Use of Weather and Climatic Information for Agricultural Planning in Tropical Countries

By K J Coughlan and A K S Huda

Background

- Farmers have historically used climatic information in an intuitive or "rule of thumb" fashion for planning and decision making on land or crop management. Such indigenous knowledge ranges from visual weather predictors to surrogate biological indicators
- Over recent times, the availability of data bases of historical climatic information and the development of predictive tools ranging from correlation analysis to computer simulation models have made the climatic information useful to a much wider range of stakeholders
- These include Government, business, researchers and community groups for setting policy, economic analysis, and establishment of research priorities.

Background (cont)

This paper provides:

1. **A discussion of issues in planning and decision making using weather and climate data. Terms are defined**
2. **Illustrations of issues and various approaches from examples from our own experience, and those of others.**

   Little specific attention to scientific forecasting tools including models. Accept them as crucial methods to push our forecast further from pure guesswork and closer to perfect knowledge. This obviously increases the utility of forecasts

Context of Decision Making

Three basic variables in use of meteorological data:

1-Complexity of Data required

2-Information used for decision making:

- ***Actual historical weather data: e.g. crop insurance***
- ***Parameters derived from weather data :e.g. biomass***
- ***Indicators developed from statistical climatic data-forecasting for decision making and planning***

3-Decisions/forecasts made?

Decisions regarding crop insurance, drought assistance, farming and grazing decisions based on SOI and contingent probabilities, predictions of National crop yields, predictions of future agricultural and pastoral productivity

SUBJECT OF LATER CASE STUDIES

Barriers to Decision Making for Planning

But there are many barriers to simple decision making, for example:

Technical Limitations

- **Data lack: Local historical rainfall or hydrology data to relate to long history of Global /regional indicators such as SOI**
- **Limiting factors to crop growth not recognised: e.g. radiation or soil fertility**

Social Limitations

- **Understanding the terminology of probabilistic occurrences ("There is a 40% chance of above median rainfall")**
- **Acceptance of the decision making process: Education that negative consequences will occur, for example no response to quality seed and fertilisers, pest infestation after periodic spraying was not recommended**

Attitudes towards Risk in Decision Making

- **Tools provide a basis for increasing the probability of predicting, say, a favourable growing season**
- **But the prediction still contains a variable degree of uncertainty**

"forecasts that are more than guesswork but fall short of perfect information"

- **An example may be for two extremes for farmers in an uncertain environment:**
  - **The capital-rich farmer with large farming area**
  - **The resource-poor farmer with small area**

The "Wheat Hunter"

- A title for a large farmer in Australia who can operate in a very uncertain environment where crop failure is common
- The enterprise can be economic for the risk taker as large profits can be generated in good years
- The enterprise can benefit from tools such as ENSO Phase since inputs can be maximised in good years

The Resource-poor Farmer

- In Developing Countries farmers are naturally more risk adverse, and cannot afford to lose inputs in poor years.

- Predictive tools can still be used, but support is required to "spread the risk" through strategies such as index-based crop insurance and supply of inputs (quality seed, fertilisers, pesticides) by Government

The Impact of negative outcomes

- **Every decision based on climate information should be subjected to simple economic analysis, for example:**

  EV = (P_s*Vs –P_F*V_F)
- **Even if probability of success is increased by climate forecasting, the Expected Value of the outcome may still be negative.**
- **Even a positive EV may be unacceptable if losses from negative outcomes are high**

A Matrix of Planning Issues

	Farm	Regional	National	Global
Short term (days)	Pest Control Response Farming	Hazard management		
Medium Term (Months)	Use of ENSO Signal	Prediction of Crop Harvests		
Long Term (years/ decades)		Long-term viability of cropping Climate change scenarios		

Weather and climate information for short-term decisions

- **Over the shorter term , the approach is to accept the existing climate variability and make decisions through better prediction of future conditions**

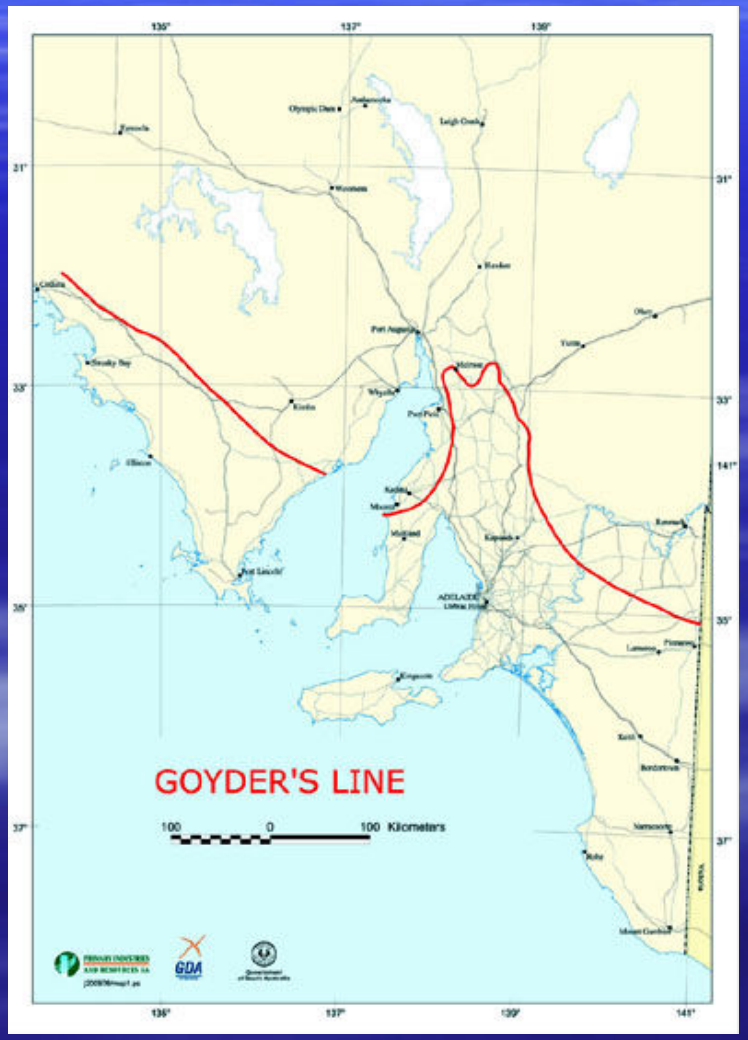
Two obvious examples:

- **Response Farming uses immediate previous weather data to predict the future-Contingent Probabilities. For example date**
- **Seasonal Climate Forecasting (SCF) such as the SOI approach, which develops tools based on atmospheric pressure differences between Darwin and Tahiti**

Climatic variation over the longer period

- In this case past climatic information and agricultural productivity may not be applicable to future planning (as assumed for shorter-term decision making)
- Long term variations can be natural or (as proposed in the present climate change scenarios) man-made
- Many examples from the past of natural longer-term variations making farming not viable

Goyder's Line



Goyder's Line

- George Goyder was Surveyor General in South Australia in the mid nineteenth century
- Drew a line, also marked by vegetation changes, where he proposed that rainfall became too low for viable cropping
- Around 1865 there were heavy rains and farming extended beyond Goyder's line.
- Farms abandoned within 5 years as rainfall returned to historical average
- Other attempts have followed but nature has always won

Two important lessons for agricultural planning:

1. Danger of using short-term climate (years) as a basis for determining cropping viability
2. The value of long term data if it is not subject to systematic change (if the statistical past represents the future)

Case Studies Issues in use of climate data for agricultural planning

- **The paper briefly outlines tools and options for planning in terms of a two-way matrix:**
  - **Geographic scale: Farm, region, national, global**
  - **Time scale: short (weeks) medium (months), long (years, decades)**

Some Variables to think about for individual case studies

- What meteorological data to use
- Tools to convert data into decision making
- Spatial and temporal scales of operation
- What decision is made ?
- Who makes the decision?
- Who benefits from the decision?
- Involvement of beneficiaries in decision making? Participatory Action Research
- Potential positive and negative outcomes-risk management , as discussed previously

Case Studies
1-Managementof Fungal Diseases

- Concentrate on diseases with maximum sensitivity to weather conditions
- Aim to reduce pesticide use compared with periodic spraying

Two types of approach have been tested in India:

1. Use of regression equations between recent weather parameters and disease incidence and crop damage-Development of regional and local advisories
2. On farm tactical decision making based on the outputs of models derived from weather data, crop simulation models and disease epidemiological models.

   High complexity in modelling the plant pathology-crop physiology-agro-meteorology interaction, including predicting micro-environment (leaf wetness)

Positives: The output advice is simple and major determinants of disease occurrence (high humidity, low sunshine/cloudiness and temperature) are relatively easy to predict)

Negatives: Disease response must be considered in conjunction with other weather sensitive limitations, such as insects and Nitrogen fertility

Case Studies

2-Using SCF Information with Farmers in Tamil Nadu, India

- Use of short-term and SOI predictions for cropping season decisions by farmers during the north-east monsoon
- Farmer groups established by both state agricultural extension specialists and village presidents
- The case study tests and illustrates the importance of participatory approaches for farmers to have ownership of decisions
- Decisions by farmers are usually more uncertain than complex, but communication and education is required to ensure appreciation of risk

Major outcome was that SCF were regarded as more acceptable than medium-term forecasts because the negative consequences of incorrect short-term decisions were more immediate and difficult to rectify

Case Studies
3-Grazing Management in Zimbabwe

- Limited work in this area using SOI Phase to manage both drought and better than average years
- Strategic decisions can be made regarding pasture carrying capacity and day-to-day decisions such as whether or not to buy, breed, sell, agist or feed the existing herd

Case Studies
4-Irrigation management in Lombok

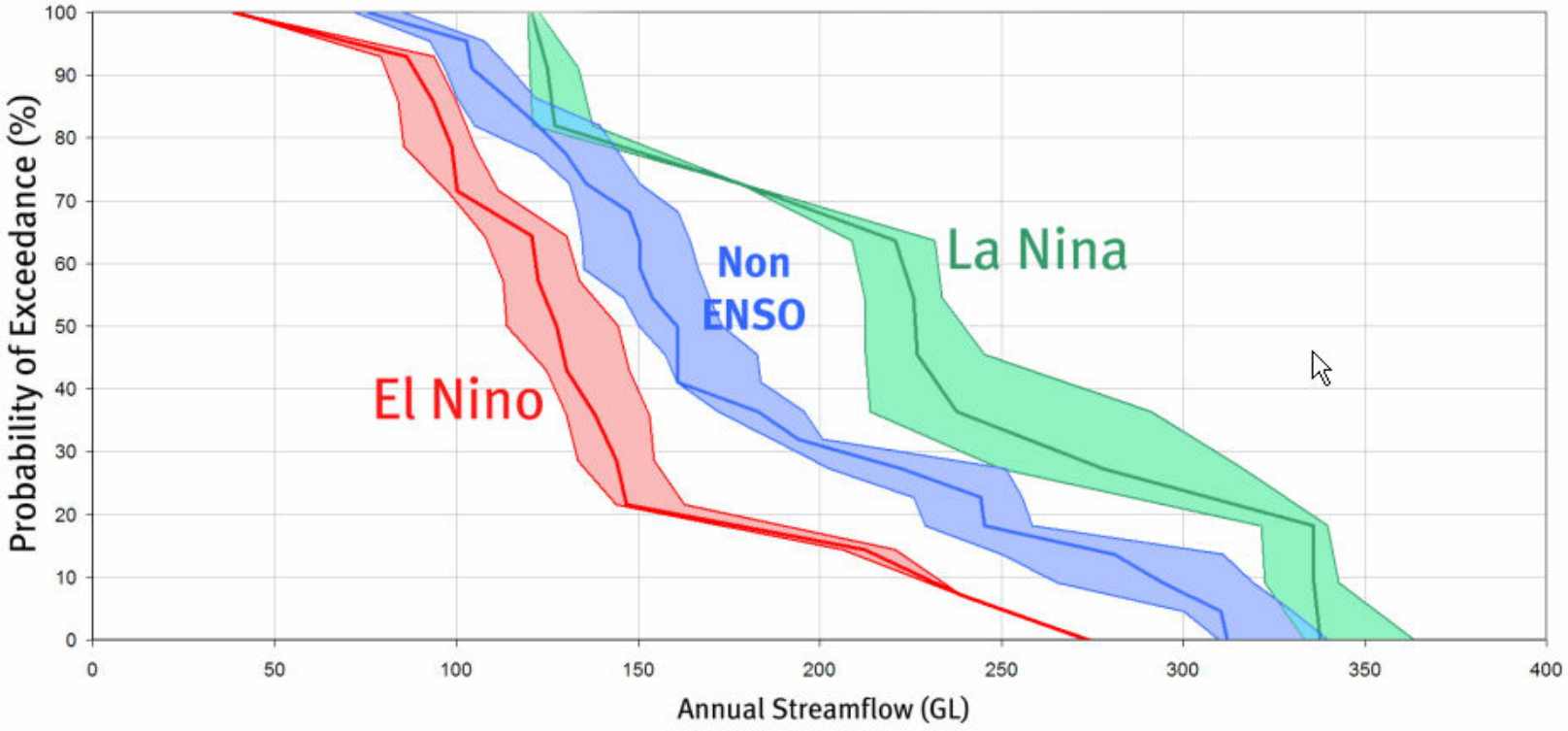
- **Improved irrigation management is critical as international demand for water resources increase**
- **For example, Dr Frank Rijsberman, Director General IWMI says :**

  "More that one third of the world's food is produced on about 250 Million hectares of irrigated land, accounting for about 80% of global fresh water consumption".
- **Results for Lombok suggest a strong Annual streamflow respond to ENSO. For example, in El Niño years there is 70% chance of exceeding 105 GL compared with 190 GL in La Niña years.**
- **These results are used to optimise choice of crop and planted area.**
- **In this case the decision makers and water managers are local government, and farmers the beneficiaries**

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Distribution of Annual Streamflow at Majeli Wier, Indonesia for El Nino, La Nina, and Non-ENSO years.



Case Studies
5-Predicting National Crop Yields

- An iterative approach based on planted area and simulated yield (using an agro-climatic stress index model) for different agro-ecological zones
- Initial estimates are based on average yields over the past 20 years
- Later estimates use actual growing season rainfall to date and predicted rainfall based on SOI to predict yields in the different zones
- Ground truthing and interviews with local industry representatives are used to improve estimates
- The final estimate is based on harvest data

THE PHILOSOPHY BEHIND THIS APPROACH IS THAT IT PROVIDES EARLY INFORMATION FOR PLANNING, AND THAT INFORMATION BECOMES MORE PERFECT AS THE TIME FOR DECISION MAKING APPROACHES

Some uses of predicting crop yields:

1. Government drought assessment
2. Forward buying and selling of crops by Grain Companies
3. By Feedlots to secure adequate and timely grain inputs
4. Insurance Companies to develop seasonal insurance products

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Case Studies
6-Rice Imports for the Philippines

- Philippine Institute for Development Studies (PIDS)
- Rice policy National Policy Paper examining how SCF can affect national decisions, particularly with respect to rice importation
- Rice imports have played an important part in the rice supply-demand situation in the Philippines since 1990
- Accurate forecasting of volume and timing of imports in El Nino years result in substantial economic benefits
- Benefits include avoiding rice shortages (with higher prices) and excess rice (leading to higher storage costs)

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Case Studies
7-Insurances and Benefits

- Government support at a National or regional level requires the definition of “Drought”.
- Programs usually involve the use of historical weather data and derived parameters such as soil moisture and simulated pasture growth to provide a “trigger” for assistance to farmers and graziers
- Programs often supported by Government, even in Developed Countries, because extreme drought thought to be out of the control of primary producers
- Attitudes changing and now support for strategies such as fodder conservation and amalgamating uneconomic farms in more marginal areas

- One good example is the World Bank Program to use Index-based Weather Insurance (usually based on Rainfall) to protect poor farmers from crop failure
- This program encourages farmers to use inputs such as improved varieties and fertilisers

Case Studies
8-Climate Change Scenarios and crop production

- **Agriculture has contributed about one-third of the increase in atmospheric C in the last 250 years. Land clearing has resulted in an increase in arable area from 265Mha in 1700 to about 1500Mha in 1980. So agriculture and agricultural planning is strongly relevant to the climate Change debate**
- **WHAT IS THE PROJECTED IMPACT?**
- **WHAT AGRICULTURAL PLANNING OPTIONS ARE AVAILABLE TO ADDRESS?**

Case Studies
8-Climate Change Scenarios and crop production

- **Projected changes in crop productivity from climate change to 2050, due to changes in temperature, precipitation and evaporation:**

  Australia = -17%

  China = - 4%

  India = -25%

  Least Developed Countries = - 18%

  USA = - 4%

  Europe = - 4%
- **Note the uneven distribution of effects**
- **Also note that the simulation does not take into account carbon fertilisation or potential plant adaptations such as drought and heat tolerance**

Australian Commodities Dec.2007 http://www.abare.gov.au/publications_html/ac/ac_07/ac_07.html

8-Climate Change Scenarios and crop production (cont)

- **Scenarios for different crops**

Rice = -4.7% (-0.4)

Wheat = -4.4% (-0.5)

- **Figures in brackets are with C fertilisation, but these results are controversial, and dependent on methodology**
- **Note that our proposed agricultural response to climate change is a combination of adaptation (varieties, water management) and attempting to reverse the predicted anthropogenic component (for example Carbon sequestration)**

8-Climate Change Scenarios and crop production (cont)

- **Problem for long term variations is that the past may not be a good predictor of the future**
- **Positive and potentially negative consequences of decisions**
- **For example, carbon trading may have a positive influence in reducing global vegetation clearing, particularly in developing countries, but inappropriately-managed strategies may reduce National growth**
- **Political Decisions required for climate change planning, but:**

  "the wish to know exactly what is going on is independent of politics and scientists must never bend their desire for knowledge to any political cause, however noble"* -David Whitehouse in the *New Statesman

8-Climate Change Scenarios and crop production (cont)

- Planning is required here to develop strategies that will reduce atmospheric CO2 without unintended consequences, and preferably to do no harm “even if we have got it all wrong” (win-win)
- Likely Agricultural strategies in the right environment are management systems that reduce use of oil-based products or that sequester C in either soil or plants
- Problem of non-compliance- How to

Agricultural Planning-Matters for our consideration

- **Data requirements for decision making- minimum data sets, and what data is available in Developing Countries**
- **AppropriateTools- from rule of thumb to computer simulation (cropping systems simulation, pest and disease models, general circulation models).**
- **Application of 1 and 2, particularly for developing countries**
- **Proposed Networks and Programs**

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