INTEGRATED ASSESSMENT OF CLIMATE CHANGE IMPACTS ON SELECTIVE FARMING SYSTEMS IN SOUTH AFRICA

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1 September 2019

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OBJECTIVE

To determine possible impacts of projected future climates on the financial vulnerability of selective farming systems in South Africa:

Case studies

- Vredendal, Western Cape Province (LORWUA): Irrigation - winter rainfall region.
- Moorreesburg, Western Cape Province: Dryland - winter rainfall region.
- Hoedspruit, Limpopo Province (Blyde River WUA): Irrigation - summer rainfall region.
- Carolina, Mpumalanga Province: Dryland - summer rainfall region

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CLIMATE CHANGE IMPACT MODELLING

The modelling framework consists of four modules. These are:

- Climate change impact modelling:
  - Modelling of physical climate data (daily minimum and maximum temperatures and daily rainfall from different downscaled GCMs) that impact on crop yield and quality through APSIM and CCCT modelling
  - Hydrological modelling (ACRU model) - impact of climate change on the availability of irrigation water (for the Blyde River WUA)
  - Changing crop irrigation requirements (as a result of climate change) through SAPWAT3 model
- Dynamic Linear Programming model
- Modelling interphases
- Financial Vulnerability Assessment model

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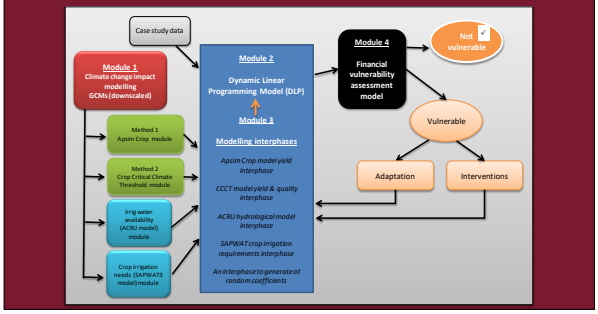
Integrated climate change modelling framework



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CLIMATE CHANGE IMPACT MODELLING

- General Circulation models (GCMs)
  - The GCMs are: CCC (Canada), CRM (France), ECH (Germany), GISS (USA) and IPS (France). All of the future global climate scenarios that were downscaled by CSAG to point scale for use in this study were based on the A2 emissions scenario
- APSIM (crop yield modelling)
  - APSIM was developed to simulate biophysical processes in agricultural systems particularly as it relates to the economic and ecological outcomes of management practices in the face of climate risk

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CLIMATE CHANGE IMPACT MODELLING

- CCCT (crop yield and quality modelling)
  - Empirically downscaled daily climate values (rainfall, minimum and maximum temperatures)
  - Physical/biological critical climate thresholds for different crops
  - Expert group discussions (for guidance on crop critical climate thresholds and also the impact on yield and/or quality should a threshold be exceeded)
- ACRU (hydrological modelling)
  - The daily present and intermediate climate values from downscaled GCMs were used in the ACRU model to project future changes in dam levels

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CLIMATE CHANGE IMPACT MODELLING

- SAPWAT3 (crop water requirement modelling)
  - a program that is extensively applied in South Africa and was developed to establish a decision-making procedure for the estimation of crop irrigation requirements by irrigation engineers, planners and agriculturalists
- Whole-farm dynamic linear programming approach
  - The main objective of the mathematical modelling exercise is to simulate the selected farming systems (case studies) with the best available information

CLIMATE CHANGE IMPACT MODELLING

- Financial Vulnerability Assessment model

  The output of the DLP whole-farm model feeds into an excel-based financial assessment model
  - Internal Rate of Return (IRR)
  - Net Present Value (NPV)
  - Cash flow ratio
  - Highest debt ratio
  - Highest debt

ADAPTATION STRATEGIES

- Within the context of this study the focus will be on autonomous adaptation, in other words, adaptation strategies which can be applied at farm level without support from other levels e.g. policies, etc
- Adaptation strategies to lessen the impact of climate change were identified for each case study through expert group discussions
- Adaptation strategies along with their cost/benefit implications were incorporated in the model to evaluate their suitability and ability to overcome the potential negative financial impacts as a result of changing climates

RESULTS AND DISCUSSIONS

- (LORWUA) – Irrigation, winter rainfall region
  - APSIM - All the GCMs project a 20-year average decrease in yield, varying 9% to 18%
  - CCCT - All five models project a decrease in yield for wine grapes, table grapes and raisins and a decrease in quality for table grapes
  - A 10% - 11% average annual increase in irrigation requirements
  - Adaptation strategies to counter the impact:
    - (a) Shift in wine grape cultivars towards cultivars that are more tolerant towards projected climate change
    - (b) Increase raisin and table grape production
    - (c) Install shade nets over table grapes production areas

RESULTS AND DISCUSSIONS

- (Blyde River WUA) – Irrigation, summer rainfall
  - CCCT - Although, only one out of five GCMs projects a decrease in yield for citrus, all models project a negative impact on quality. For mangoes the models project a negative impact on both yield and quality
  - An 8% average annual increase in irrigation requirements
  - All indications are that the availability of irrigation water for the Blyde River WUA area irrigators (in terms of quota consistency) will not be negatively affected by the projected climate scenarios
  - Adaptation strategy to counter the impact of climate change on financial vulnerability is to install shade nets over mango and citrus production areas

RESULTS AND DISCUSSIONS

- Moorreesburg, Western Cape Province – Dryland, winter rainfall region
  - APSIM - The different GCM projections (20-year average) vary from a decrease of 4% to an increase of 4% compared to present yield
  - CCCT - no major changes in yield, from the present to the intermediate future, are projected
  - Adaptation strategies to counter the impact of climate change on financial vulnerability were included in the model. These strategies include:
    - (a) Cropping systems
    - (b) Production practices

RESULTS AND DISCUSSIONS

- Carolina, Mpumalanga Province – Dryland, summer rainfall region
  - APSIM - One model projects an average decrease of 25% while three models project an increase in average yield of approximately 10%
  - CCCT - All five models project an average increase in yield of approximately 10%
  - Adaptation strategies to counter the impact of climate change on financial vulnerability were included in the model. These strategies include:
    (a) Cropping systems
    (b) Production practices

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CONCLUSIONS

- This study clearly indicates the importance of biophysical factors and the capacity to adapt to climate change
- The Moorreesburg as well as the Carolina case study results indicated that changing to conservation agriculture (more resilient cropping system) improves the adaptive capacity of the farming systems
- In the Blyde River WUA case study, shade netting improves the biophysical adaptive capacity of mangoes and citrus (in terms of yield and quality). The LORWUA case study showed similar results for table grapes under shade nets

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CONCLUSIONS

- Without the capacity to implement adaption strategies such as conservation agriculture (Moorreesburg and Carolina), shade netting (LORWUA and Blyde River WUA) and structural changes to land use patterns (LORWUA), the farming systems of the selected case studies will financially be extremely vulnerable to climate change (as indicated by reduction in IRR and NPV, higher debt ratios and decreasing cash flow ratios)
- The high capital cost of certain adaptive strategies, e.g. shade nets would not be affordable to all farmers, especially on smaller operations and those that are highly geared

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CONCLUSIONS

- This study shows the importance of research for cultivar development e.g. short grower cultivars (e.g. maize) for the summer rainfall area and more heat resistant cultivars for the Blyde River WUA area (citrus and mangoes)
- It also points out the importance of locality for future plantings and the projected switch to cultivars that are more tolerant to increasing temperatures (e.g. wine grape cultivars in the LORWUA area)
- This study points out that citrus and mangoes in the Blyde River WUA area are extremely vulnerable to increasing temperatures. This is because prices of perishable produce depend to a large extent on quality grading and market requirements.

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ACKNOWLEDGEMENT

- Acknowledgement to the Water Research Commission (WRC) for initiating, managing and funding this research project under the directed call for proposals and to the Department of Agriculture, Forestry and Fisheries (DAFF) for co-funding the project (WRC, 2010).

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