

# The High Price of Hydro Power

Presentation to the New Zealand Hydrological Society Conference  
December 7, 2011

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NZ Hydrological Society Conference, Wellington, 6-9 December, 2011

**Hydro power provides most of New Zealand's electricity supply, but seeking the most economic MW was often at the expense of a high marginal cost (defined in multiple ways)**



**Clyde Dam Spillage (Clutha River)**



Huka Falls (partially drowned). Was it really necessary for those few metres of Lake Aratiatia?



Depleted Waikato Falls  
(Tongariro River) with Rangipo  
Power Station tailrace  
discharge in foreground

With  $\approx 200$  metres of head  
on the Rangipo turbines,  
could we not have given  
away a few metres to have  
the tailrace exit above the  
falls?



Clyde high dam – we could have had low dams for about the same power output without flooding Cromwell and the orchards

And it still goes on.. the southern hydro lakes look attractive in the big view...



..but in reality we are imposing a slow death on their shorelines with the seasonal cycle of hydro storage (shoreline sluicing operation). But presently there is no other option for gaining energy storage for winter.

Shoreline retreat at Lake Pukaki



Photo: Varvara Vetrova

Seasonal water level fluctuations over several metres do not permit equilibrium lake beaches (glacial till gives “soft” shorelines)

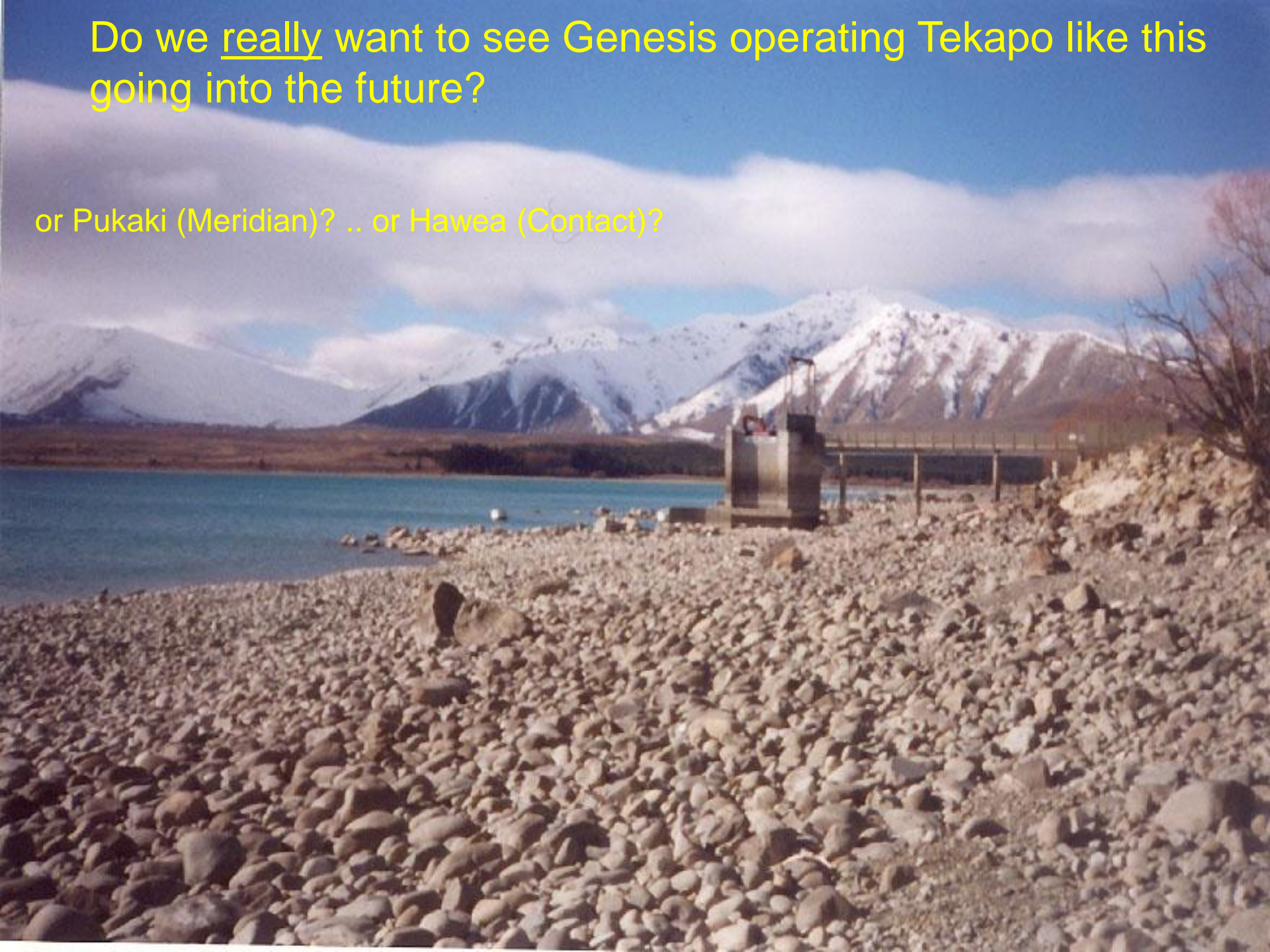


Photo: Varvara Vetrova

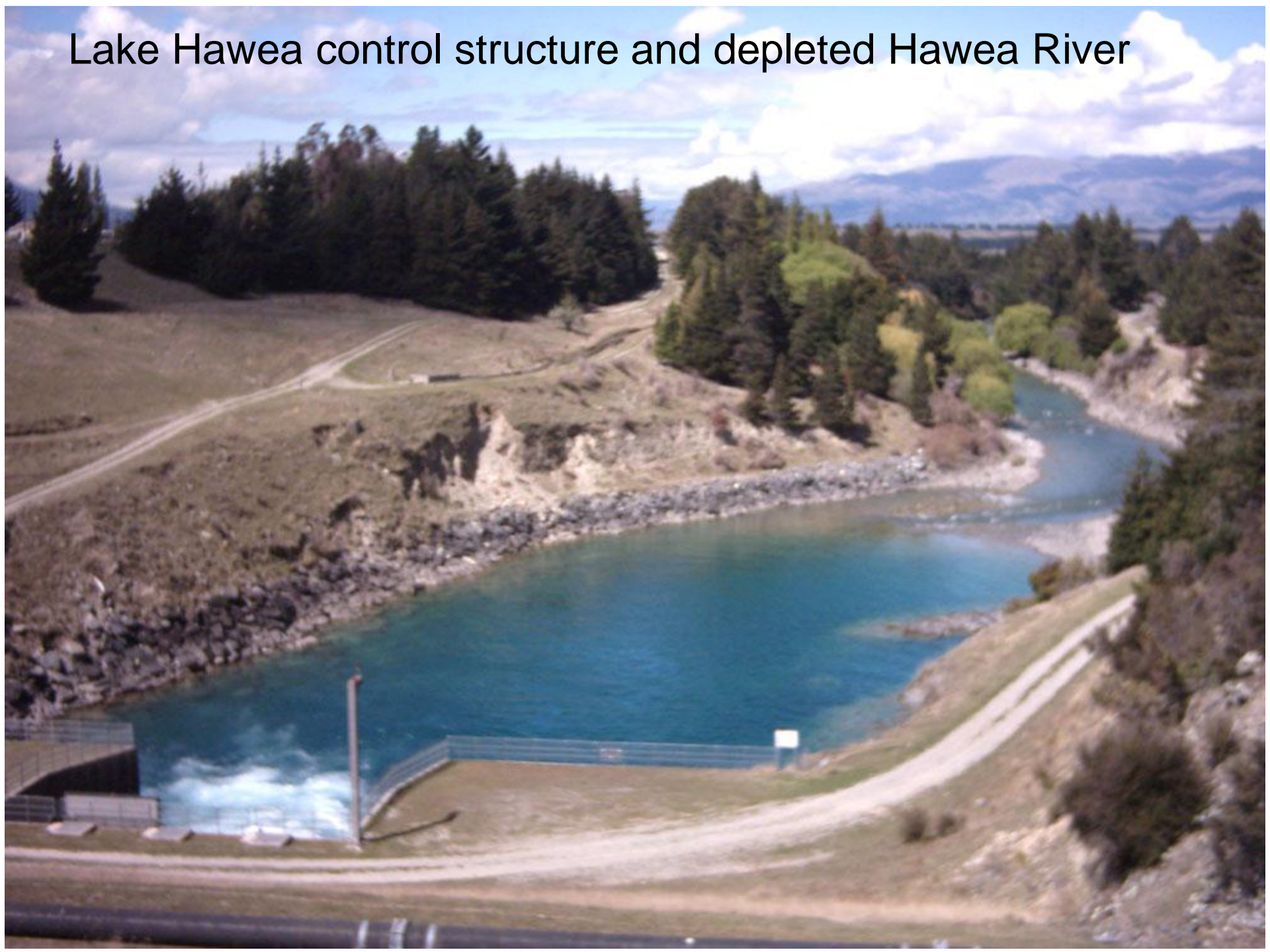


Do we really want to see Genesis operating Tekapo like this going into the future?

or Pukaki (Meridian)? .. or Hawea (Contact)?



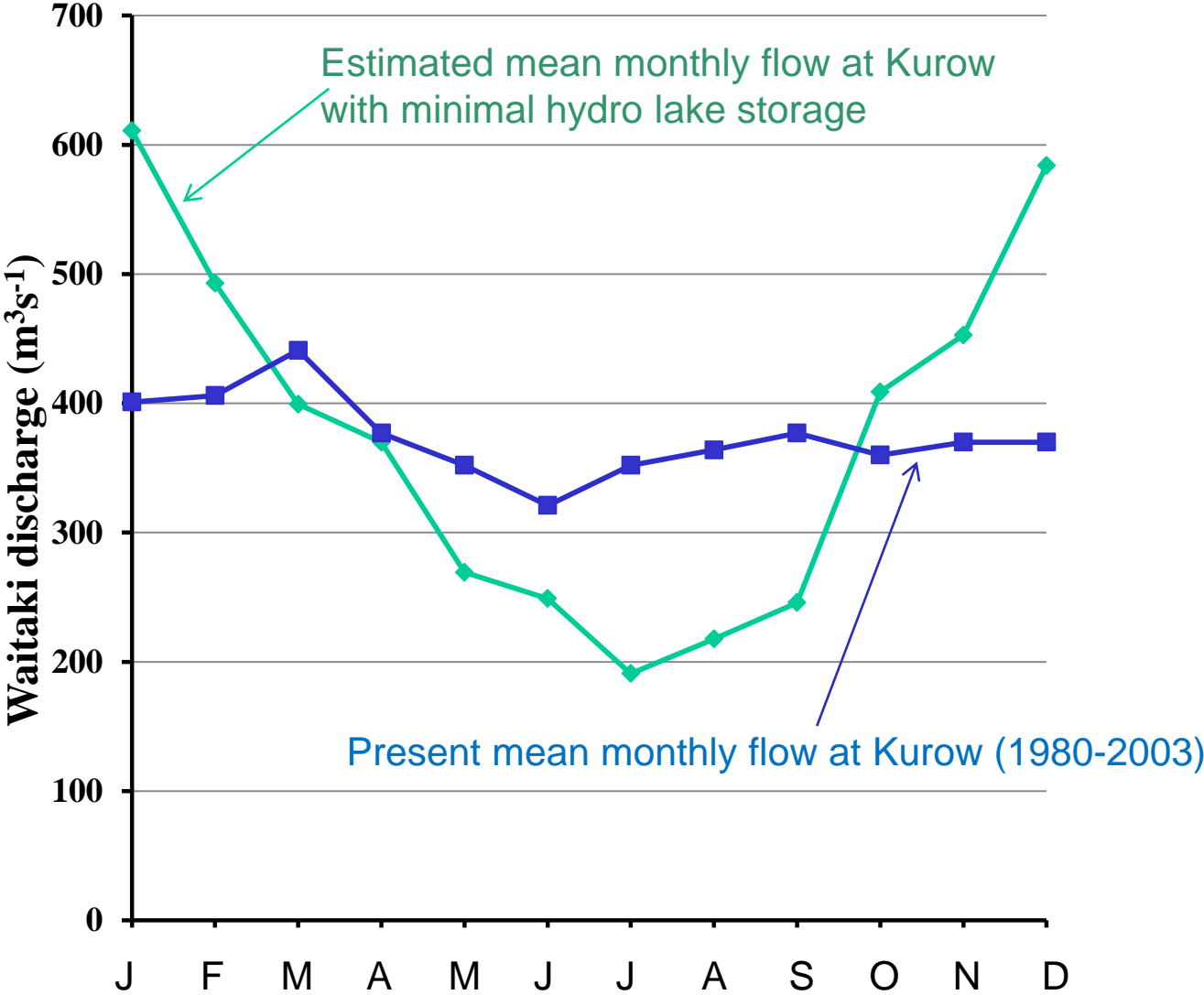
# Lake Hawea control structure and depleted Hawea River



# Aspects of the high price of hydro at present

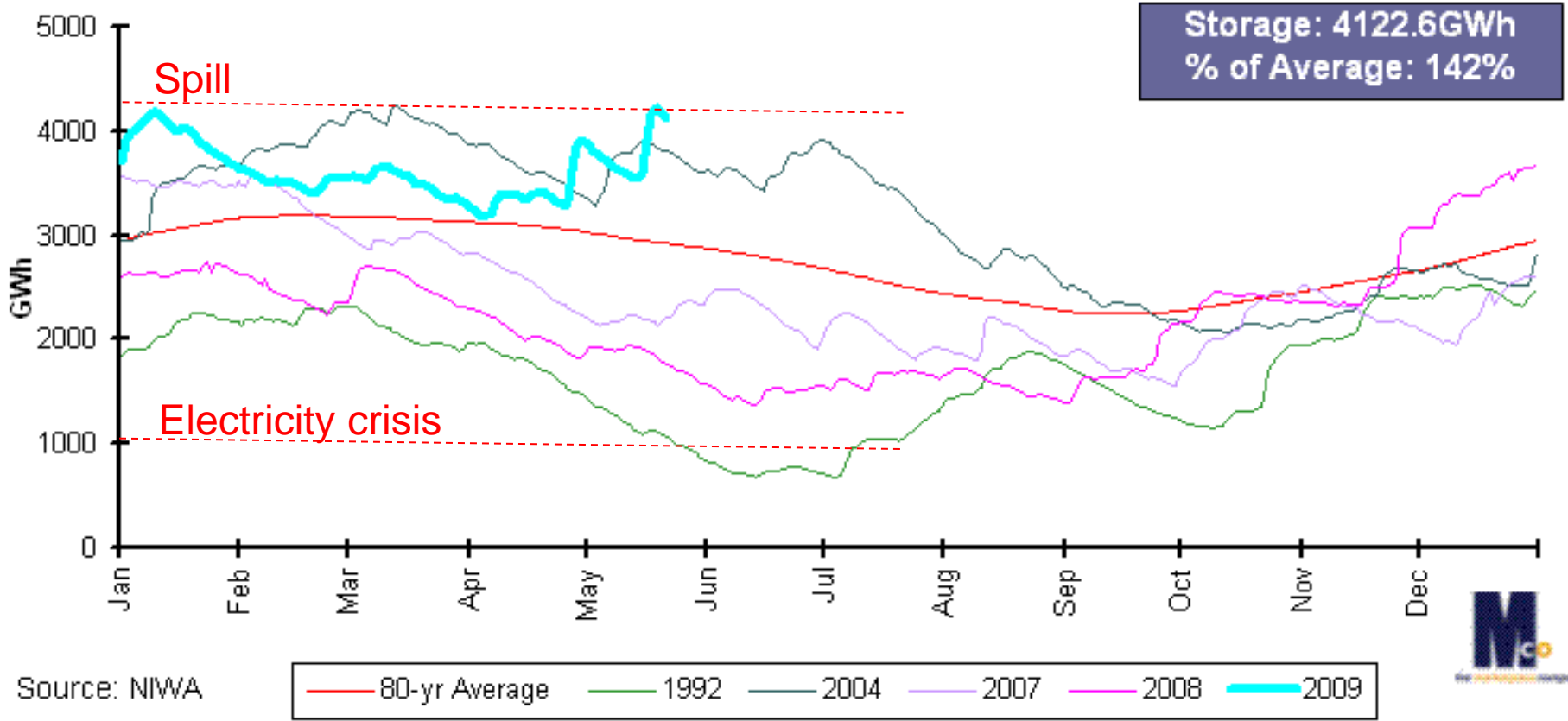
- Tourism icons like Huka Falls and Waikato Falls compromised.
- Ongoing shoreline damage in main South Island hydro lakes.
- Loss of summer irrigation and recreation water, particularly in the Waitaki Valley.
- Irrational market price fluctuations due to minimal total storage (rumour effect), with implications for carbon release.

Waitaki River water now not available for irrigation and recreation (October to February): 128 m<sup>3</sup> s<sup>-1</sup>



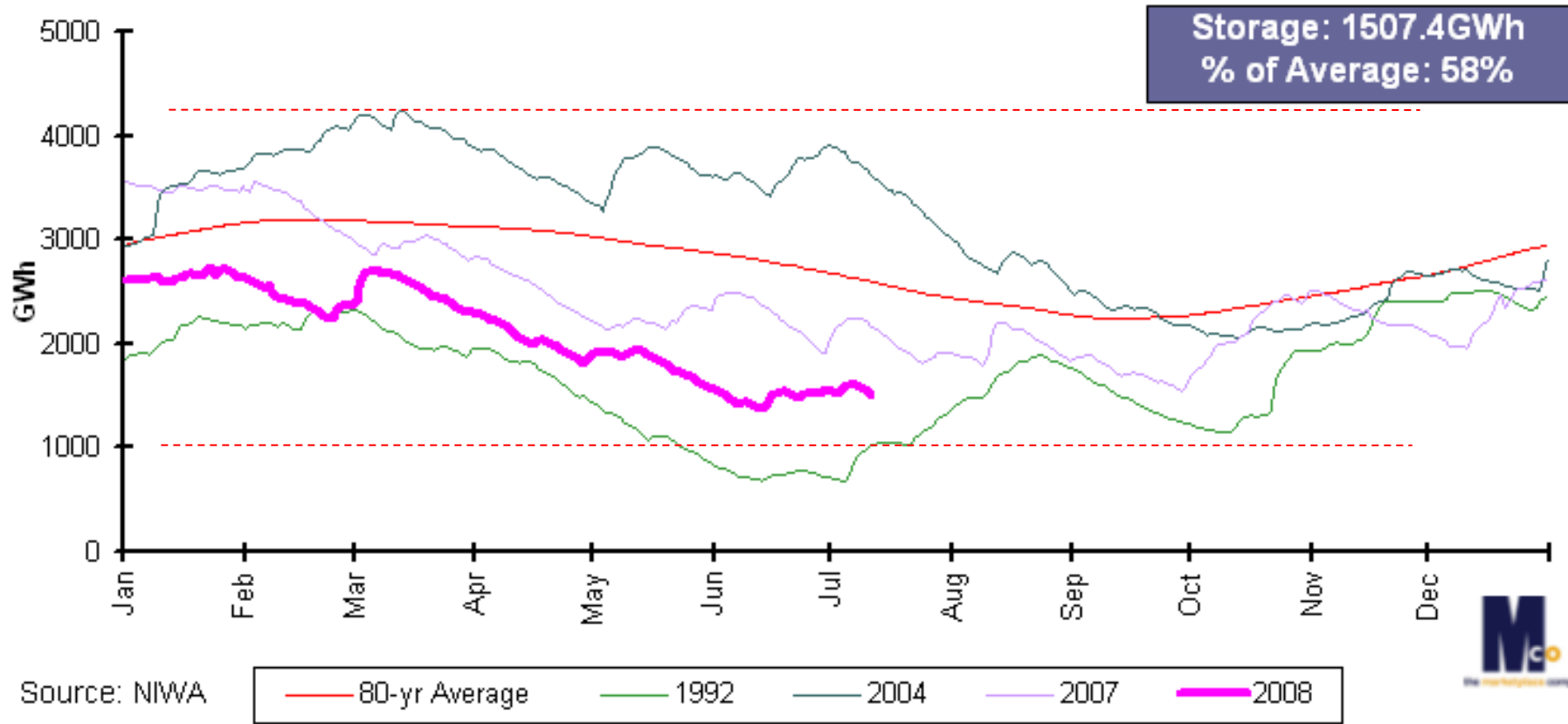
# A tale of two winters: national storage situation in the winters of 2009 and 2008

New Zealand Daily Storage  
(Updated daily last on Friday 22 May 2009)

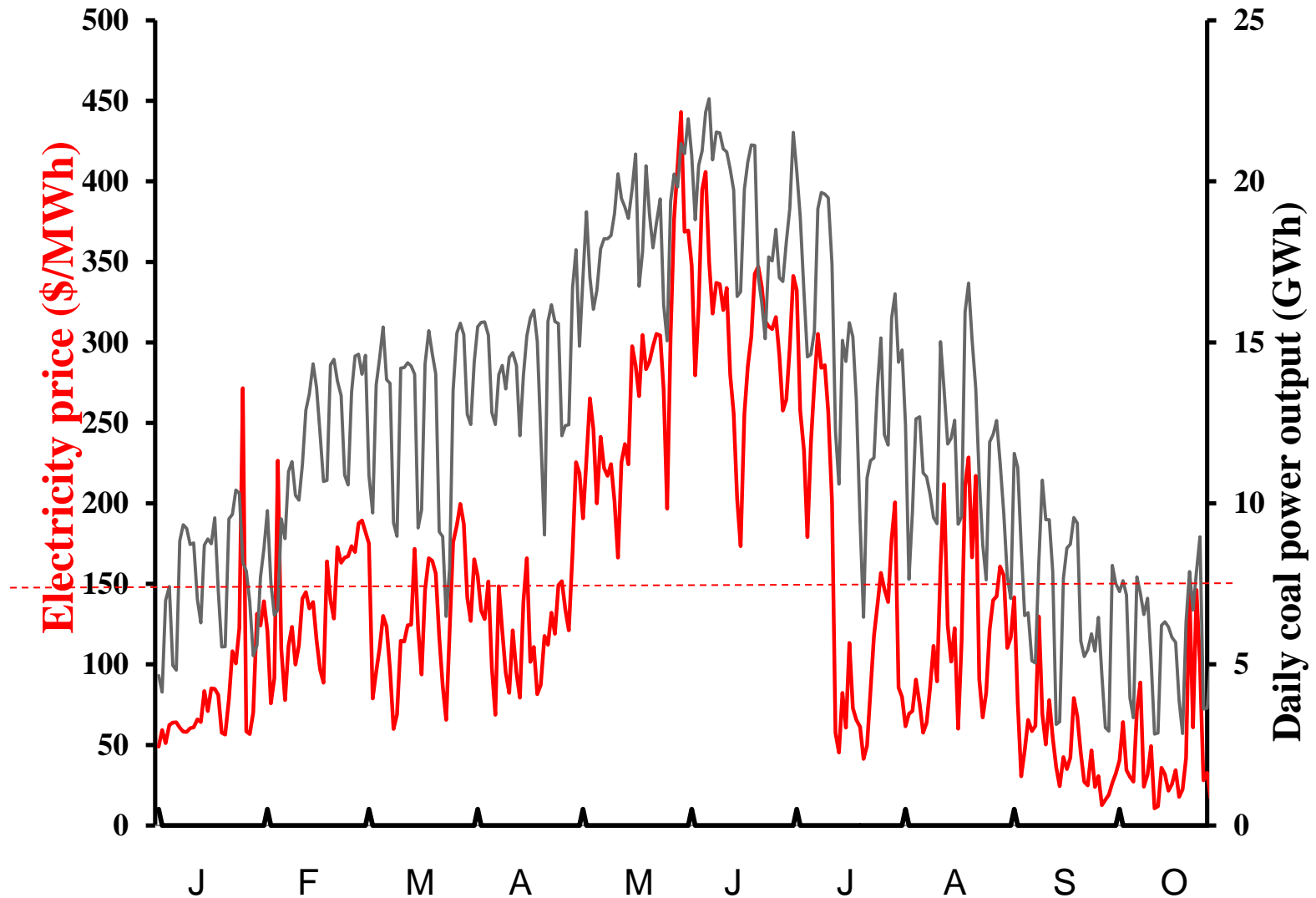


# Winter of 2008

New Zealand Daily Storage  
(Updated daily last on Friday 11 July 2008)



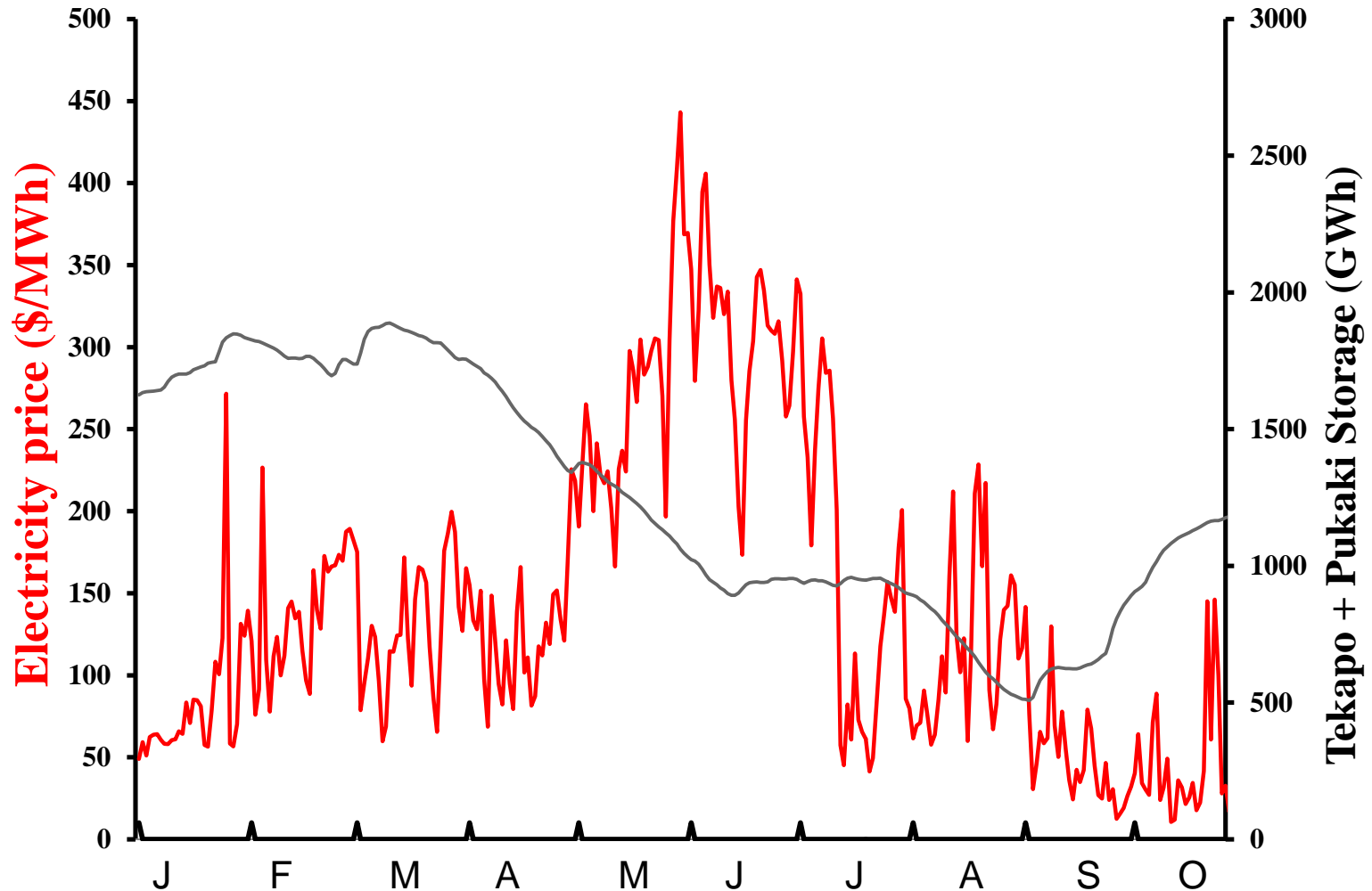
# 2008: Correlation of market electricity price and coal-fired power output



Mean daily Haywards price

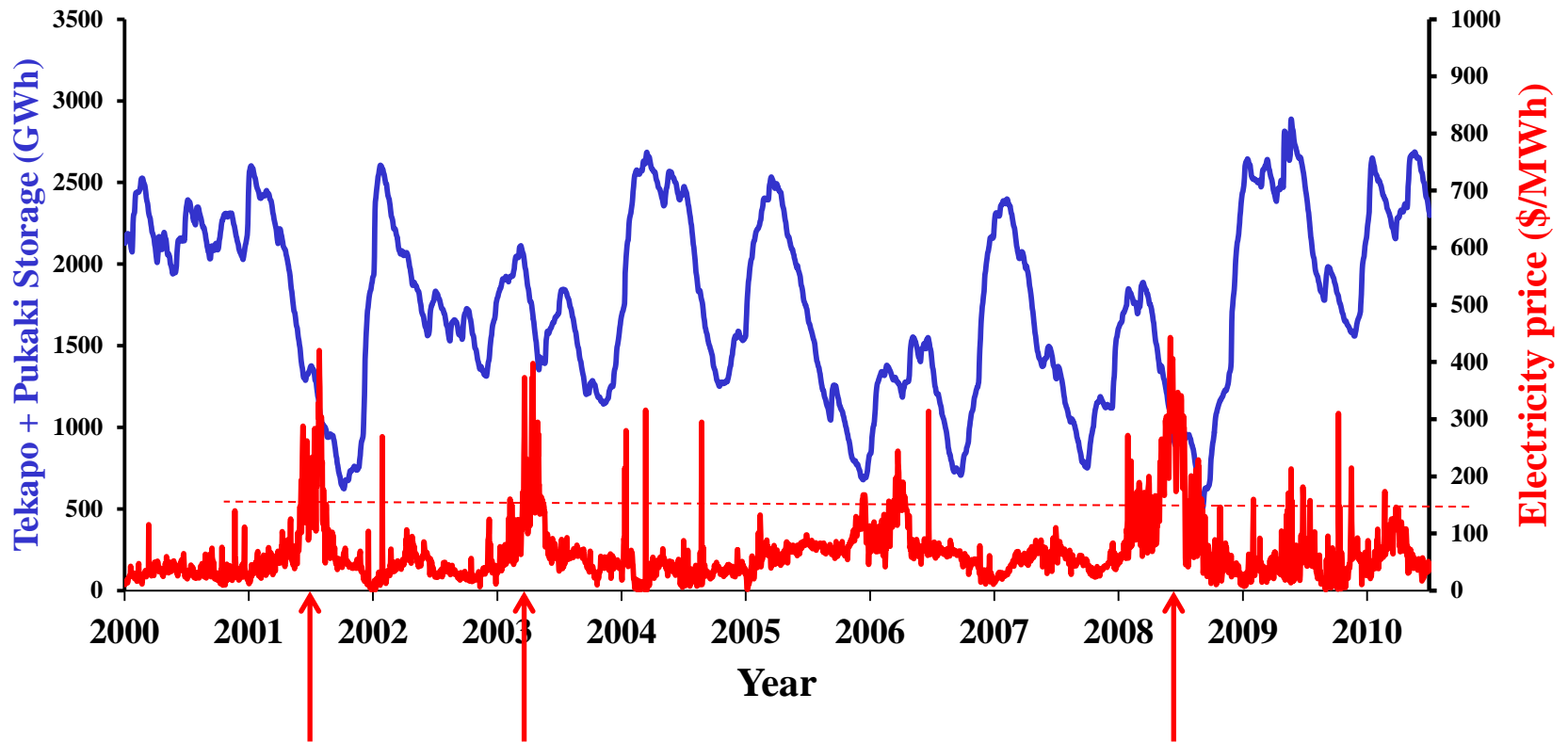
Coal-fired power directed to South Island

# 2008: Correlation of electricity price and hydro storage (higher storage = lower prices)





High electricity prices tend to be associated with falls in autumn-winter southern hydro lake levels (leads to more thermal generation)



## Around this time last year..

### Summer sun set for golden run (Stuff news 1/12/2010)

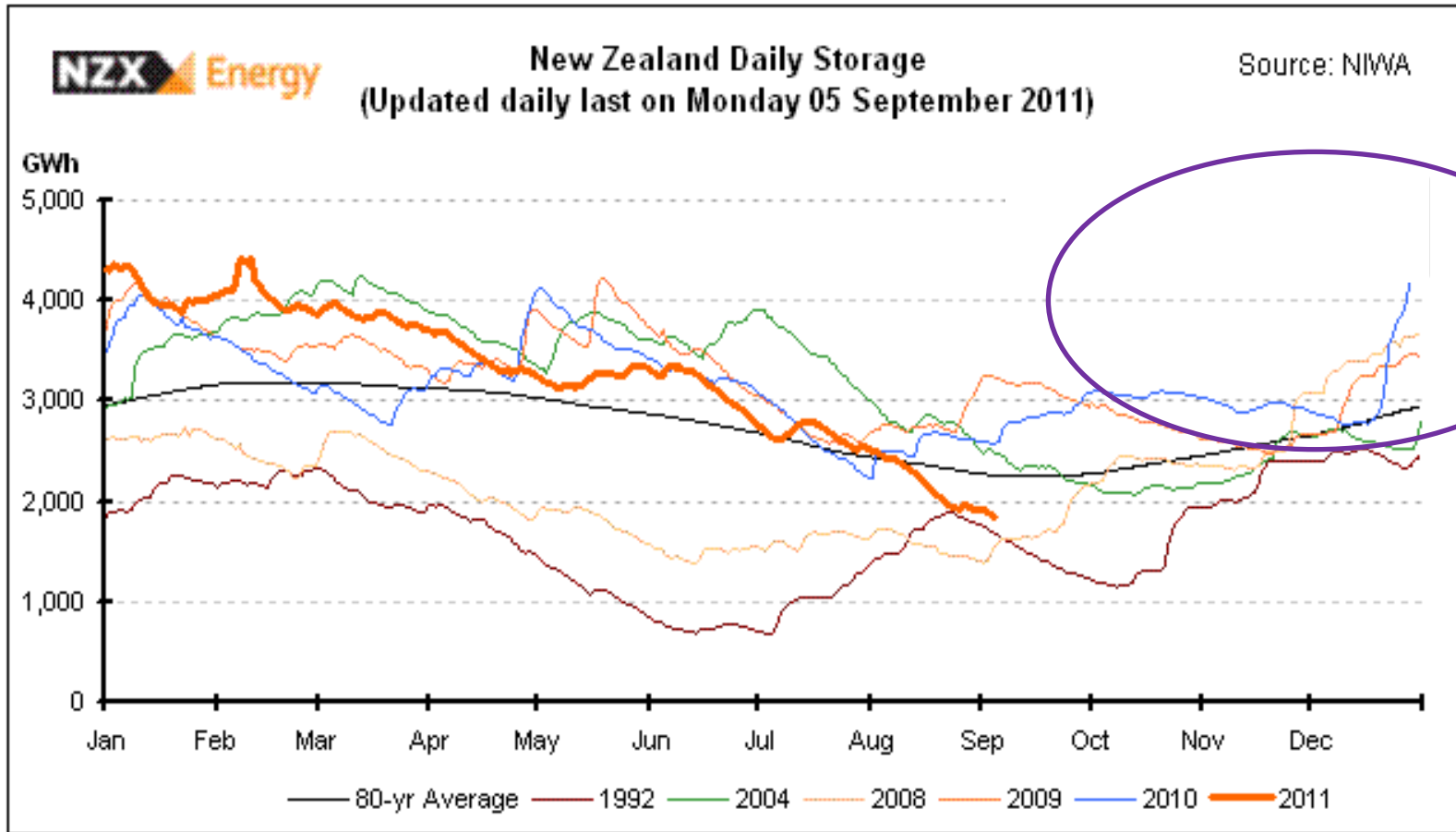
According to Niwa's three-month climate outlook Kiwis can expect a **hotter, drier summer than usual with the driest weather expected in the far South.**

Niwa said a "moderate to strong" La Nina weather pattern to persist until at least the end of February.

La Nina - the opposite of El Nino - means settled, warmer-than-normal weather, with high pressure systems moving across the country, said Niwa principal scientist James Renwick.

Although the **driest weather is expected in the West Coast, Southland and Fiordland**, given the already extremely dry conditions in the North Island, farmers hoping to avoid the dreaded drought could be unlucky, Renwick said.

# 2010 in blue..



January 1, 2011

## Water, water everywhere

KATARINA FILIPE



JOHN BISSET/Timaru Herald

**AMAZING VIEW:** Ten-year-old Sam Vorley, of Christchurch, watches water spilling from the Aviemore dam

The new year has brought respite for thousands of sodden campers in the Waitaki, with camp ground supervisors saying the flooding seems to be receding.

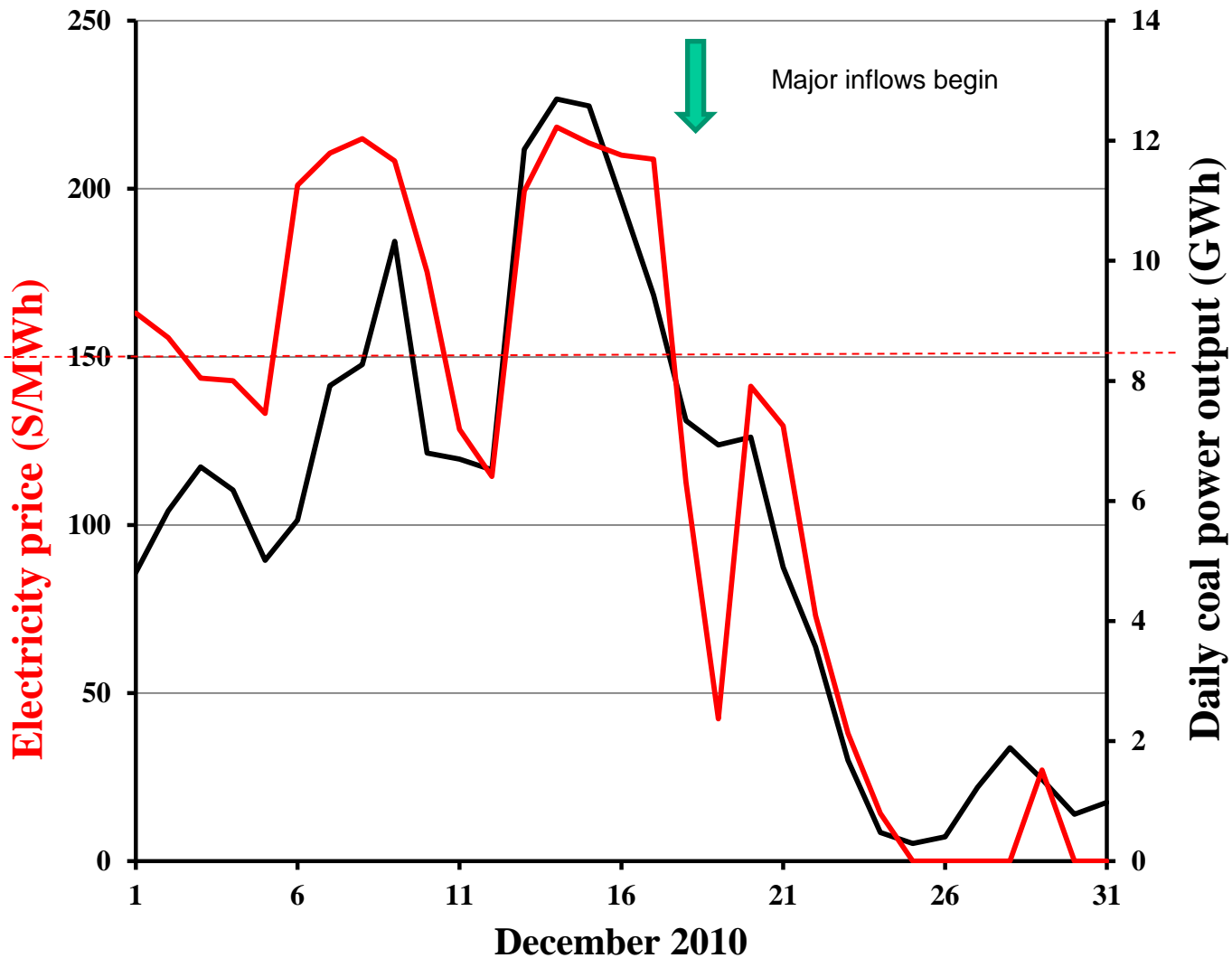
More than 700mm of rain fell at Mt Cook over Christmas, forcing Meridian Energy to spill water through the Upper Waitaki hydro system, as its lakes became swollen and inundated shoreline campers.

Nearly 100 campers near the Ahuriri River were asked this week to move to higher ground as the river rose. Those who failed to heed the warnings or were away from other sites in the Waitaki Valley suffered flooding of their tents and caravans.

Waitaki District Council camp supervisor Simon Fox said it had been a rough start to the holiday season but things were looking up.

While the wet weather had upset a few campers, most had stuck it out, with more arriving yesterday to celebrate New Year's Eve, he said.

# December 2010: Market electricity price and coal-fired power output



# December 2010: cost to the nation

- Needless CO<sub>2</sub> emission to atmosphere from 200 GWh hours of coal-fired power production
- Needless high electricity market prices, including 7 days in excess of \$150 / MWh
- Waitaki spill losses in January (lost generation opportunity and loss of water for potential irrigation use)

- Most of the “high price” issues are related to poor use of hydro storage (learning from the past)
- Use storage in remote rock basins, not scenic lakes in glacial till (creating the future?)

Use the Tongariro Power Scheme as a storage model

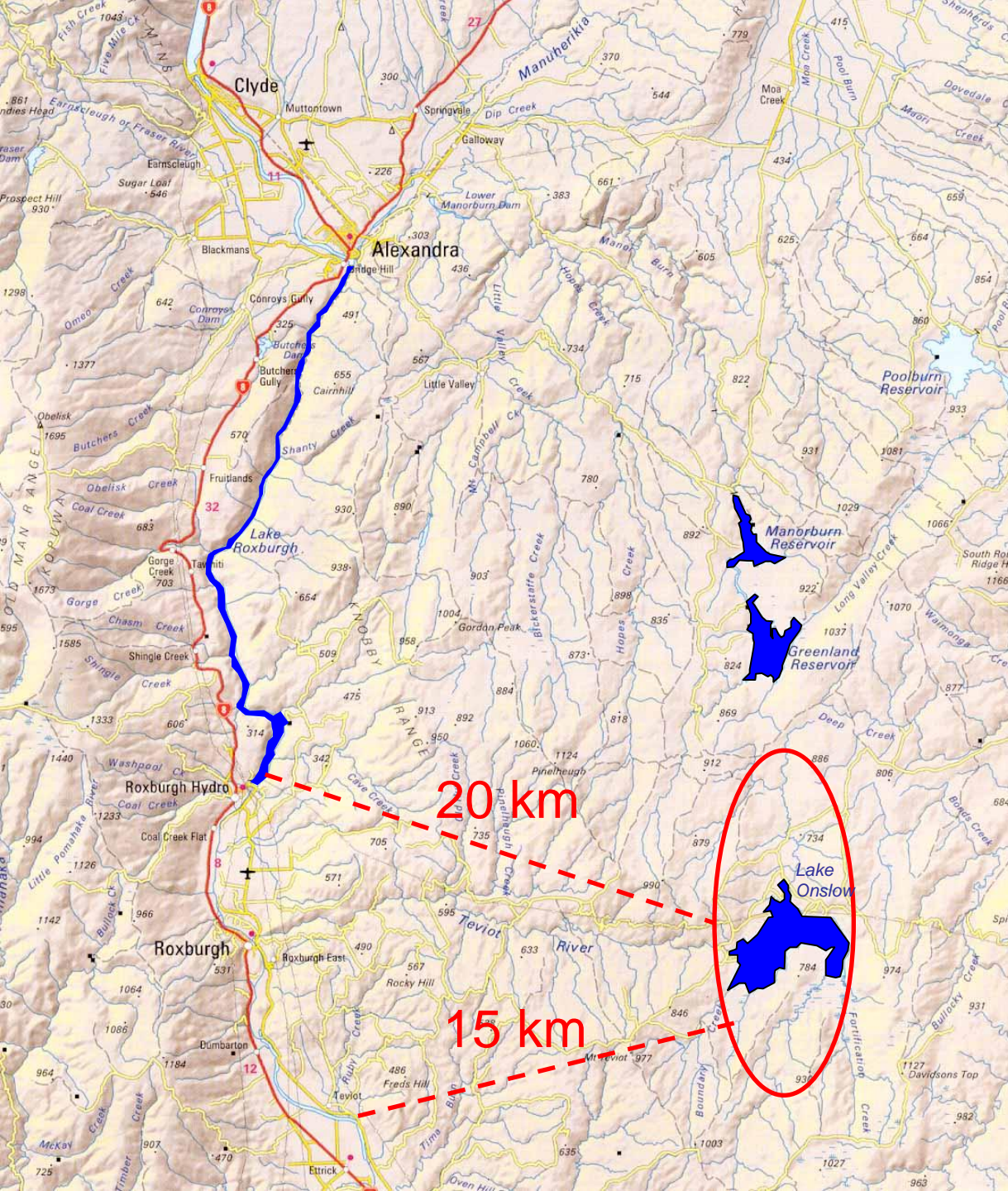
Lake Rotoaira: public access, high environmental value, 39 cm operating range





Lake Moawhango: artificial reservoir in a military reserve, restricted public access, lower environmental value, 9 metres operating range





Location of a possible seasonal pumped storage reservoir in the Onslow schist rock basin, Central Otago

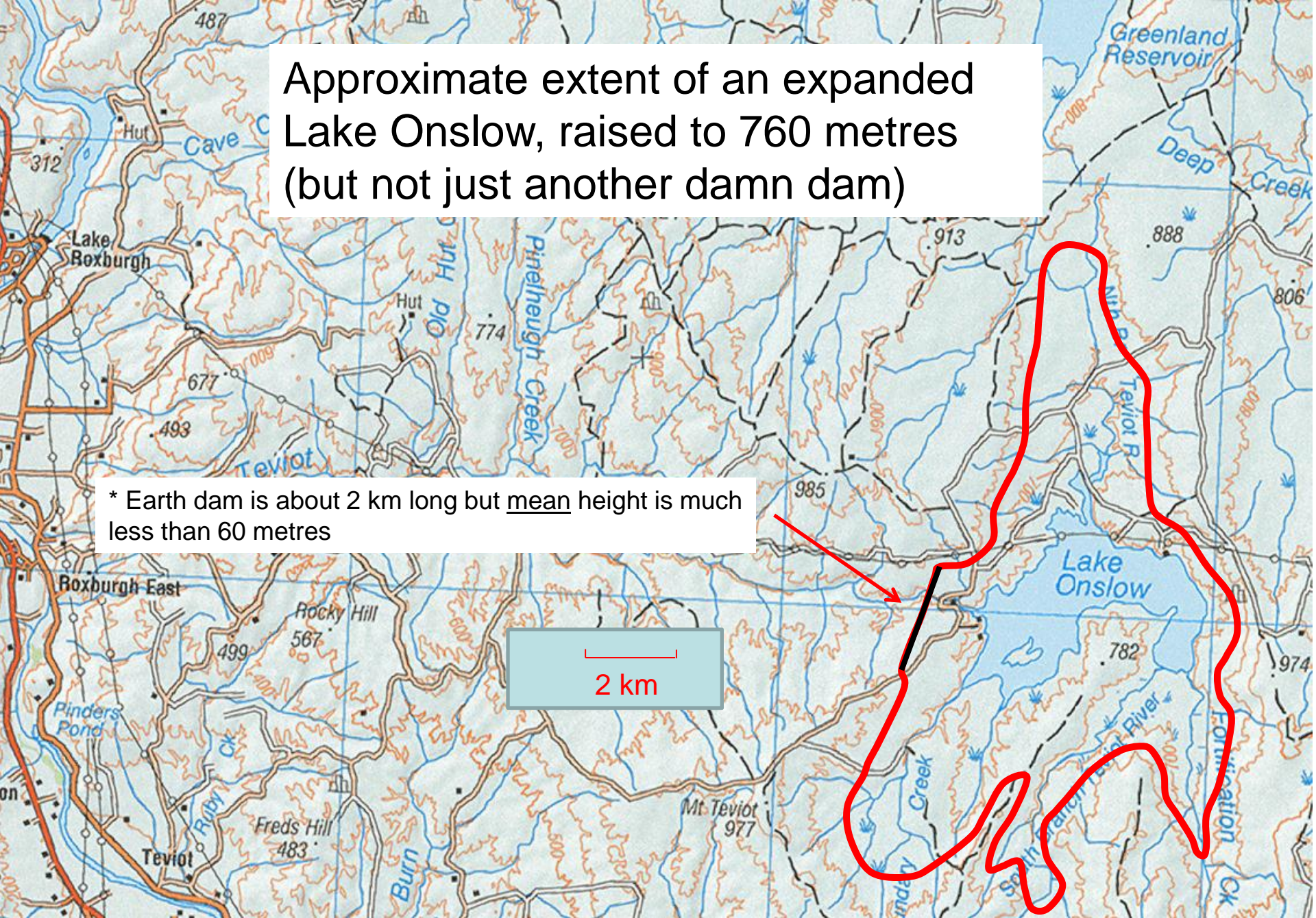
Efficiency  $\approx 100\%$



Approximate extent of an expanded Lake Onslow, raised to 760 metres (but not just another damn dam)

\* Earth dam is about 2 km long but mean height is much less than 60 metres

2 km



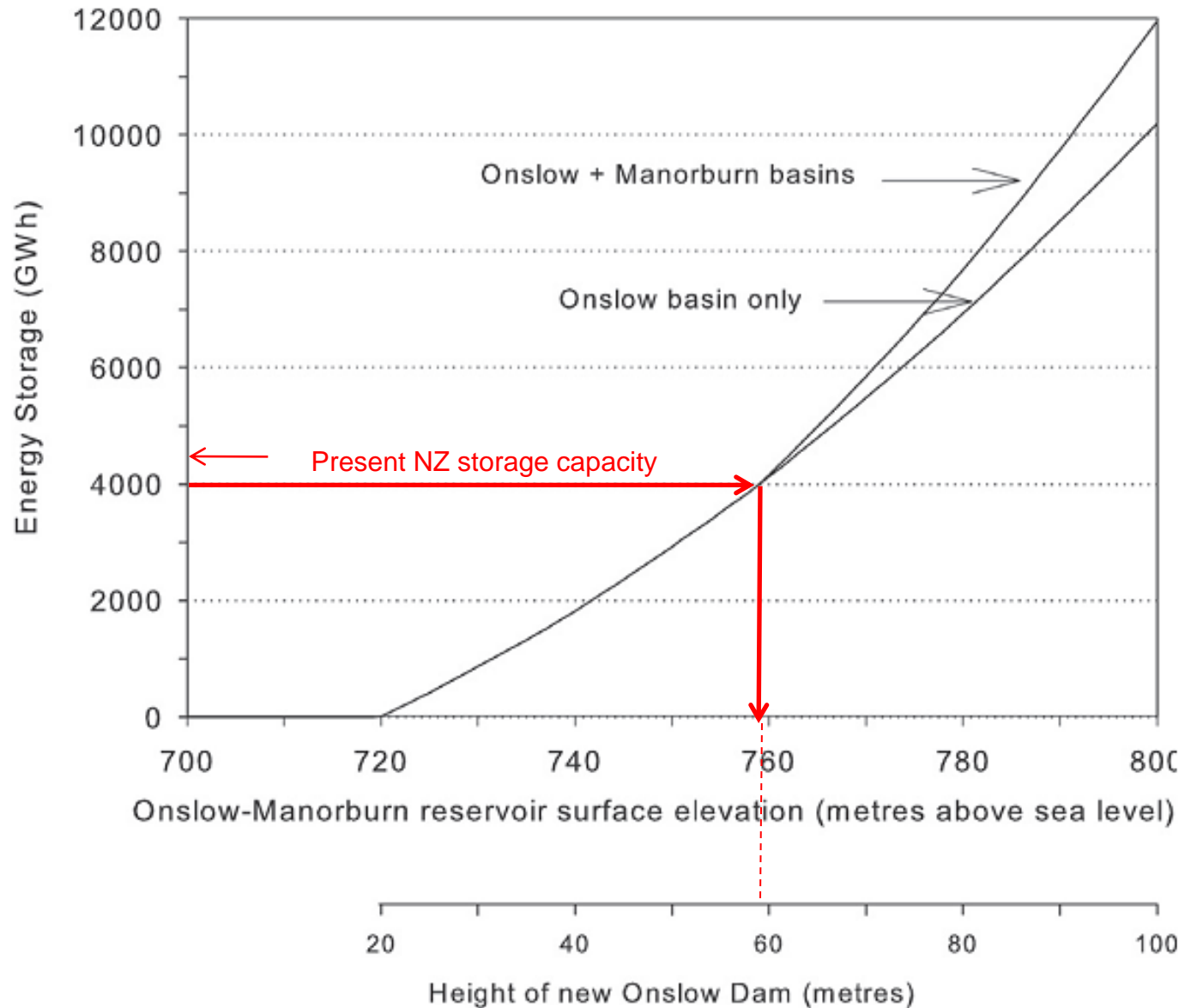
Earth dam site: Teviot Stream exit (not a large river valley)



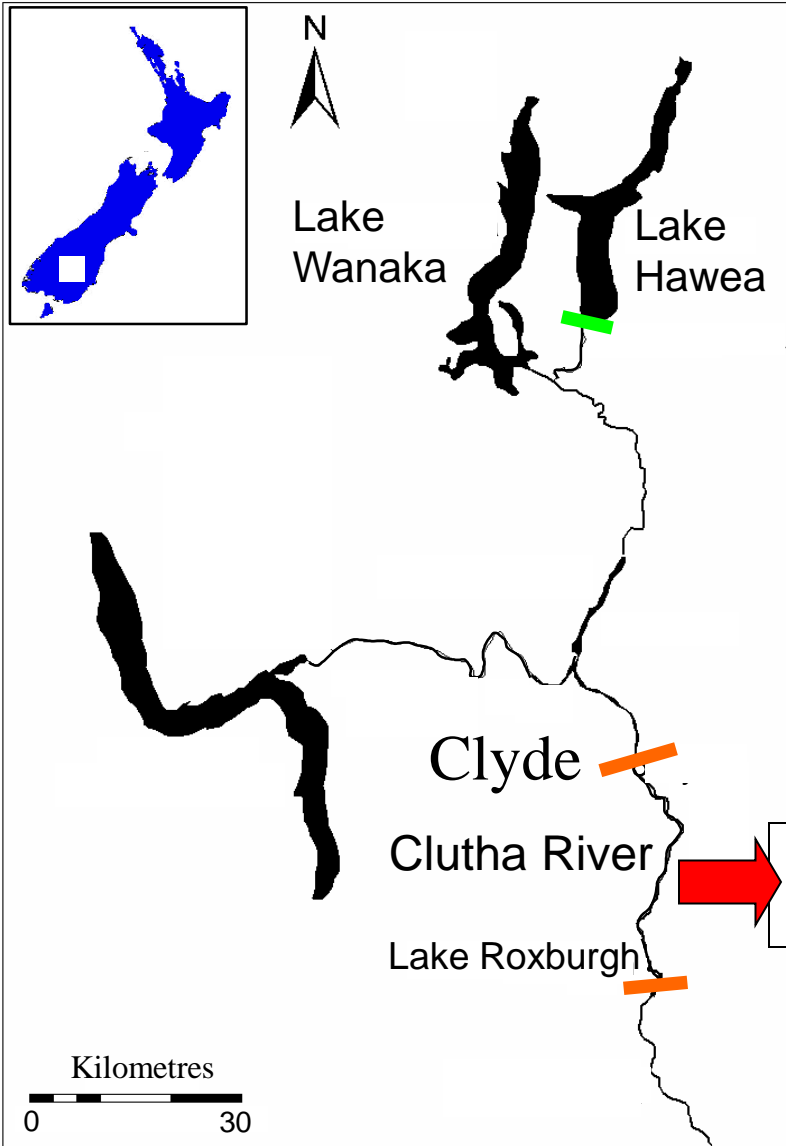
# Northern portion of Lake Onslow



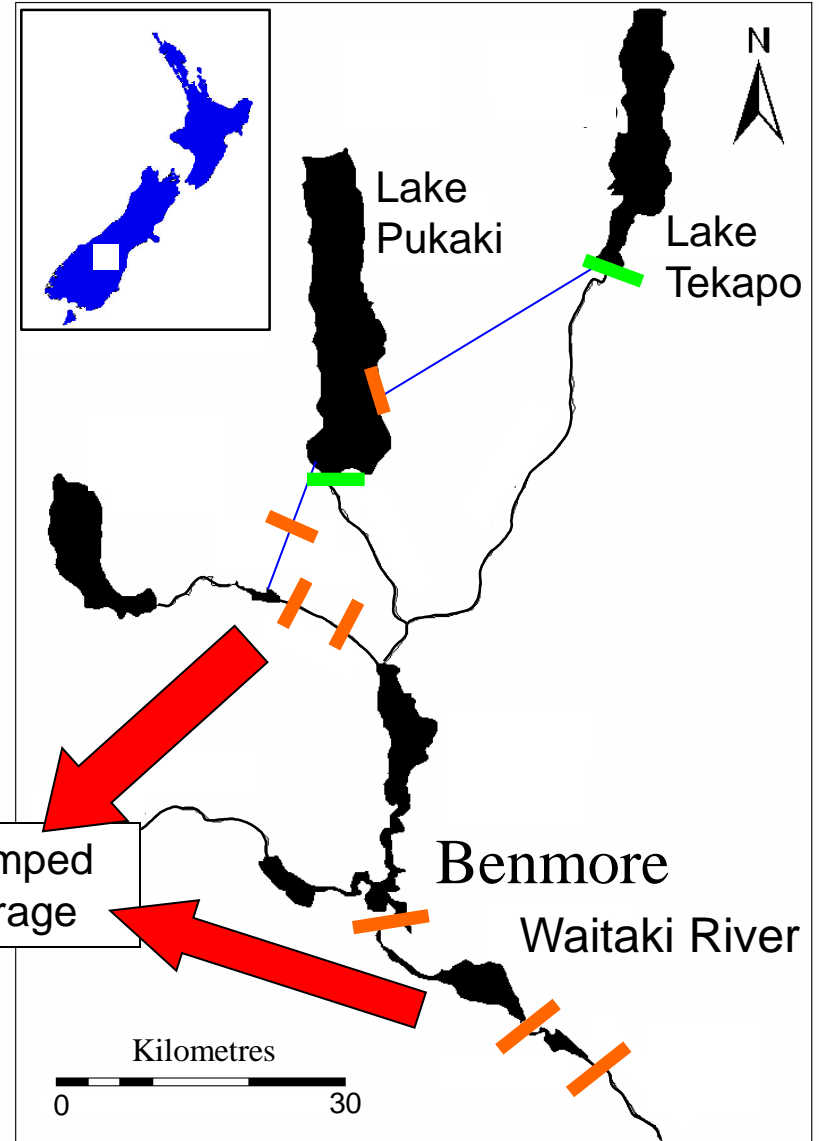
# Suggested scheme: 60-metre earth dam, about equal to total national energy storage capacity



# New operating system with Onslow pumped storage: Spring & Summer

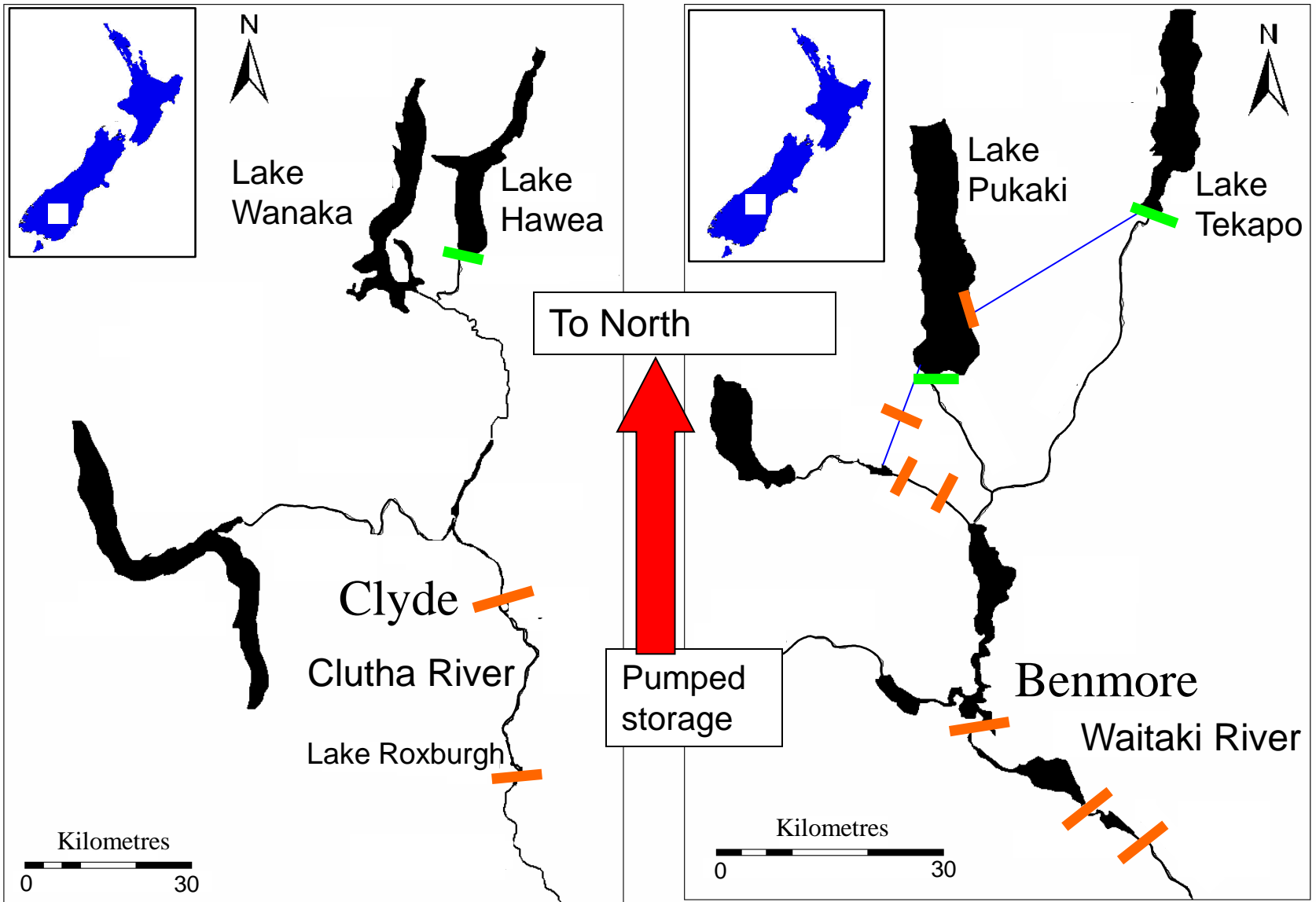


Clutha Power Scheme



Waitaki Power Scheme

# New operating system with pumped storage: Autumn & Winter

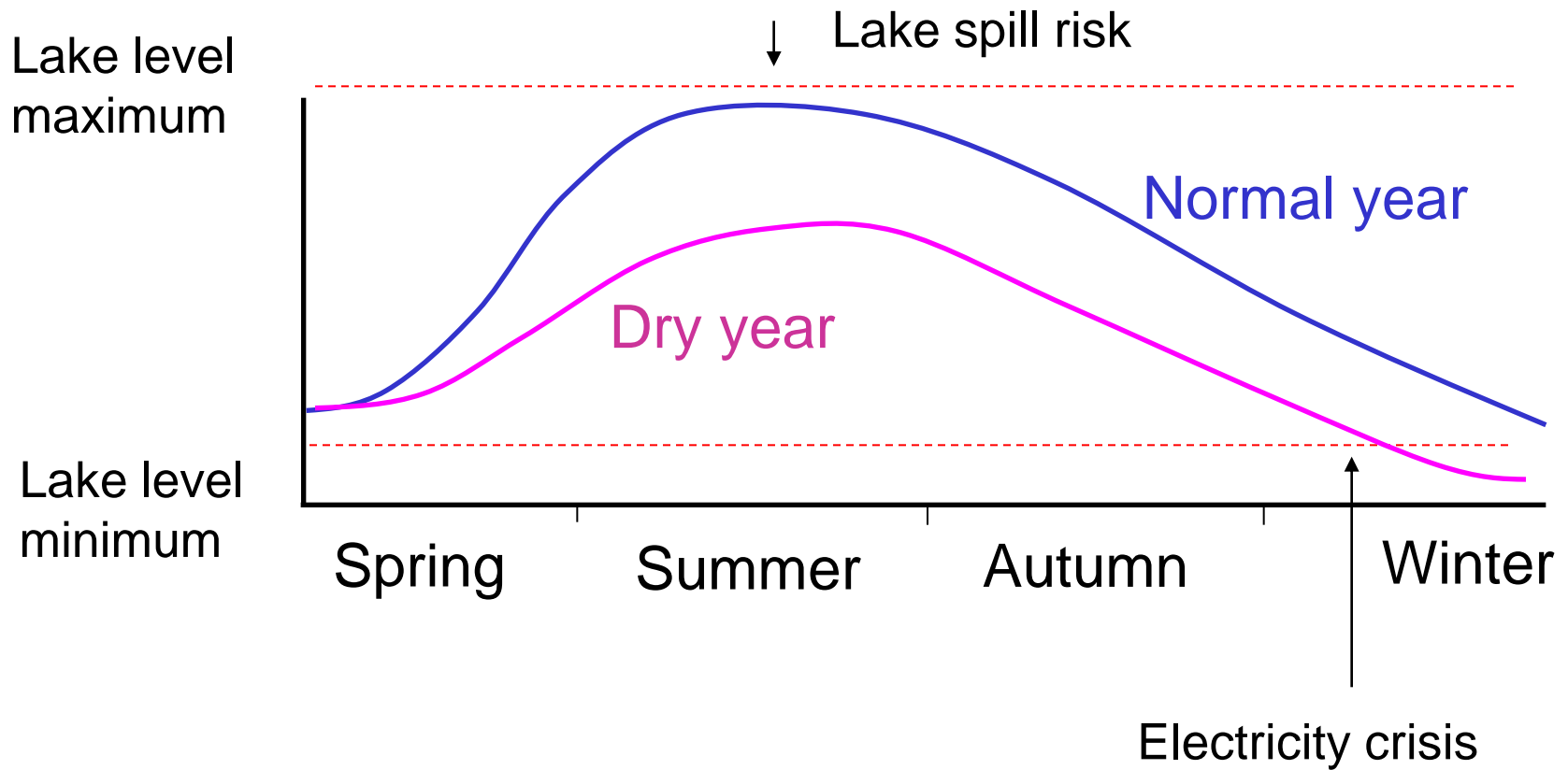


Clutha Power Scheme

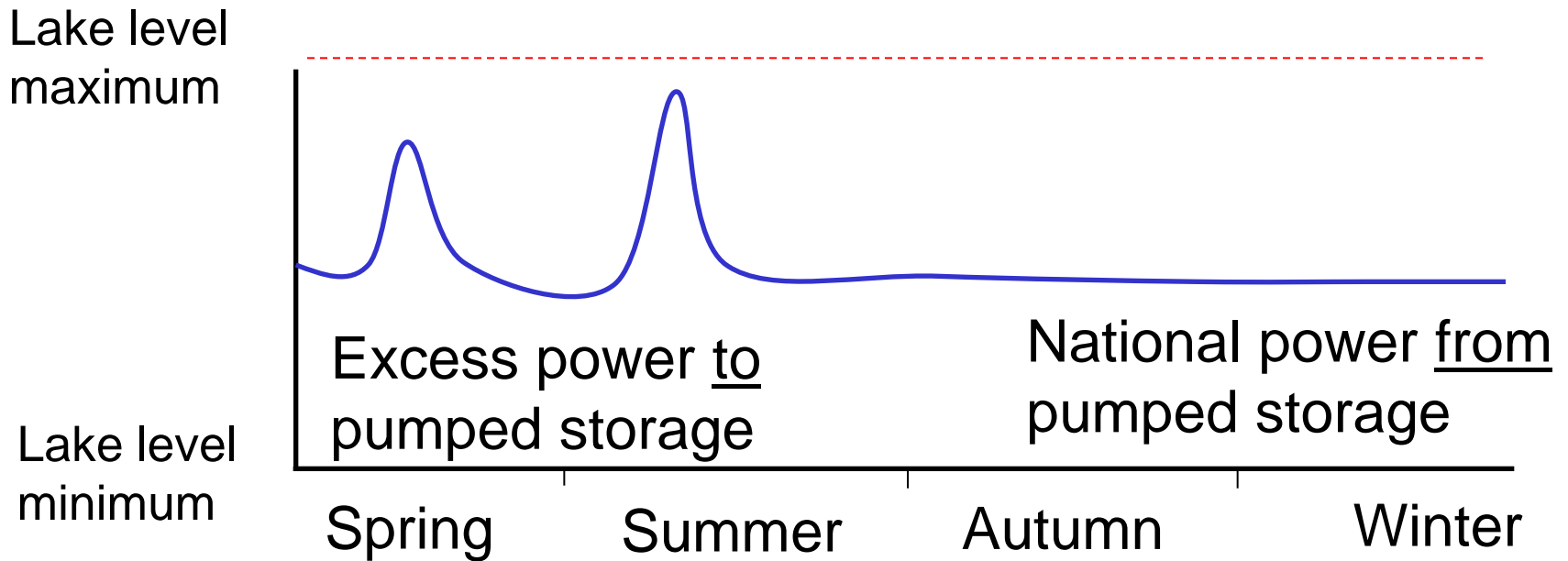
Waitaki Power Scheme



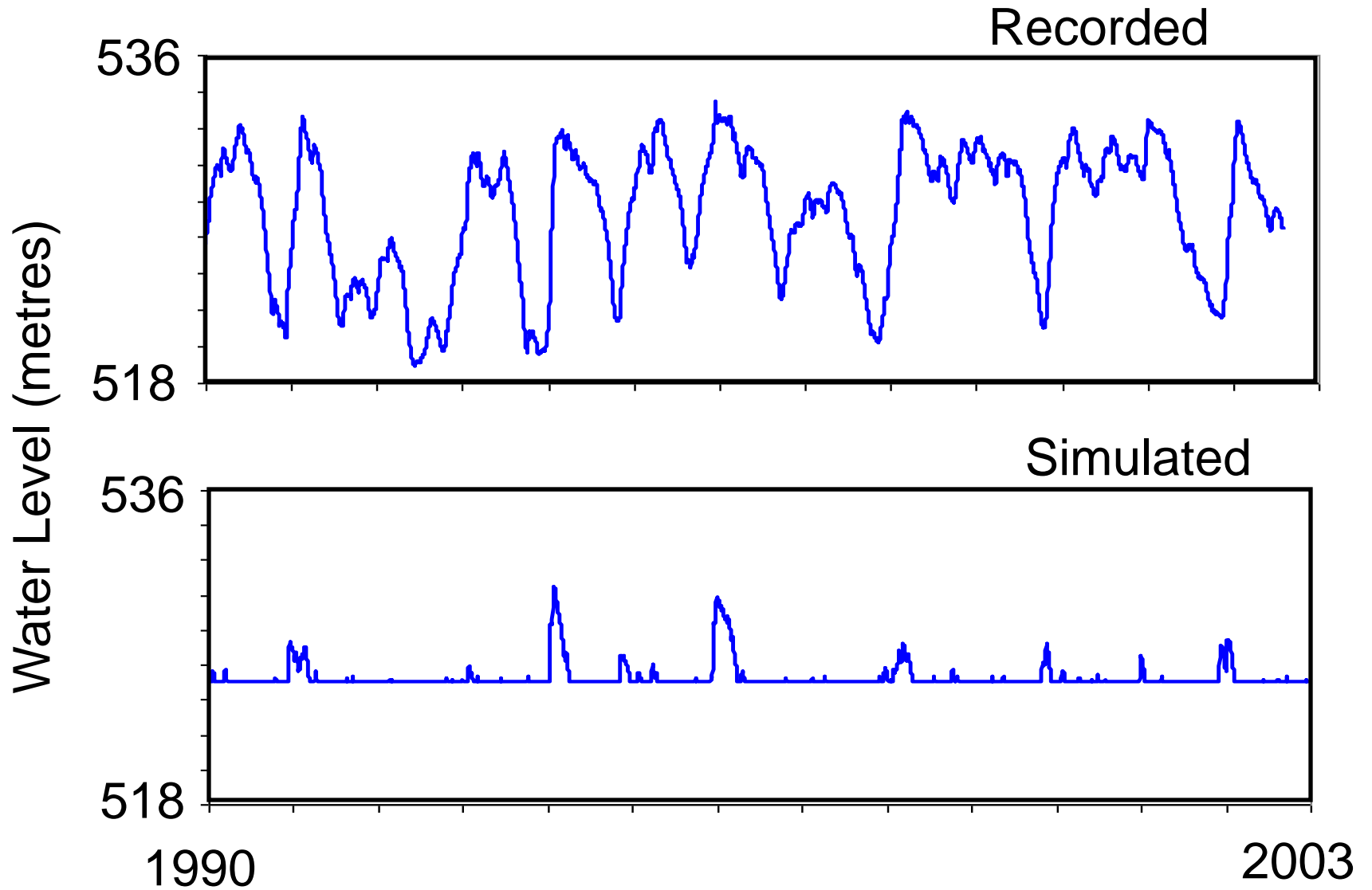
Current hydro lake management: store water in spring and summer to get through autumn and winter:



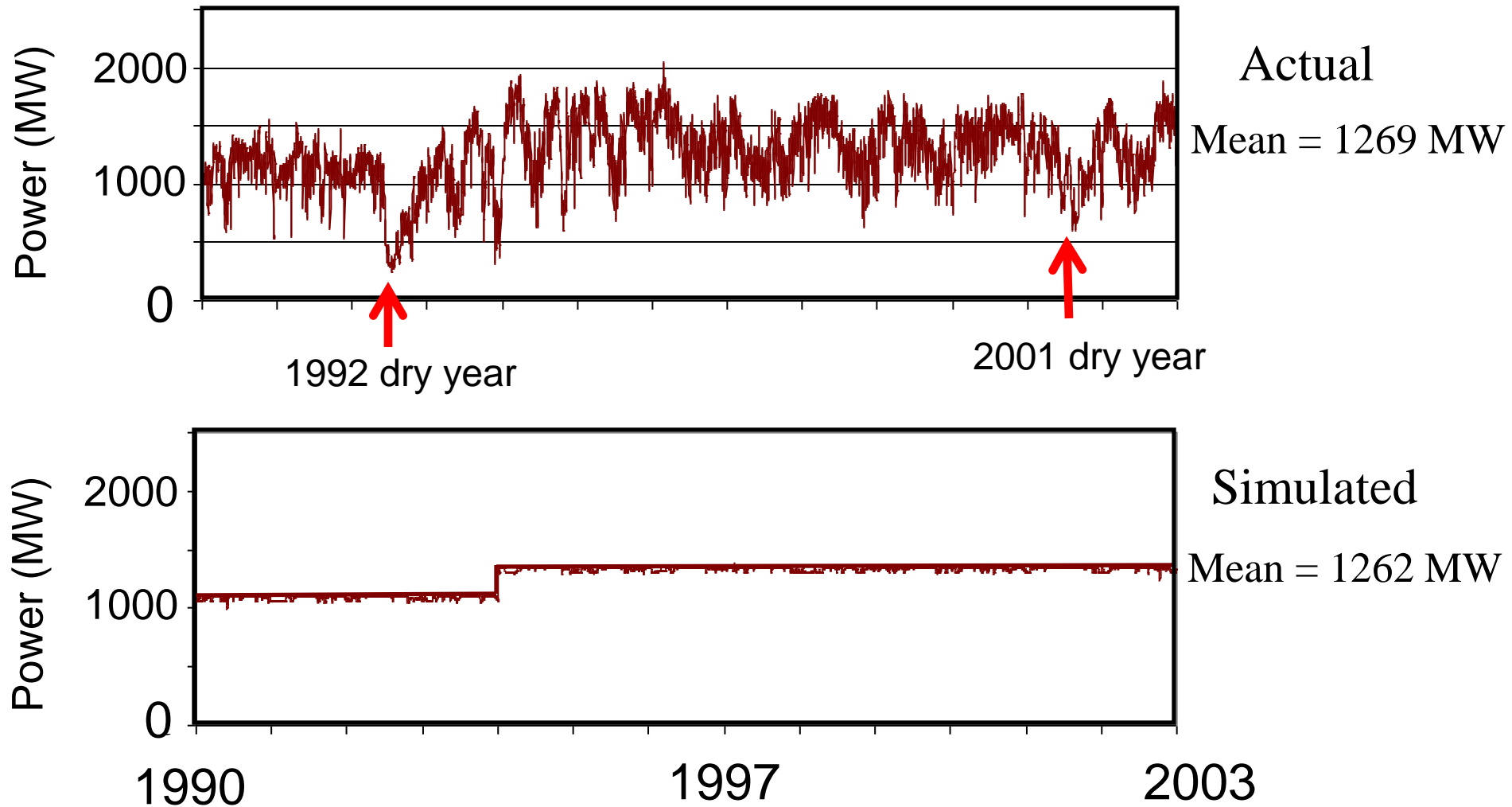
# New hydro lake level management with the Onslow pumped storage scheme operating



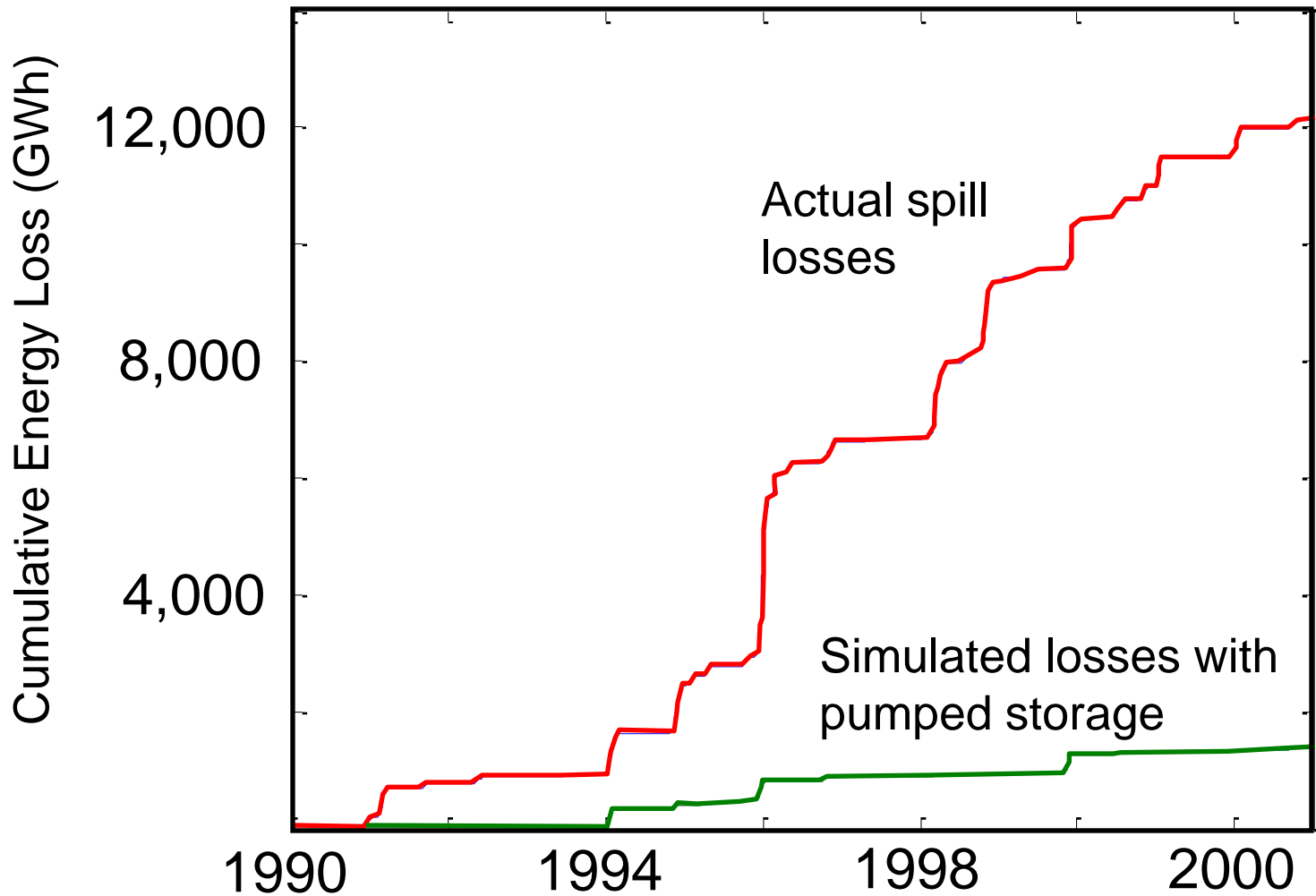
# Recorded and simulated Lake Pukaki water levels (1990-2003)



# Simulation result: Southern New Zealand power yield maintained (1990 – 2003)



Simulations (1990-2003) indicate pumped storage energy loss is offset by reduced spill in Clutha and Waitaki schemes



# But Onslow is not economic..?

- “Economic” is with reference to a market
- We construct markets for the national good, with goals in mind
- Expand current electricity market to include a long-term security of supply market, and heavy penalty for scenic lake level variations away from a fixed level.

# Advantages of shifting storage to Onslow

- More than  $100 \text{ m}^3\text{s}^{-1}$  of extra Waitaki summer water
- Stable scenic lake levels
- Stable lower electricity prices (less thermal generation)
- South Island security of power supply
- Dunedin city water supply
- Reduced Queenstown & Wanaka flood risk

We really should look to start on a total change to the current South Island seasonal hydro operation

End

