Mao goes to Bondi:

Viticulture & Climate Change in Asia-Pacific

Vinay Pagay

Dreer Award Recipient, 2008-09

PART I: CHINA

China – Shanghai

China – Shanghai

www.indiana.edu/~overseas/pics/shanghai1.jpg

China – Beijing

China – Beijing's Air

China – Beijing's Air

China – Beijing's Public Gardens

'Nine-dragon' Chinese Juniper
(*Juniperus chinensis*)

China – Xi'an, Shaanxi Province

Xi'an – China's Ancient Capital

Bell Tower (西安钟楼)

Great Mosque (西安大清真寺)

Army of Terracotta Warriors (兵马俑)

China – Yangling, Shaanxi Province

Northwest Agriculture & Forestry University
College of Enology

China – NWAFU, Yangling

Northwest A&F University Teaching Vineyard

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Northwest A&F University Teaching Vineyard

China – Viticulture And Wine History

- Fruit wine first made in China 8,000 years ago
- Late-2nd c. BCE: Han traveller Chang Ch'ien introduces *V. vinifera* from Central Asia
- 1892: Changyu Pioneer Wine Co. established
- 1937: Japanese invasion brings many varieties to North China and Manchuria
- 1949: PRC founded; growth of industry commences
- Late-1970s: Foreign consultants and winemakers bring expertise; growth of wine industry begins
- 1990s: Chinese universities expand their curriculum to include oenology and viticulture
- 2000s: Rapid growth of vineyards and wineries

China – Viticulture And Wine History

‘He’ wine vessel

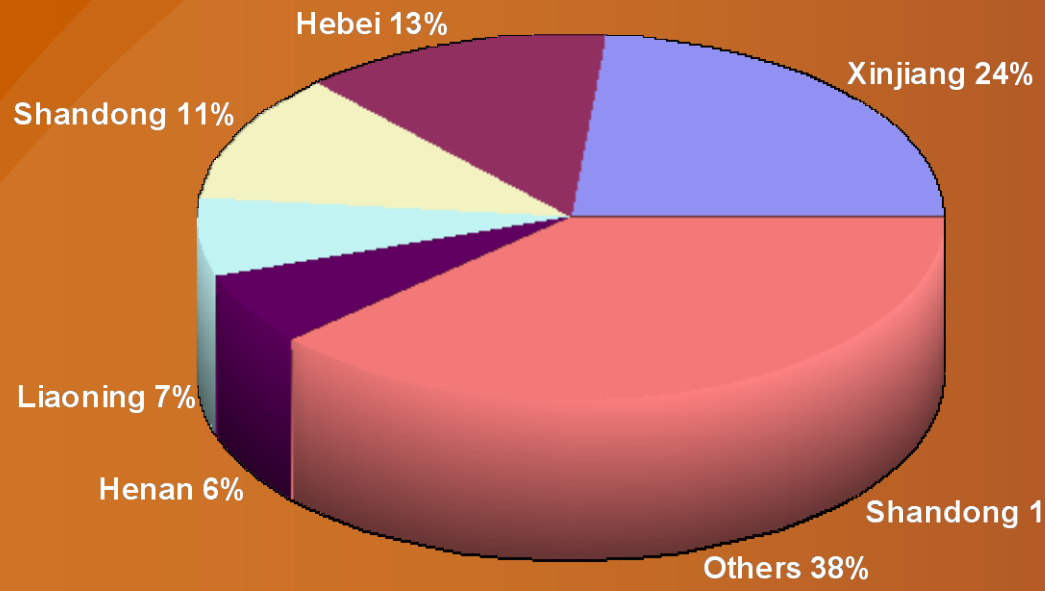
7th-6th c. B.C.

The Shanghai Museum

China – Viticultural and Climatic Regions

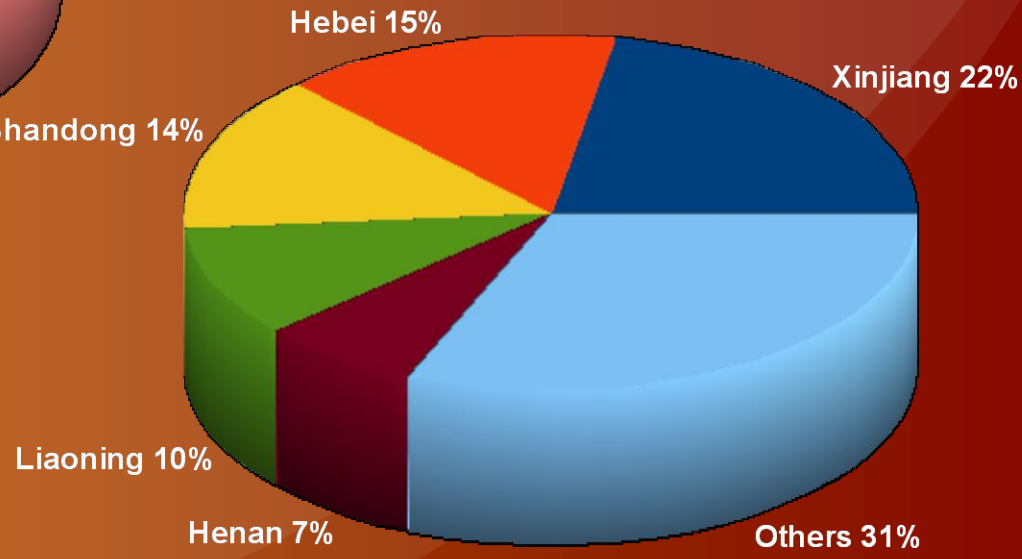
China – Vineyard Acreage and Grape Production, 2006

Total acreage: 419,000 ha



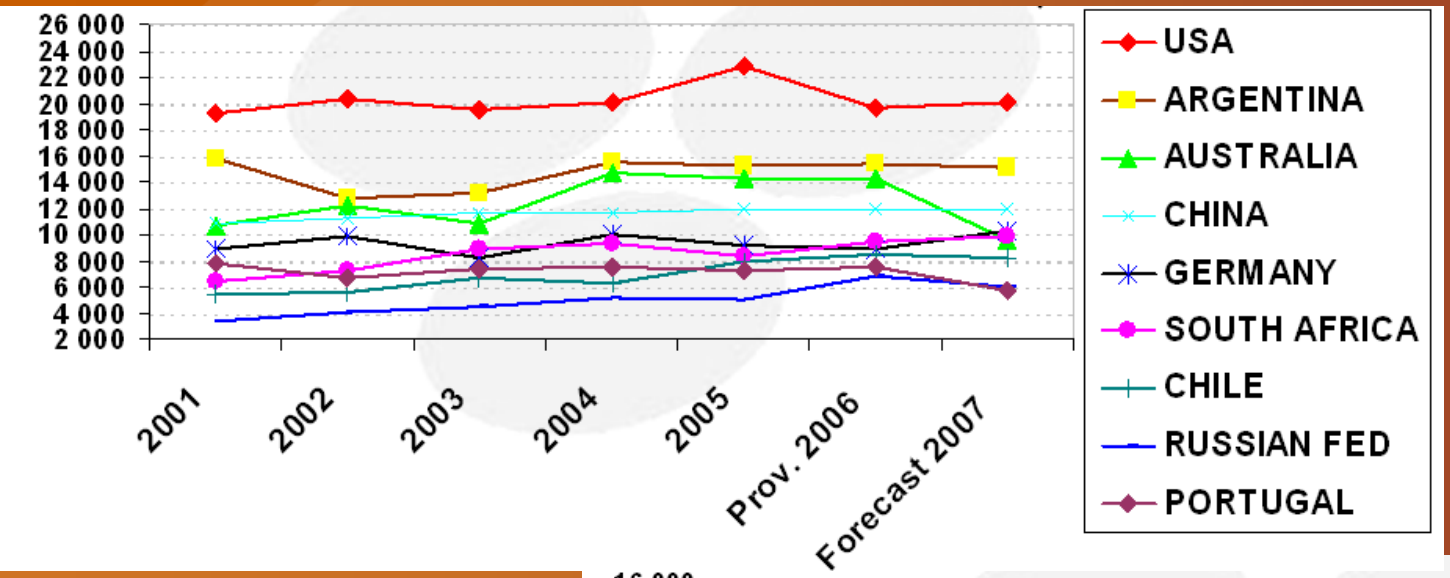
Total production:

6.3 million tons



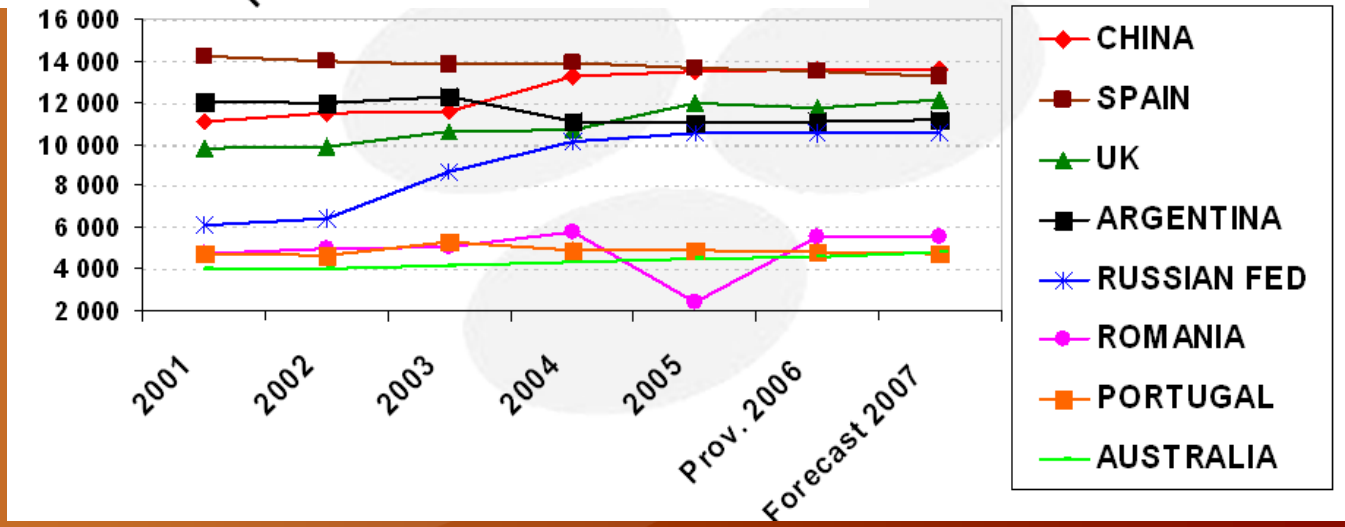
Sources: China Agriculture Yearbook 2007, OIV 2007

China - Wine Production and Consumption



PRODUCTION ('000 hL)

CONSUMPTION ('000 hL)



Source: OIV 2005

China – Grape Cultivars

Longyan

Traditional Varieties

- Long-yan ('Dragon's Eye')
- Niu-nai ('Cow's Nipple')
- Wuhebei ('Kishmish', Thompson Seedless)
- Hong-jixin ('Red Cock's Heart')
- Bai-jixin ('White Cock's Heart')
- Beichuan
- Yantai 73 (Yan 73)

Yan 73

International Varieties

- Muscat Hamburg
- Cabernet Sauvignon
- Chardonnay
- Carmenere ('Cabernet Gernischt')
- Riesling (Italian, White)
- Rkatsiteli
- Syrah
- Merlot

Niunai

China – Wild Grape Cultivars

'Shan Putao' (*Vitis amurensis*)

'Sì Putao' (*Vitis davidii*)

China – North East

- Provinces
  - Heilongjiang
  - Jilin
  - Liaoning
- Climatic Conditions
  - Cold winters
  - Dry summers

China – Regional Production North East

‘Shan putao’ vineyard in Jilin province

China – Regional Production North East

Pergola trellising

Vine burial, costs

China – Regional Production North East

Ice-wine production in Liaoning province

China – Regional Production
North Central, East

- Provinces/Regions
  - Beijing
  - Shandong
  - Tianjin
  - Hebei
  - Henan
  - Shanxi
- Climatic Conditions
  - Warm, humid
  - Much rainfall

China – Regional Production
North Central

Young Cabernet Sauvignon vineyard, Shanxi province

China – Regional Production North Central

Cover cropping in a young vineyard, Shanxi province

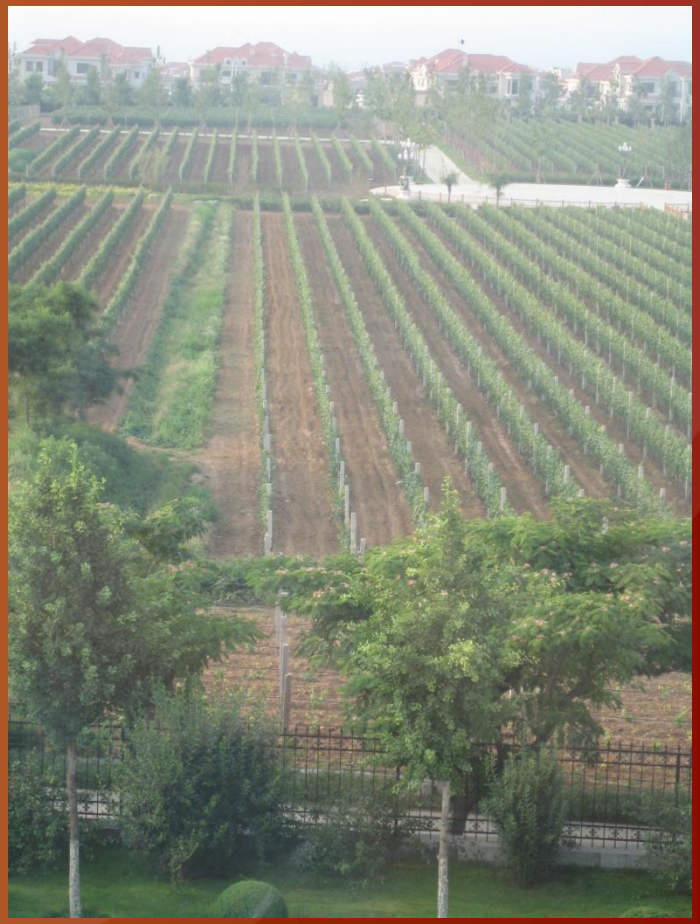
China – Regional Production
North Central

Yellow River (黃河), Houkou Falls, Shanxi province

China – Regional Production North Central

Private reservoir for irrigation water near Taiyuan, Shanxi province

China – Regional Production
Shandong Province



Chateau Changyu Castel, Yantai

China – Regional Production
Shandong Province

COFCO Chateau Junding, Penglai

China – Regional Production
Shandong Province

Grapevine Nursery at Chateau Junding, Penglai

China – Vine Training Systems

Fan training on an arbor

Dragon training on an arbor

China – Xinjiang Province

China – Regional Production
Xinjiang, Northwest China

Young vineyard

Gansu Province

Suntime vineyard

Changji, Xinjiang Province

China – Regional Production
Xinjiang, Northwest China

Grape Valley, Turfan

Xinjiang province

China – Regional Production
Xinjiang, Northwest China

Raisin Production, Turfan

Xinjiang province

China – Vineyard Irrigation

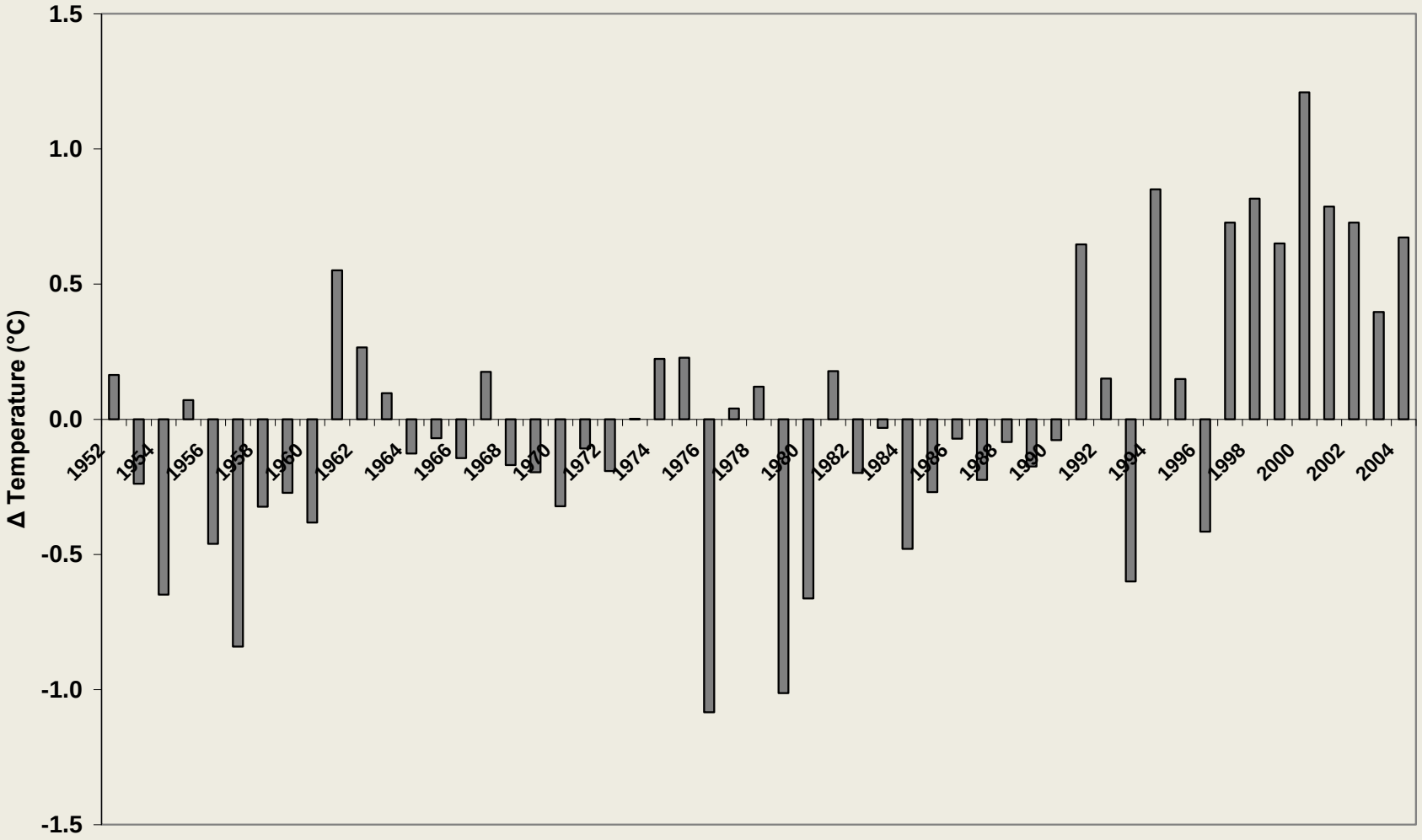
Ditch or Furrow Irrigation

China – Regional Production
Xinjiang, Northwest China

‘Kareji’ sub-surface irrigation

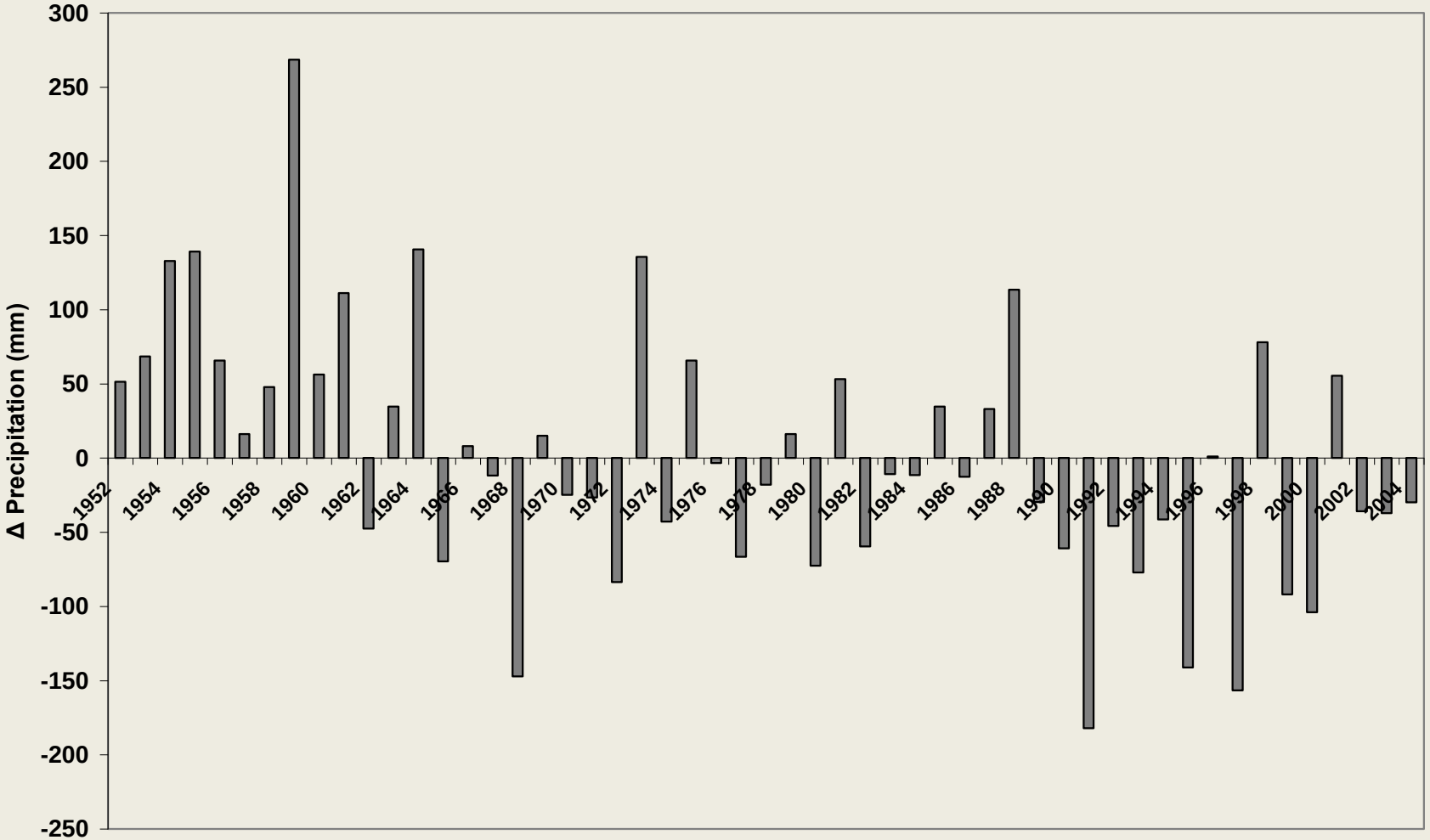
Turfan, Xinjiang province

China – Evidence for Climate Change



Mean growing season temperature anomaly from seven major agricultural centers in China (1952-2004)

China – Evidence for Climate Change



Mean growing season precipitation anomaly from seven major agricultural centers in China (1952-2004)

China – Evidence for Climate Change

Survey Results and Grower Testimonials

- General consensus → climate is changing!
- Winter temperatures rising , Yellow River freezes later
- Spikes in spring temperatures followed by frosts (Xinjiang)
- More ‘hot‘ days (>35°C) during growing season
- Advanced phenology
- Increased severity of droughts
- Less available irrigation water
- Melting glaciers

Tian Shan Mountains, Xinjiang


PART II: INDIA

Northern India

Ladakh ('Little Tibet')

Thiksay Gompa
(Monastary)

Ladakh ('Little Tibet')

North India – Himachal Pradesh

Beas River, Manali

North India – Himachal Pradesh

Dr. YSP College of Horticulture and Forestry, Nauni (Solan)

Climate Change in India

- Region with high vulnerability to climate change
  - Agriculture contributes ~18% of GDP
  - 65% of population depends on agriculture (economically)
  - 60% of agricultural area is climate-dependent
- Northern India at greater risk than Central or Southern India
- Winter temperatures rising faster than summer temperatures
- Snow days and winter precipitation decreasing
- Migration of crops is already occurring; temperate belt moving northward and to higher altitudes
- Frequency of droughts have been variable: high in the 70's and early 80's, lower in the 90's and now

Climate Change Policy in India

- The Energy and Resources Institute (TERI), New Delhi
  - Energy policy analysis
  - Clean Development Mechanism (CDM) implementation
  - Impacts, vulnerabilities, and adaptation assessments
  - GHG monitoring and mitigation analysis
- International Rice Research Institute (IRRI) &

  Indian Center for Agricultural Research (ICAR), New Delhi
  - Assessment of climate change in the Indo-Gangetic Plain and coastal areas
  - Effects on agricultural productivity particularly wheat and rice
- Government of India
  - Short-term: Disaster management agencies (NIDM), crop insurance schemes, high quality weather forecasting
  - Long term: Environmental impact of new development, green buildings

India – Major Viticultural Regions

Western India – Nashik, Maharashtra

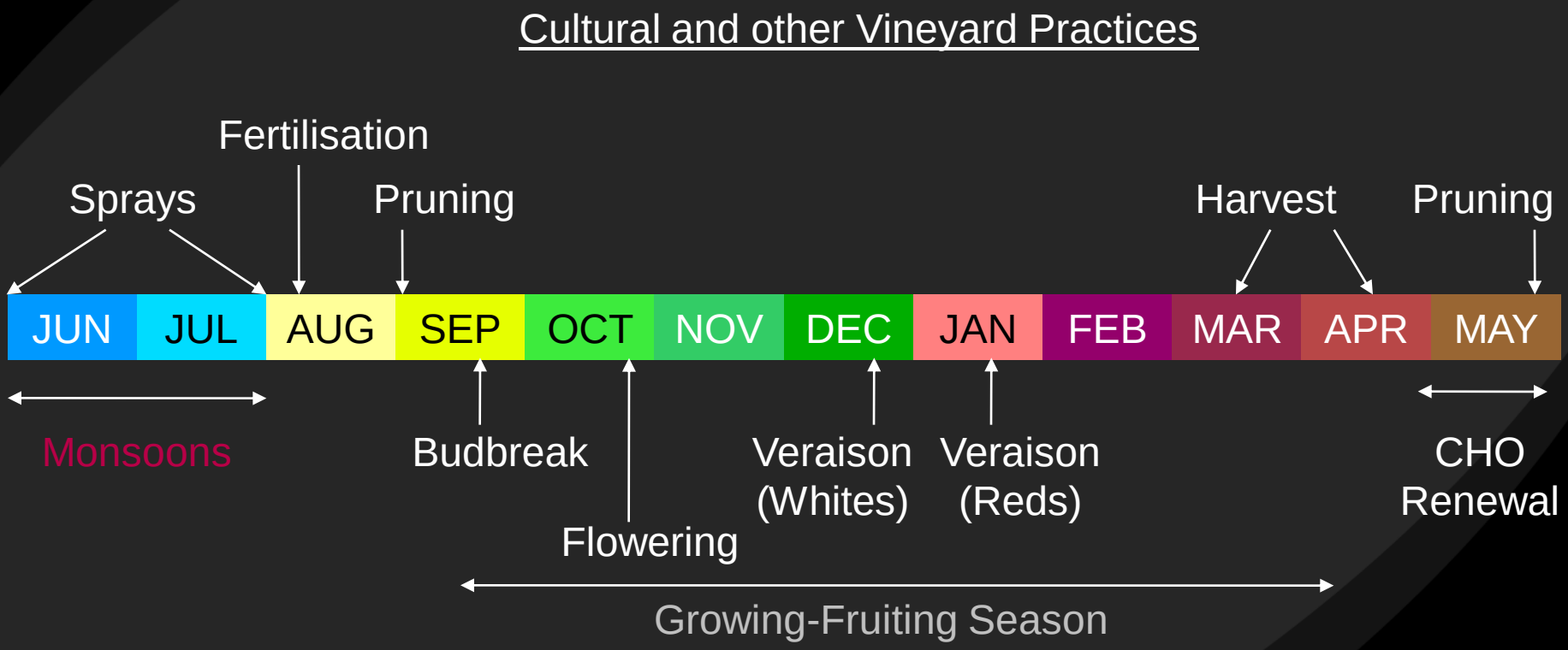
N. D. Wines

Sula Vineyards

Western India – Nashik, Maharashtra

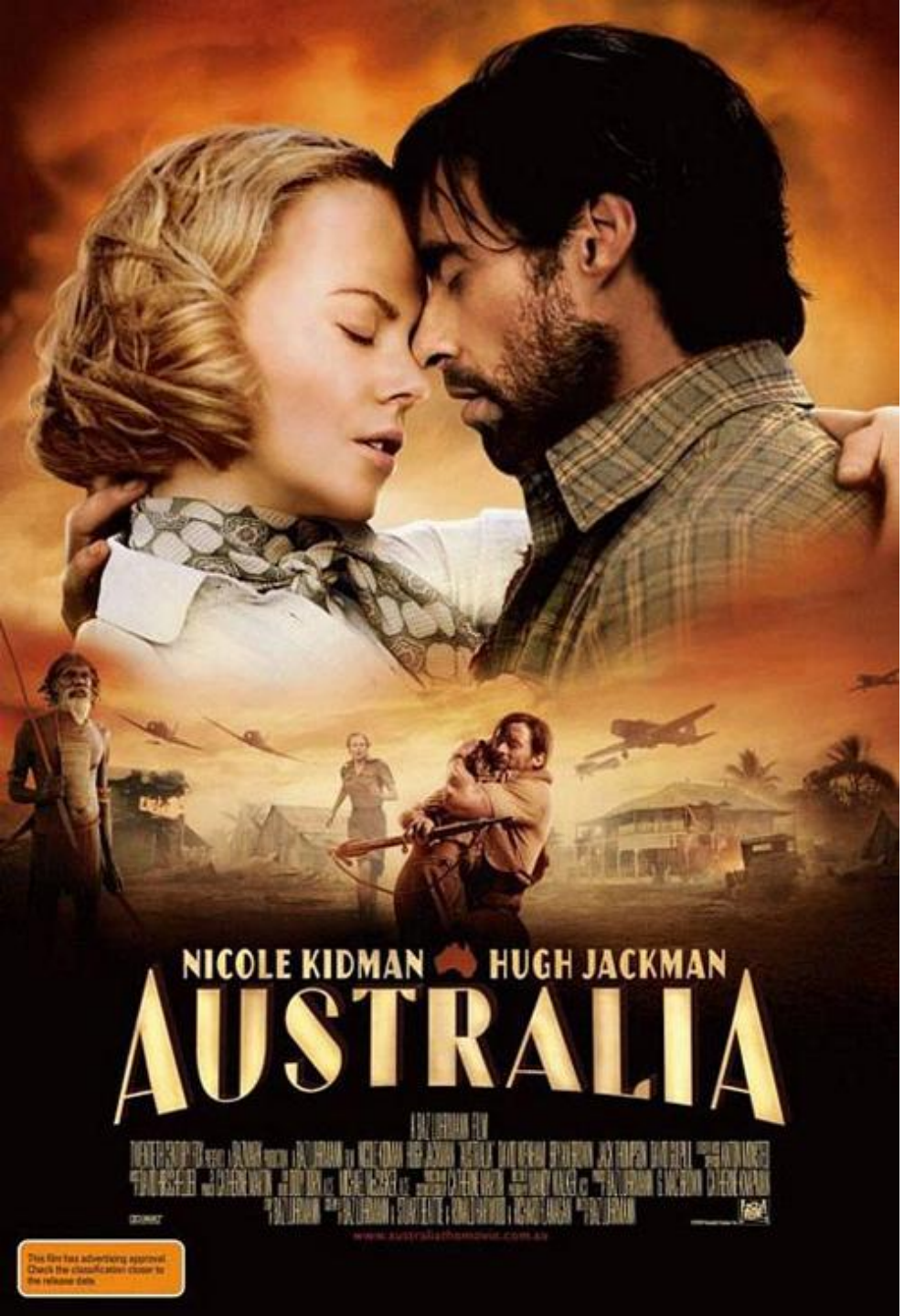
High cordon trained Chenin blanc grapevines

Tropical Viticulture – Grapevine Phenology



Tropical Viticulture – Major Challenges

1) Adequate cane maturation (lignification)
   - Vine remains in conditional dormancy
2) CHO reserves build-up
   - Lacking sufficient dormant period
   - Results in poor shoot growth, fruitset, declining productivity



PART III

Australia's National Floral Emblem

Golden Wattle (*Acacia pycnantha*)

Adelaide South Australia

Yurabilla Trail, Adelaide Hills

Adelaide and the Torrens River

Port Noarlunga

Adelaide, South Australia

- Surrounding wine regions:
  - Adelaide Hills
  - Barossa Valley
  - McLaren Vale
  - Clare Valley
  - Langhorne Creek
  - Coonawarra

Adelaide Hills

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Waite Agriculture Research Institute

Glen Osmond (Adelaide), SA

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AUSTRALIA

SUB CRUCE LUMEN

Division of Wine and Horticulture
Waite Campus

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Wine Innovation Cluster Building

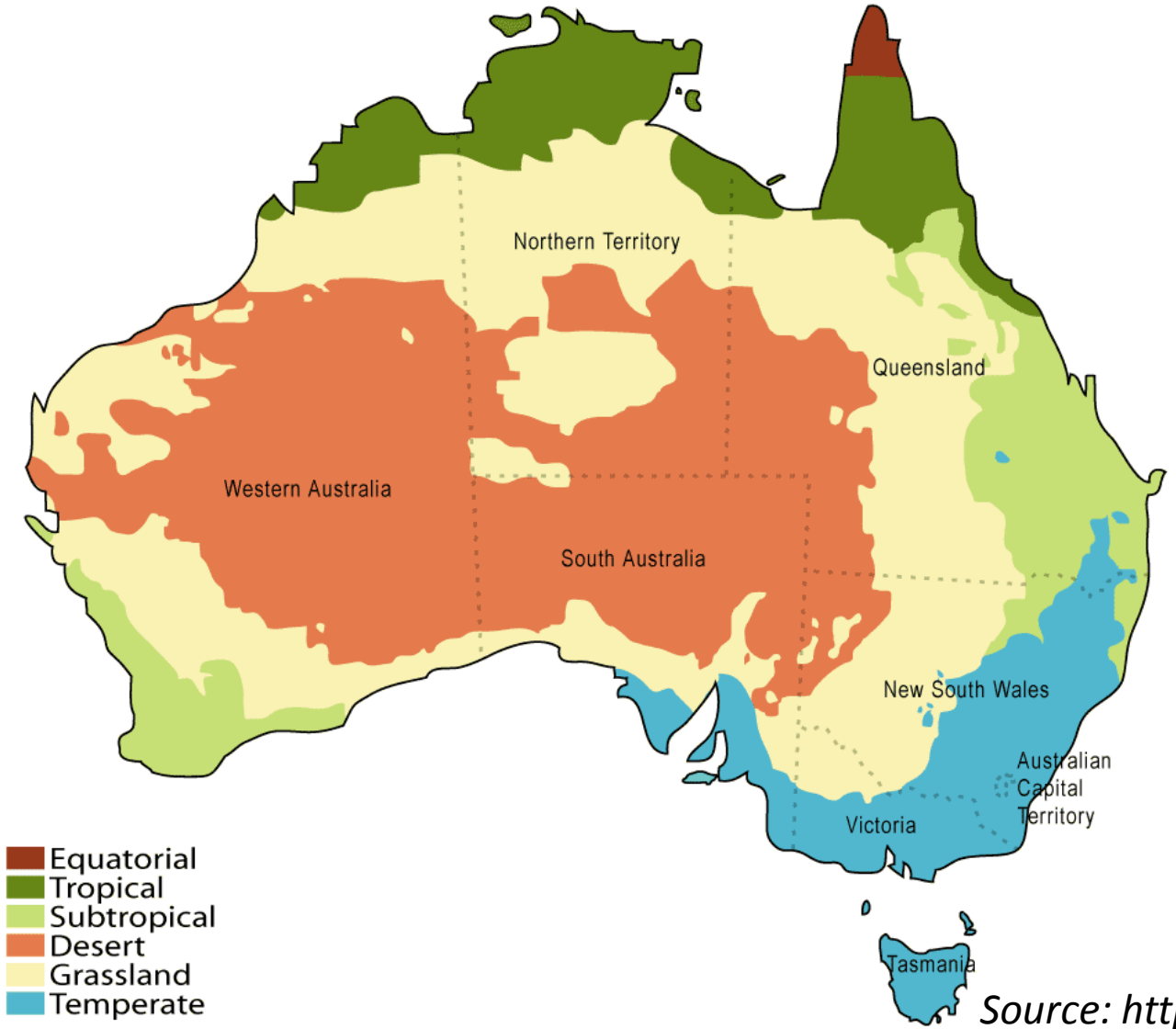
Plant Research Center

The Australian Wine Research Institute

Major Wine Regions of Australia

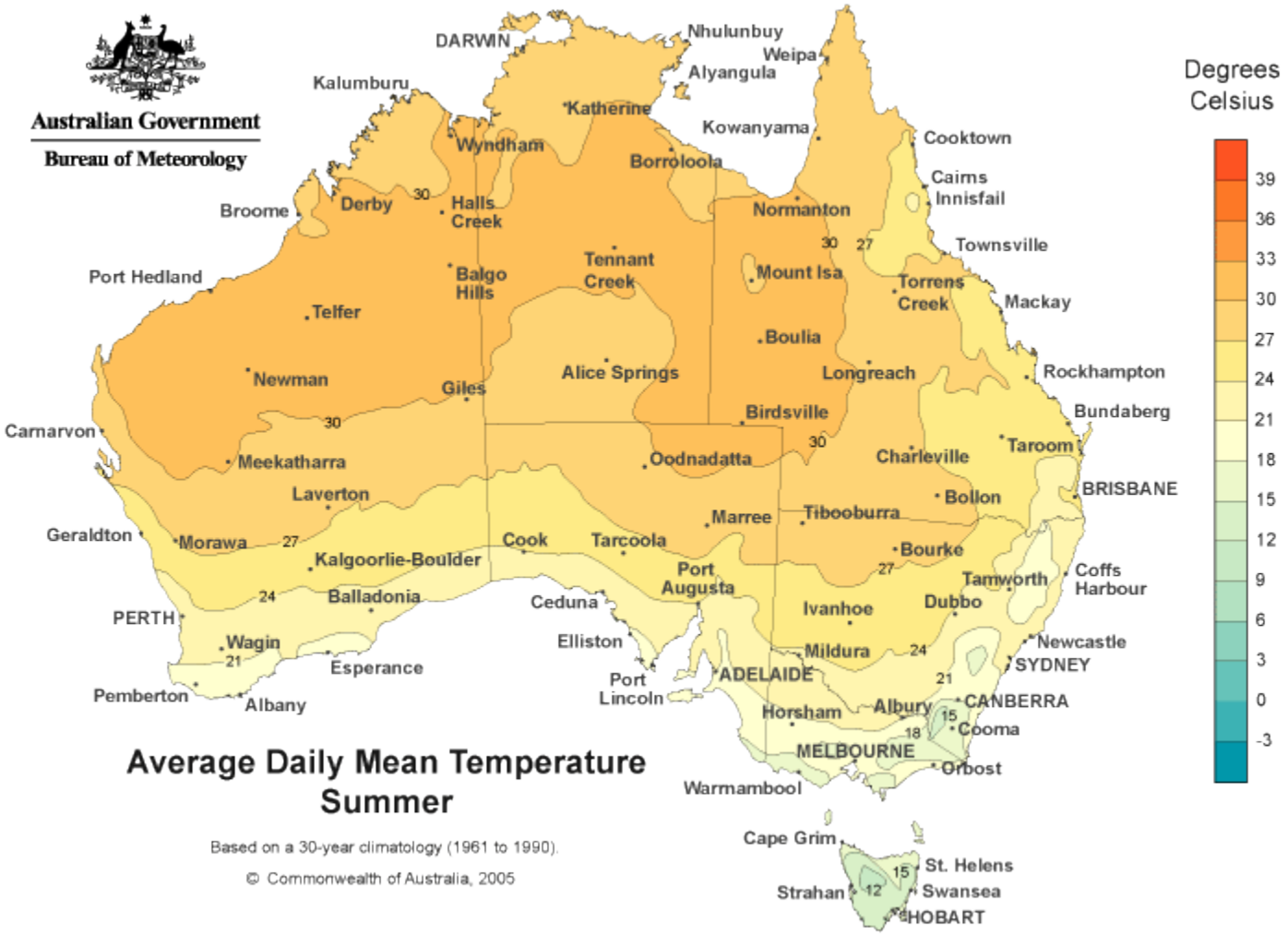
Map Source: Australian Wine Bureau

Australia – Agro-climatic Regions



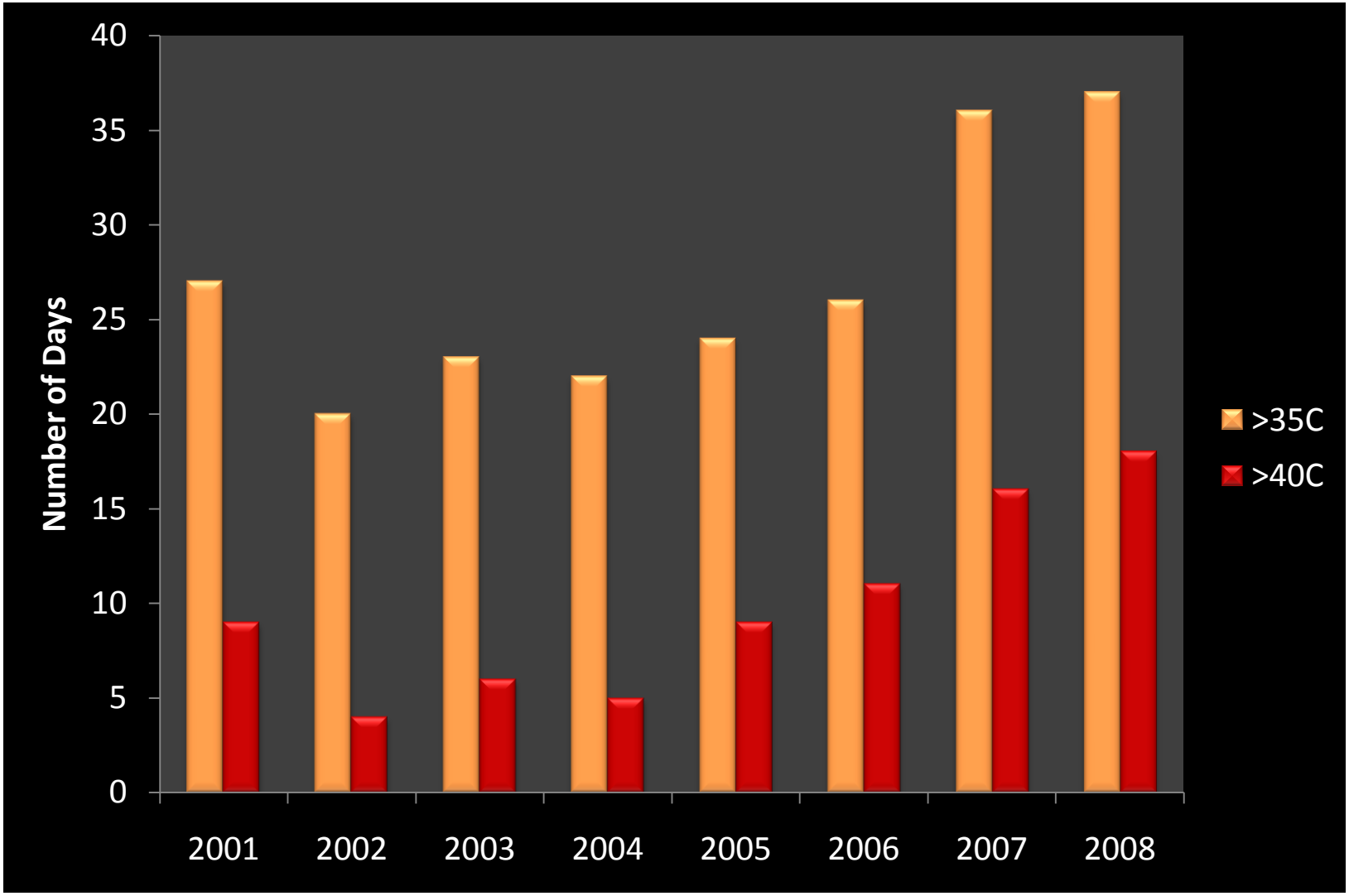
Source: http://mapsof.net

Climatic Trends - Temperature



Considerable variation in mean growing season temperatures across main agricultural regions

Temperature Extremes - Barossa Valley



Temperature data for Nuriootpa, SA courtesy Bureau of Meteorology, Australia

Temperature Extremes

Adelaide Heatwave 2009

- 28th January: second warmest day in recorded history, hottest day in 70 years:

  45.6°C

- Record set for warmest night (minimum):

  33.9°C

- Consecutive days above 35°C:

  15

Temperature Extremes

Adelaide Heatwave 2009

Cabernet Sauvignon vines
Irrigated @ 1 ML/ha

Temperature Extremes

En route to Mount Lofty, Adelaide Hills

February 17, 2009 Max. Temp: 34.2°C

Hot, thirsty marsupial finds water!

Temperature Extremes

Jacob's Creek, Barossa Valley

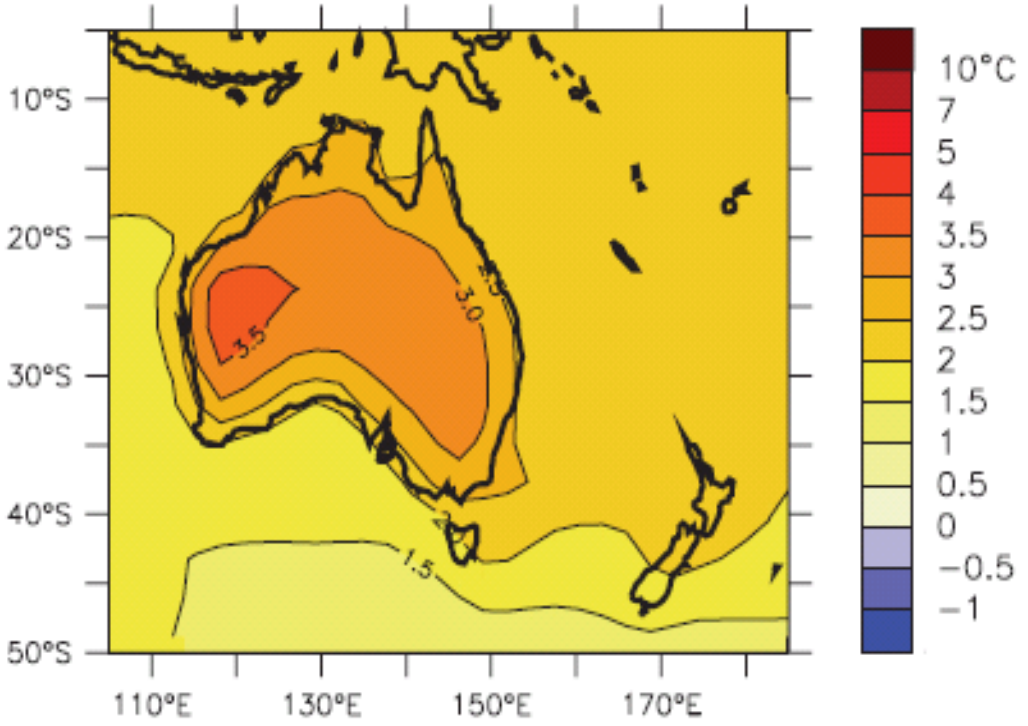
January 31, 2009 Max. Temp: 41°C

Climatic Predictions for Major Viticultural Regions for 2100

- Temperature increase of ~2.6°C (mostly summer)
- ~4% reduction in precipitation (mostly winter)
- Little change in inter-annual variability

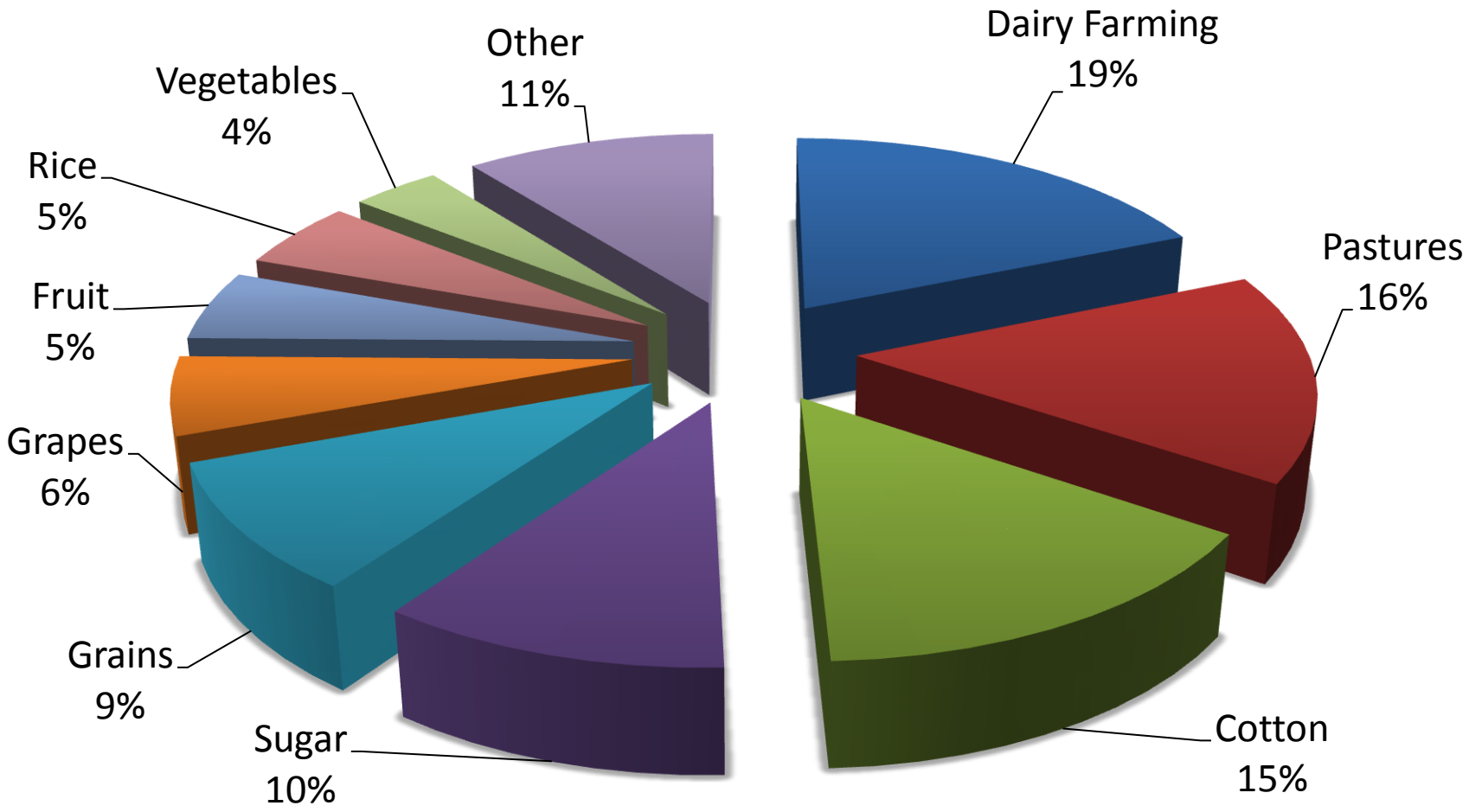
Dec-Jan-Feb
Temperature Response (°C)

1980-1999 to 2080-2099



Source: IPCC AR4 WG1 Report, 2007

Agricultural water use in Australia



Agricultural water use: 14,000 GL (2004-2005)

Source: National Water Commission
Australian Government
www.nwc.gov.au

Irrigation Water Loss is a Major Issue

According to the National Water Security Plan (2007):

- 10-30% water lost before reaching farm gate
- 20% lost in distribution channels
- 60% water applied using high-volume channels or inefficient systems
- 10-15% water lost through over-watering

Water access entitlements and a pot of beer

285 mL beer:

- QLD, TAS, VIC: 'Pot'
- NSW, ACT, WA: 'Middy'
- SA: 'Schooner'

Water access entitlement:

- VIC: 'Water share'
- NSW: 'Water access license'
- QLD: 'Water allocation'

Dictionary of Terms for Water Access Entitlements and Transactions (National Water Commission)

Water Security, Allocations, Trading

- High vs. general or low security water
- Current Murray allocations to SA:
  - 13% of original allocation (as of Nov/2008)
  - 2.5 ML/ha (Riverland), 1.6 ML/ha (Langhorne Creek)
- Water trading:

  Water balance = Allocation minus Crop requirement

  (allocation depends on availability)

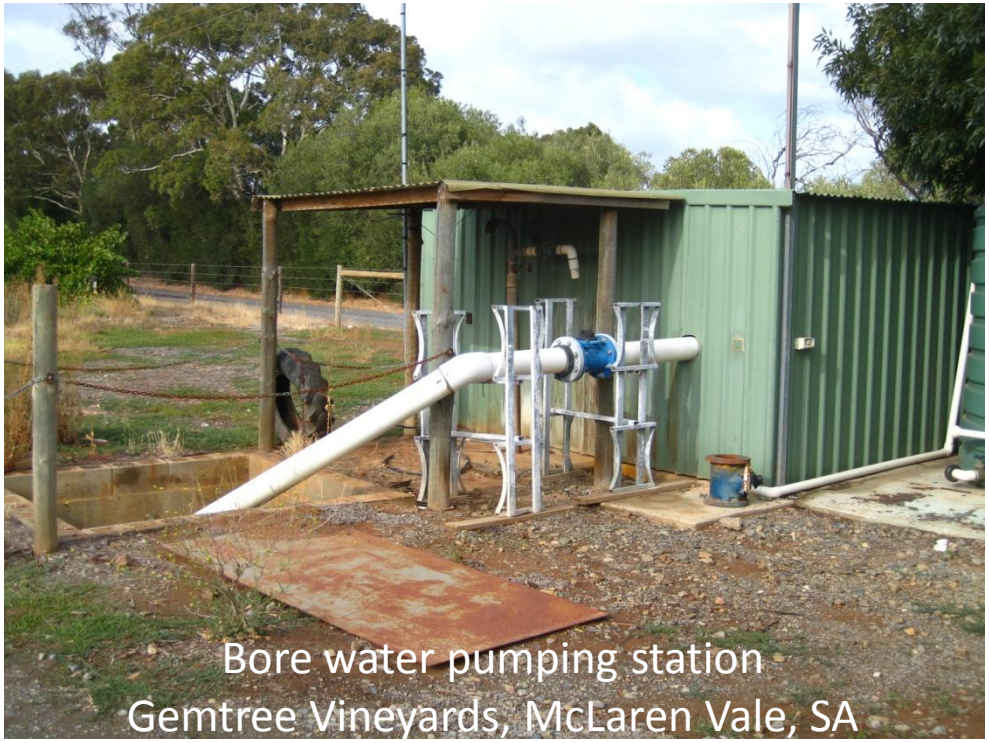
  +ve balance: potential water seller

  -ve balance: potential water buyer
  - Prices range from AU$200 - AU$1000/ML

Murray photo :
National Geographic Magazine
(April 2009)

Sources of irrigation water

- Rivers
  - Strict allocations
- Bores/Aquifers
  - Restricted
- Dams (Reservoir)
  - Restricted
- Rainfall
  - Highly variable
  - Unpredictable



Bore water pumping station
Gemtree Vineyards, McLaren Vale, SA

Climate change: Implications for irrigated agriculture/viticulture

- What we already know:
  - Advanced and rapid phenological progression
    - Ripening and harvest will be in warmer conditions
  - Cultivars already at their limits will suffer
    - Cooler areas may benefit
  - Well-watered vines can recover from high temperature events without much leaf loss
- Need to investigate:
  - Effects of timing and duration of heat stress and elevated CO_2 on vine physiology and crop development

Elevated Temperature Study

Objectives

- Investigate reproductive performance of Shiraz grapevines subjected to elevated temperatures in a field-setting
  - Both timing and intensity of heat stress were assessed
  - Physiological responses concurrently evaluated by SARDI
- Parameters assessed included:
  - Flowering and fruitset
  - Yield components
  - Pollen viability, germination, and pollen tube growth
  - Ovary development, ovule cell viability
  - Berry and seed development

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Elevated Temperature Study

SARDI - Nuriootpa Research Center

Under-vine Tents
~3°C above ambient

Whole-vine Chambers
~10°C above ambient

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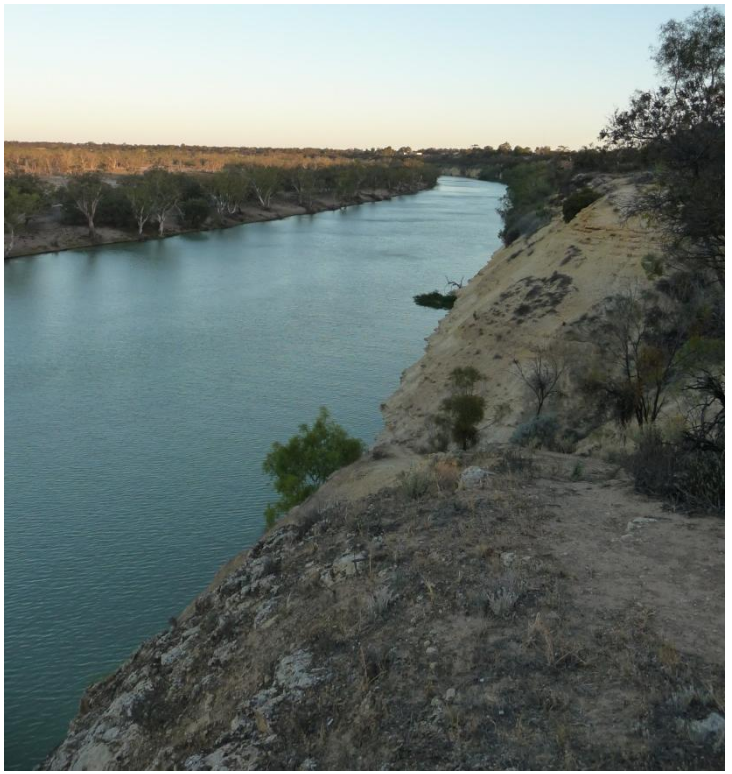
Climate Change Adaptation: What is Australia doing?

- Government
  - Ratified Kyoto Protocol (1997)
  - Emissions Trading Scheme (2010)
- Climate Forecasting on a Regional Scale
  - CSIRO: main research body looking at climate change, modeling, and impacts on agriculture
  - Improved prediction certainty
  - Frequency and intensity of extreme climate events

CSIRO

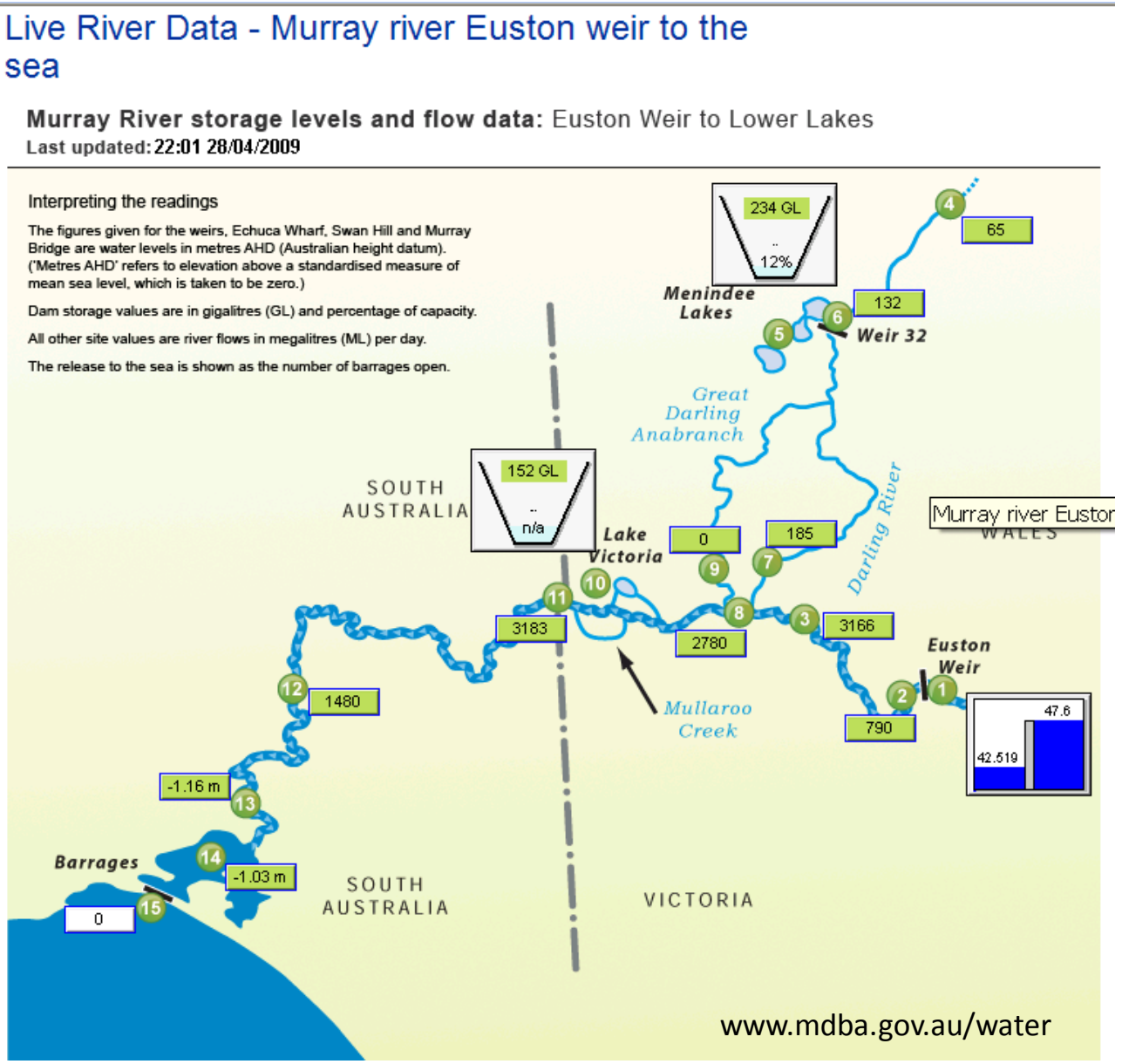
Climate Change Adaptation: Irrigation Water & The Murray

- Improved monitoring of water flows (MDBA)
- Salinity management and salt interception
- 'Living Murray' program (2003)



Murray Darling Basin Authority

- ✓ Water trading
- ✓ Water use
- ✓ Water quality
- ✓ Groundwater
- ✓ Water sharing
- ✓ Wetlands
- ✓ Irrigation
- ✓ Subsurface water



Water Harvesting and Storage

Inflatable Dam, Penfolds, Clare Valley

Irrigation Research in the Riverland

Oxford Landing, SA

10% irrigation

100% irrigation

Grapevine canopy development affected by water-stress

Irrigation Research in the Riverland

Oxford Landing, SA

10% irrigation

100% irrigation

Water-stressed vines have uneven fruitset

Soil Moisture Measurement

- Irrigation scheduling based on soil moisture levels

Gypsum Block at Oxford Landing

Sentek's EnviroSCAN

Climate Change: Adaptation Strategies

Variety and Rootstock Selection

Grenache (left row) & Tempranillo (right row) vines show good drought tolerance (near-isohydric, 'pessimists')

Climate Change: Adaptation Strategies

Rootstock Trial at SARDI, Nuriootpa

Shiraz grapevines on Schwarzmann rootstock, non-irrigated

Climate Change: Adaptation Strategies

A clean-cultivated vineyard, McLaren Vale, SA

Climate Change: Adaptation Strategies

- Increased use of organic techniques, cover crops, mulches to improve soil moisture retention

Saltbush (Genus: *Atriplex*)
SARDI-Nuriootpa (Barossa), SA

Within-row grass cover crop and mower
Gemtree Vineyards, McLaren Vale, SA

Climate Change: Adaptation Strategies

Precision Irrigation Management

- Delineate strategic management zones
- Optimize water & fertilizer distribution and uniformity
- Accurate measurement of weather, soil moisture, fertility
- Regulated deficit irrigation

Coldstream Hills (Winery), Yarra Valley, VIC

Climate Change: Adaptation Strategies

- Canopy management and trellis design
  - Increase leaf area and shading e.g. CA sprawl
- Artificial shading, nets
- Evaporative cooling
- Planting new varieties and rootstocks, including GM-rootstocks for improved drought & salinity tolerance
- Increased use of technology:
  - Monitoring water application and vine water status
  - Yield sensors and maps
  - Plant Cell Density mapping

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Dr. Cassandra Collins
University of Adelaide

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The Viticulture Team at Waite

L to R: Cassandra Collins, Chris Penfold, Luke Johnston, Vinay Pagay, Catherine Cox, Tintu B.

Thank you!

Tian Shì (‘Heaven Lake’), Xinjiang