The use of seasonal forecasts in South Africa during the 1997/98 rainfall season

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Abstract

Forecasts can never be perfect, but with improved understanding of South Africa's climate systems, the ability to predict certain climate scenarios s increased. The South African Weather Bureau is obliged to forecast these different weather and climate scenarios, while government and the private sector have a role to play in advising the public, and farmers in particular. Since climate scenarios such as seasonal drought cannot be prevented, the farming community and other water sensitive sectors of society has to accept variability and adapt to it as a normal part of management. A wide range of measures is required in response to climate variation, such as the improvement of early warning systems and the co-operation between different private and public sectors.

During the 1997/98 rainfall season in South Africa, warnings of a strong El Niño event developing stimulated a great awareness and need for seasonal climate prediction by the public. As part of a strategy to be pro-active in planning and decision-making, the South African Weather Bureau issues seasonal outlooks through the Long-term Operational Group Information Centre (LOGIC) on a monthly basis to a large number of end-users in South Africa. The outlooks are distributed through fax, mail, the internet, e-mail and telephone. The Weather Bureau has a responsibility to ensure that this information is used to maximum benefit by their clients. Therefore, it is necessary to evaluate the use and understanding of this information by the end-user. A questionnaire was compiled and sent to end-users in order to determine how the information was absorbed by the end-user community, and what influence this information had on their planning processes during the 1997/98 summer rainfall season. Responses were received from a wide variety of sectors, including agriculture, water management, energy supply, construction, education and policy-making. It is evident from the results that users did change decisions because of the El Niño warnings during the 1997/98 rainfall season. The need for education and collaboration between different stakeholders in the user- and scientific communities is evident - users need more information on how to use and interpret the information, while forecasters need to assess what information the user actually needs, and what is the best way in presenting the information to the end-user. These issues need further attention. This paper summarises the responses to the questionnaire.

Introduction

Uncertainty about future climate conditions is an important retarding factor for decision-making in agriculture, food security and many other water sensitive sectors of the economy. It is the highly variable nature of rainfall over much of Southern Africa which enhances the potential use and value of reliable and dependable seasonal forecasts in the decision-making processes of different sectors. Recent droughts experienced in South Africa (e.g. 1991/92) have created greater awareness and recognition of the risks involved amongst decision-makers in both the private and public sectors, and stimulated a need for long-term investments in drought-mitigation measures. However, the knowledge that rainfall is so variable imparts considerable inertia on the implementation of such measures, which often require major shifts in policy and redirection of investments (Mjelde et al., 1996; Nicholls, 1996).

Since 1994 the South African Weather Bureau (SAWB) is actively involved in the research and development of seasonal climate predictions (Klopper et al., 1998; Landman and Mason, 1999; Tennant, 1999) with the aim to provide the best possible information on future climate conditions so that the risk in economic and social decisions are reduced. Although forecasts generally possess positive value over a broad spectrum of decision-making problems and forecast time ranges (Mjelde et al.,1996; 1997; Sonka et al., 1988), the actual use and value of seasonal forecasts depend on the nature and structuring of the individual user's decision-making problems, on various characteristics of the information on which their decisions are based and on a variety of behavioural characteristics of the user. Climate information, even perfect forecasts, has limited value if it cannot be understood and used by the recipient to support the decision-making process (Glantz, 1977; Chagnon, 1992). Significant impediments on the use of forecasts that exist (Nicholls, 1996) include a lack of flexibility in both user's economic and decision-making models and in operational systems or practises to respond to improved information. Also, the impact of climate forecast information on profitability is only marginal compared to the impact of the variation of input costs, interest rates, market prices and other factors which may be outside the influence of the user. Users may have little belief in the accuracy of forecasts through personal experience, hearsay or bad publicity. Other constraints on the optimal use of climate forecast information includes factors such as the information provided is too general, non-specific to an area or particular application, received too late for use and is often too difficult for the user to interpret and apply.

The importance of user confidence for the application of climate forecasts emphasises the need for forecasts to be designed and developed with the requirements of the user very much in mind. Assessing the value of climate forecasts is fundamentally an interdisciplinary problem (Ehrendorfer and Murphy, 1992; Murphy, 1994), requiring expertise from such fields as economics, operations research, psychology, statistics and system analysis as well as climatology. Most studies of the value of forecasts have been conducted in the developed world (Lyakhov, 1994; Mason, 1996; Mjelde et al., 1988; 1997; Mosley, 1994; Nicholls, 1996). A clear need exists to extend these studies into the developing world where

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substantial benefits are perhaps more likely to be realised.

On a national scale farmers are the biggest single group using seasonal outlook information. Yet they are a diverse group because of the widely differing climatic conditions and the wide range of crops grown. Agricultural production, as for most economic activities, is not simply the result of the decision of what to produce, but includes important considerations on the amount and timing of applications such as variety, fertilisation rate, etc.

Already more than nine months prior to the 1997/98 rainfall season in South Africa, warnings of a developing El Niño event were issued to the public. During the period August 1997 to March 1998 more than 2000 telephone enquiries were received by the Long-term Operational Group Information Centre (LOGIC) at the SAWB. LOGIC was established in October 1996 at the SAWB to cater for the growing demand for real-time information by the public and sophisticated end-users of monthly and seasonal climate predictions. The LOGIC distributed between 400 and 500 seasonal outlooks every month during the 1997/98 season through fax, mail and e-mail. These two-page outlooks contain information on the current state of the climate system and a comparison with previous severe events such as the 1982/83 El Niño is made. Information is included on the expected development of the current climate phenomena and consolidated outlooks for the expected seasonal rainfall and temperature of Southern Africa are provided. Furthermore, special advisories were compiled quarterly to update government and managers on the expected climate conditions. Information on the developing El Niño was also provided by other institutions, the media and through the internet.

In an effort to assess the use of seasonal climate forecasts during the 1997/98 rainfall season in South Africa, a questionnaire was compiled and sent to end-users of seasonal outlook products. The aim of the questionnaire was to determine whether these products reached the end-users effectively, and how their decisions were influenced by this information. It is believed that the producers of these outlooks could deliver a better and more effective service to the South African community with this feedback in mind. Responses received from 80 end-users are evaluated here.

Method

A questionnaire (**Appendix A**) was compiled and sent to end-users of seasonal outlooks issued by the SAWB during the 1997/98 rainfall season. The questions were aimed at determining who the users are and what their sources of information are. Secondly, questions were asked to determine how sophisticated the users are - do they understand the information given to them and do they know how to apply it to their specific scenarios? The main aim of the questionnaire was to determine if end-users reacted on the forecasts of an El Niño event developing, and how did they change decisions to incorporate the information. Finally, some questions dealt specifically with the service rendered by the SAWB.

Results

To determine the use and benefits of seasonal outlook products it is firstly important to know which sectors are represented by the respondents. Table 1 shows that the respondents represent a wide range of interests, from agriculture, water management and policy-making to food processing and construction.

Besides the SAWB, other sources of information available to respondents include the media and research groups at different universities and institutions. About half of the respondents received seasonal outlooks on a regular basis before the 1997/98 season. When asked if they had received contradicting forecasts or statements during the season, 75% respondents replied that they had not. Twenty-five per cent of the respondents claimed they had received conflicting information and this can be explained as follows:

- Firstly, minor differences occurred between SAWB outlooks and those of other institutions, the main reason being the lack of standardisation between forecasts so that different regions or seasons are being predicted for by different institutions. During the 1997/98 season the Climate Research Group (CRG) from the University of the Witwatersrand (Mason et al. 1996) and the SAWB standardised their outlooks to predict for the same homogeneous rainfall regions and corresponding seasons. Currently the model output from the CRG and SAWB is combined into one consolidated forecast which is issued by LOGIC. Users receiving outlook information from other institutions such as the Glen Agricultural College also experienced some uncertainty since they issue a more application-orientated product to the farmers in the Free State province, while the SAWB concentrate on issuing seasonal climate outlooks for the country as a whole. It is thus clear that a need exists for even

TABLE 1
FIELD OF SPECIALITY OF RESPONDENTS TO QUESTIONNAIRE

Sector	Speciality
Climatology / Meteorology	Research
Energy	Dehumification of substation Energy supply
Water	Water management Agrohydrology
Food Industry	Food analysis Food processing
Farming (commercial and small farmer)	citrus, sugar, forestry, cut flowers, maize, wheat, vegetables, pasture seed, tobacco, sunflower, cotton, grazing, soya bean, tea, coffee, cash crops, fruit, dry beans, sugar-cane, stock (sheep, cattle, milk), wildlife, ostrich
Nature conservation	
Construction	Dam construction Roof repairing
Policy-making	Government policy for agriculture Disaster management Strategic planning Food security
Education	

closer collaboration between the SAWB and other institutions issuing seasonal forecasts.

- Some confusion was created by the media. Respondents had different opinions in this regard, some indicated that they believed the newspapers to be more reliable. Others preferred to listen to radio or television broadcasts. Only one forecast is issued to the media, thus it is again a matter of interpretation by the journalist or presenter. Also, the media tend to exaggerate with headlines such as "El Niño: act now or face disaster" (*Pretoria News*, 7 November 1997), "State departments brace themselves for El Niño chaos" (*Pretoria News*, 10 September 1997) and "Emergency El Niño" (*Argus*, 18 September 1997). This emphasises the need that the SAWB should focus on efforts to involve and explain to the news media exactly what is meant by a certain forecast or statement.
- Finally, forecasts given by Prof. Peet Pienaar (*Landbouweekblad*, 1998a), who uses mainly the phases of the moon as predictor, contradicted the SAWB seasonal outlooks in many instances. It should be kept in mind that both the temporal and spatial extent of these two products differs dramatically and is in no regard comparable.

Discrepancies between model results might cause confusion in many instances, but in the case of the 1997/98 El Niño almost all the scientifically sound prediction models (both nationally and internationally) predicted similar probabilities of below-normal, near-normal and above-normal rainfall over South Africa. In the majority of cases where conflicting information was reported the underlying reason was different interpretations of the forecast.

One of the questions raised in the questionnaire was how end-users experienced the season, in other words did they experience a "normal" season or not ("Normal" in this instance would refer to the individual's perception of what normally happens during a season). Two thirds of the respondents considered the weather in their area to have been "not normal" during the 1997/98 season. The explanations range between "extremely dry", "very warm" and "poor distribution" to "above-normal rainfall during an El Niño season" depending on the region. Seventy per cent of the respondents anticipated the El Niño to have a negative impact on their activities, 26% thought it would have a positive effect and 4% did not expect any effect at all.

The *Landbouweekblad* (4 September 1998) reported the 1997/98 season to have had the smallest maize planting in 40 years in South Africa and many reports also indicated a reduction of livestock carrying capacity. From the questionnaire it was evident that around 75% of the respondents had changed their decisions or strategies as a result of the warnings of an El Niño event developing. Those not reacting on the reports explained that they did not need to change plans because the dams were full as a result of the previous season's good rainfall. Some claimed not to have believed the media reports and one respondent stated that he hoped the forecasts were going to be wrong. 80% of the respondents stated that they had been better off having the information available on rainfall and temperature expectations. This is an important statement which emphasises the need for more information, as well as the need for plans and education on how to interpret and apply the information to particular scenarios.

The action taken by farmers and other end-users who responded to the warnings included:

- Changed crop varieties (selection of short season maize hybrids, introduction of faster growing varieties)
- Delayed or earlier planting (not planted at all in specific cases)
- Reduced seeding
- Planning more conservatively
- Conservation of moisture
- Conservative use of fertilisers
- Reduced stock (sold cattle before the season started)
- Developed an additional system of troughs for stock
- Greater volumes of raw material were contracted for food-processing purposes
- Changes to temperature of driers to save electricity
- Increased cooling systems and better water management
- Changes to the planned employment of labour
- Adjustment of risk profiles
- Advised clients according to a dry season
- Governmental departments developed a drought policy.

A few questions dealt with the service rendered by the SAWB specifically. Questions were related to the format of outlooks and the understanding of these products by the public. An overwhelming 97% stated that the outlooks were understandable and that they were able to interpret the information. They also understood the concept of probability forecasts and were able to apply the information.

It is the goal of the SAWB to stay in touch with end-users and accommodate their needs where possible. A number of very valuable suggestions and comments were given on how to improve the service rendered by the SAWB, the most important being a need for updated information on the Internet.

Requests to include wider geographical areas were also received and special reference was made to Namibia and Mozambique. Many requests for forecasts in specific areas were received, for example the Overberg region, Klein Karoo, Koue Bokkeveld, etc. Some end-users requested more technical information, for example hindcast results or historical rainfall records together with forecasts. Others still wanted explanations on terms like "convection". It is thus clear that the SAWB must cater for a broad audience and try to find the best way to satisfy these needs. Other parameters that are of interest to end-users are wind speed and direction, flood risk, cold and heat waves, fire-hazard risk information, pest and disease risk, influence of tropical cyclones, relevance of climatological and other cycles, hydrology, crop yields and snow. Although this information is available on a short-term time-scale, many of these parameters are not predictable on seasonal time-scales. These kinds of demands indicate a further need to educate end-users and to make sure they understand the difference between short- and longer-term predictions and how these are compiled. To address this problem a series of information brochures were compiled discussing different topics of interest such as "*What is La Niña*", "*How is a seasonal outlook compiled*" and "*What products and services are provided by the Weather Bureau*".

Conclusion

This paper intented to determine the current use of seasonal climate forecasts in South Africa. A questionnaire was compiled and sent to end-users of products issued by the SAWB in order to determine the current state of use by different users. From the analysis performed here it is clear that the service rendered by the SAWB in terms of seasonal forecasting is very useful and extremely relevant. Many respondents expressed a need for this information since it does have an impact on decisions made by end-users in various sectors ranging from agriculture and farming to disaster management and planning. There is a need to predict those climate factors that are directly relevant to the user, feedback from users are

therefore essential. It became clear that liaison and education between users and producers of seasonal outlook products are fundamental - both ways. An educational programme alone might however not be sufficient to derive full value from climate forecasts, but innovative outlook design strategies may be necessary to make users respond to the desired probability distributions. This suggests that seasonal forecasts are only part of a larger, interdisciplinary system and the connection between the different disciplines should be built upon and strengthened to optimise the use of these products.

Although forecasters agreed that the 1997/98 El Niño was the strongest on record, they also ensured the end-users in South Africa that the impact will be less than in the 1982/83 season due to full dams and high soil moisture that were carried over from the previous good rainfall season. But nearly all media reports mentioned El Niño and drought together as if they go hand-in-hand. And this is what the public heard. The media has a critical role to play in the interaction between users and producers of seasonal forecasts since education and communication are essential to improve public awareness and understanding regarding risk reduction. Therefore, the media comprises an important and powerful instrument that can be used for changing perceptions and creating public awareness. Forecasters are in desperate need of guidelines on how to feed the media information in such a way that it reaches the end-user in a non-fictional, fact-wise manner.

There is a need to reach all levels of society, and in particular the small-scale farmers. Feedback from these farmers will further improve the service rendered by the SAWB and will ensure that the entire South African society is reached. Kininmonth (1994) stated that economic benefits from seasonal forecasting are being maximised through understanding, monitoring and predicting the global climate system by way of research into regional climate impacts, international co-operation, and the development of industry sector applications and services. The promotion of the service so that decision-makers will confidently apply climate information to improve sustainability and optimise productivity of rural resources will also enhance economic benefits. Research is a key support mechanism for any activity and even more so if the vulnerability of the population to natural disasters (floods, droughts, etc.) are great. Research should thus continue in order to better understand and predict the climate of South Africa, so that seasonal climate forecasts and services can improve continuously.

References

CHAGNON SA (1992) Contents of climate predictions desired by agricultural decision makers. *J. Appl. Meteorol.* **31** 1488-1491.

EHRENDORFER M and MURPHY AH (1992) On the relationship between the quality and value of weather and climate forecasting systems. *Idojaras* **96** 187-206.

GLANTZ MH (1977) The value of long-range weather forecast for the West African Sahel. *Bull. of the Am. Meteorol. Soc.* **58** 150-158.

KININMONTH WR (1994) Economic benefits of long-range weather forecasting. *WMO/TD **630*** 226-229.

KLOPPER E, LANDMAN WA and VAN HEERDEN J (1998) The predictability of seasonal maximum temperature in South Africa. *Int. J. Climatol.* **18** 741-758.

LANDBOUWEEKBLAD (1998a) Peet se weerdagboek. 30 January. **1030** 65.

LANDBOUWEEKBLAD (1998b) Nog minder mielies nou verwag. 4 September. **1061** 77.

LANDMAN WA and MASON SJ (1999) Operational long-lead prediction of South African rainfall using canonical correlation analysis. *Int. J. Climatol.* (in press).

LYAKHOV AA (1994) Analysis of economic benefits of short term, medium term and long term forecasts. *WMO/TD - No 630 Geneva* 278-280.

MASON BJ (1996) The role of meteorology in the national economy. *Weather* (November) 382-393.

MASON SJ, JOUBERT AM, COSIJIN C and CRIMP SJ (1996) Review of seasonal forecasting techniques and their applicability to Southern Africa. *Water SA* **22** 203-209.

MJELDE JW, SONKA ST, DIXON BL and LAMB PJ (1988) Valuing forecast characteristics in a dynamic agricultural production system. *Am. J. Agric. Econ.* **70** 674-684.

MJELDE JW, THOMPSON TN and NIXON CJ (1996) Government institutional effects on the value of seasonal climate forecasts. *Am. J. Agric. Econ.* **78** 175-188.

MJELDE JW, THOMPSON TN, NIXON CJ and LAMB PJ (1997) Utilising a farm-level decision model to help prioritise future climate prediction research needs. *Meteorol. Appl.* **4** 161-170.

MOSLEY MP (1994) Economic and social benefits of meteorological and hydrological services to the water sector. *WMO/TD - No 630 Geneva* 78-82.

MURPHY AH (1994) Assessing the economic value of weather forecasts: An overview of methods, results and issues. *Meteorol. Appl.* **1** 69-73.

NICHOLLS JM (1996) Economic and social benefits of climatological information and services: A review of existing assessments. *WCASP-38, WMO/TD* **78**. 37 pp.

SONKA ST, CHAGNON SA and HOFING S (1988) Assessing climate information use in agribusiness. Part II: Decision experiments to estimate economic value. *J. of Climate* **1** 766-774.

TENNANT WJ (1999) Numerical forecasting of monthly climate in Southern Africa. *Int. J. Climatol.* (in press).

Appendix A

Questionnaire: 1997/98 Season

With the following questionnaire we aim to determine if long-term forecasting products reaches the end user effectively and how his decisions are influenced by this information. Ultimately the producers of these forecast products will be able to deliver a better service to the end user. We would be grateful if you could fill out this questionnaire and send it back to us at your earliest convenience. More that one answer to a certain question may be applicable to you.

1) In which field do you specialise?
Agriculture / Commercial Farming / Small Farmer / Water Management / Health / Disaster Management / Strategic Planning / Food Security /
Other: specify:_____

2) In case of farming, specify your main activity (e.g. life stock, maize, wild life, vegetables, etc.)
_____

3) Did you receive seasonal outlooks during the 1997/98 rainfall season?
Yes / No

4) How often did you receive the outlooks? *Once / More than once / Monthly*

5) When did you receive these outlooks?
Before the start of the season / *During the season (October tot March)* / *Upon your request*

6) What was the source of your information?
Weather Bureau / Radio / TV / Newspapers / Other media / Universities /
Other: Specify _____

7) Through what means did you receive the outlook information?
Fax / Mail / Internet / E-mail / Media

8) Did you ever receive contradicting forecasts? *Yes / No*
Explain please: _____

9) Did you ever receive outlooks on a regular basis before the 1997/98 rainfall season? *Yes / No*

10) Was the weather in you area normal during the 1997/98 season? *Yes / No*
Explain: _____

11) Did you expect the season would have a *positive* or *negative* impact on your activity?

12) Have you changed any of your decisions or strategies as a result of the information you received through the **media**? *Yes / No*
Explain_____

13) Would you have been better off not using the information given on rainfall and temperature? *Yes / No*

If you receive outlooks from the Weather Bureau, please answer the following:

14) Are the outlooks understandable? *Yes / No*

15) Were you able to interpret the information? *Yes / No*

16) The Weather Bureau uses probabilistic forecasts - in other words a probability (or percentage) is coupled to the chance of above-normal, near-normal or below-normal rainfall or temperature occurring. Do you understand the concept of probability forecasts and how to apply it? *Yes / No*

17) Have you changed any decisions during the season on grounds of the information provided by the **Weather Bureau**? *Yes / No*
Explain:_____

18) Do you have any suggestions on how the format of the outlooks issued by the Weather Bureau can improve?
_____
_____

19) Is there any additional information that you would like to receive on a regular basis?
_____
_____

20) The Weather Bureau operates an operational long-term forecasting office (the LOGIC). Have you ever contacted or visited the LOGIC? *Yes / No*

In case you have contacted the LOGIC, please answer the following:

21) Did you *phone / send a fax / send e-mail / visited* the LOGIC?

22) Was the service provided efficient? *Yes / No*

23) Do you have any suggestions on how the service could be improved?

_____
_____
_____