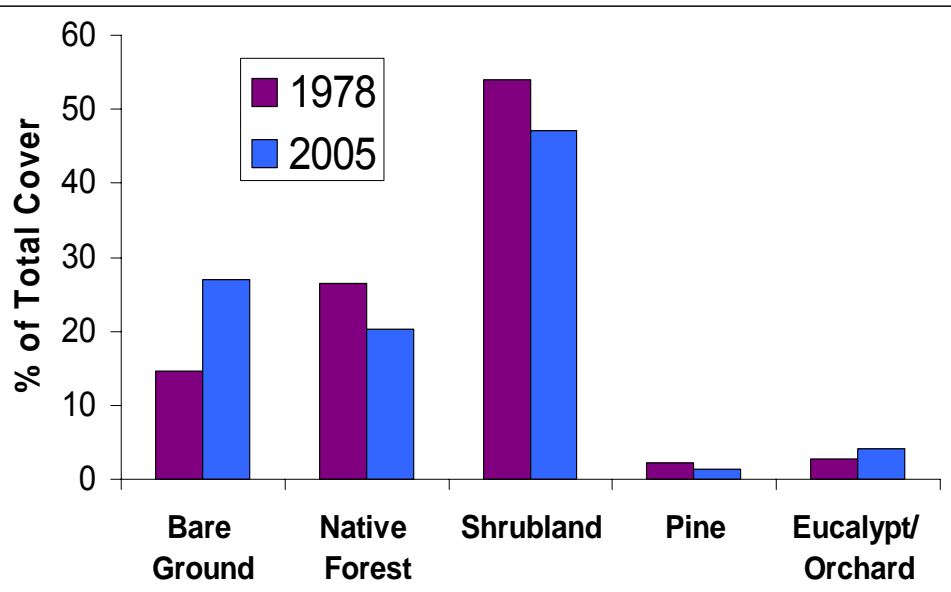
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Land Cover Change

1978

- Bare Ground
- Native Forest
- Shrubland
- Pine Plantations
- Eucalyptus Plantations and Irrigated Orchards

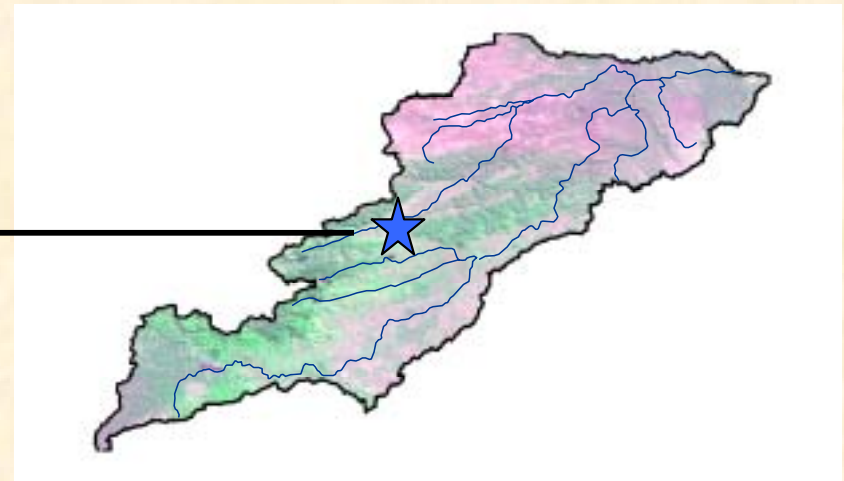
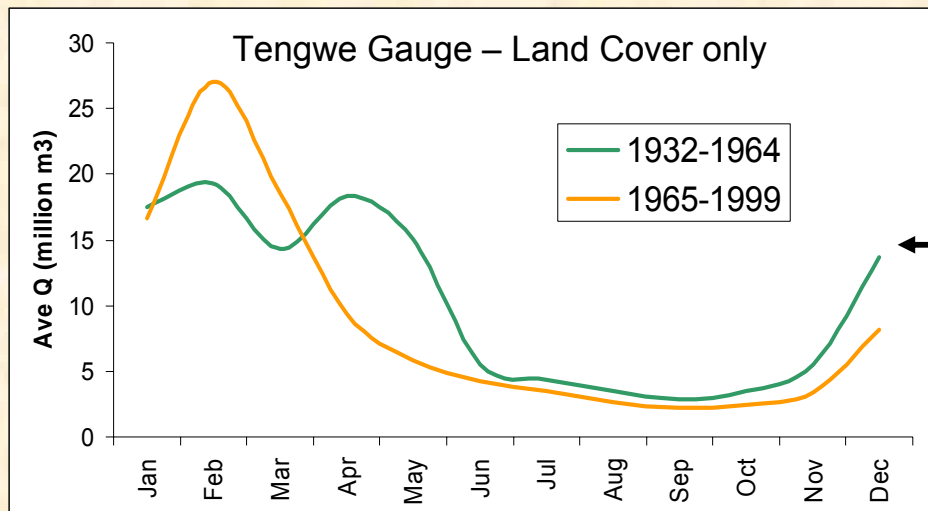
2005



Hypothesized Role of Land Cover Change in Reduced Baseflows



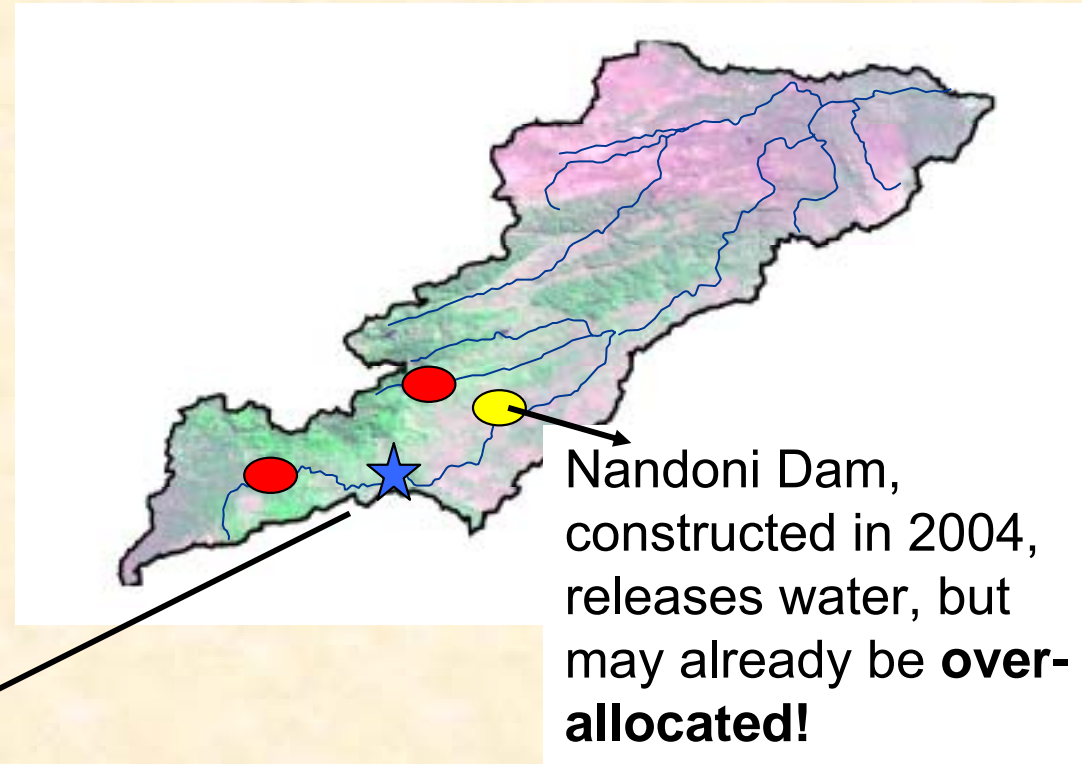
- Population growth and agricultural practices have resulted in:
 - Reduced rainfall infiltration and percolation (more overland flow)
 - reduced groundwater recharge
 - reduced baseflows



Hypothesized Role of Dams in Reduced Baseflows

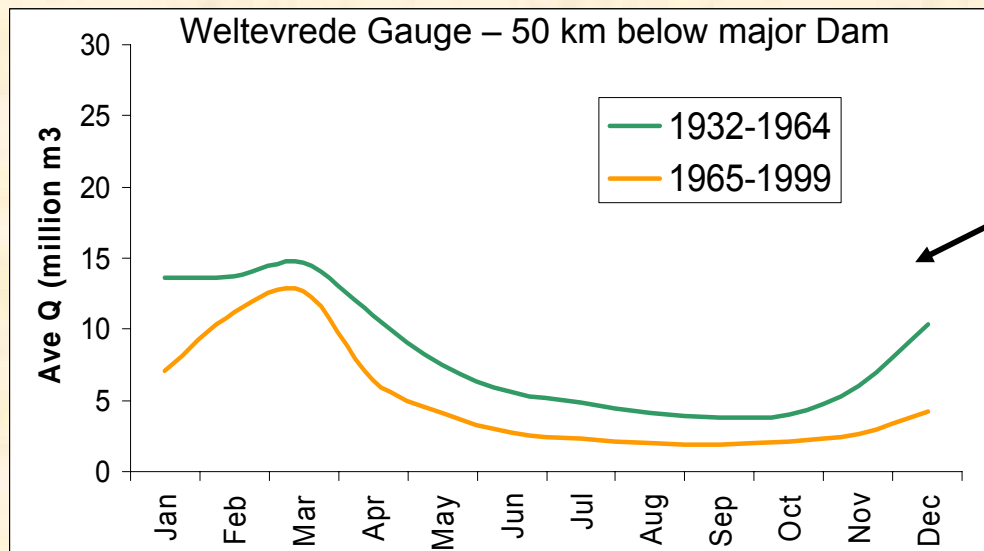


- Dams established in 1952 and 1982 are managed for **total retention**.



Nandoni Dam, constructed in 2004, releases water, but may already be **over-allocated!**

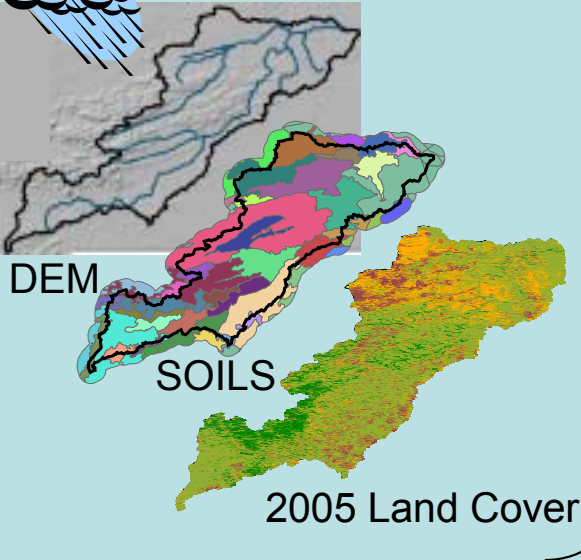
- Due to the downstream dependence on instream flows, these dams have reduced baseflows



Research Questions

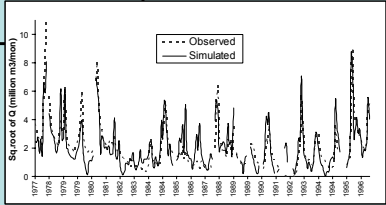
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Modeling Framework



Build and calibrate model

30-year river discharge record



Transfer parameter estimates

Scenarios

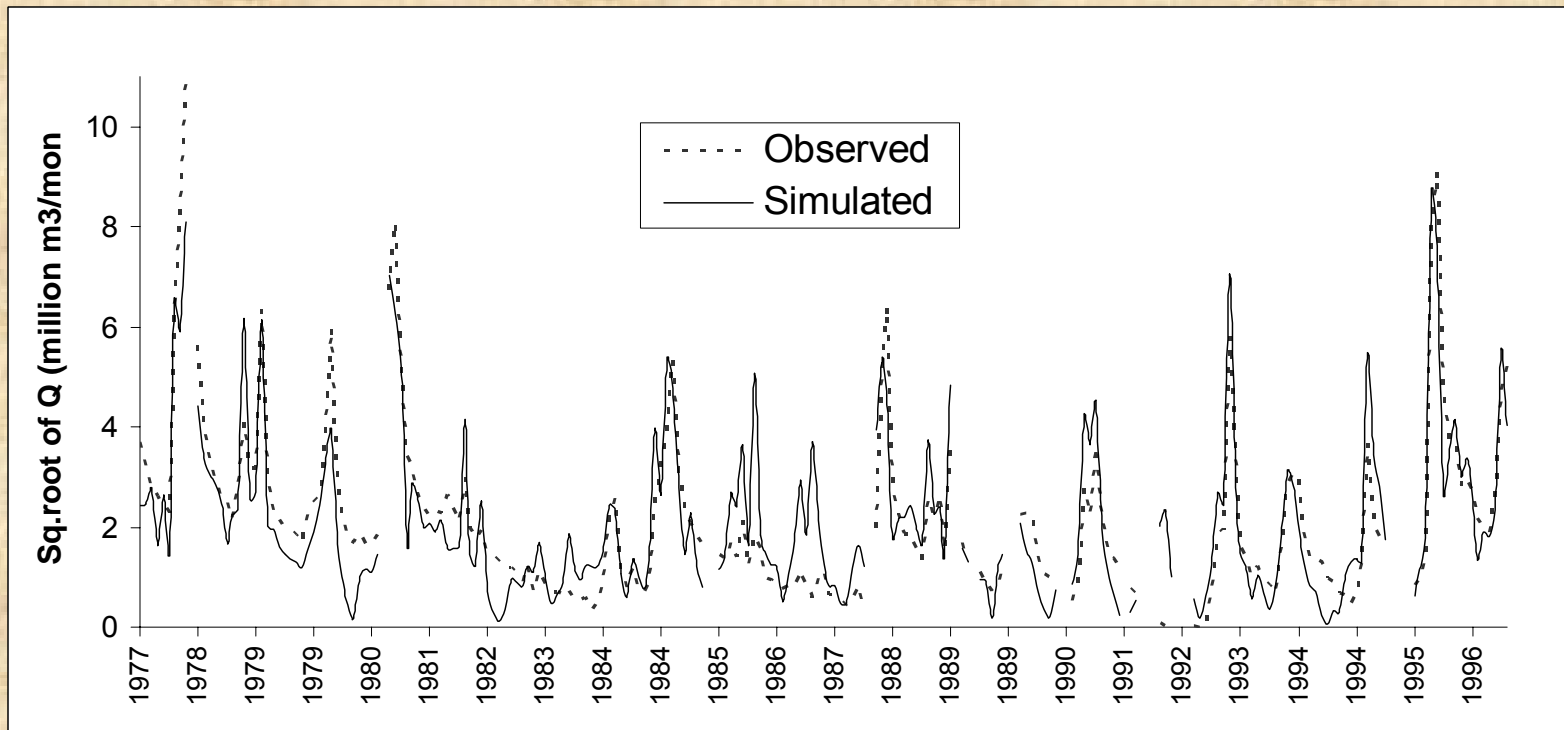
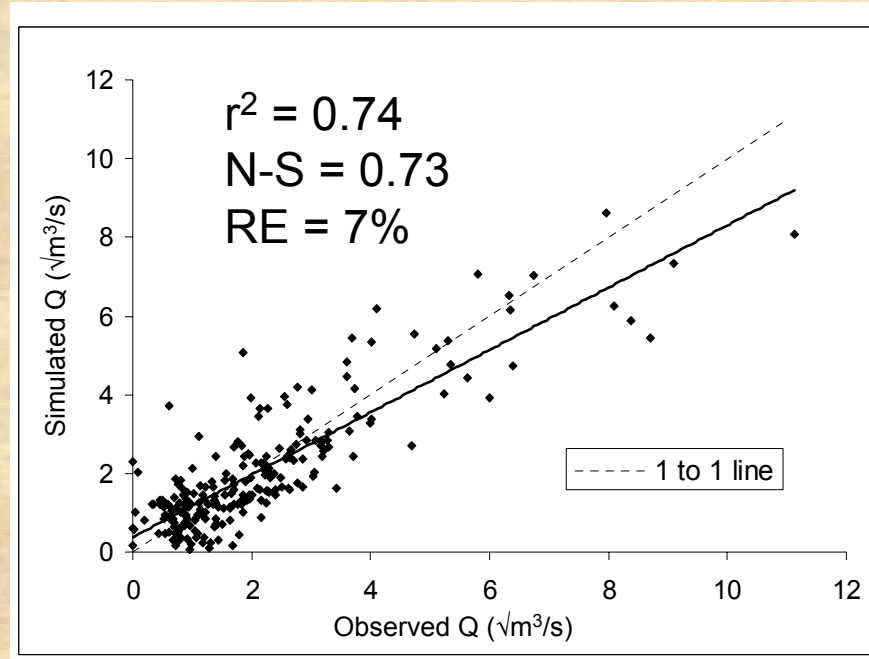
Name	Dams	Land Cover
2 Dams/ Baseline		+
1978		+
No dams		+
Nandoni - no release		+

Run Model

Compare outputs:

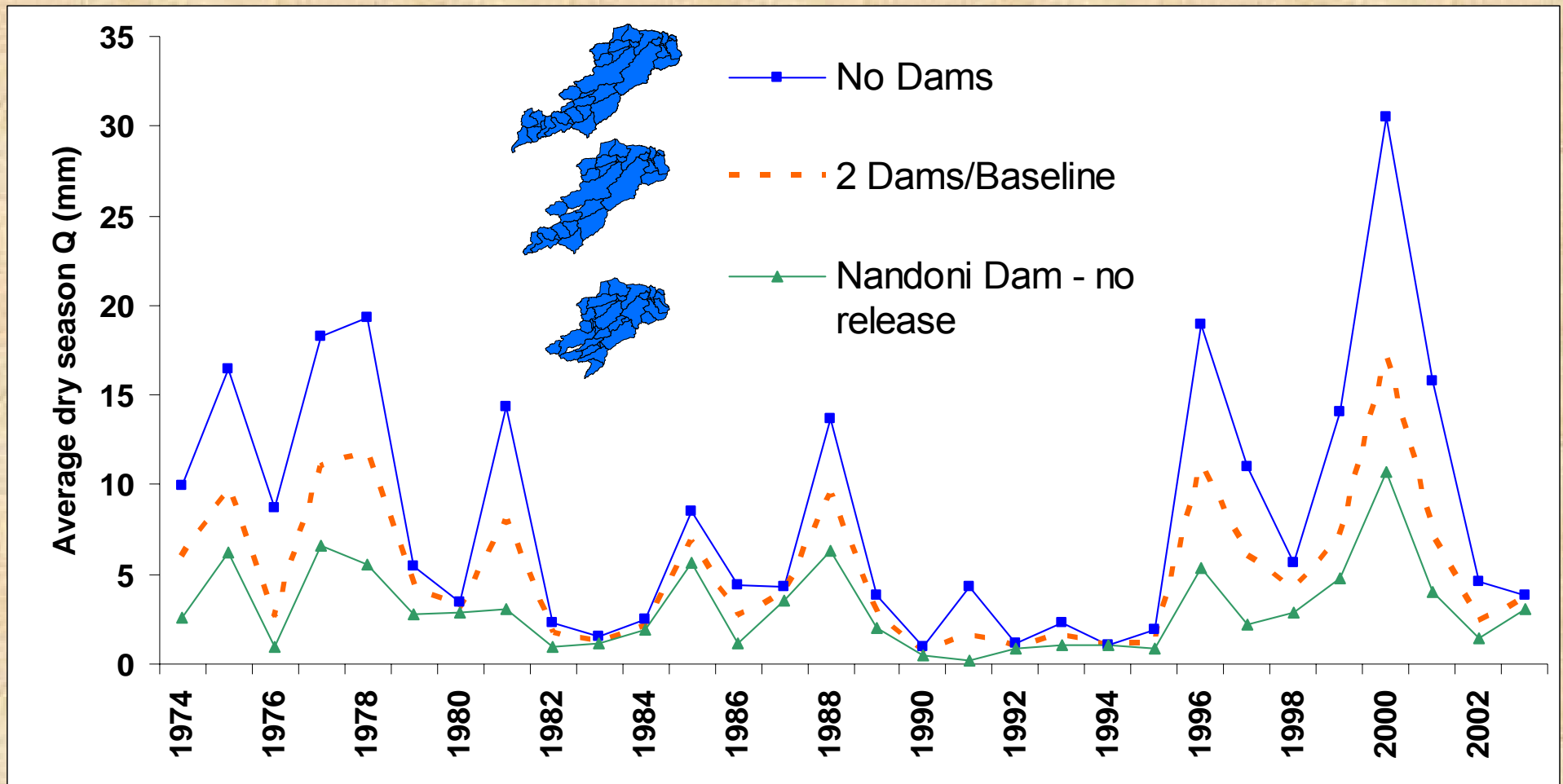
- a. Dry season flows
- b. # of months $Q < 1.5 \text{ m}^3/\text{s}$
- c. # of times $Q < 1.5 \text{ m}^3/\text{s}$ for 3 or more consecutive months (extended drought)

Model Performance



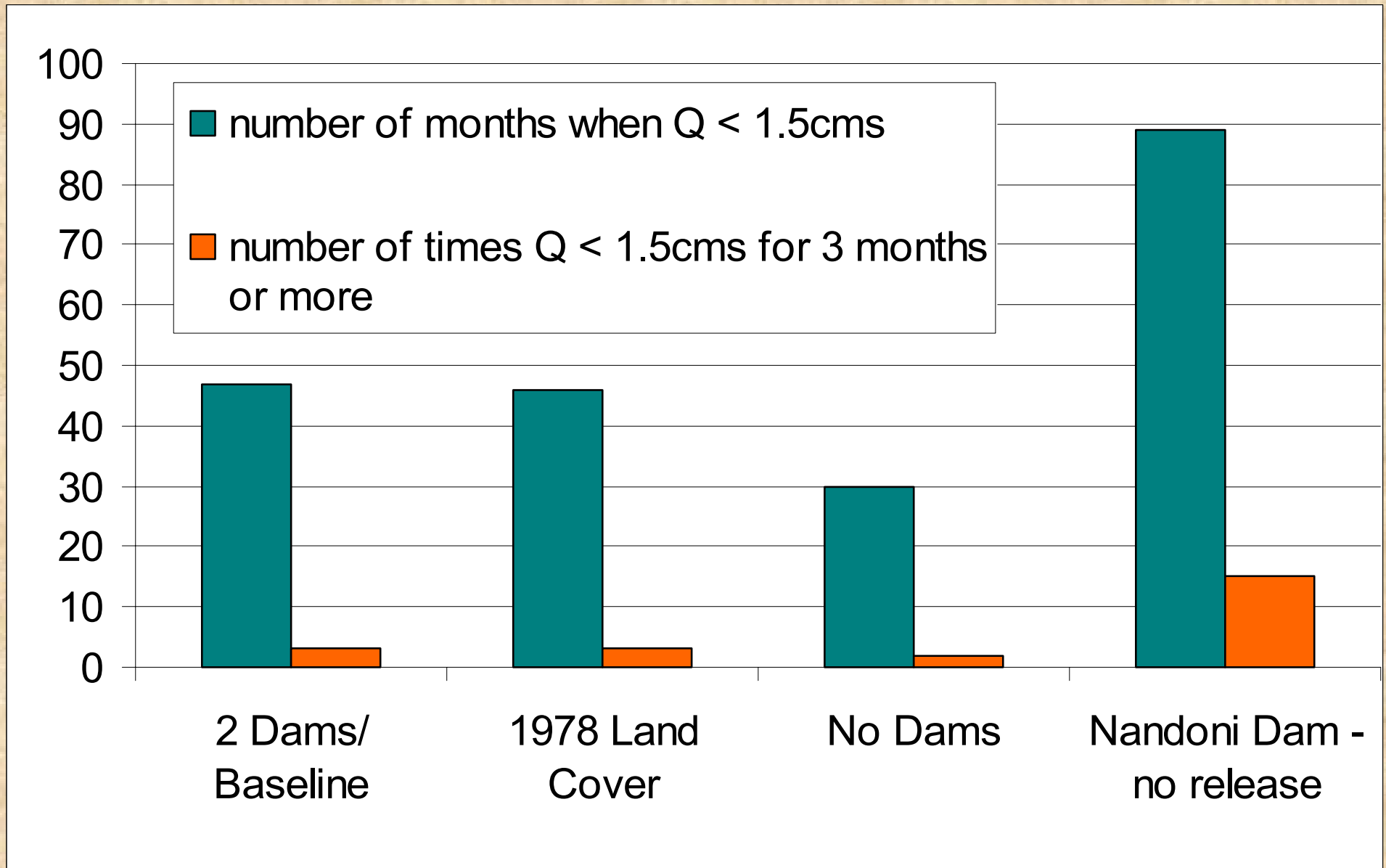
MODEL RESULTS

Modeled average dry season yield at Kruger National Park



MODEL RESULTS

Modeled abundance and persistence of extremely low flows in Kruger National Park under all scenarios (1974-2003)



MODEL RESULTS

Land Cover Change

- Why no difference between 1978 and 2005 output?

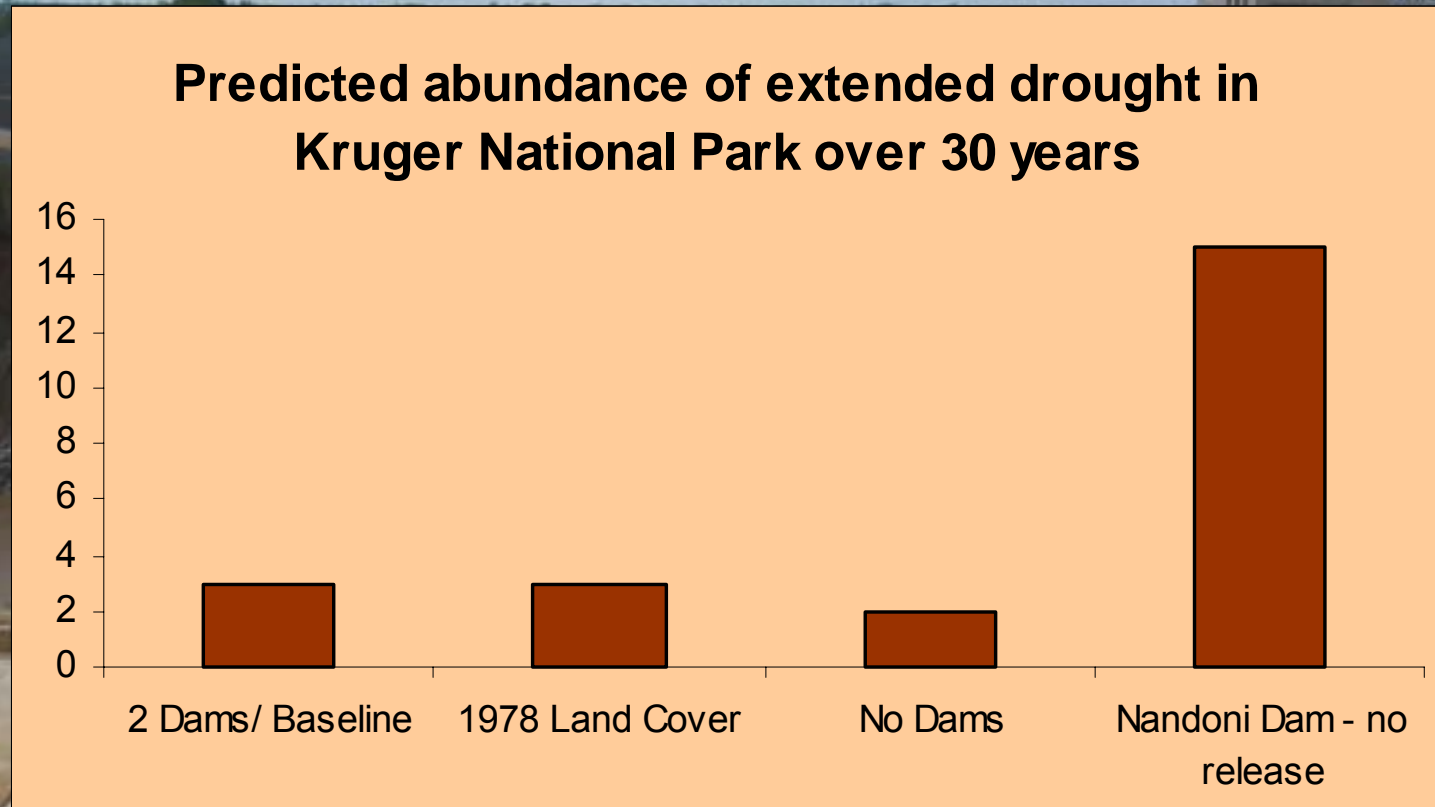
Explanations

- 12% increase in bare ground occurred primarily in low precipitation regions – not sufficient to trigger model response**
- Weaknesses in ground water component of model**

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Management Implications



Dam management is **more important** than land cover change

-Next steps:

- Held meeting with DWAF (dam management agency)**
- Hope to educate and influence future strategies through publications and outreach**

Acknowledgements

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- Wyoming NASA Space Grant Consortium and Wyoming NASA EPSCoR (NASA Grant #NGT-40102 40102 and #NCC5-578)
- University of Wyoming, USA

People

- Dr. Scott Miller, major advisor
- Dr. Thomas Gyedu-Ababio, KNP River Manager
- Patrick Xibambu, project assistant
- Sandra Mac Fadyen, KNP GIS and Remote Sensing Analyst
- Jaques Venter, KNP Biological Technician
- Thomas Mbokota, KNP head ranger

Thank You!

