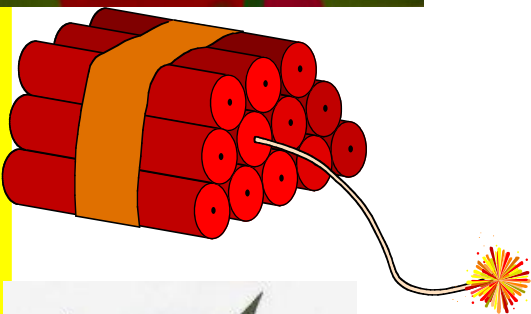


# Food Authentication and Traceability: An Asian and Australian Perspective

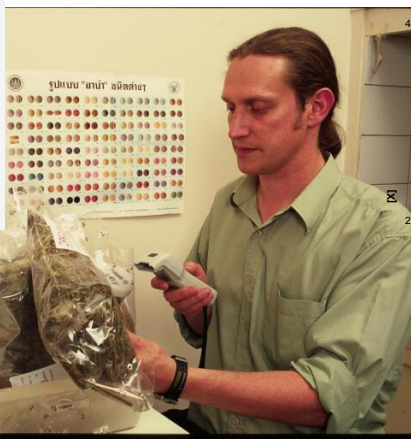


Associate Professor Stewart Walker  
Forensic, Environmental and Analytical Chemistry  
Flinders University,  
Adelaide, South Australia

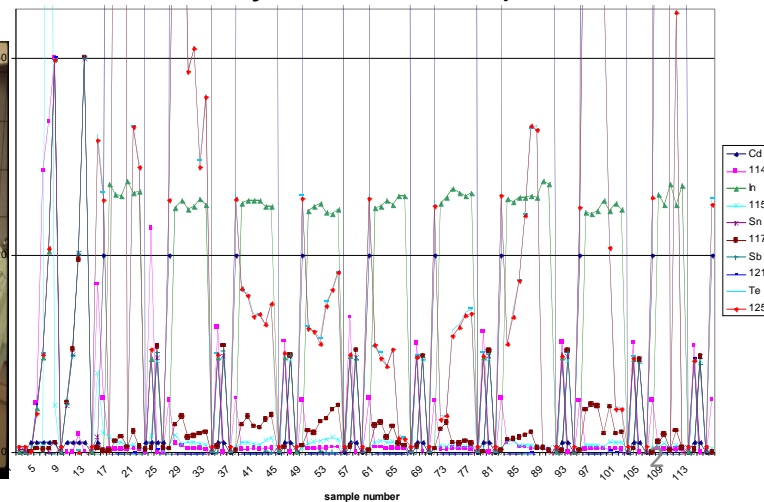




## Advanced Analytical Techniques Environmental, Industrial, Medical and Forensic Arenas



Multi elemental analysis of Cannabis samples



# Aims of this presentations

- illustrate the combined application of isotope ratio and trace metal analysis for food authentication and traceability
- with specific reference to the Asian and Australian perspective

# REASONS

Some reasons why countries in the Asian and Australian region are interested in using these techniques to investigate food authentication and traceability include:-

- desire to have confidence in what we are eating
- desire to pay a correct price for the product
- health and food safety issues
- prevention of criminal activities
- and safeguarding environments by preventing the spread of disease and invasion of non-indigenous species.



# Aims of truth in labeling

- You get what you pay for
- Content is as labeled
- Country of origin is as listed
- Safe to eat
- Sustainable



# EXAMPLE OF TWO WAY TRAFFIC

Commodity from Country/Location A

Passed of as coming from Country/Location B



Commodity from Country/Location B

Passed of as coming from Country/Location A

# ‘Australian’ Wine - Jacob’s Creek -2011

Crime: - Forging cheap end of  
market 2GBP in London

Spelling mistake on label

SOUTH EASTERN **AUSTRLIA**



Photo: Illustration: Stephen Willard

<http://www.telegraph.co.uk/foodanddrink/wine/8434587/Fake-wines-Dont-keep-concernsbottled-up.html>

# ‘Australian’ Wine - Jacob’s Creek -2011

Crime: - Forging cheap end  
of market

Spelling mistake on label

SOUTH EASTERN **AUSTRLIA**

Blend of wine  
50% Austria  
50% Australia ?



Photo: Illustration: Stephen Willard

<http://www.telegraph.co.uk/foodanddrink/wine/8434587/Fake-wines-Dont-keep-concernsbottled-up.html>



Fongyee Walker  
The Australian  
Oct 24 2011 pg23

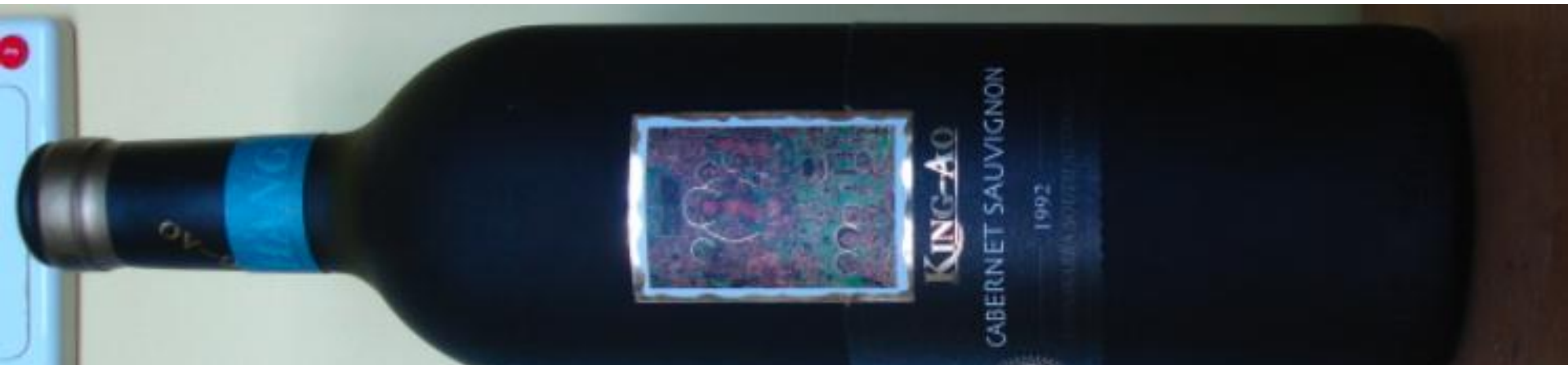
Chinese wine companies  
routinely passed off  
imported wine as their  
own creation.

WHY? Enter wine show –  
judges like it – gets high score  
But wine sold to consumer  
isn't wine tasted in competition



# Case Study “King-Ao” wines

I took custody of two wine bottles of interest.  
I studied the labels, cover, cork and bottles.  
Sent them to Russell Frew, Otago for IRMS  
And John Watling, UWA for ICPMS



# Holistic Forensic Investigation



Holistic Forensic Investigation: 1] What the labels tell me 2] What the bottles tell me 3] What the closures tell me 4] What the corks tell me 5] what the isotope ratios tell me 6] What the ICPMS trace elements tell me

## Mahler, Symphony No. 3



Mahler's original titles for the movements were: 1] "Summer Marches in" 2] "What the Meadow Flowers tell me 3] "What the Creatures of the Forest Tell Me" 4] "What Night Tells Me" 5] "What the Morning Bells Tell Me" 6] "What God Tells Me"

died in Vienna on May 18, 1911

# Separation and clustering of wine regions in Australia (Watling et al)

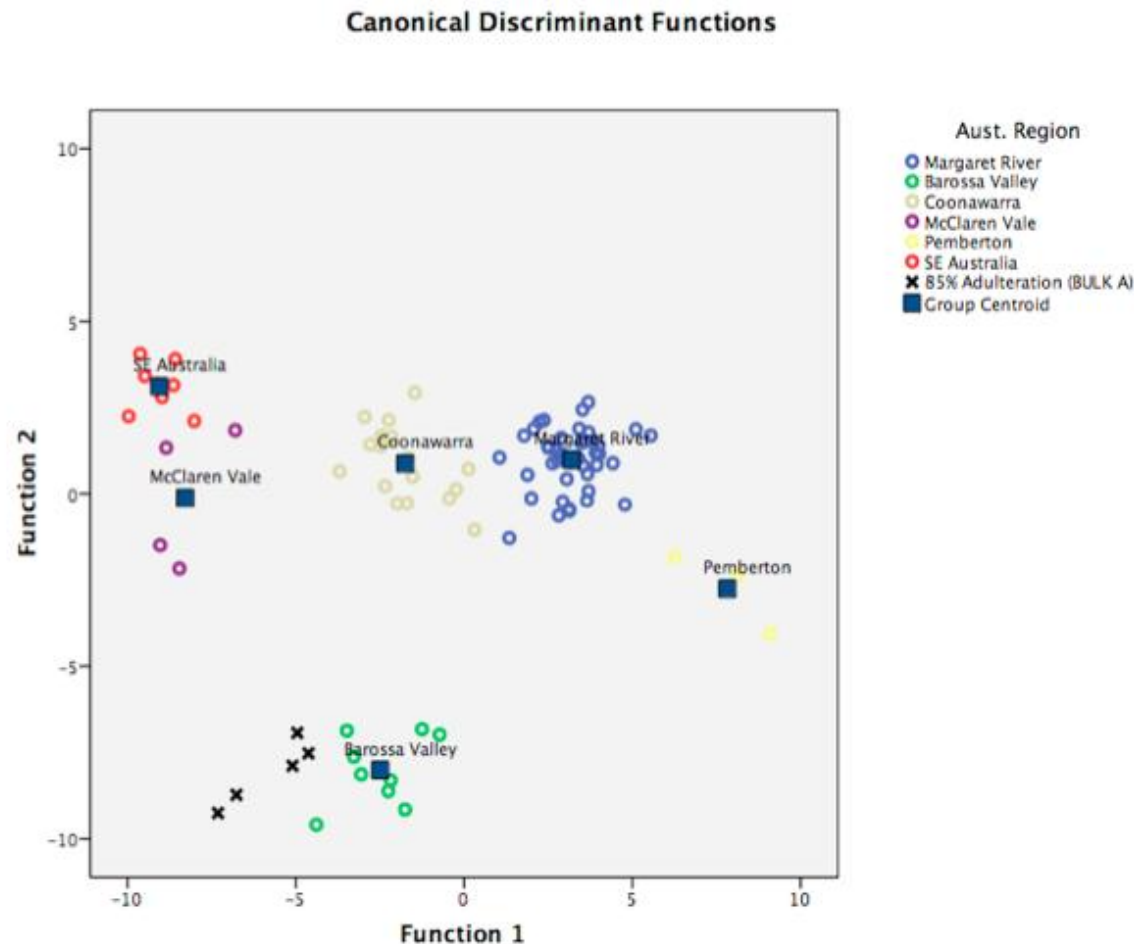


Fig. (2). Plot of first 2 discriminant scores determined for trace element profiles determined for Shiraz samples sourced from six regions.

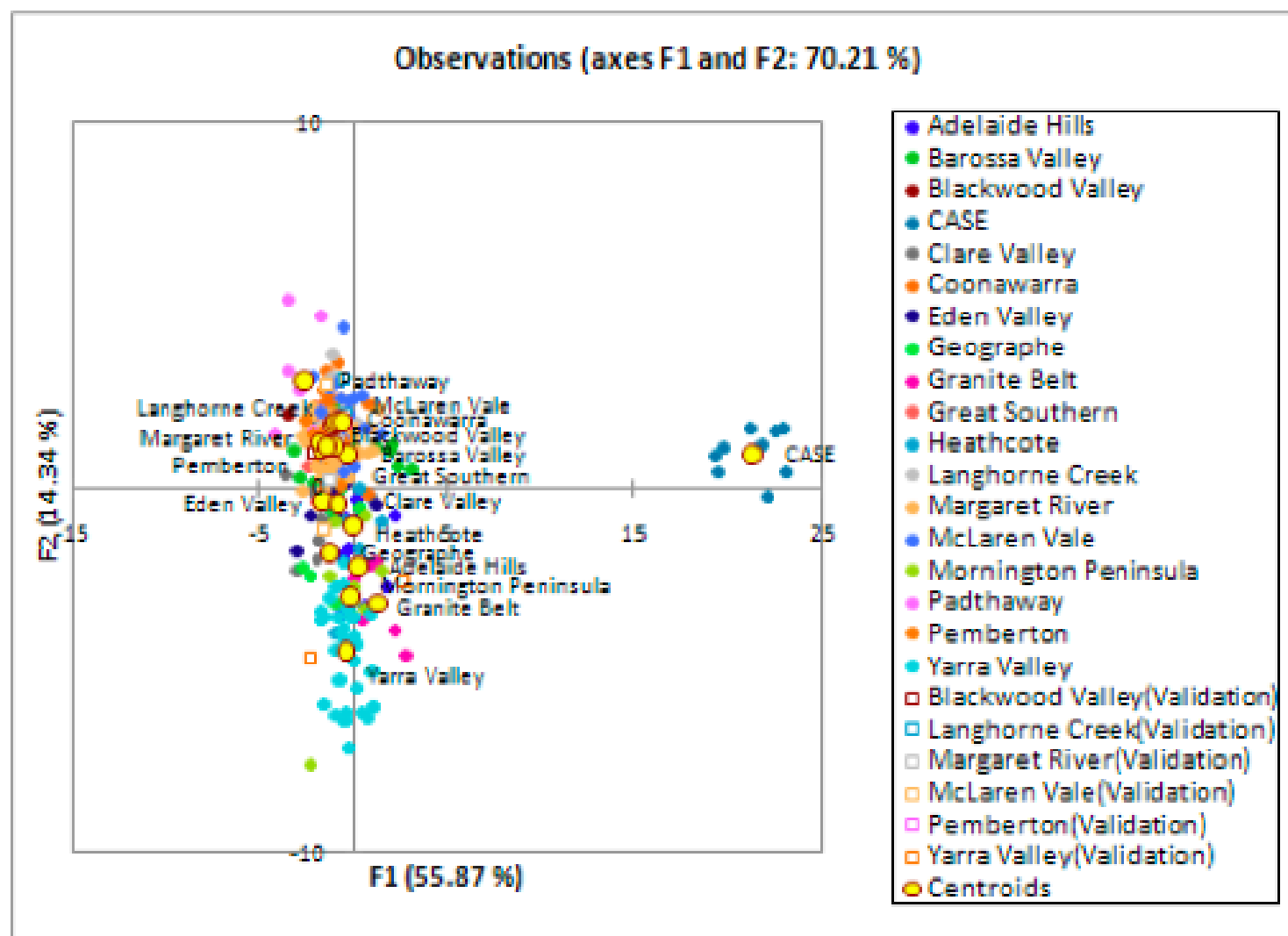


Fig. (4). Discriminant plot generated using forward stepwise LDA detailing separation of data associated with the suspect wine sample from wine samples originating from 17 Australian Wine Regions.



# Food Authentication and Traceability: An Australian and Asian Perspective

- 1) **C**URRENT STATUS
- 2) **C**HANGES
- 3) **C**HALLENGES
- 4) **C**ONCLUSIONS

# To put Australia in Perspective How Australia Compares



<http://www.personally-selected-aboriginal-art.com/australian-maps.html>

# Australia vs Europe

(Not including Tasmania or New Zealand)



# Australia vs Europe

“We've golden soil and wealth for toil;  
Our home is girt by sea;’  
Australian National Anthem

Area = 7, 682,300 km<sup>2</sup> of ‘golden soil’\*  
As we are “Girt by sea”\* our coastline > 36,000 km  
And “our land abounds in nature's gifts”\*



Climate ranges from – Scandinavia  
Tropical

to Dessert

To Mediterranean ITALY

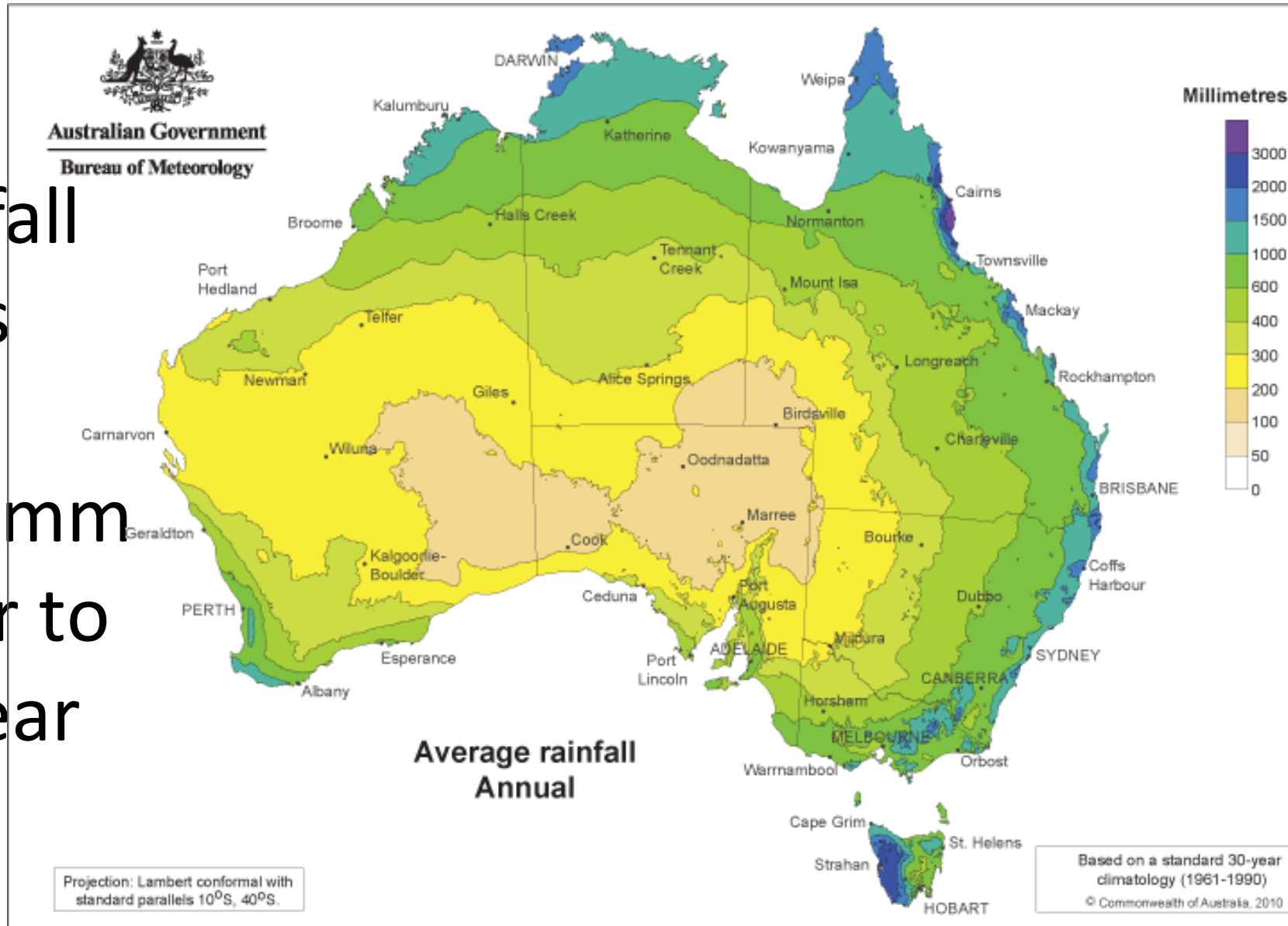
to Alpine

GREECE

\*Australian National Anthem



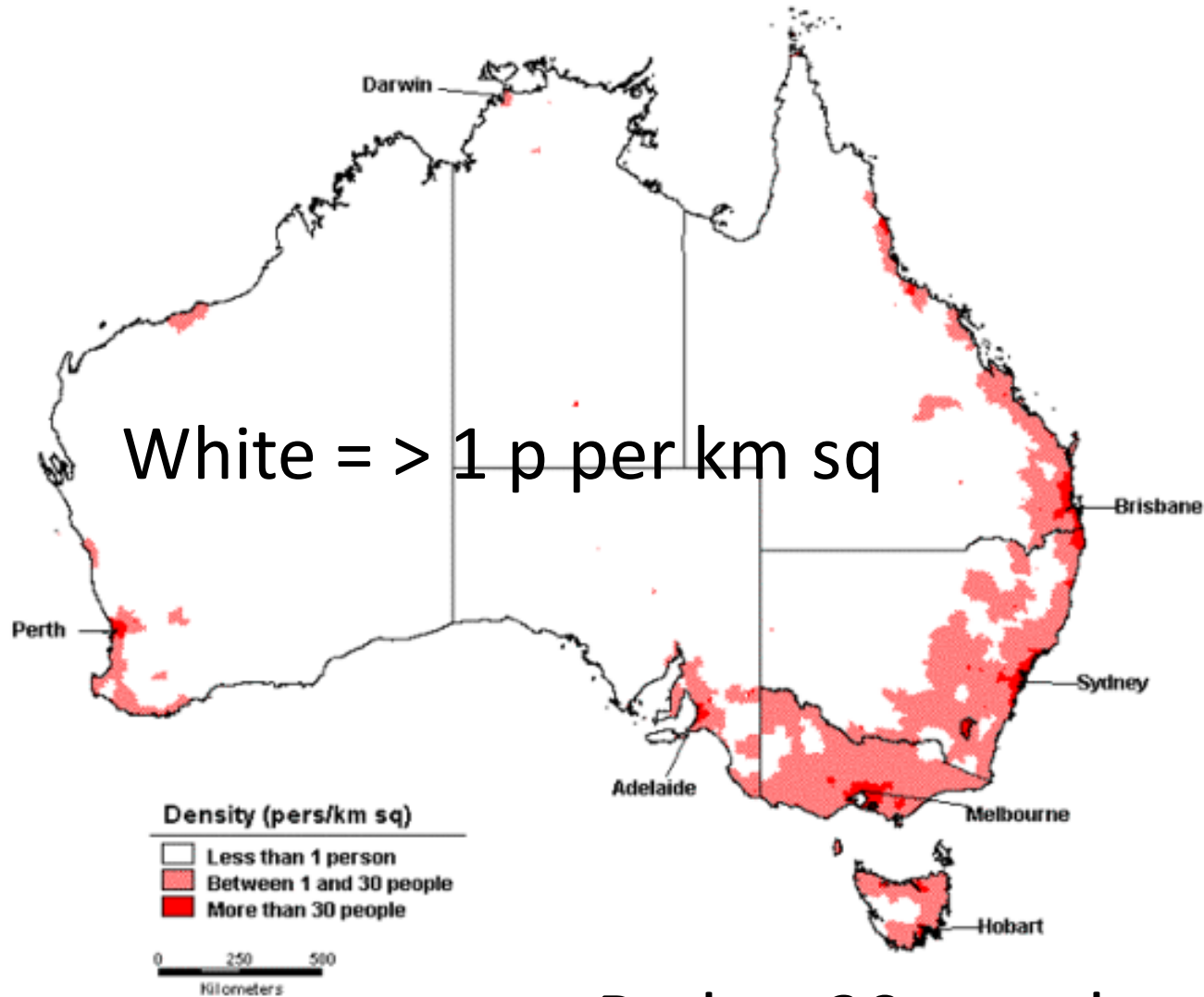
Rain fall  
varies  
from  
3000 mm  
a year to  
0 a year





# Very sparsely populated

<http://www.welcomeaustralia.com.au/port/html/ppopulation.htm>

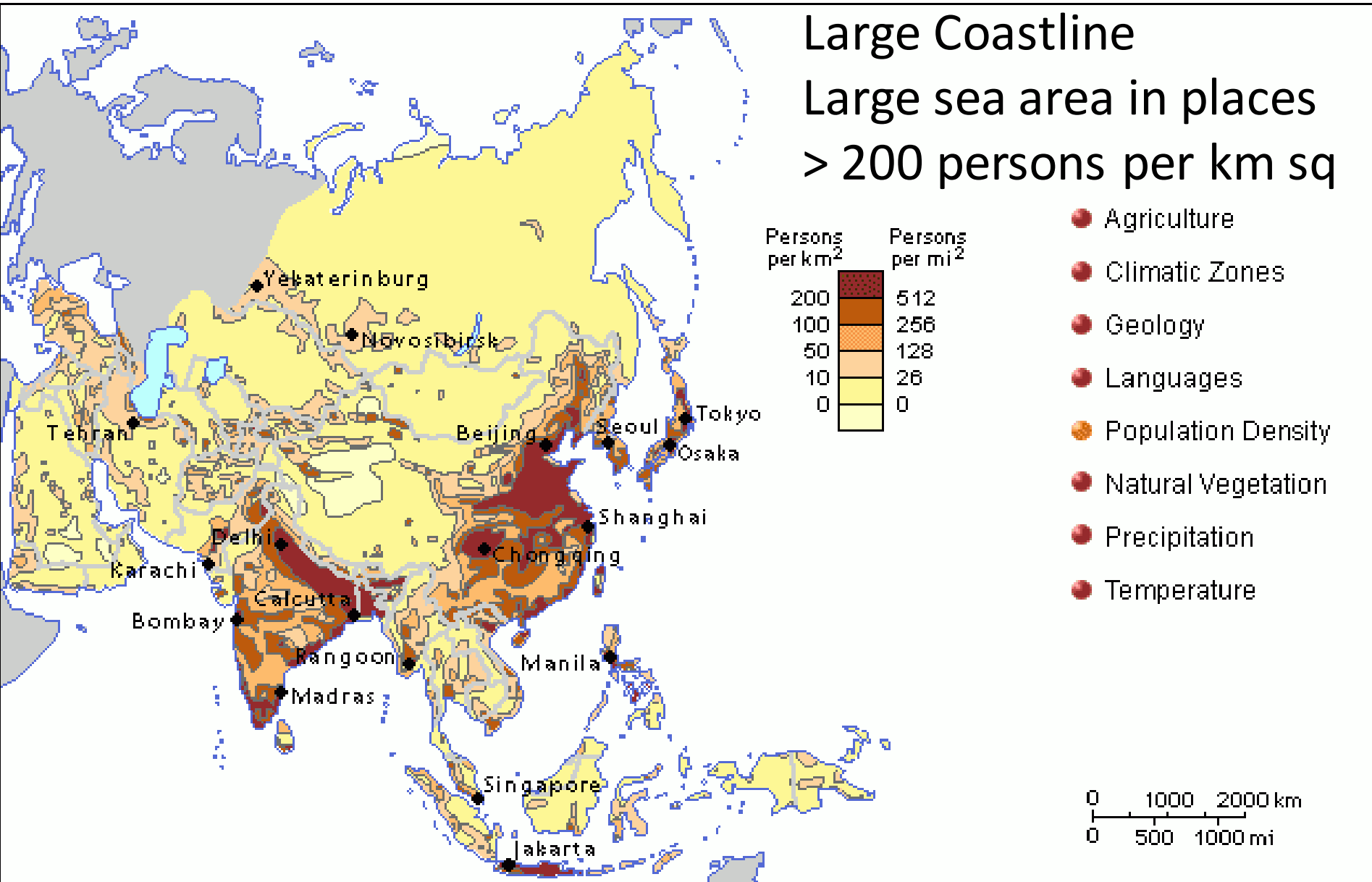


Red = >30 people per km sq

Large Area

Large Coastline

Large sea area in places  
> 200 persons per km sq

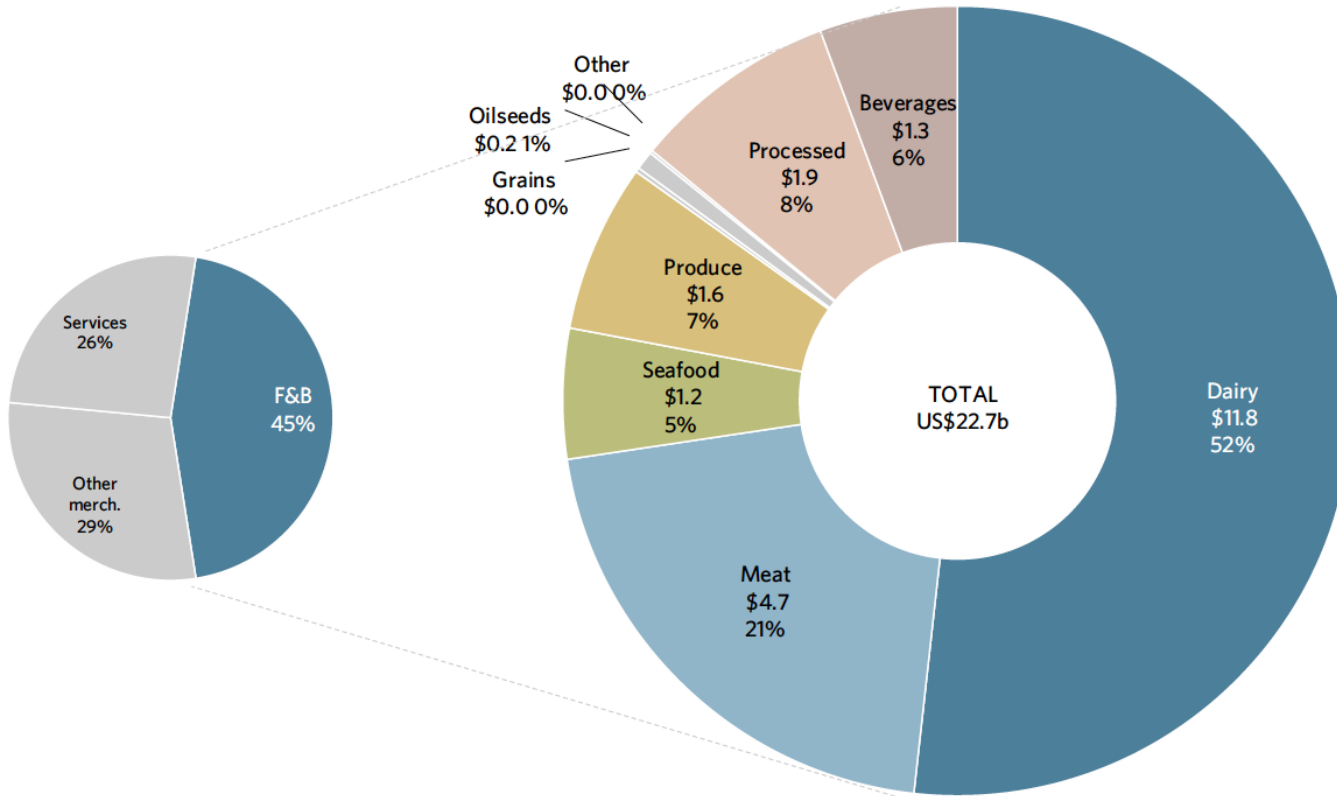


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<http://go.grolier.com/atlas?id=mtps004>

# Current status NZ

Total value of New Zealand food & beverage (F&B) exports by defined super-category  
US\$b; 2013



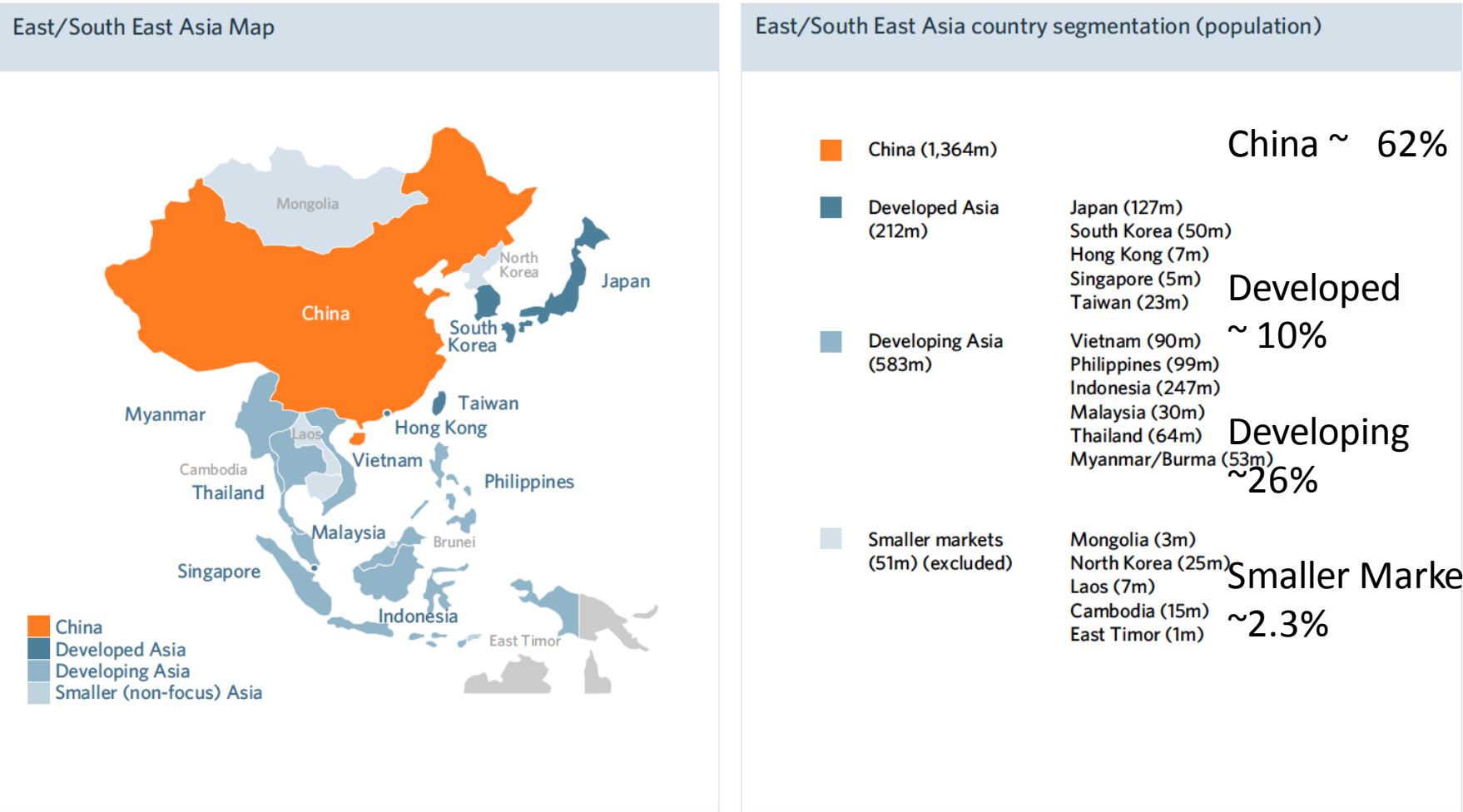
Food and Beverage Exports accounts for 45% NZ GDP Dairy 52% Meat 21%

This explains John Keogh's comment Monday – Fonterra – 12% NZCurrency -2.4%

WHAT DOES ASIA WANT FOR DINNER?

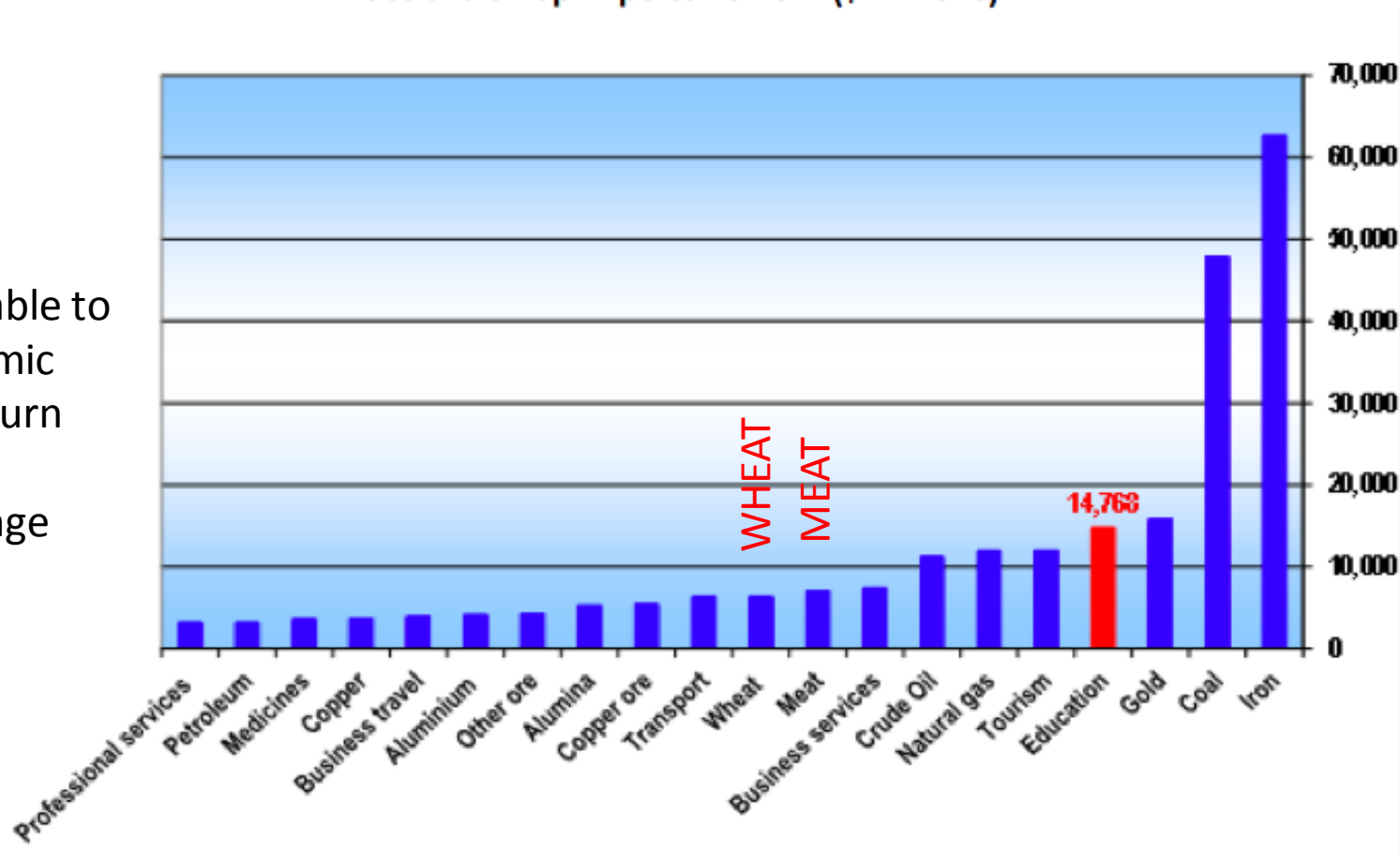
Emerging Market Opportunities for New Zealand food & beverages  
in East & South East Asia July 2014; v1.00  
Part of the Food & Beverage Information Project,  
[www.foodandbeverage.govt.nz](http://www.foodandbeverage.govt.nz)

This report focuses on ten key developed and developing markets of East and South East Asia



## Australia's Top Exports 2011/12 (\$ millions)

Venerable to  
Economic  
Downturn  
And  
Exchange  
rates



Education for NSW is second only to coal as an export

**Education as an Export for Australia: Green Shoots, First Swallows, but Not Quite Out of the Woods Yet**

Stephen Connelly and Alan Olsen

presentation at the Australian International Education Conference in Canberra on Thursday 10 October 2013



## F&B exports to E/SE Asia: NZ vs. peers

US\$m; 2012



Aus US\$14,834 M

NZ US\$7,932 M

Note: Uses 2012 not 2013 as 2013 data only available for a few countries as of 4/2014

Source: UN Comtrade database; Coriolis analysis

WHAT DOES ASIA WANT FOR DINNER?

Emerging Market Opportunities for New Zealand food & beverages in East & South East Asia

July 2014; v1.00

IAEA-CN-222

Part of the Food & Beverage Information Project, [www.foodandbeverage.govt.nz](http://www.foodandbeverage.govt.nz)

## F&B exports to E/SE Asia: NZ vs. peers

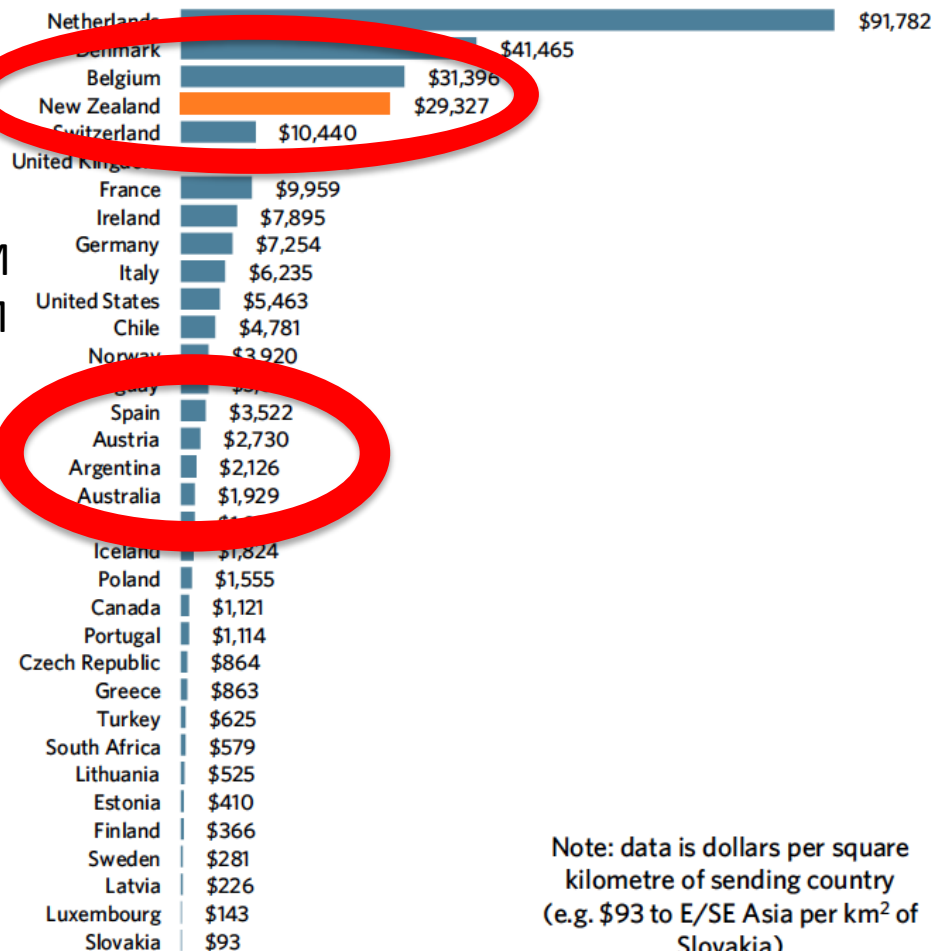
US\$m; 2012



Aus US\$14,834 M  
NZ US\$7,932 M

## F&B exports to E/SE Asia per square kilometre

US\$/km<sup>2</sup>; 2012



Note: data is dollars per square kilometre of sending country (e.g. \$93 to E/SE Asia per km<sup>2</sup> of Slovakia)

Note: Uses 2012 not 2013 as 2013 data only available for a few countries

Source: UN Comtrade database; Coriolis analysis

WHAT DOES ASIA WANT FOR DINNER?

Emerging Market Opportunities for New Zealand food & beverages in East & South East Asia

July 2014; v1.00

IAEA-CN-222

Part of the Food & Beverage Information Project, [www.foodandbeverage.govt.nz](http://www.foodandbeverage.govt.nz)

# Reasons to provenance food and beverage

- Security of food supplies (covered already)
- Preservation of Agricultural Industry
  - economic protection from cheap imports
  - Disease (quarantine – exclusion zones)

# Exported prawns lead to reduction of nutrients from Australian waters



Imported prawns with disease if used for fishing can lead to contamination of Australia

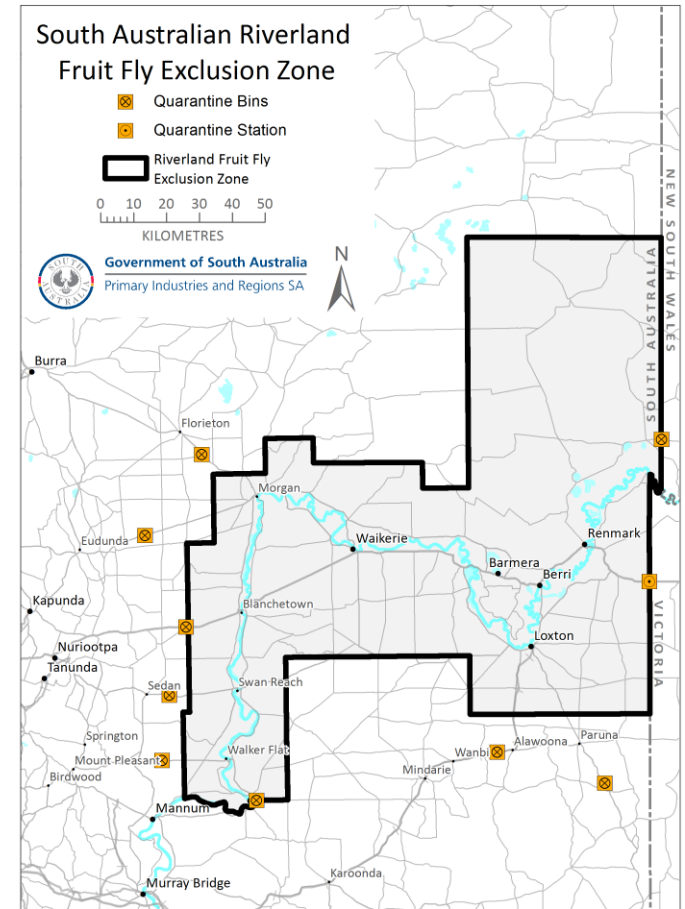
You should not take any fruit or vegetables over state borders unless they comply with state regulations.

**Fines of up to \$100,000 may apply**

Only fruit and vegetables  
purchased within  
South Australia may be taken in to  
the South Australian portion of the  
Fruit fly Exclusion Zone  
.....as long as you have a valid shop  
receipt...to accompany it.

<http://www.murrayriver.com.au/fruit-fly-free-zone/>

[http://www.pir.sa.gov.au/\\_\\_data/assets/image/0020/186104/riverland\\_fruitfly\\_map.png](http://www.pir.sa.gov.au/__data/assets/image/0020/186104/riverland_fruitfly_map.png)





# Coles fined \$61,200 for selling imported fruit as home grown



news.com.au

National

World

Lifestyle

Travel

Entertainment

Technology



A worker stocking the shelves at Coles. Source: Supplied

**Supermarket giant Coles has been fined \$61,200 for selling imported fruit that it advertised as Australian-grown.**

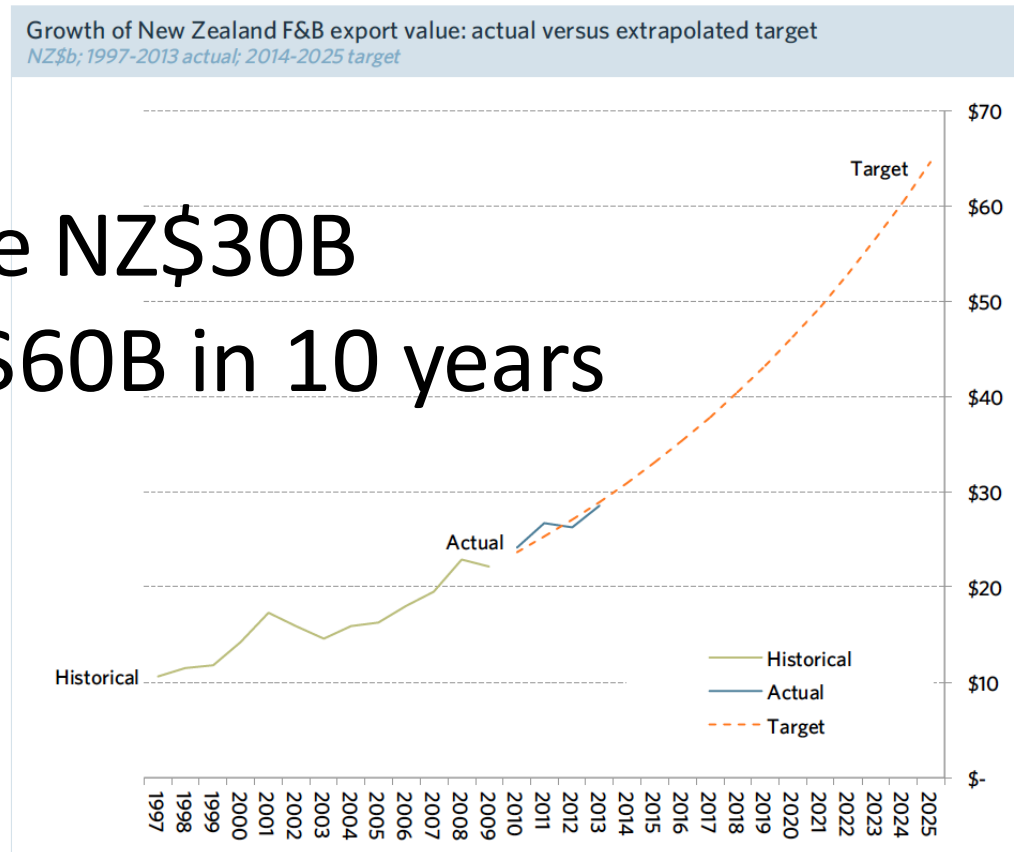
<http://www.news.com.au/finance/business/coles-fined-61200-for-selling-imported-fruit-as-home-grown/story-fnda1bsz-1226672630541>

news.com-222

## 2) CHANGES

# NZ Expansion Target

Double NZ\$30B  
To NZ\$60B in 10 years



Source: Statistics New Zealand Infoshare database; Reserve Bank of New Zealand; Coriolis assumptions, estimates and analysis

WHAT DOES ASIA WANT FOR DINNER?

Emerging Market Opportunities for New Zealand food & beverages in East & South East Asia

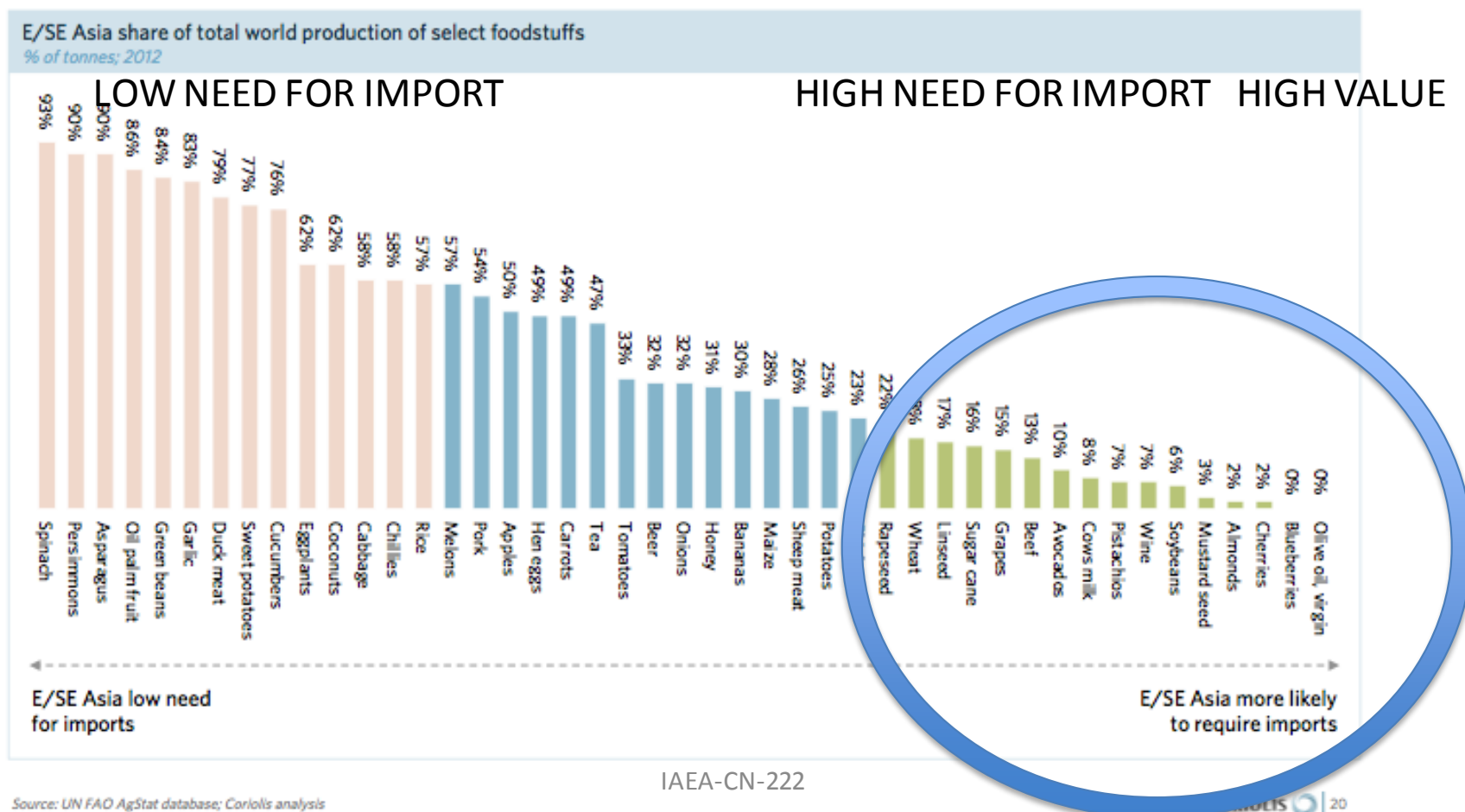
July 2014; v1.00

Part of the Food & Beverage Information Project, [www.foodandbeverage.govt.nz](http://www.foodandbeverage.govt.nz)

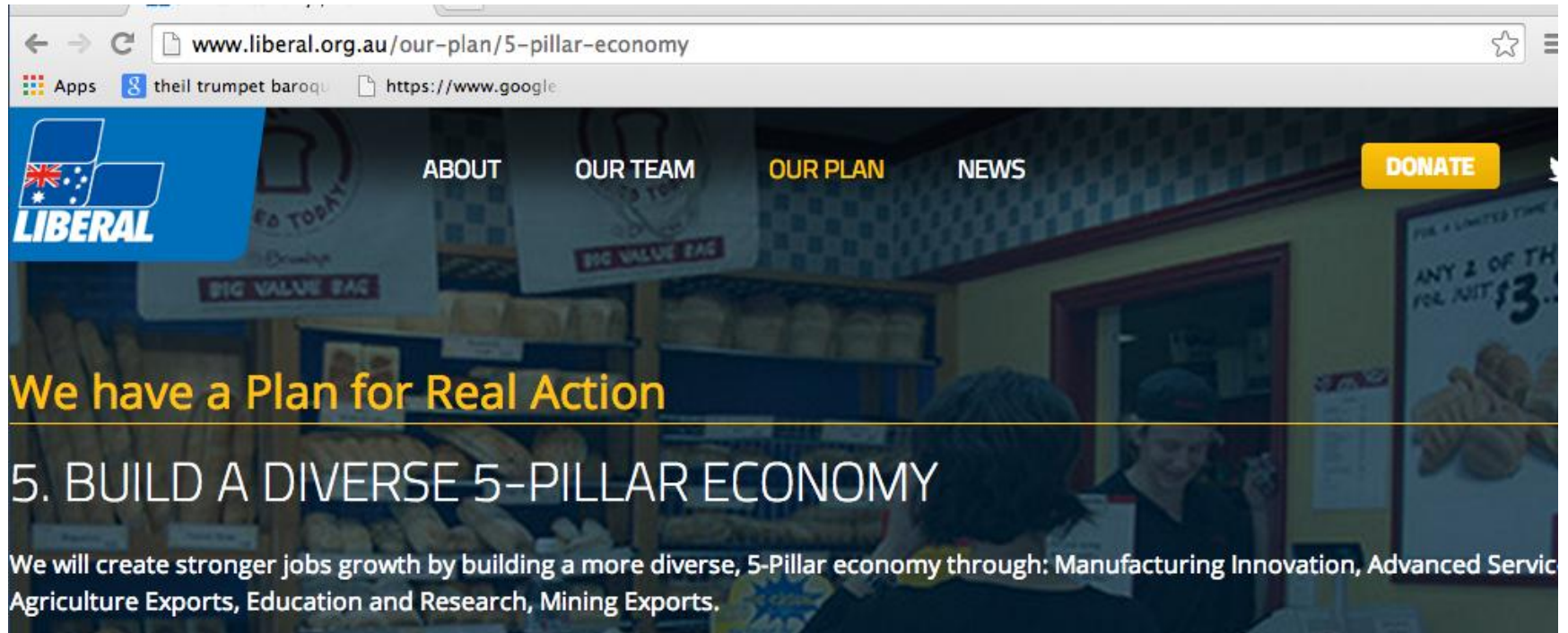
IAEA-CN-222

# Demand for products - target

As a major food producing region, E/SE Asia's need for imported foods will vary by product



# Australia



## Building a diverse 5-Pillar economy

To guard against having all our eggs in the one basket of mining, we will build a more diverse, world-class economy – a 5-Pillar economy – to unleash Australia's real economic potential. We will build on our strengths in Manufacturing Innovation, Agriculture Exports, Advanced Services, world-class Education and Research, as well as boosting our Mining Exports, to make the most of our comparative advantages in international markets.



# 'Food Bowl of Asia'

## REQUIRES FOOD PROVENANCING AND ORIGIN OF FISH PRODUCTS

### **Building on our strengths in Agriculture Exports**

We will unleash the real economic potential in our agricultural industry by removing the shackles and burdens holding the industry back and by making the industry more productive and globally competitive. We will:

- build on our comparative strength in food production and better manage our precious water resources to help our agriculture sector become the 'Food Bowl of Asia' and achieve 'food security' in a world demanding more of our food resources;
- support our fishing industry and review the declaration of new Marine Protected Areas. We will establish genuine consultation with the fishing industry on research and strengthen the connection between science and fishing policy; and



# Trade agreement

In the news



PM says 'on track for China trade agreement'

Sky News Australia - 19 hours ago

Australia and China are on track to seal a free trade deal in the next few days.

Example – 1 Million head of cattle per year  
Exported from  
Australia to China



<http://www.skynews.com.au/news/top-stories/2014/11/10/pm-says--on-track-for-china-trade-agreement-.html>

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We've heard a lot about the stakeholder->

Stakeholders want to know what animal  
the steak they are holding comes from



### 3) CHALLENGES

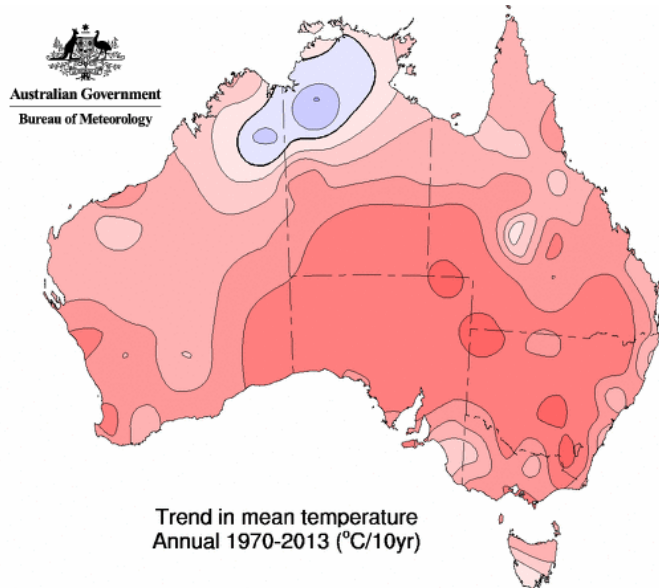
NZ arable land is 'fully arablated'

Australia's "land abounds in nature's gifts"\*

And has "boundless plains to share"\*

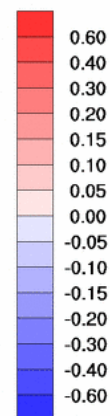
Options for growth

- 1) More productive (higher yield kg/km<sup>2</sup> and \$/km<sup>2</sup>)
- 2) More utilizing sea (or land based) aquaculture



Trends in Rain fall  
(1976-2013)

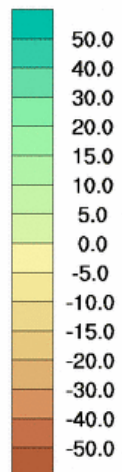
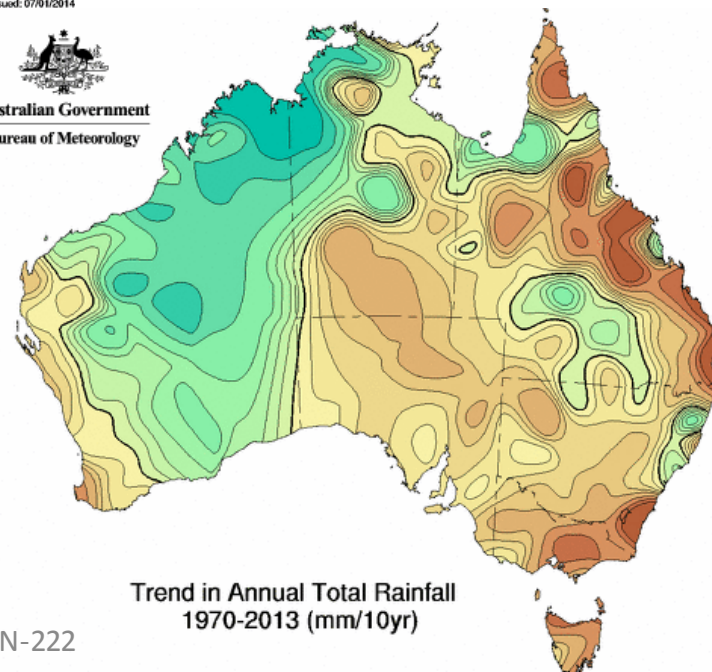
varies from  
+ 50 mm/10 year to  
-50 mm/10year



# Temperature Trends °C /10 yr

Issued: 07/01/2014

Australian Government  
Bureau of Meteorology



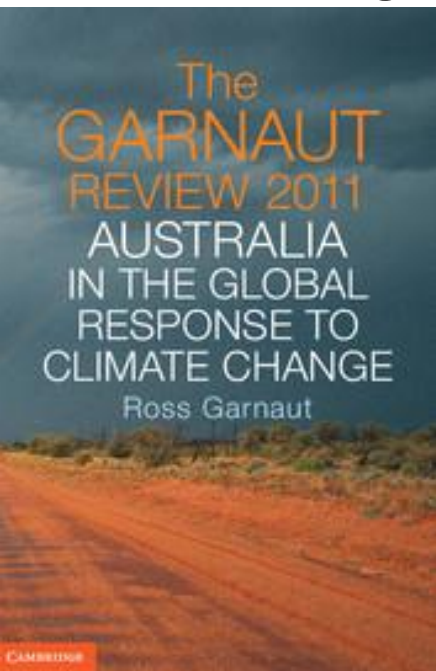
IAEA-CN-222

# Predicted Decrease in Productivity

Garnaut  
Review  
2011

Australian Bureau of Agricultural and Resource  
Economics and Sciences (ABARES).

## Climate Change



The gross value of NSW agriculture production in 2009-10 was \$8.4 billion. ABARE modelling in 2007 estimates the following declines in agricultural production for NSW compared to a compared to a world with no human-induced climate change.

Approximate decline in production by 2030 and 2050

	Approximate decline in production by	
	2030 (%)	2050 (%)
<b>Wheat</b>	8.4	11.6
<b>Beef</b>	0.7	3.0
<b>Sheep meat</b>	8.1	13.2
<b>Dairy</b>	5.5	11.3

-8.4 %

-0.7 %

-8.1 %

-5.5% by 2015



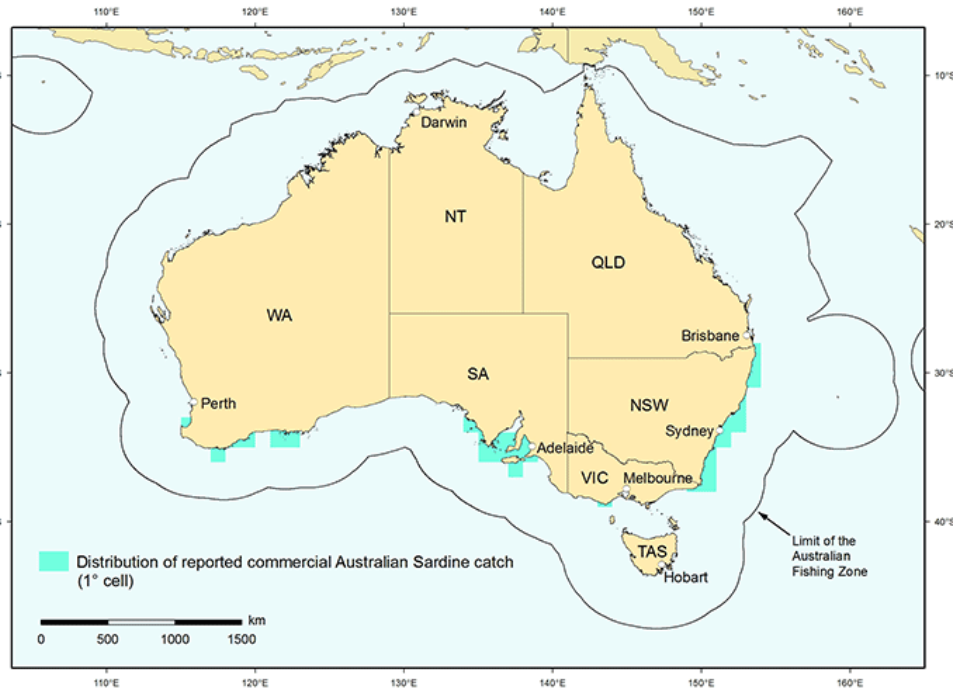
Australian Government

Department of the Environment

<http://www.climatechange.gov.au/climate-change/climate-science/climate-change-impacts/new-south-wales>



# Australian Marine Boundaries Well Defined



However, other boundary  
disputes may lead to  
'Food fight'



Salmon with barcode  
Photo Stewart Walker

[Map http://www.fish.gov.au/reports/finfish/Pages/sardine.aspx](http://www.fish.gov.au/reports/finfish/Pages/sardine.aspx)



# CONCLUSIONS

## Combine IAEA Training Workshops and Country Missions With Research

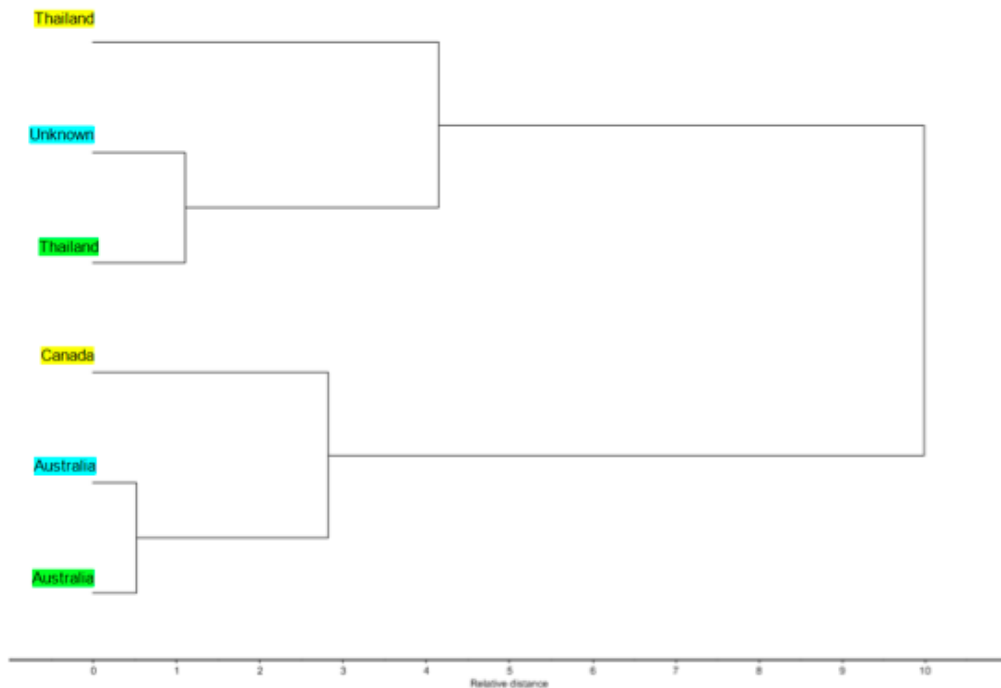
- Combining IRMS, ICPMS and Spectrometric Analysis and Chemometrics
- Rice
- Wine
- Sea Cucumbers
- And other materials
  - Fertilisers
  - Hair

Visualisation program

IAEA-CN-222



# RICE – comparison of rice (6 grains)



Unknown B  
clustered with Thailand.

Unknown A  
did not cluster with any source

Labeling  
“Japanese Sushi Rice”

Japanese Rice for making Sushi  
Or  
Rice for Making Japanese Sushi

Muldoon, B. D., The provenancing of rice allowing geographical origin discrimination via Isotope Ratio-Mass Spectrometry (IR-MS) and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). BSc. Honours Thesis, Flinders University, 2013

# Comparison and discrimination of ... materials via multiple analytical techniques and chemometrics

Roy Lehmann, Honours Thesis, Flinders University Nov 2014

## 3.4.1 UN

The hierarchical cluster analysis (HCA) results are output in the form of a dendrogram (Figure 3.4.1.a) displayed below.

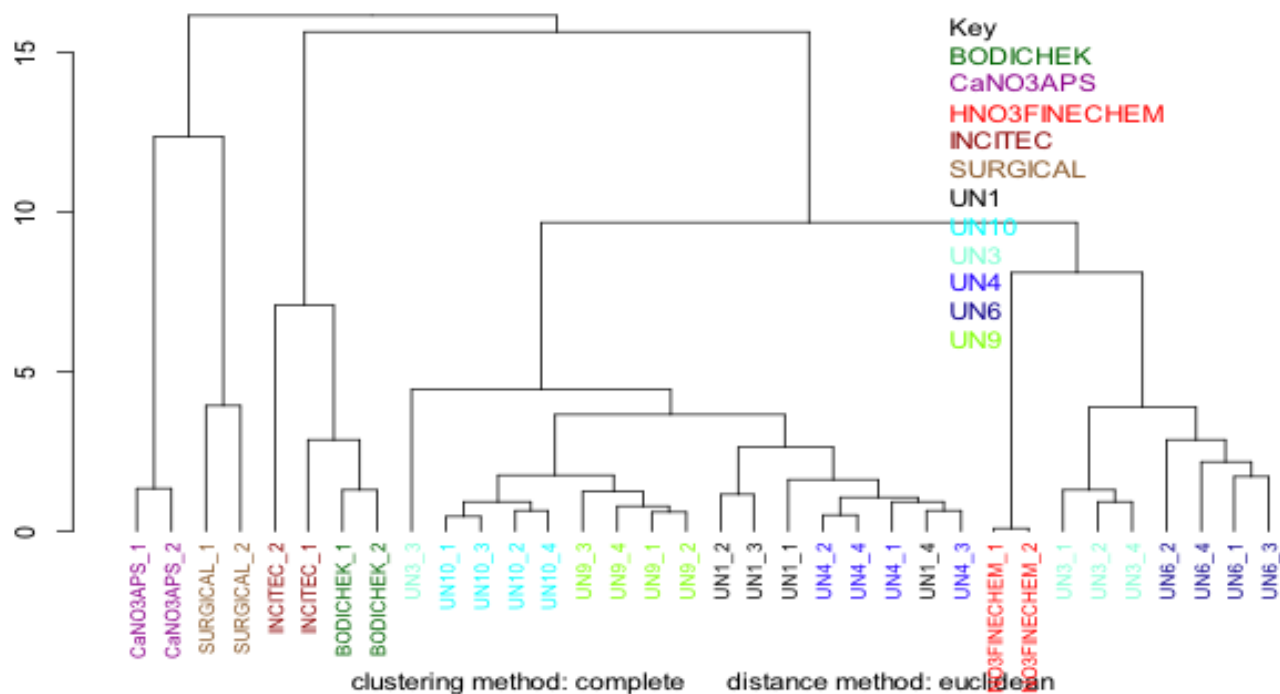


Figure 3.4.1.a: Hierarchical cluster analysis of UN samples and starting materials.

Discriminating between different Urea nitrate fertilisers.

# Messenger

Wednesday, August 27, 2014 | [www.iaea.org/messenger](http://www.iaea.org/messenger)

## Mane man

Professor goes 10  
years without a  
haircut for science

[ SEE PAGE 4 ]

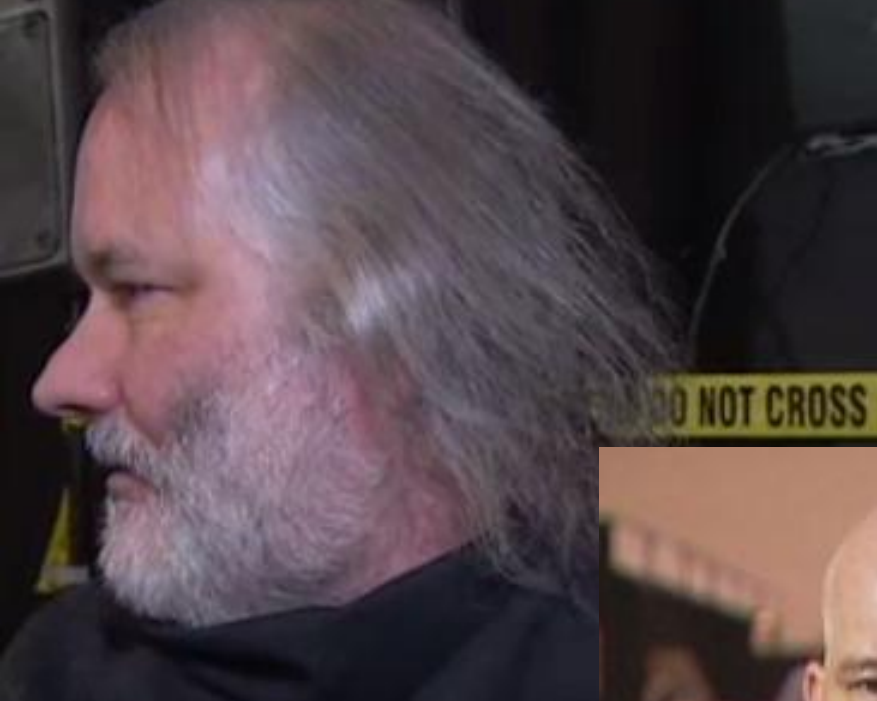
PHOTO

Photo Mark Brake

IAEA-CN-222

# HAIR

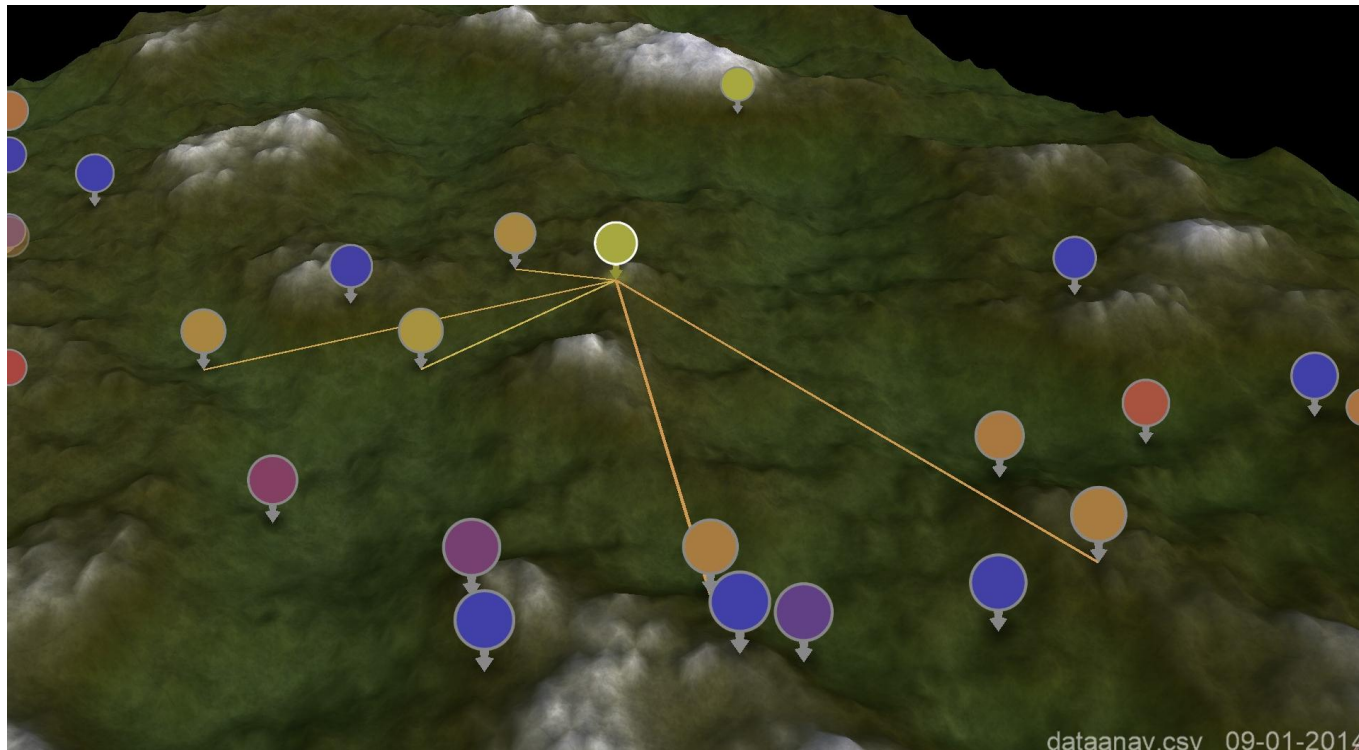
traps trace  
metals  
and isotopes





# Flinders Visualisation Program

From database can calculate and present degree of similarity or dissimilarity between multiple samples from different sources. Can rotate, zoom in or out and select which samples to compare.



© Walker, G.S., Wesson, B.R. and Wilkinson, B. 2013 Flinders University



# Aims of Food authenticity and traceability

Food and food security is a growing global concern and having a reliable, confirmable, diet is a daily concern for inhabitants of the Asian and Australian region (and other areas).

Analytical chemistry, coupled with chemometrics and comparison visualisation program will assist in this goal.



# Thank

Organisers

For opportunity to attend and present  
(and play my violin at Mozarthaus, Vienna)

Colleagues and research students

Hosts of IAEA Workshops

And you for your attention

If interested in hair analysis or  
Data Comparison and Visualisation Program

See me or contact me

[Stewart.Walker@flinders.edu.au](mailto:Stewart.Walker@flinders.edu.au)



# Abstract

- This presentation will illustrate the combined application of isotope ratio and trace metal analysis for food authentication and traceability with specific reference to the Asian and Australian perspective. Building on the experience of the author (who has presented at seven IAEA RTC's in Pakistan, Malaysia, Indonesia, Vietnam and The Philippines), and some relevant case studies, the use of isotope ratios and trace elements for identification of the origin and potential adulteration of foods and beverages will be discussed.
- Examples of applications of these techniques include: 1) passing off produce from country A as coming from other countries or conversely passing off non-country A produce as if they originated from country A, and 2) detecting, and prosecuting, people who were taking seafood from a protected marine area and claiming it came from another area. Some reasons why countries in the Asian and Australian region are interested in using these techniques to investigate food authentication and traceability include:- desire to have confidence in what we are eating, desire to pay a correct price for the product, health and food safety issues, prevention of criminal activities, and safeguarding environments by preventing the spread of disease and invasion of non-indigenous species. Food and food security is a growing global concern and having a reliable, confirmable, diet is a daily concern for inhabitants of the Asian and Australian region.