Manaaki Whenua
Landcare Research

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

MAKING A DIFFERENCE FOR A TRULY CLEAN, GREEN NEW ZEALAND

MFE (*SMF – Sustainable Management Fund*) project

- Work carried out by Landcare Research
  Barry Fahey, Lindsay Rowe, Rick Jackson
- Extra funding and input from
  - Tasman District Council (project management)
  - Environment Canterbury
  - City Forests Ltd (Dunedin)
  - Hawkes Bay Regional Council
  - Marlborough District Council
  - Environment Southland
  - Horizons MW

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

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

Outputs

- Reports
  1. The hydrology of Pinus radiata plantations: an annotated bibliography.
  2. Hydrology of Douglas fir plantation/forests: an annotated bibliography
  3. NZ Land-use hydrology: an annotated bibliography
  4. Summary of catchments with data suitable for use in the evaluation of landcover effects on water availability
  5. Synthesis of hydrological information on landcover effects of different vegetation covers
  6. Land use and water resources: hydrological effects of different vegetation covers
- Decision support tool

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

Model structure

- Uses an interactive graphical user interface
- Which works from an EXCEL spreadsheet

1. Collect background information
2. Load information into spreadsheet
3. Run model
4. Run scenarios

Case studies

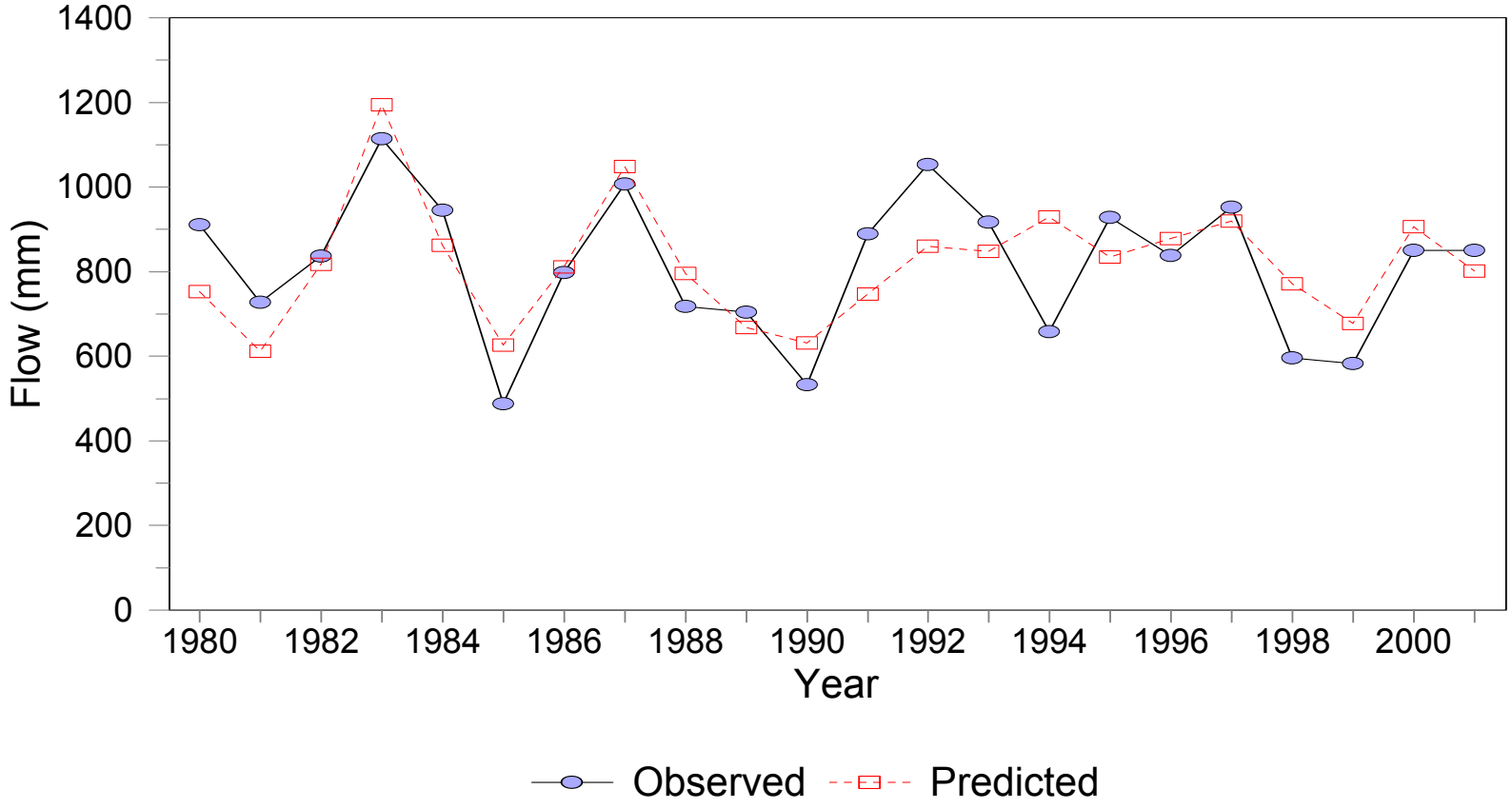
- Small catchments
  - Glendhu, upper Waipori, upland east Otago
  - Kainui, Wai iti catchment, Nelson
- Larger diverse catchment
  - Shag river, north-east Otago
- “Blind” run of model
  - Rocky Gully, Hunter Hills, South Canterbury

Glendhu experiment

- Operating since 1980
- Control catchment (214 ha) of snow tussock
- Flow compared with an adjacent catchment (310 ha) planted in 1982 (pines)

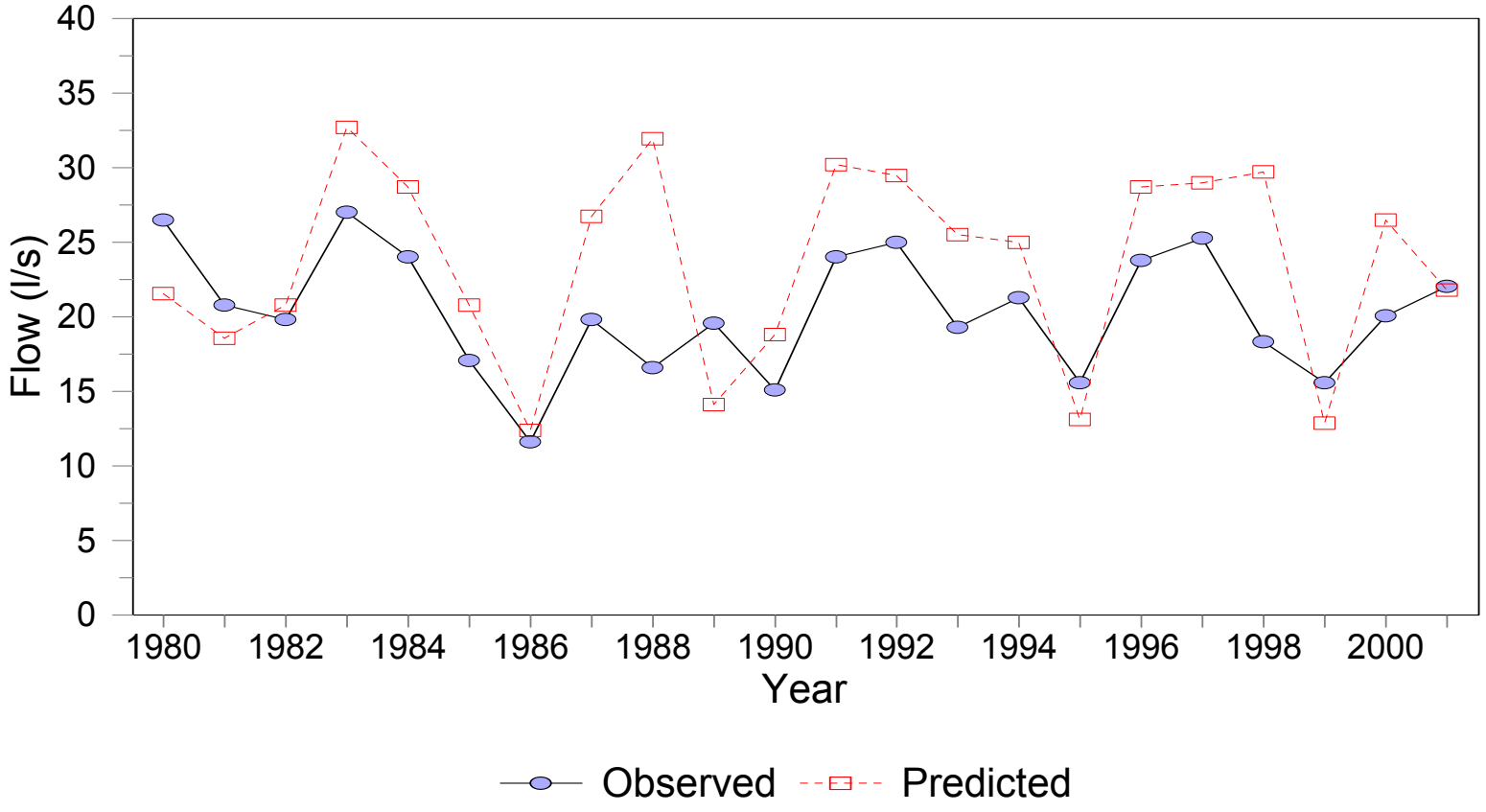
Glendhu tussock catchment

Annual flows (1980-2001)



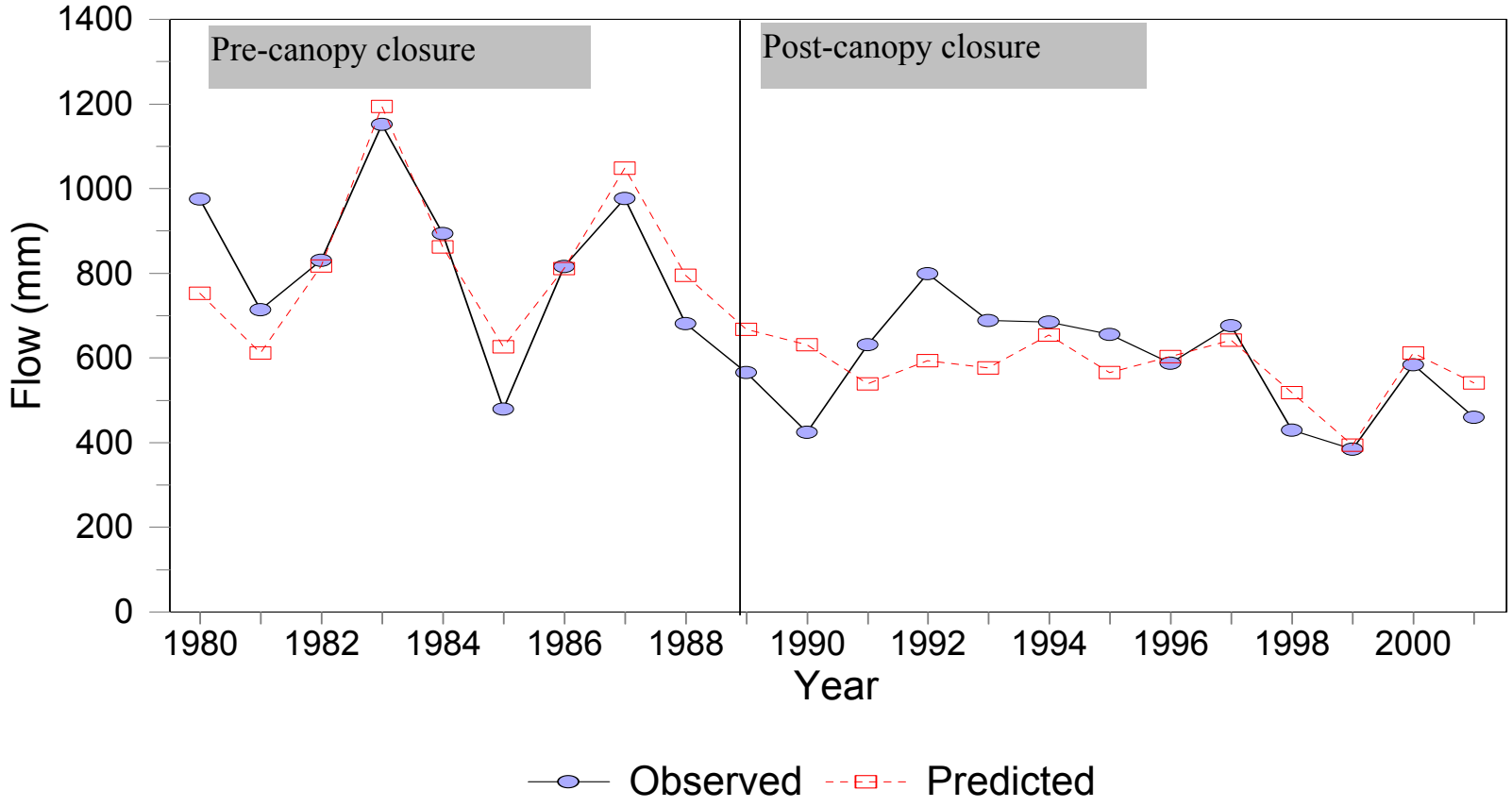
Glendhu tussock catchment

7-day low flows (1980-2001)



Glendhu planted catchment

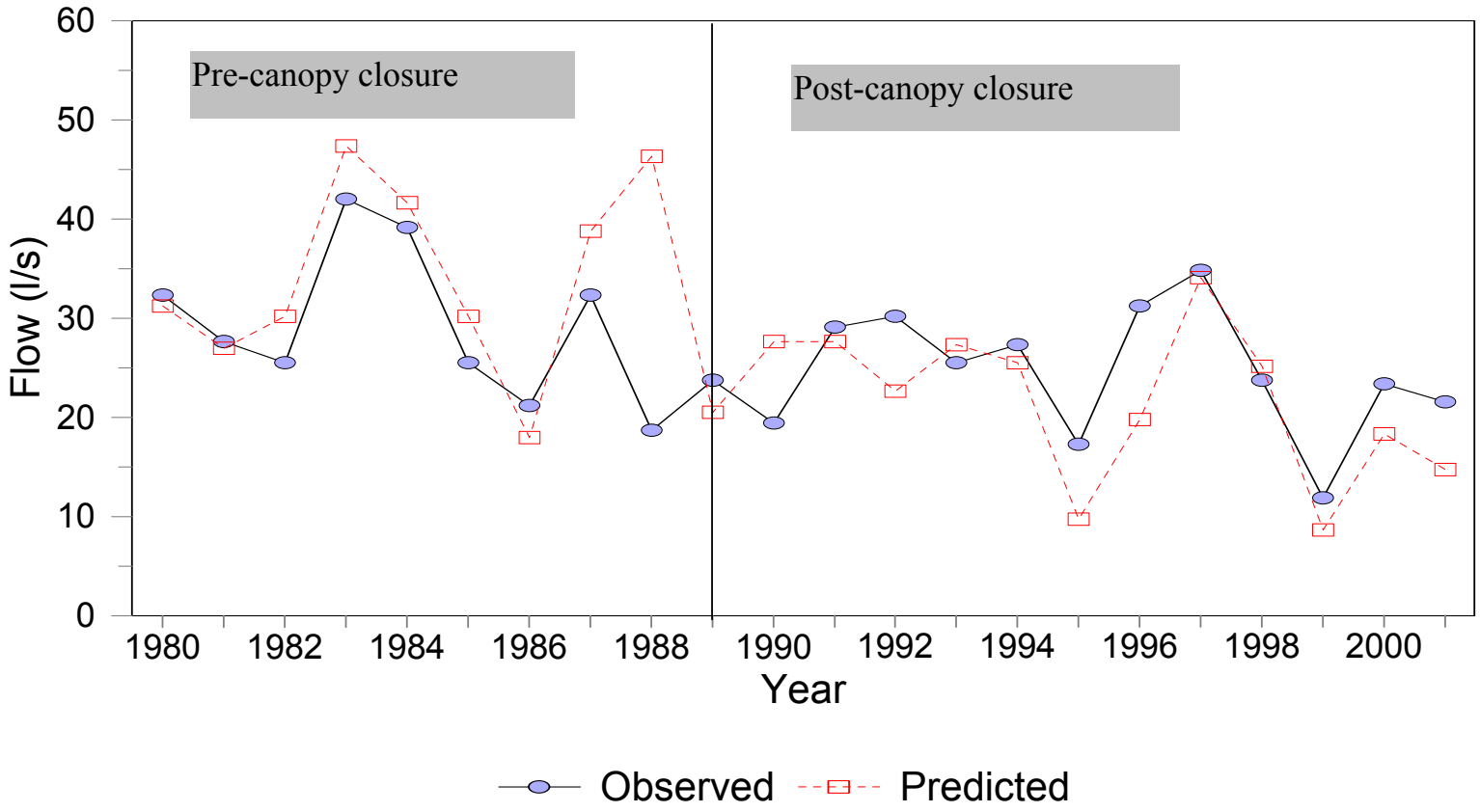
Annual flows(1980-2001)



Manaaki Whenua
Landcare Research

Glendhu planted catchment

7-day low flows (1980-2001)



Glendhu summary

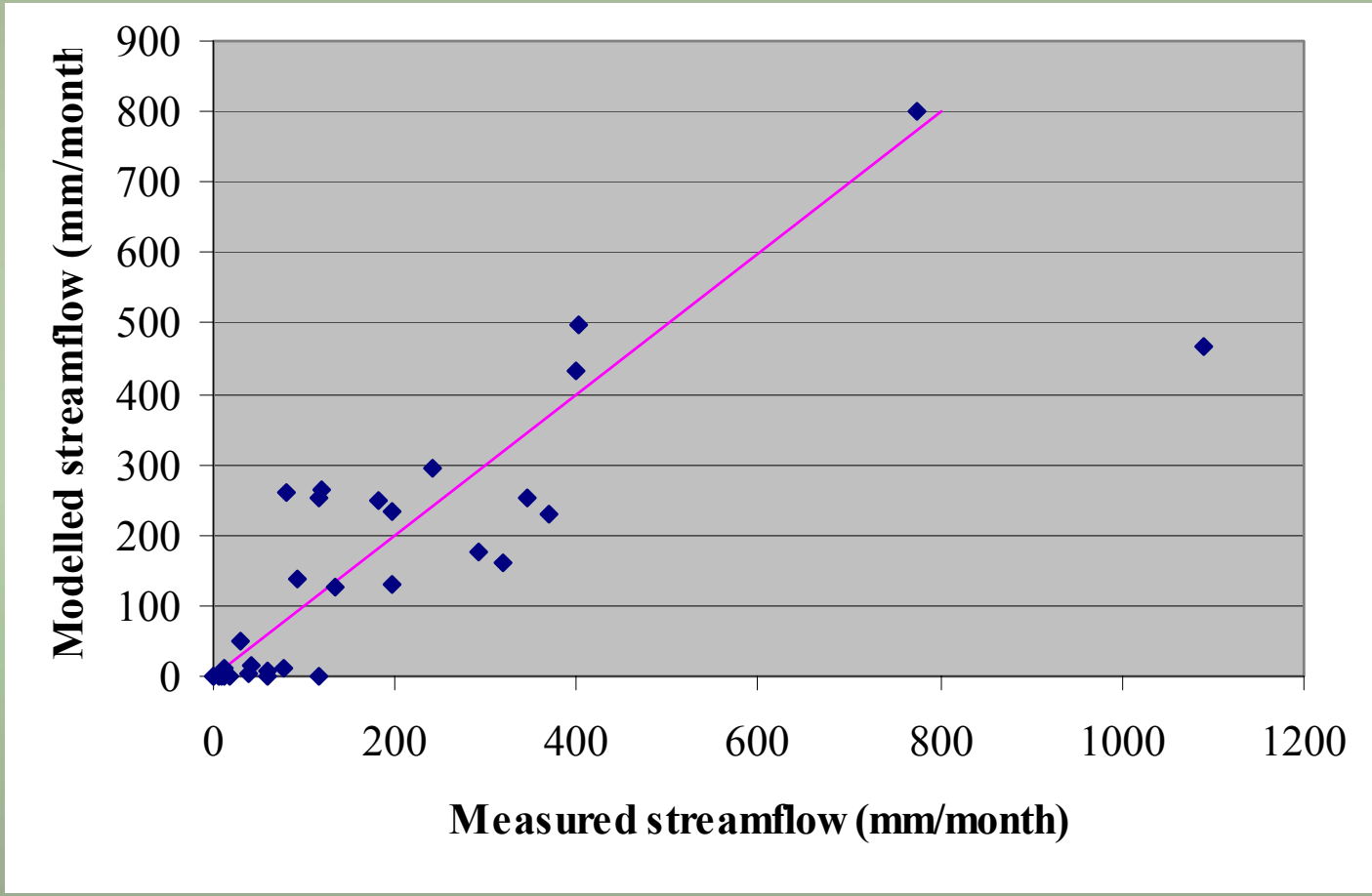
Tussock catchment (1980-2001)			
Mean flow		*Mean annual 7-day low flow*	
Observed	Predicted	Observed	Predicted
814 mm	818 mm	0.82 mm	0.95 mm

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

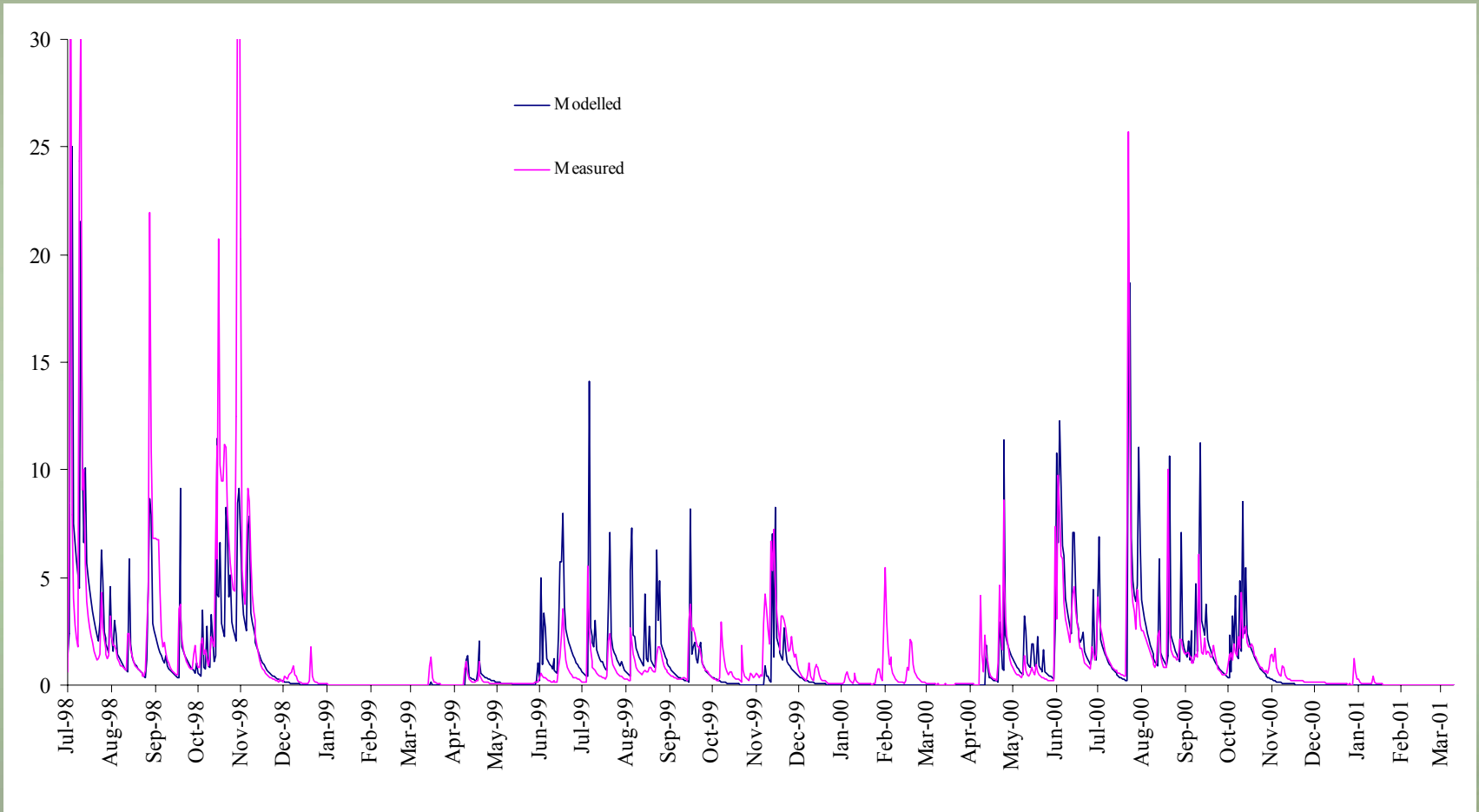
Kainui

- Small catchment (240 ha) being considered for the Wai iti river augmentation irrigation scheme
- Stream flows recorded on 420 ha catchment area

Kainui monthly flows



Kainui daily flows



Kainui summary

Annual flow *1999* *2000*		*7-day low flow* *1999* *2000*	
Observed	Predicted	Observed	Predicted
223 mm 449 mm	275 mm 473 mm	0 l/s 0.9 l/s	0 l/s 0 l/s

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.

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

“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%

Variable & parameter input

- Daily rainfall record from station mid-way up catchment
  - Available since 1967 but many gaps until 1988
  - Used data from 1989 to 2001 (13 years) mean = 845 mm
  - Headwaters up to 1350 m – record 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)

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

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

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%

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 November 2003 from:
  - Ministry for the Environment (SMF website)
  - Landcare Research, link through http://icm.LandcareResearch.co.nz