

How much streamflow is groundwater discharge?

- A method for assessment

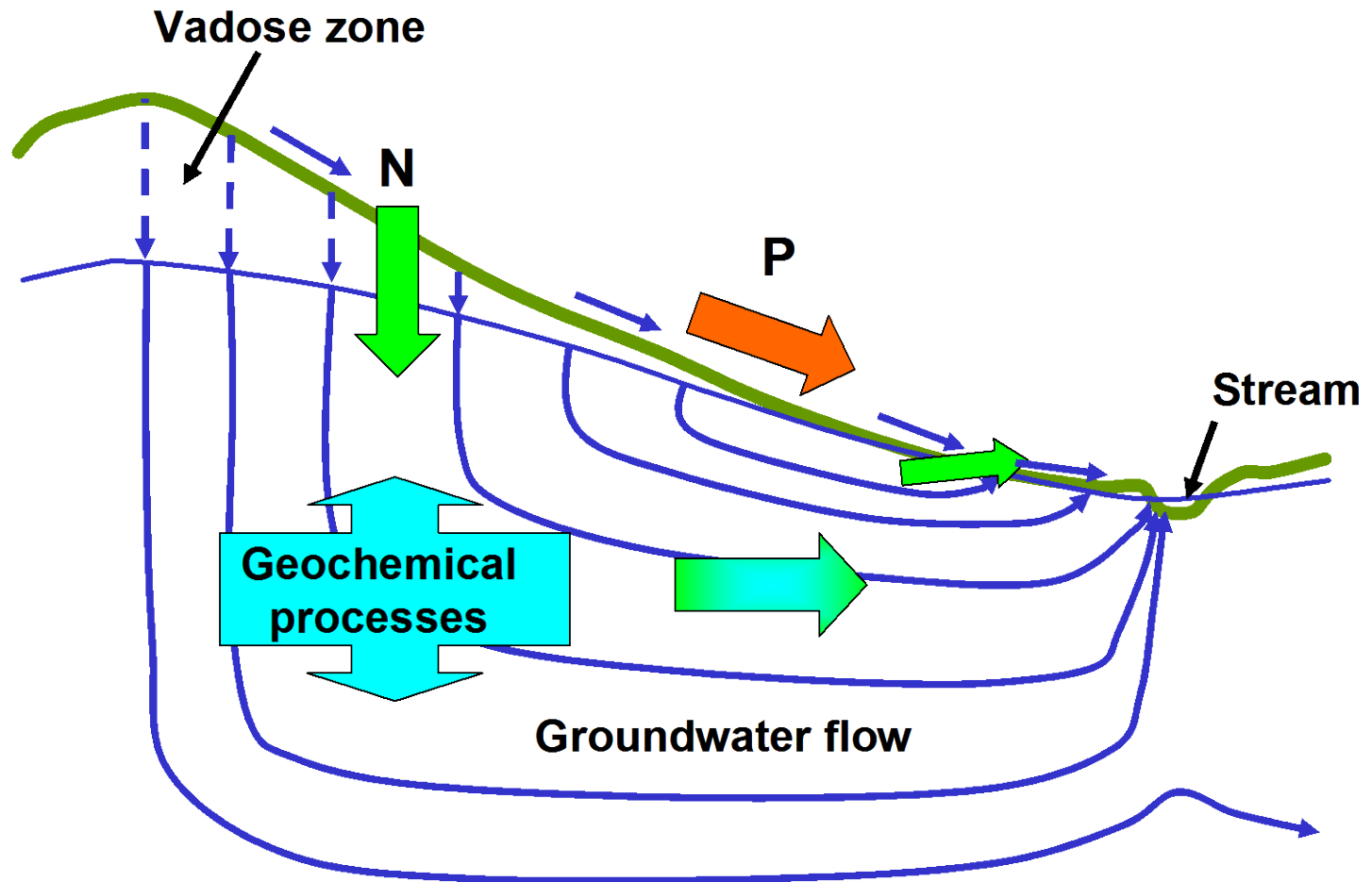
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Why do we want to know?

1. Water quality

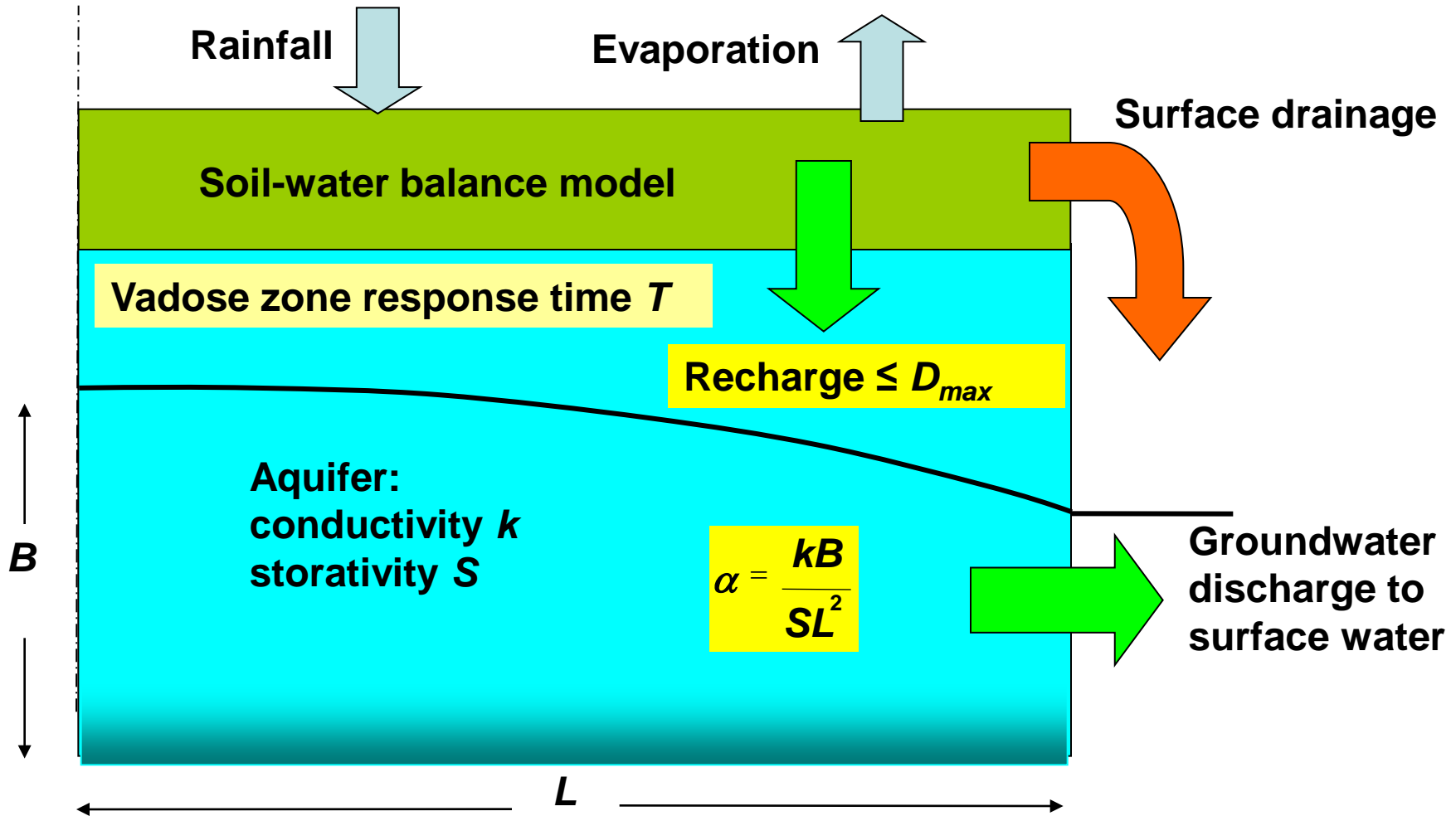


Why do we want to know?

2. Water quantity

- **Groundwater discharge is the source of “baseflow” in streams**
- **Baseflow is vital for stream ecology and human use**
- **Temporal distribution of baseflow (e.g., recession rate) is determined by the dynamics of groundwater discharge**

Model of groundwater discharge



Two questions to be addressed and two model parameters to answer them

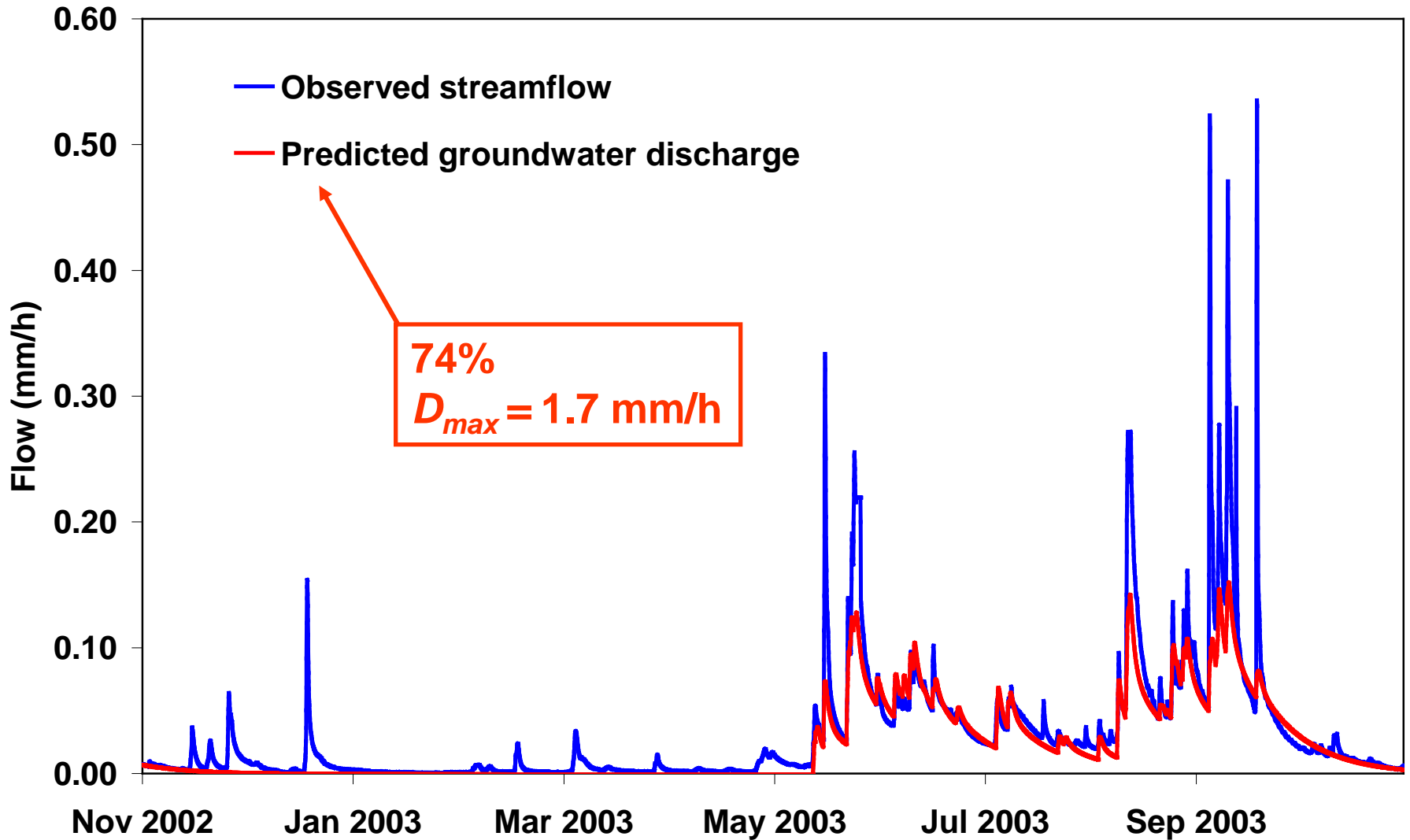
1. What proportion of catchment drainage becomes groundwater discharge?
 - Defined by the maximum recharge rate D_{max}
 - What is the temporal distribution of the groundwater discharge?
 - Defined by the parameter α of a dynamic groundwater model that maintains a set of water storage states
 - These two parameters are optimised for best fit to the lower range of streamflow values

Example 1: Toenepi Catchment, Waikato

- **Area = 15.1 km²**
- **Slope: flat (89%), rolling (10%), steep (1%)**
- **Elevation: 40 – 130 m (amsl)**
- **Land use: dairy pasture**
- **Installed surface and subsurface drainage**

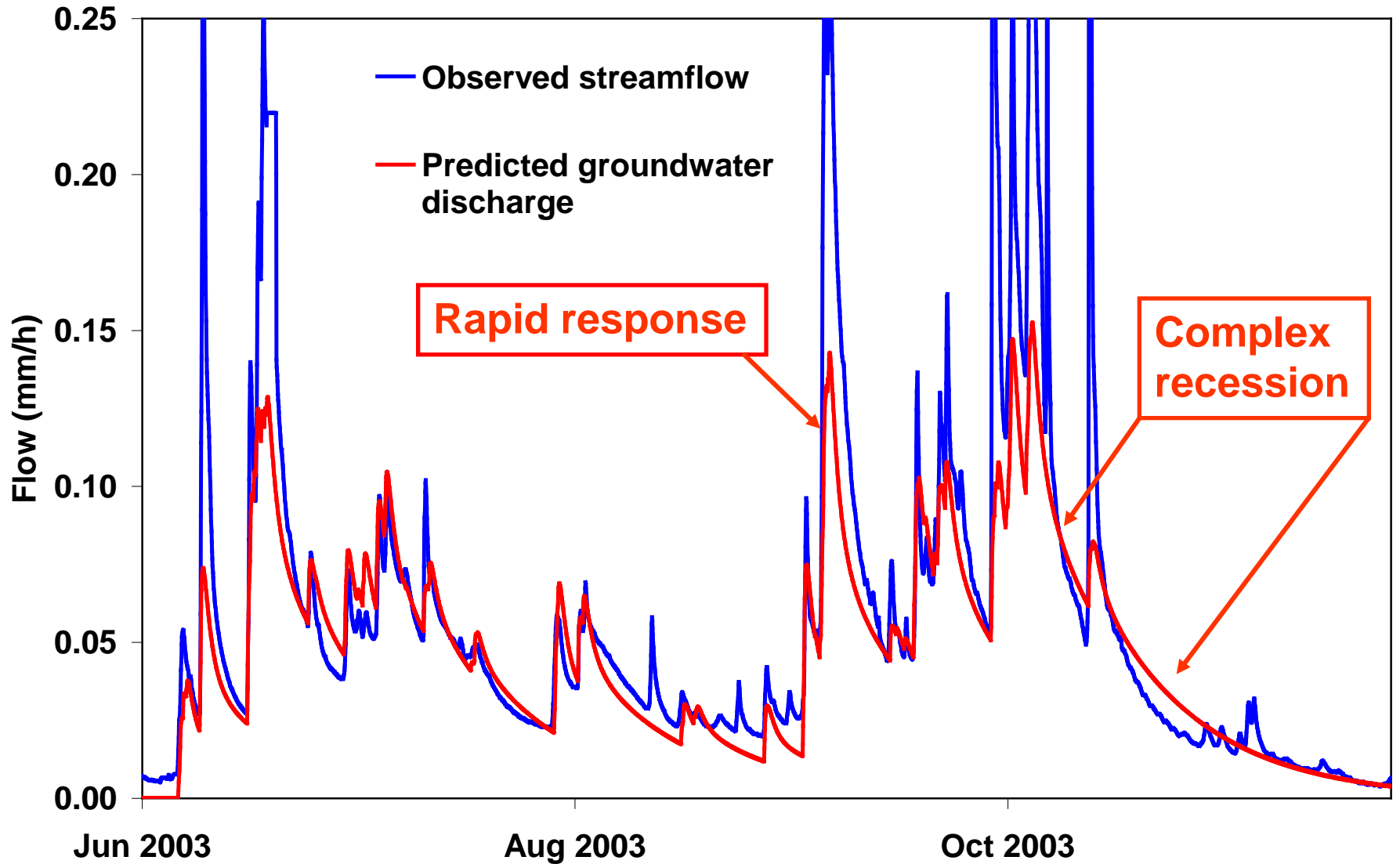
Toenepi Catchment: hourly data 24/11/02 – 23/11/03

Rainfall = 1081 mm; Streamflow = 273 mm



Toenepi Catchment

Groundwater discharge dynamics

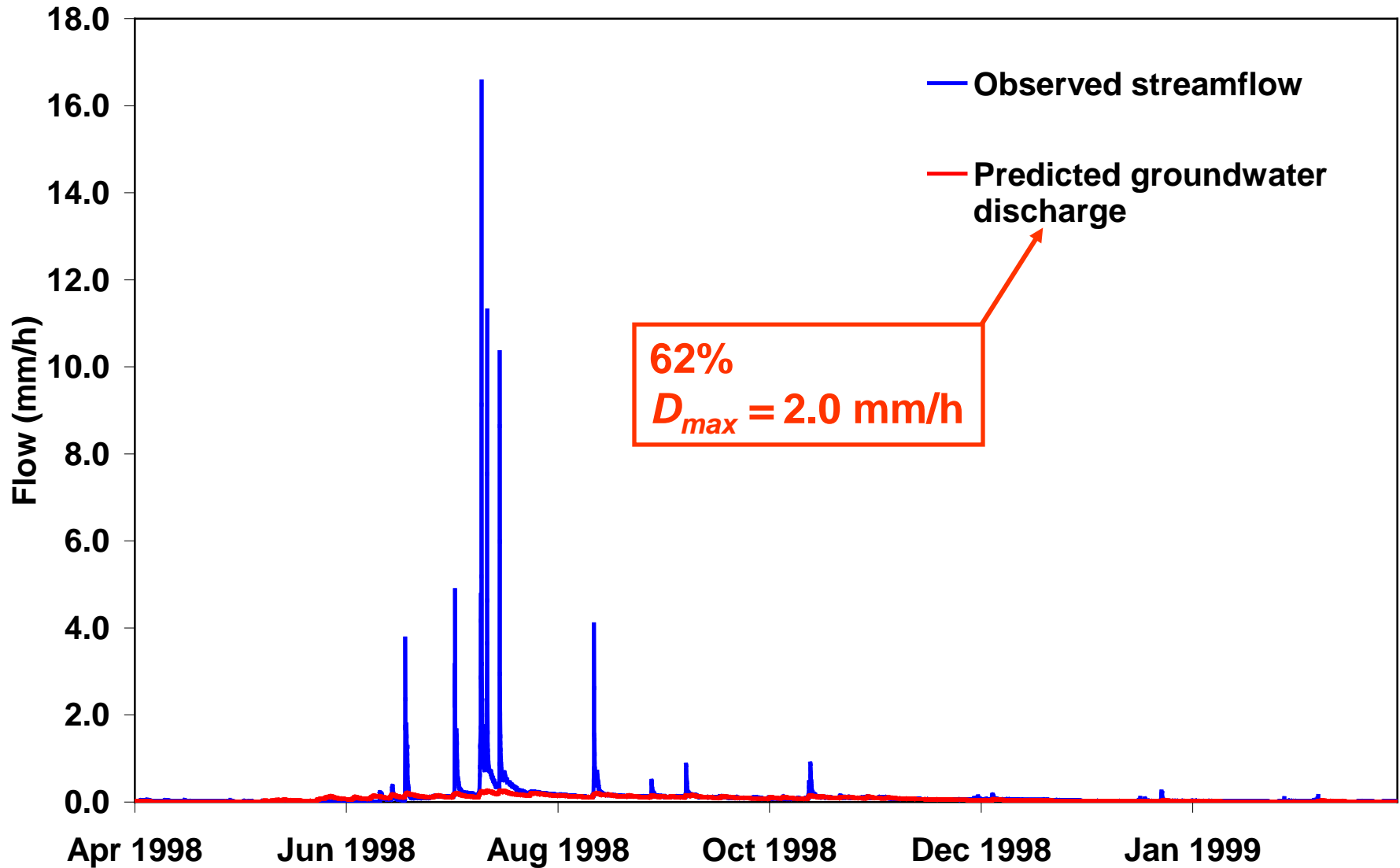


Example 2: Pukemanga Catchment, Waikato

- **Area = 3 ha**
- **Slope: hilly (17°- 20°) to steep (>30°)**
- **Elevation: 72 – 146 m (amsl)**
- **Land use: sheep pasture**
- **Headwater stream from a wetland**

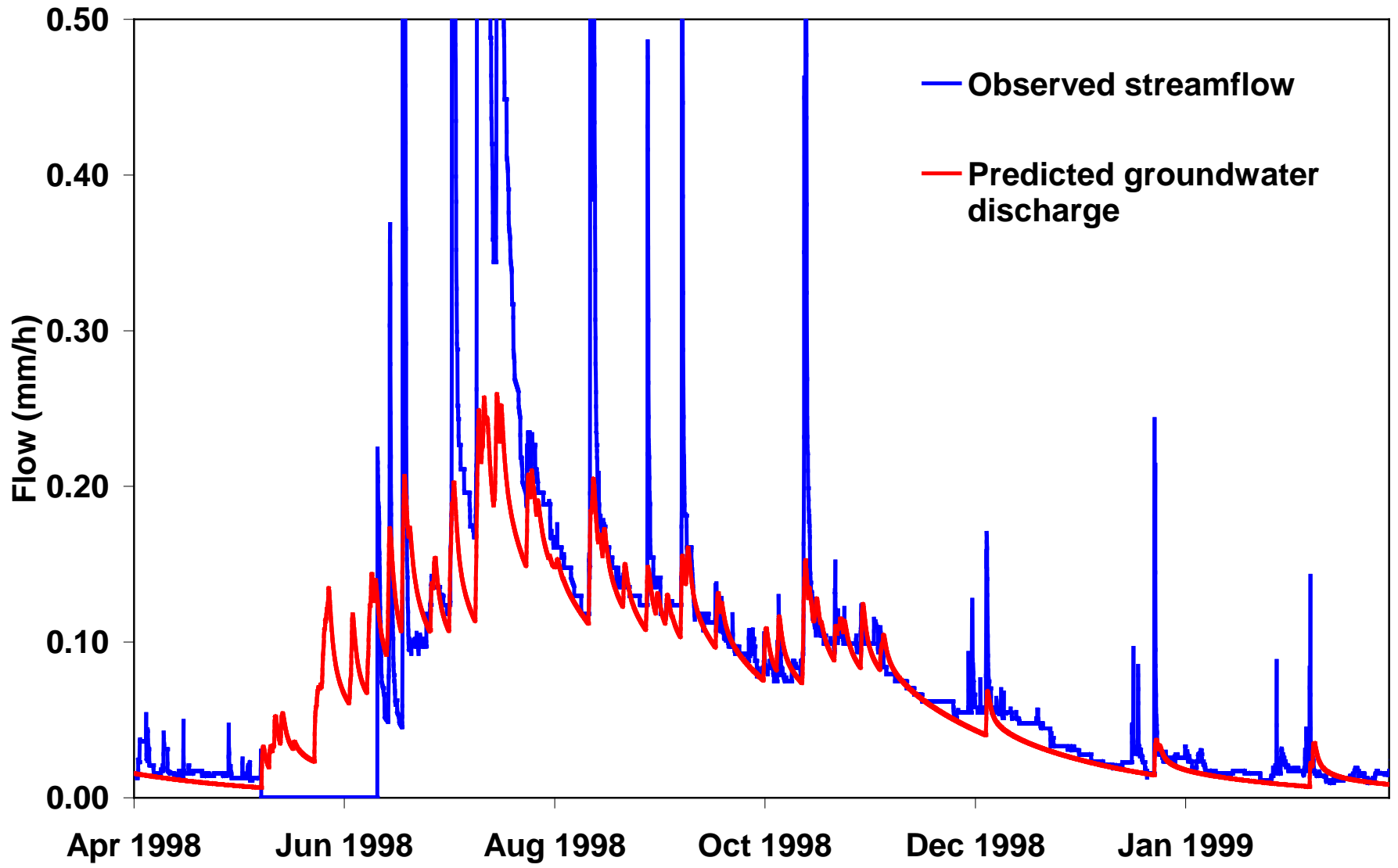
Pukemanga Catchment: hourly data 1/4/98 – 31/3/99

Rainfall = 1706 mm; Streamflow = 1013 mm; Area = 1.43/3.0 ha

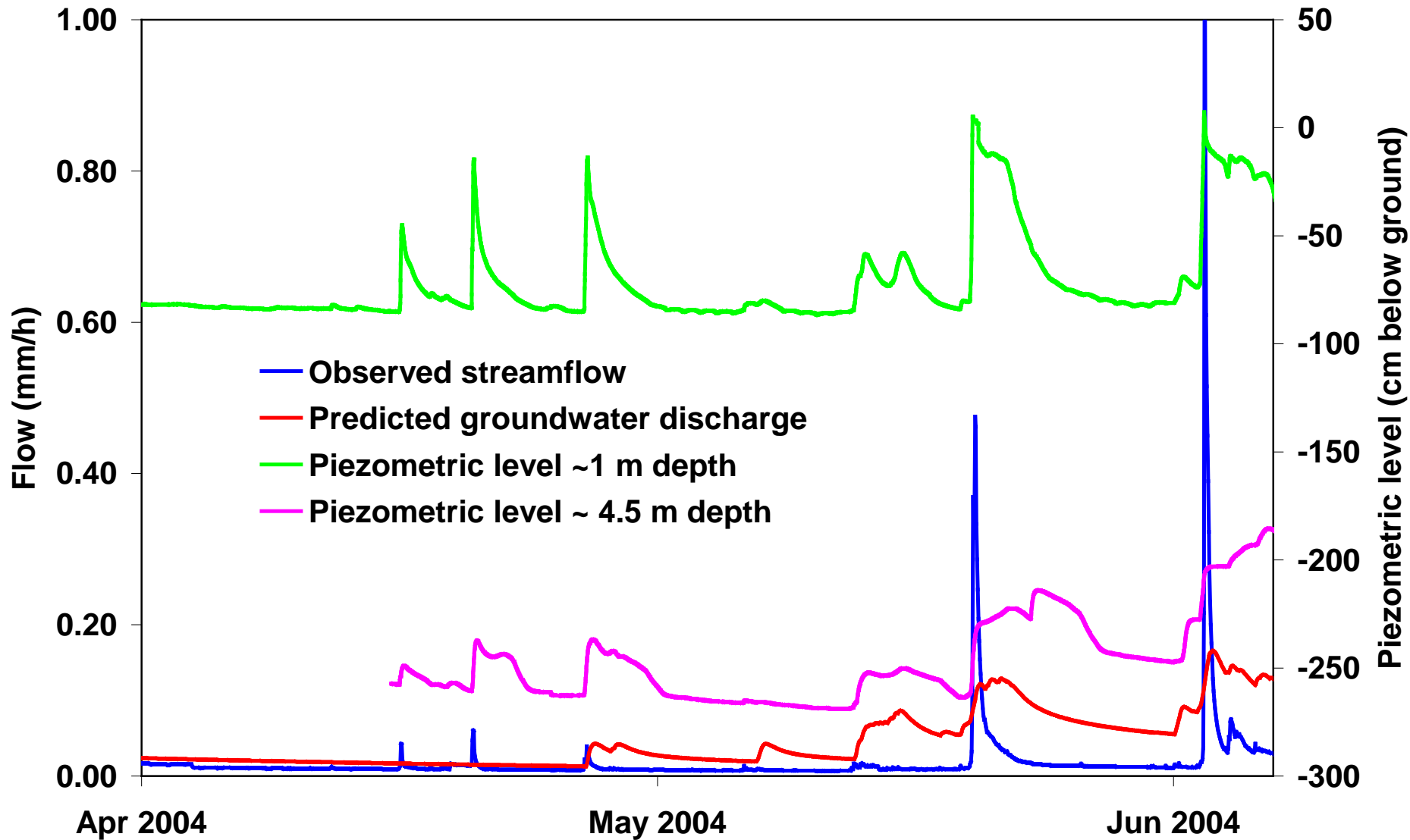


Pukemanga Catchment

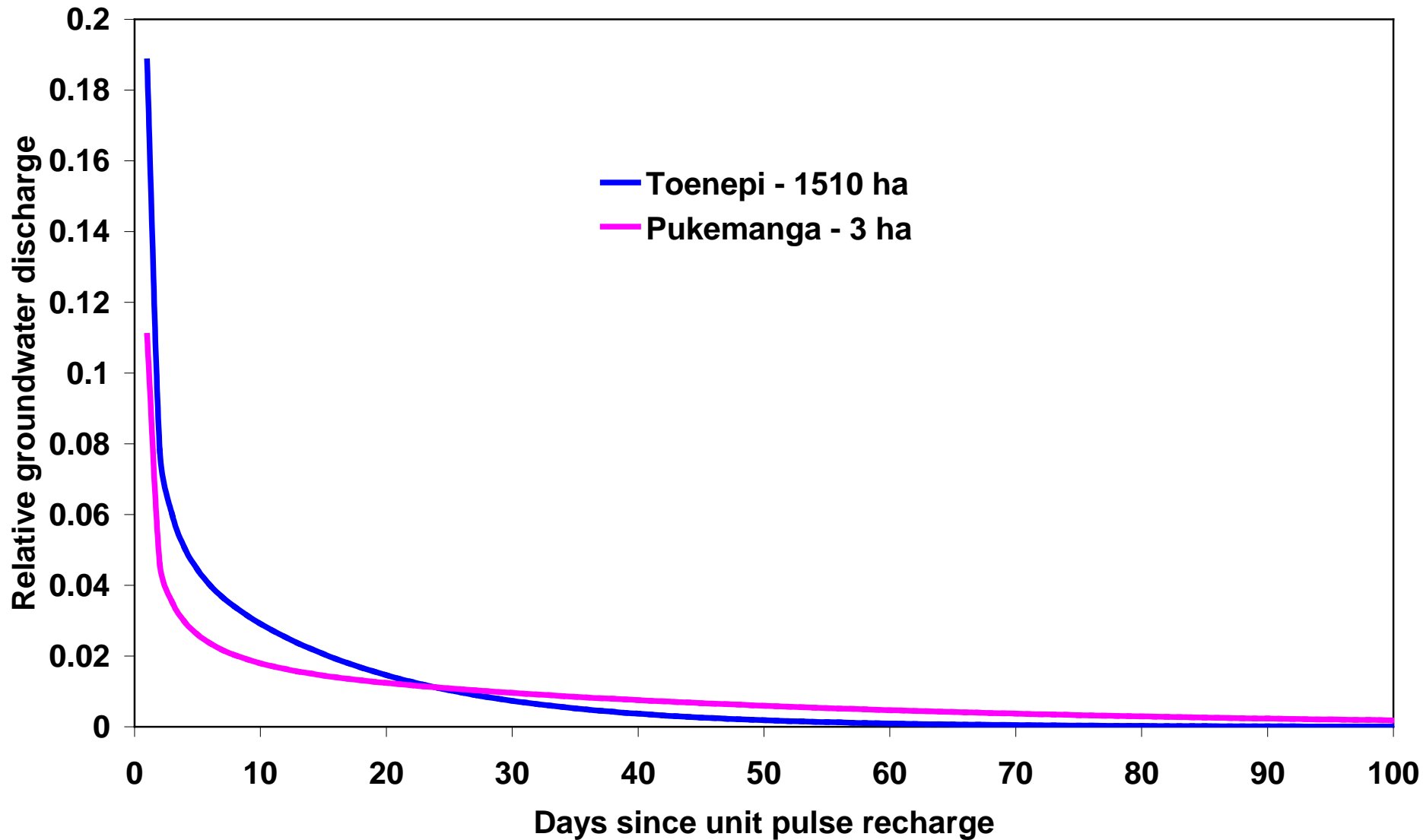
Groundwater discharge dynamics



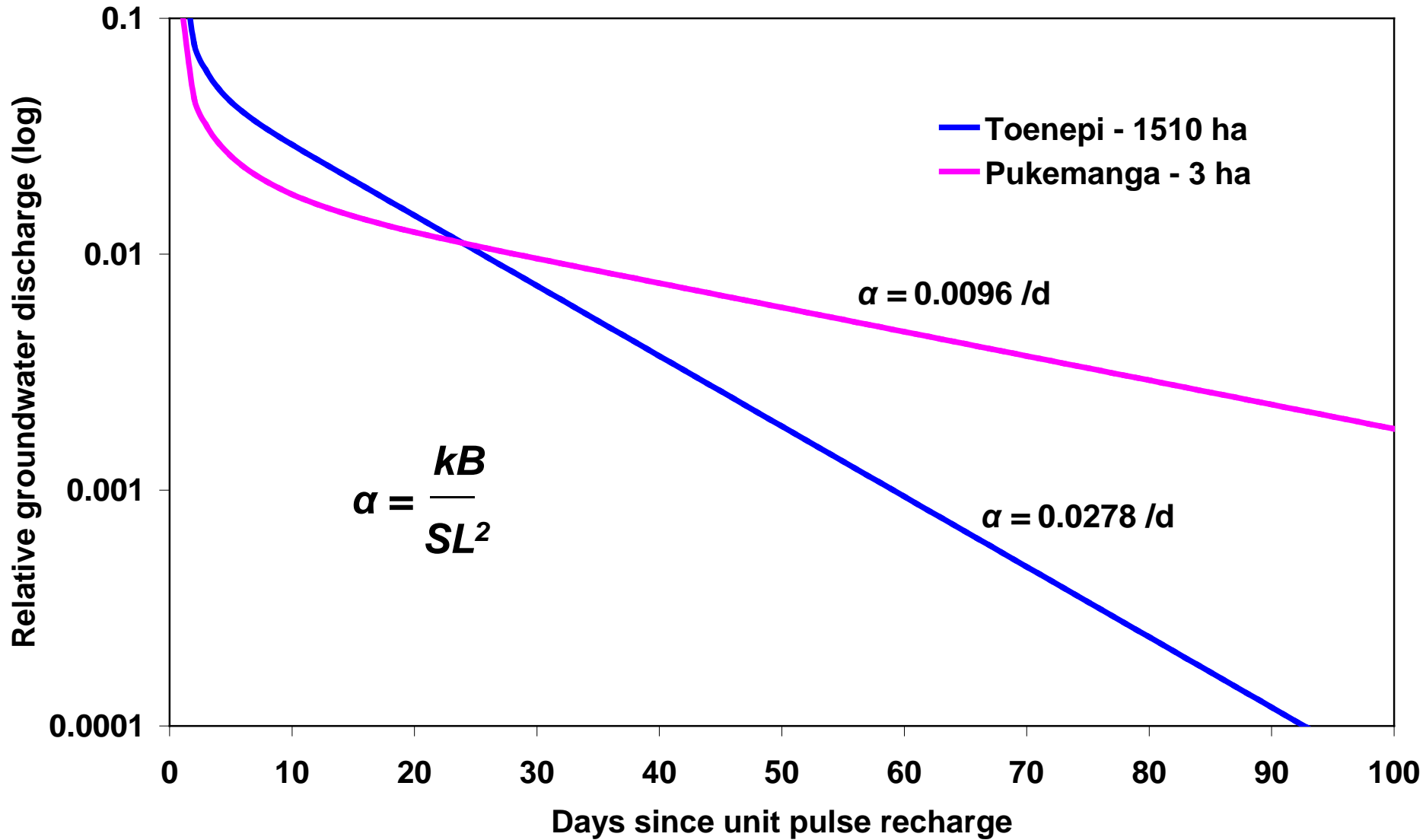
Sources of the other 38% of Pukemanga streamflow? - piezometric levels near the wetland (current research)



Comparison of baseflow recession in response to a unit pulse recharge



Comparison of baseflow recession (log scale)



Conclusions about quantity and quality

- **For both catchments, during the year of observations, more than 60% of the total annual streamflow is groundwater discharge, from recharge at rates less than 2 mm/h**
- **Quality of this groundwater discharge would be determined by leaching of the soil profile and exposure to geochemical processes in the aquifer**
- **Much of the remaining streamflow may be from drainage of saturated near-surface zones, with quality determined mainly by leaching of the soil profile (current research)**
- **Contribution of overland flow to total streamflow is small**

Conclusions about groundwater discharge dynamics

- **Response of groundwater discharge to recharge entering the groundwater surface is essentially instantaneous**
- **More of the streamflow during drainage events can be ascribed to groundwater recharge than predicted by some alternative baseflow separation methods**
- **The complex behaviour of streamflow recession is described by a single-parameter model, based on the theoretical dynamics of groundwater flow, which preserves water storage states**