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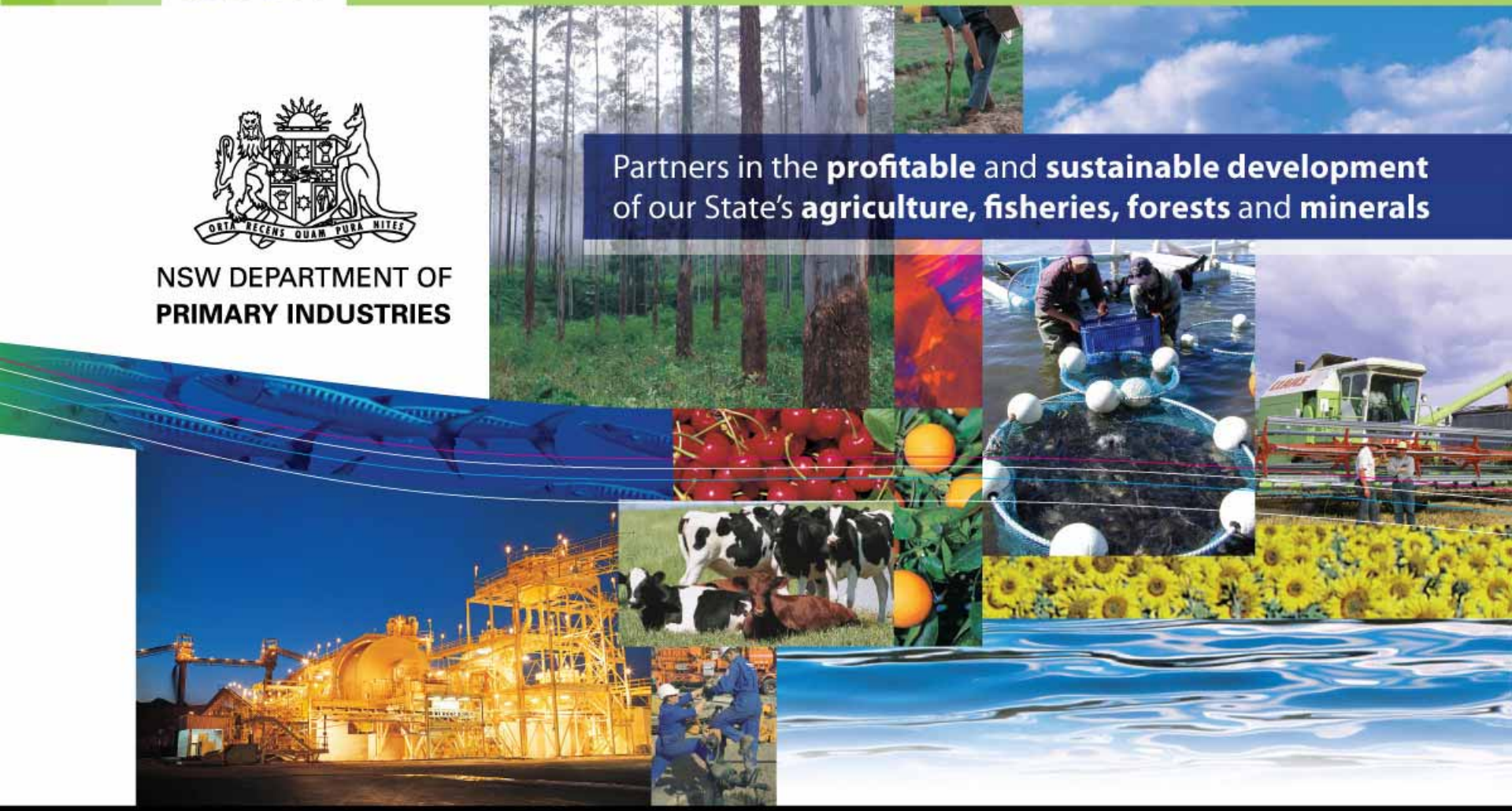


Science and Research Division

Sensitivity Study of NSW Wheat Yield to Climate Change

Qunying Luo, Amrit Kathuria and Deli Liu

Outline

- A brief overview of approaches for agricultural impact assessment from CC
- Research objectives and rationale
- Methodologies
  - Study locations
  - Tools and data
- Results
- Summaries

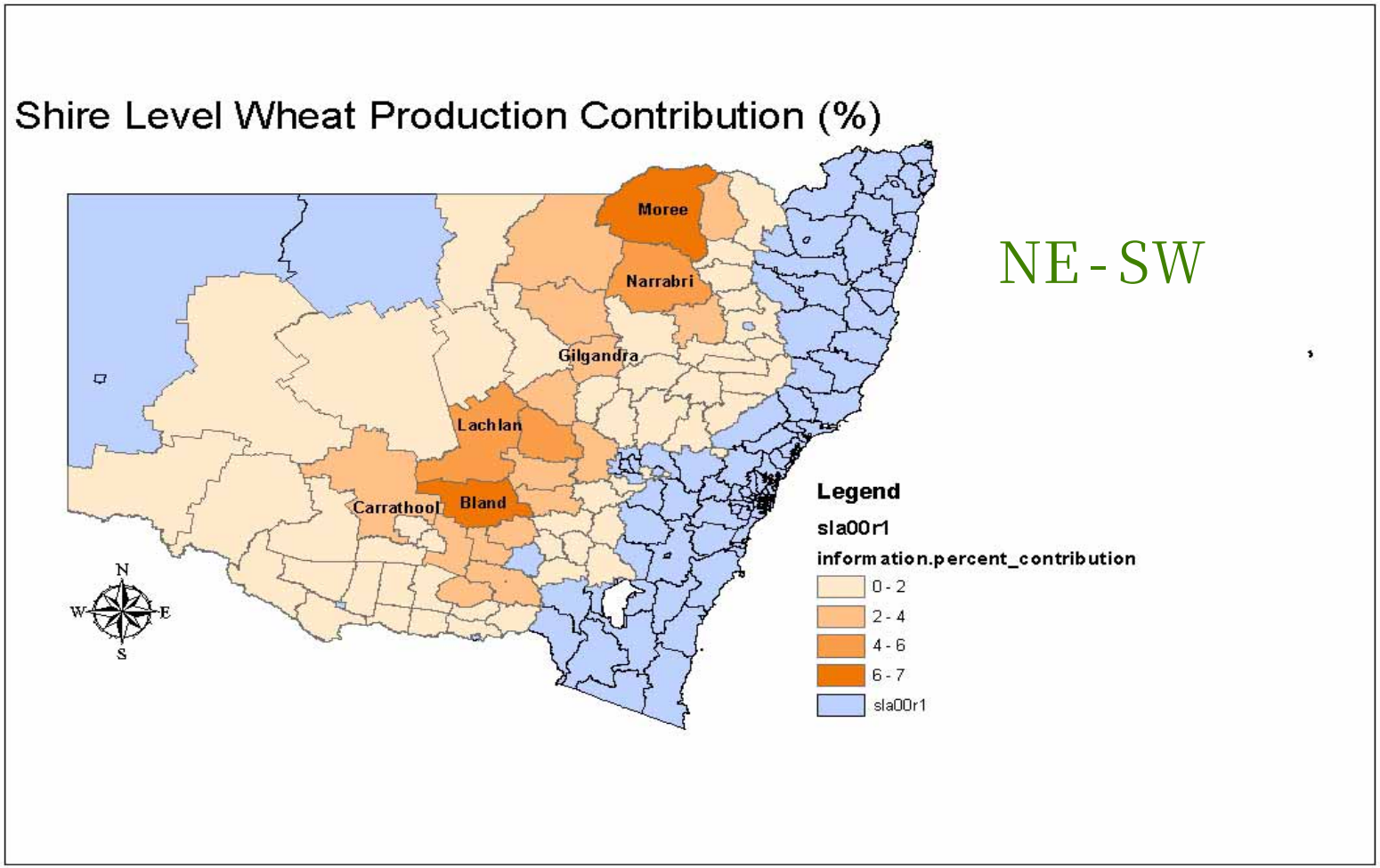
Approaches and Stages of Agricultural Impact Assessment

- Approaches
  - Simulation: one of the major methods
  - Climate changes were coupled with dynamic or mechanism crop models…
- Three distinctive stages
  - Sensitivity analysis: arbitrary changes (disconnected)
  - Scenario analysis: GCMs based
  - Bayesian analysis: GCMs based with probability assigned

Research Objectives and Rationale

- Wheat is an important crop in NSW (16% of NSW agricultural value)
- Climate is the major driving force of dryland agriculture
- Research objectives
  - Test the sensitivity of NSW wheat grain yield to climate change
  - Screen out the important environmental factors for informing adaptation

Study Locations



NE - SW

Classification of Study Locations

Locations	GSR* (mm)	Rainfall Areas
Moree	224	LRA[1]
Narrabri	280	MRA[2]
Gilgandra	259	MRA
Lachlan	201	LRA
Carrathool	210	LRA
Bland	252	MRA

*GSR: growing season rainfall from May to Oct. inclusive
1: low rainfall area, 2: medium rainfall area

Tools and Data

- Tool: the Agricultural Production System sIMulator (APSIM)-Wheat model
- Data
  - Soil water and nutrients: parameters
  - Crop genetic coefficients: P and V
  - Crop management information
    - Cultivars
    - Fertiliser/ residue application: timing, amount and type
    - Planting density and depth
  - Climate
    - Historical daily climate data: 1901-2007
    - Climate Change

Soil

- Two extreme soils
  - Kandosol, MAW* = 487mm
  - Sand, MAW = 90mm
- Initial soil condition
  - Soil water
  - Soil nitrogen
  - Residue

  reset on 1st March each year

MAW: maximum available water

Cultivars and Sowing Rules

- Cultivars
  - Sunvale: mid-late maturing cultivar
  - Janz: early mature cultivar
- Sowing rules
  - Criteria

    Medium rainfall areas: cumR[3] >= 20mm

    Low rainfall areas: cumR[3] >= 15mm
  - Sowing

    Criteria are met between 15Apr - 15Jun then sow Sunvale

    Criteria are met between 16Jun - 15Aug then sow Janz

    Criteria not met: forced sowing applies on the 15th Aug associated with cultivar of Janz

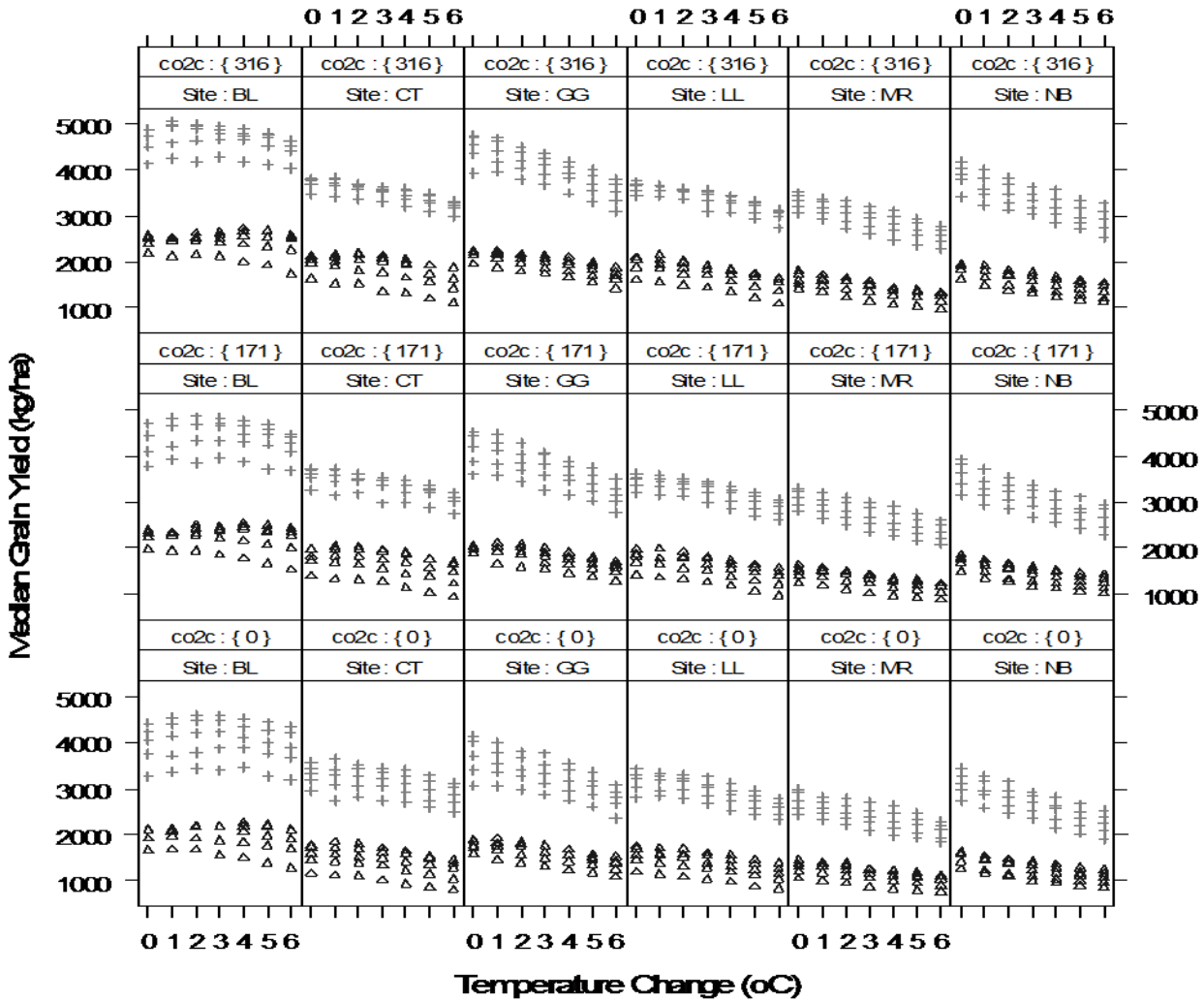
Crop Management Information

Rainfall Areas	Planting density (plants/m2)	Planting depth (mm)	Starting N (kg/ha)	Residue application (kg/ha)
MRA	150	30	187	2000
LRA	100	30	137	1000

Arbitrary Climate Changes

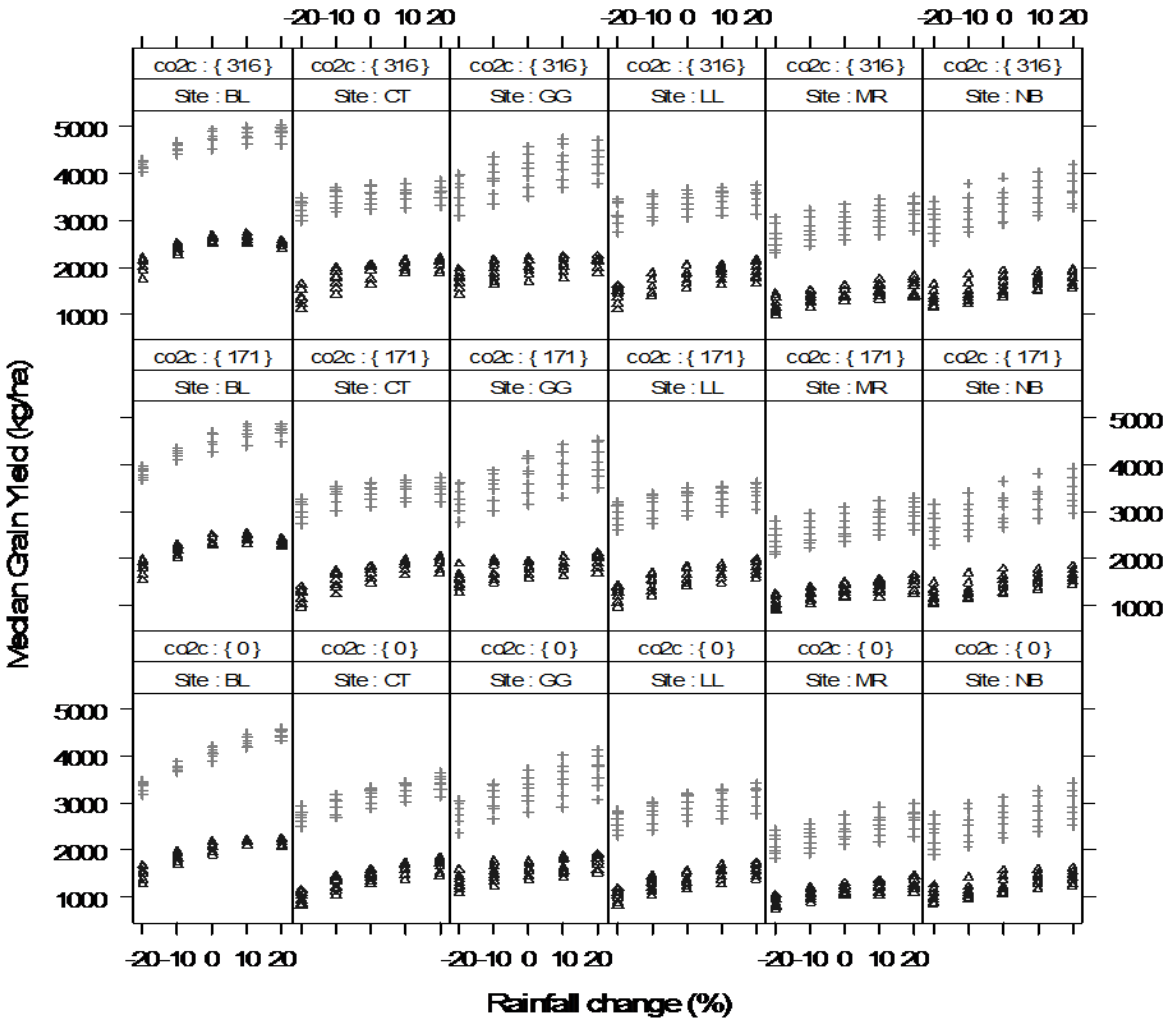
- 7 change levels in temperature: 0, 1, 2, 3, 4, 5, 6^{o}C
- 5 change levels in rainfall: 0, ±10%, ±20%
- 3 change levels in pCO_2: 0, 171, 316ppm
- Total simulation runs=1260
  - Climate changes (7*5*3*=105)
  - Two soil types
  - Six locations

Yield Response to Environmental Factors (I)



- Kandosol(+) and Sand (Δ)
- Different sites have different response to soil type
- MGY has a negative correlation with T: linear or non linear
- MGY at the last 4 sites is more sensitive to temperature change levels under Kandosol
- MGY $\propto pCO_2$

Yield Response to Environmental Factors (II)



- MGY∝ R: linear and non-linear (BL, sand)
- MGY at the last 4 sites is more sensitive to temperature change levels under Kandosol
- MGY ∝ pCO_2

More on the Relationship between MGY and Climate Changes

ΔT (°C)	0	1	2	3	4	5	6
Δrate of MGY (kg ha^{-1} °C^{-1})		-57	-60	-81	-89	-106	-112
ΔR (%)	-20	-10	0	10	20		
Δrate of MGY (kg ha^{-1} mm^{-1})		23.6	16.1	10.3	7.4		
ΔpCO_2 (ppm)	0	171	316				
Δrate of MGY (kg ha^{-1} ppm^{-1})		1.7	1.3				

The rate of decrease in MGY is more for higher Ts
The rate of increase in MGY is less for higher R and pCO2
Non-linear relationship with climate changes

Important Environmental Factors

- Soil type
- Location (R)
- Interaction (soil type X location)
- Rainfall change
- Interaction (Δtemperature X location)
- Temperature change
- pO_2 Change

ANOVA analysis with Bland under Kandosol soil as the reference, at 0.1% significant level

Informing adaptation

- Cropping on good soils with higher water holding capacity when decreased rainfall is projected
- Cropping at areas with better baseline climate such as higher growing season rainfall areas
- Promote soil water conservation practices such as no tillage, stubble retention, even though their actual beneficial effects and effectiveness need to be quantified
- Improving water use efficiency: choice of cultivars with early vigour
- Breeding drought, heat tolerant wheat cultivars

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Thank You!