A Decision Support Tool for Assessing the Effects of Land Cover Change on Water Resources

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MFE (*SMF – Sustainable Management Fund*) project

- Work carried out by Landcare Research
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  - Environment Southland
  - Horizons MW

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AIMS

- to compile background information on water use by different vegetation covers in New Zealand

- to develop a decision support procedure that will assist users and managers of land and water to predict the hydrological effects of land cover changes

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Objectives

1. Literature reviews
   - Water use by pine, Douglas fir, other (pasture, scrub, tussock)

2. Data compilation
   - Data on land use experimental catchments

3. Data analysis
   - Analyse data from 2 for annual, storm, base and seasonal flows

4. Synthesis

5. Decision Support Tool

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Decision Support Tool

- Modification of an existing water balance model to predict the hydrological consequences likely to accompany a predicted land cover change

- Provides an interactive graphical user interface to make the model accessible within a decision support tool

- Users' guide for the model and DST

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Variables required for water balance model

- Daily rainfall (from local station)

- Monthly "reference evapotranspiration" (based on published summaries and converted to daily values)

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Parameters required for water balance model

- Fraction of rainfall lost through interception

- Crop coefficient to convert "reference evaporation" to transpiration for the cover type

- Soil water storage capacities

- Base flow parameters

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"Reference evapotranspiration"

- Potential evaporation for an extensive surface of well-watered, short grass

- Main source of information:

    Summaries of water balance data for NZ stations. **NZ Meteorological Service Miscel Publication 189** (1986)

- Monthly values converted to days

- If more detail known it can be used

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Interception fraction

- Values from individual studies can be found in Report 5

- Default values used in model are:

| Pasture	0.0
Tussock grassland	0.2
Scrub	0.2
Young forest	0.1
Old forest	0.3

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Crop transpiration coefficient

- Reduces the reference evapotranspiration to a value representative of the given vegetation cover (still well-watered)

- Default values used in model are:

Pasture	1.0
Tussock grassland	0.4
Scrub	0.7
Young forest	0.8
Old forest	0.7

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Soil parameters

- Profile total available water (TAW in mm)

- Profile readily available water (RAW in mm)
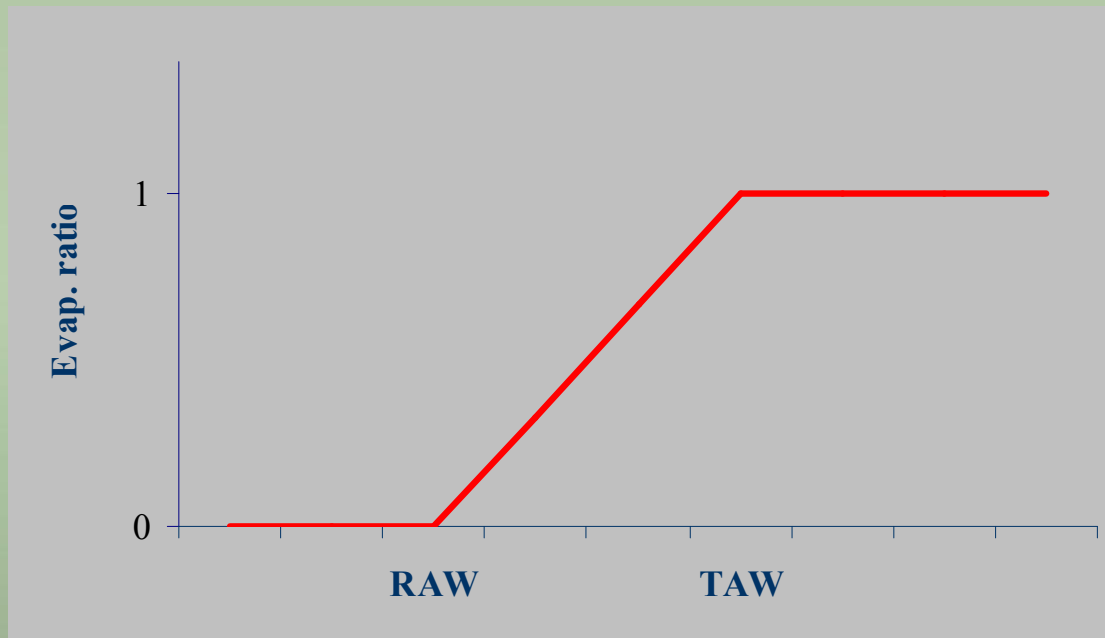
- Soil surface storage (mm)

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Baseflow parameters

- Baseflow index

  - Proportion of total flow as baseflow
  - Requires a streamflow record

- Baseflow recession coefficient

  - Determines the rate of baseflow recesion

  - Requires a streamflow record

  - Taken from table supplied with model

- Can use nearby streamflow record if none available for specific site

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Case studies

- Small experimental catchments
  - Glendhu, upper Waipori, upland east Otago
  - Pakuratahi, coastal hill country, Hawkes Bay

- Larger diverse catchment
  - Shag river, north-east Otago

- "Blind" run of model
  - Rocky Gully, Hunter Hills, South Canterbury
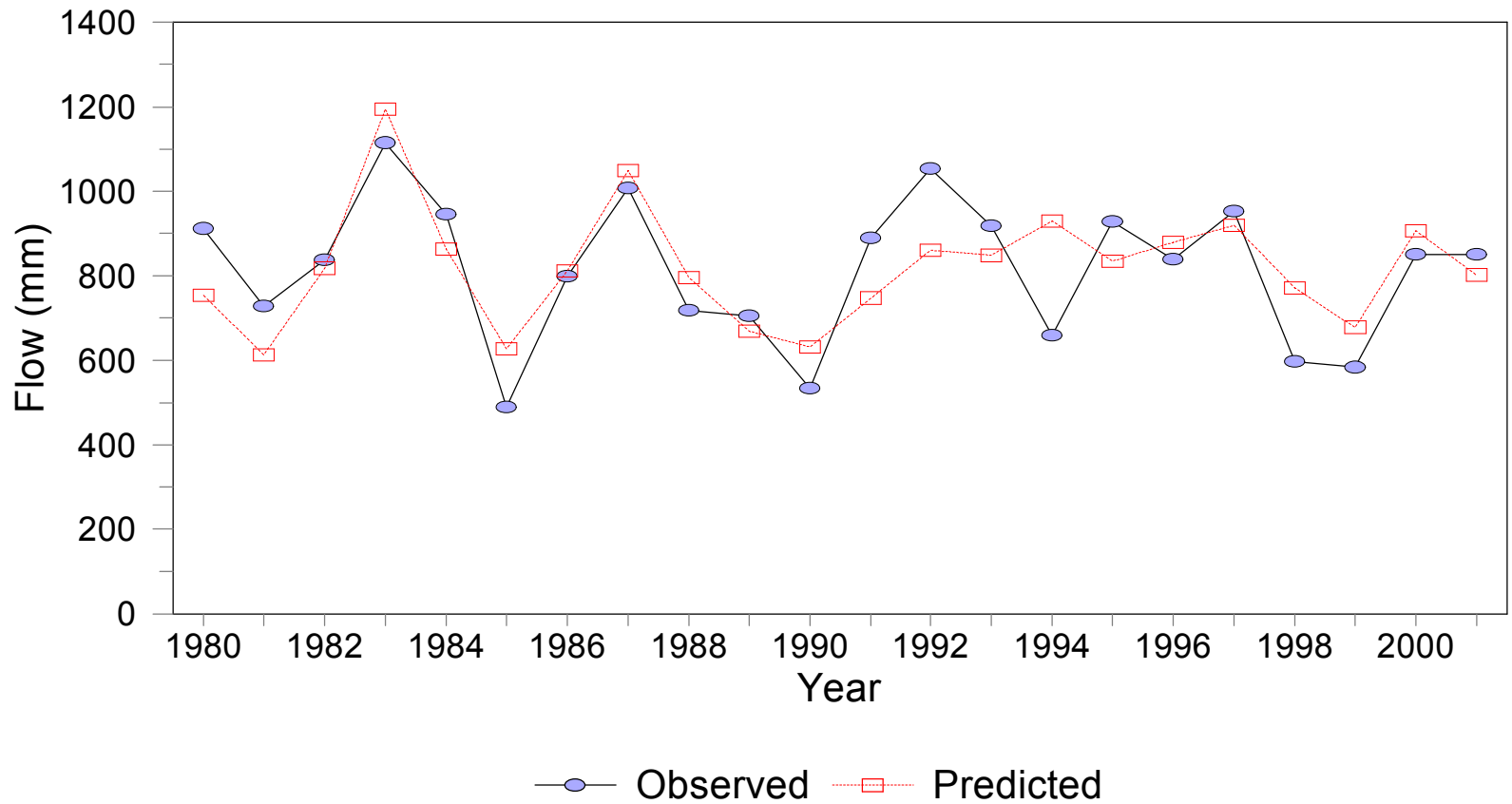
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Glendhu experiment

- Operating since 1980

- Control catchment (214 ha) of snow tussock

- Flow compared with an adjacent catchment (310 ha) planted in 1982 (pines)
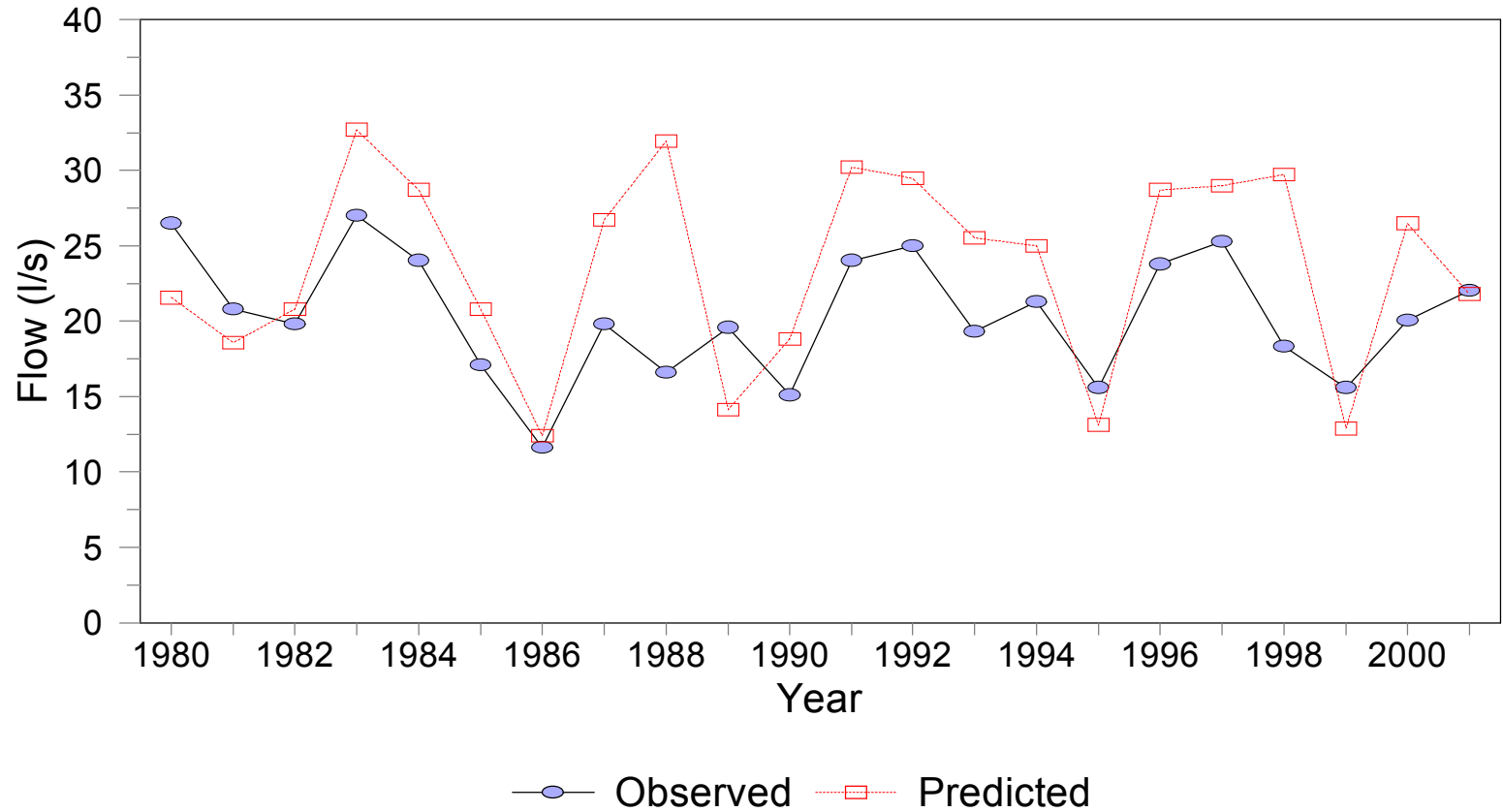
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Glendhu tussock catchment
Annual flows (1980-2001)

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Glendhu tussock catchment
7-day low flows (1980-2001)

Observed · Predicted

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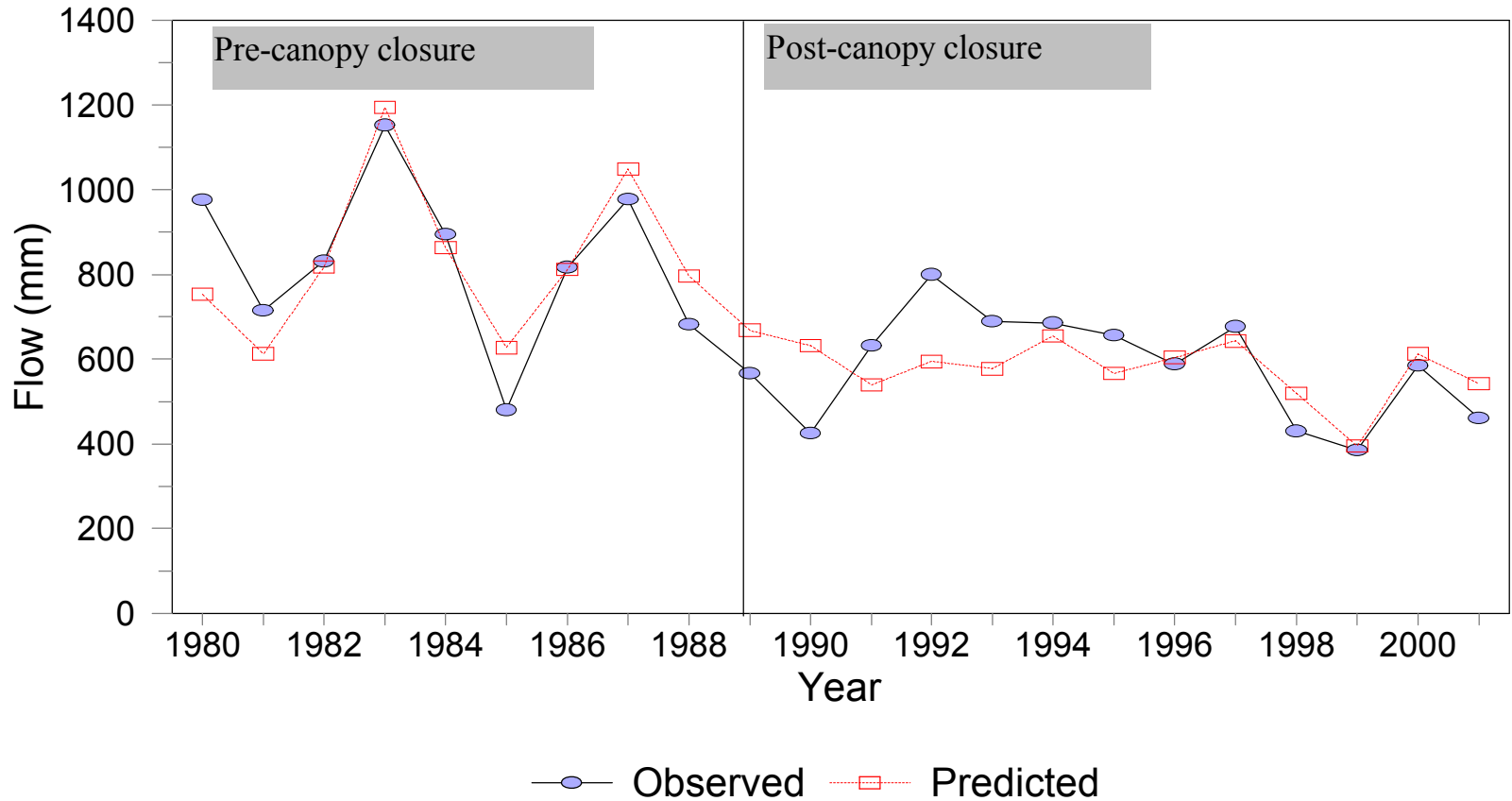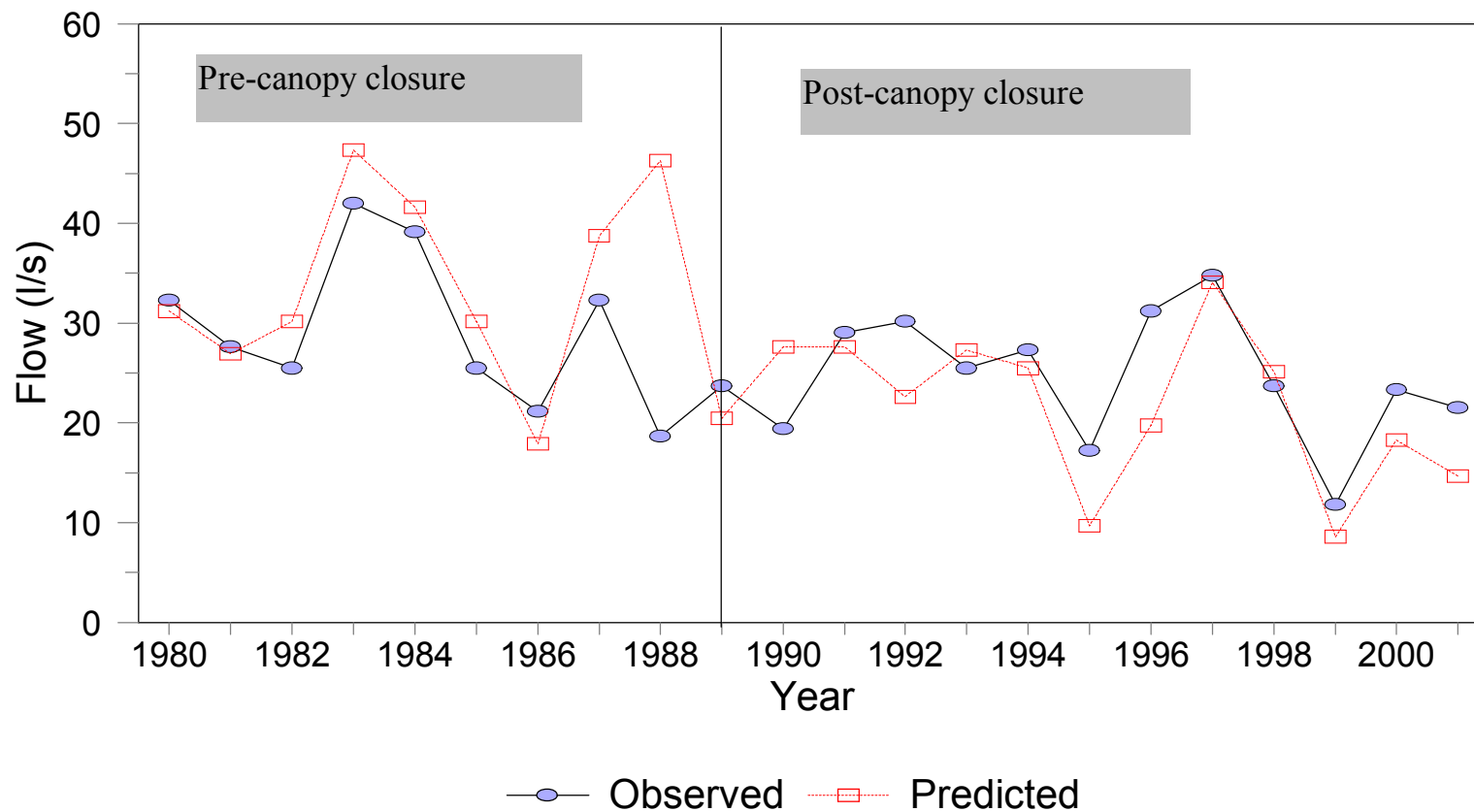**Glendhu planted catchment**
Annual flows(1980-2001)

Glendhu planted catchment
7-day low flows (1980-2001)

Glendhu summary

Tussock catchment (1980-2001)			
Mean flow		*Mean annual 7-day low flow*	
Observed	Predicted	Observed	Predicted
814 mm	818 mm	0.82 mm	0.95 mm

Pine catchment (1990-2001)			
Mean annual flow		*Mean annual 7-day low flow*	
Observed	Predicted	Observed	Predicted
584 mm	573 mm	0.69 mm	0.61 mm

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Pakuratahi experiment

- Paired catchment study north of Napier

- Comparing sediment yields form a pasture and pine catchment

- Pakuratahi (345 ha) in pine forest
  - Preharvest period 1995-1997

- Tamingimingi (795 ha) in pasture
  - 1995-2001

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Pakuratahi summary

Pasture catchment (1995-97)			
Mean annual flow		*Mean annual 7-day low flow*	
Observed	Predicted	Observed	Predicted
412 mm	431 mm	0.49 mm	0.21 mm

Pine catchment (1995-97)			
Mean annual flow		*Mean annual 7-day low flow*	
Observed	Predicted	Observed	Predicted
381 mm	341 mm	0.57 mm	0.22 mm

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Shag catchment

- North east Otago

- Large catchment – 319 km^2

- Variety of land-cover types – tussock, pasture, pines

- Reliable rainfall and flow record

- Model uses sub-areas for different land-cover and/or rainfall, and/or interception etc.

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Sub-area	Land-cover	Rainfall wghting	Interc. fraction	Crop k	TAW	RAW
1	Tuss.	2	0.2	0.3	50	25
2	Tuss.	1.5	0.1	0.7	100	50
3	Past.	1	0	1	100	50
4	Past.	1	0	1	100	50
5	Past.	1	0	1	100	50
6	Past.	1	0	1	200	100
7	Past.	1	0	1	200	100
8	Past.	0.8	0	1	200	100
9	Past.	0.8	0	1	200	100
10	Scrub	1	0.2	0.7	150	75

Shag summary (1990-2000)

Mean annual flow		Mean annual 7-day low flow	
Observed	Predicted	Observed	Predicted
179 mm	226 mm	166 l/s	137 l/s

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"Blind" run of model

- Rocky Gully – inland from Timaru, NE flank of the Hunter Hills

- 23 km^2

- Greywacke & argillite lithology

- Kaikoura steepland soils (70%) and Hurunui steepland soils (30%)

- Vegetation (from Land Cover Database)
  - Tussock 50%
  - Pasture 47%
  - Scrub 3%

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Variable & parameter input

- Daily rainfall record from station mid-way up catchment

- Weighted according to isohyets

- Reference evapotranspiration from nearest Met station (Waimate)

- Other parameters (interception, TAW, RAW etc.) derived from default values for the model (using soil information)

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Baseflow parameters

- Base flow index estimated at 0.65
  - From Jowett & Duncan (1990) Flow variability in NZ rivers. *NZ Journal of Marine & Freshwater Research* 24.

- Recession coefficient estimated at 0.98 using data from nearby Pareora river

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Rocky Gully summary (1989-2001)

Mean annual flow		Mean annual 7-day low flow	
Observed	Predicted	Observed	Predicted
314 l/s	320 l/s	80 l/s	78 l/s

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Rocky Gully scenarios

- Scenario 1: 40% of catchment converted to pines (lower region)
  - Mean annual flow reduced by 6%
  - Mean annual 7-day low flow reduced by 3%
  - Upper catchment is producing the majority of streamflow

- Scenario 2: 50% of catchment converted to pasture (upper region)
  - Mean annual flow reduced by 7%
  - Mean annual 7-day low flow reduced by 7%

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Summary

- Project will produce:
  - 6 reports summarising knowledge on land use change
  - Easy to use hydrological model
  - User guide for model

- This information (by CD or download) will be freely available from July 2003 from:
  - Ministry for the Environment (SMF website)
  - Landcare Research, link through http://icm.landcareresearch.co.nz

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