AGRICULTURAL RESEARCH COUNCIL

RESEARCH AND RESPONSE TO CLIMATE CHANGE ON AGRICULTURE

PORTFOLIO COMMITTEE ON AGRICULTURE, FORESTRY & FISHERIES

8 MARCH 2016

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ARC DELEGATION

- Dr. Shadrack R. Moephuli – CEO
- Dr. Nthabiseng Motete – Group Executive: Crop Sciences
- Dr. Johan Malherbe – Senior Researcher: Agro – Climatology
- Dr. Kingston Mashingaidze – Research Team Manager: Field Crops
- Mr. Abel Masekoameng – Jermat Seeds
- Mr. Andrew Taylor – Capstone Seeds

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ARC Mandate

In accordance with the Agricultural Research Act, 1990 (Act no. 86 of 1990, as amended by Act 27 of 2001) the objects are to conduct research, drive research and development, drive technology development and transfer (dissemination) of information in order to:

a) Promote agriculture and industry;

b) Contribute to a better quality of life; and,

c) Facilitate or ensure natural resource conservation.

To achieve its objects, the ARC may undertake and promote research, development and technology transfer in connection with:

- the optimal utilization of the agricultural resources and the improvement of the production capacity of such resources

Accordingly, the ARC captures, processes and archives climate data to be used for:

- Agricultural research including the development of decision support systems, crop modelling, and provision of advisories like irrigation scheduling, crop disease warning and drought early warning

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The 2015/16 El Niño and impacts in SA

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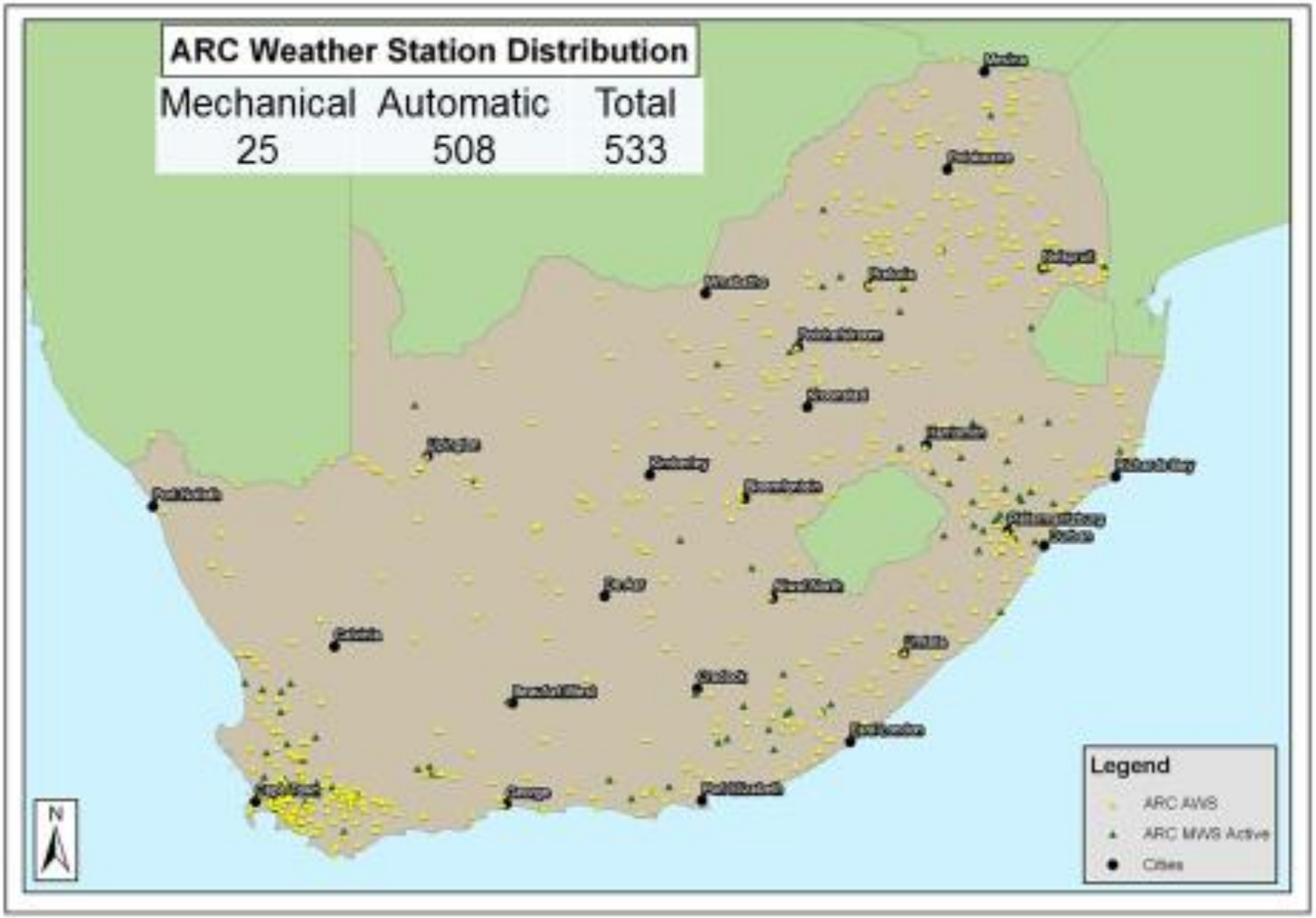
Dust storm in the farming area of Welkom (Photo: Christa Lombard (ARC)


ARC Weather Station Distribution
Mechanical Automatic Total
25 508 533
Legend
ARC AWS
ARC MWS Active
Cities
N

UMLINDI ("the watchman" in Zulu)

Monthly climate and vegetation monitoring newsletter

Purpose

To provide simplified information about climate and vegetation conditions to

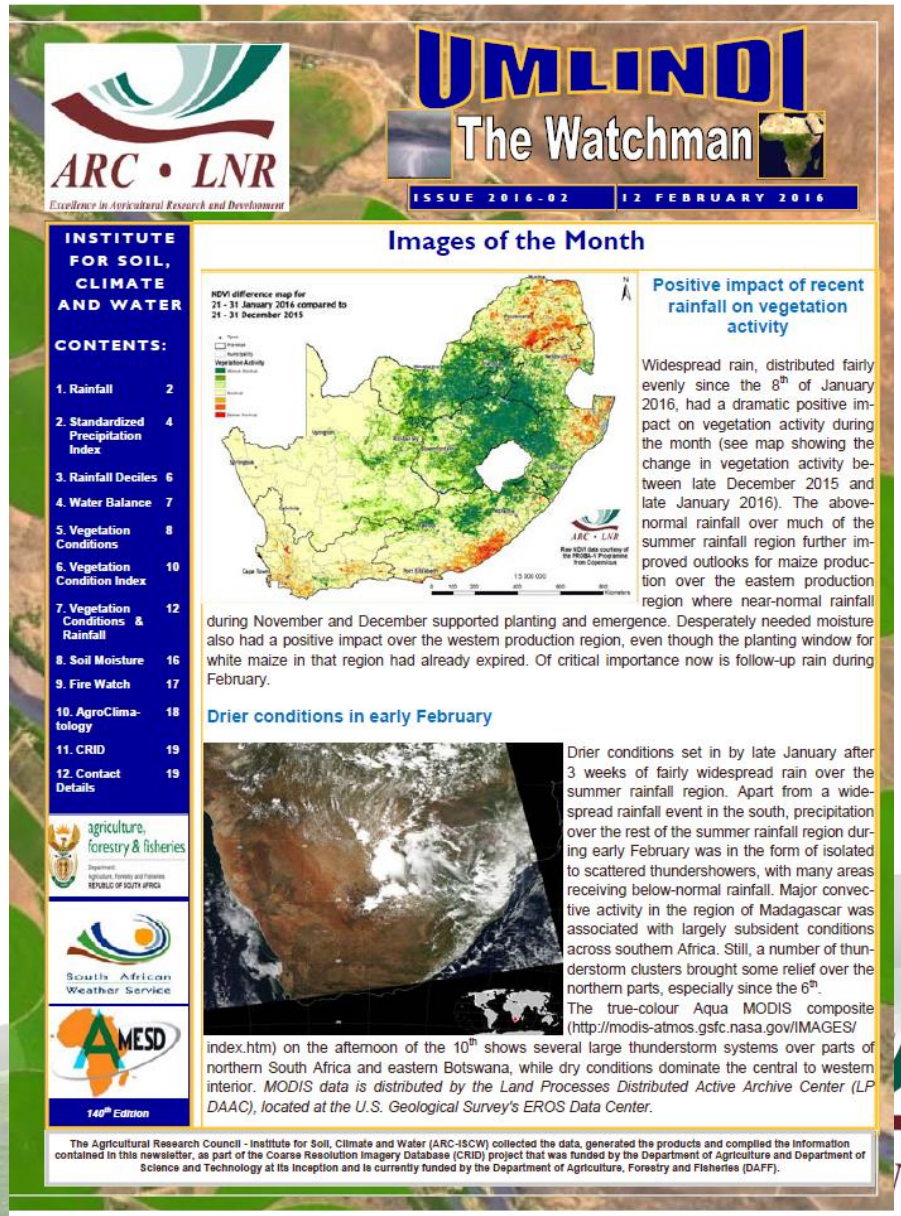
- Policy and decision makers
- Organizations
- Farmers
- Banks
- The public

Users

Over 300 direct subscribed users

Available on the ARC website

http://www.arc.agric.za/Pages/Newsletters.aspx



Information dissemination

National Agrometeorological Committee

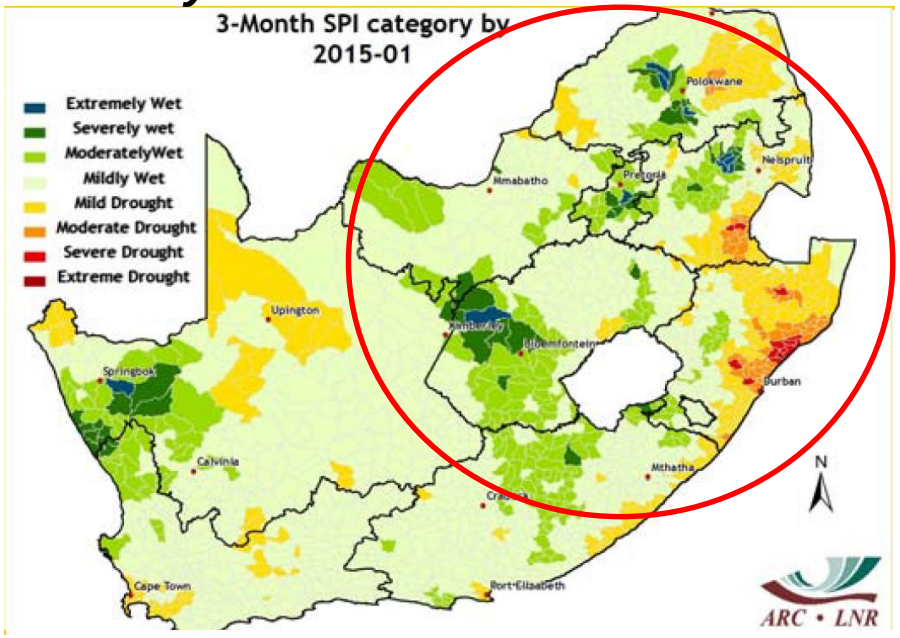
- 3-Monthly dissemination (committee meets once every 3 months)
- Information relevant to all types of farming, mainly focusing on drought occurrence
- Vegetation, rainfall monitoring throughout the season
- Identification of potential drought stricken areas
- Advisory based on potential risks of climate to agriculture

Crop Estimate Committee

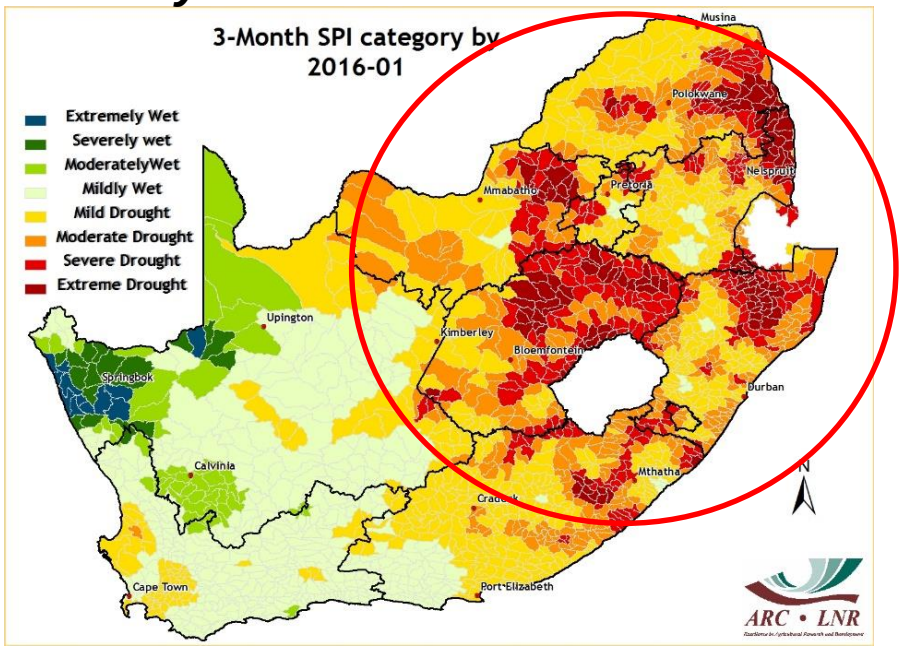
- Monthly dissemination (committee meets every month)
- Information relevant to crops (summer maize and winter wheat)
- Vegetation, temperature and rainfall monitoring throughout the season
- Output of crop growth models
- Output of NDVI/Yield statistical forecasts

UMLINDI newsletters

January 2015



January 2016



The above figures show that the current season (January 2016) is drier than the previous season (January 2015). The current situation is a result of El Nino, which restricted rainfall in most parts of the country last year. The figure of January 2016 indicates the degree of soil moisture deficit, which made planting impossible during the planting season.

Information about drought conditions has been communicated by the ARC to stakeholders including farmers.

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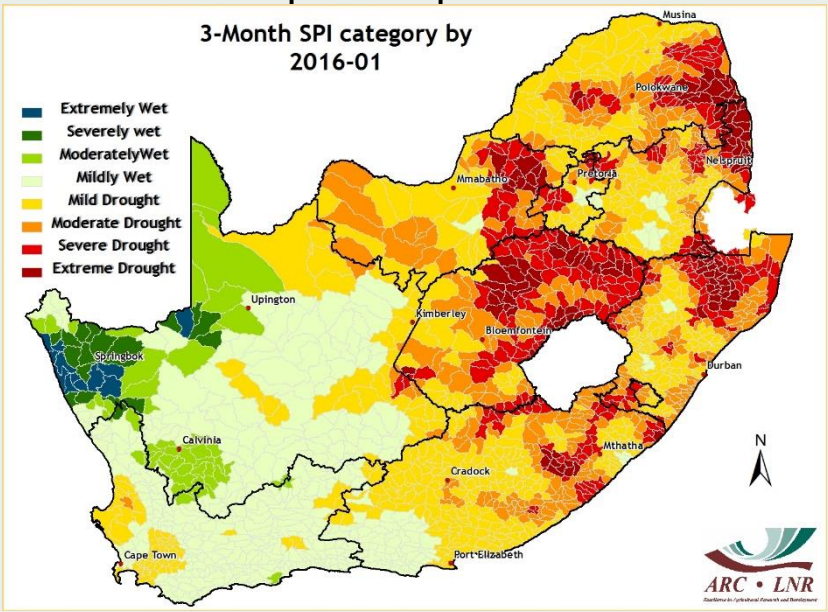
Current climate and vegetation conditions

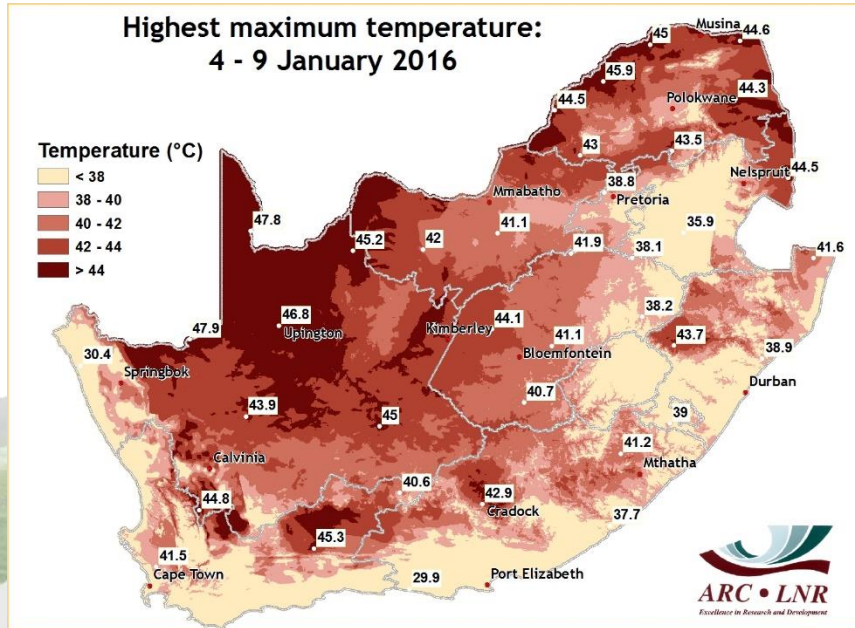
- **Standardized Precipitation map for October - December**



Much of the central parts of the country, including the western maize production regions, experienced extreme drought conditions during November to January, while the eastern maize production region in Mpumalanga was less negatively affected.

Observations

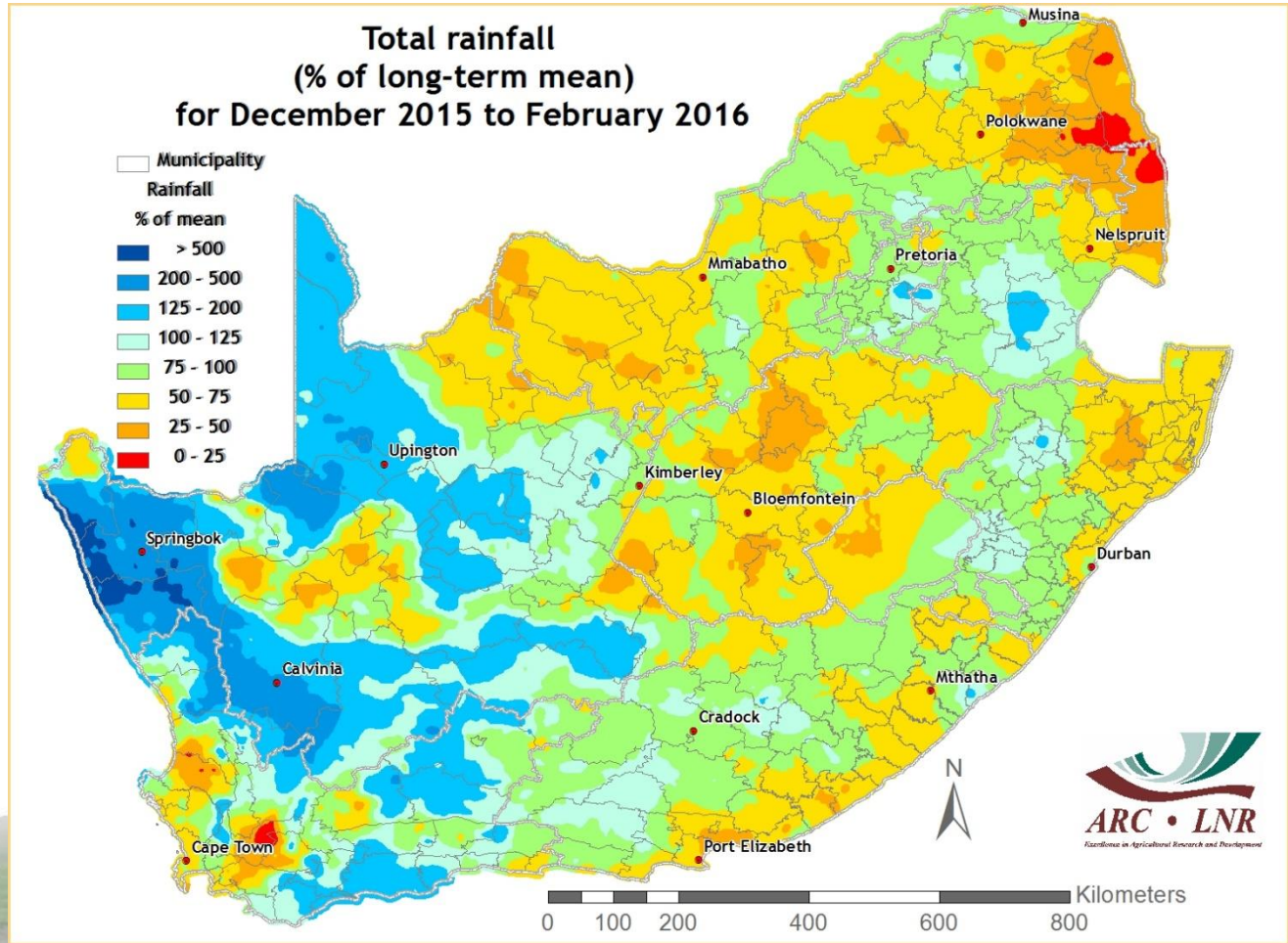
Hot and dry conditions prevailed during October to December 2015. Several heat waves occurred. Especially the white maize areas (North West and Free State) were badly affected – and farmers could not plant maize within the planting window. The eastern maize production region (for yellow maize – Mpumalanga) received normal rainfall during November to January, with planting and successful emergence.



Dry conditions were associated also with several heat waves, having further negative effects on planted crops/intentions to plant.

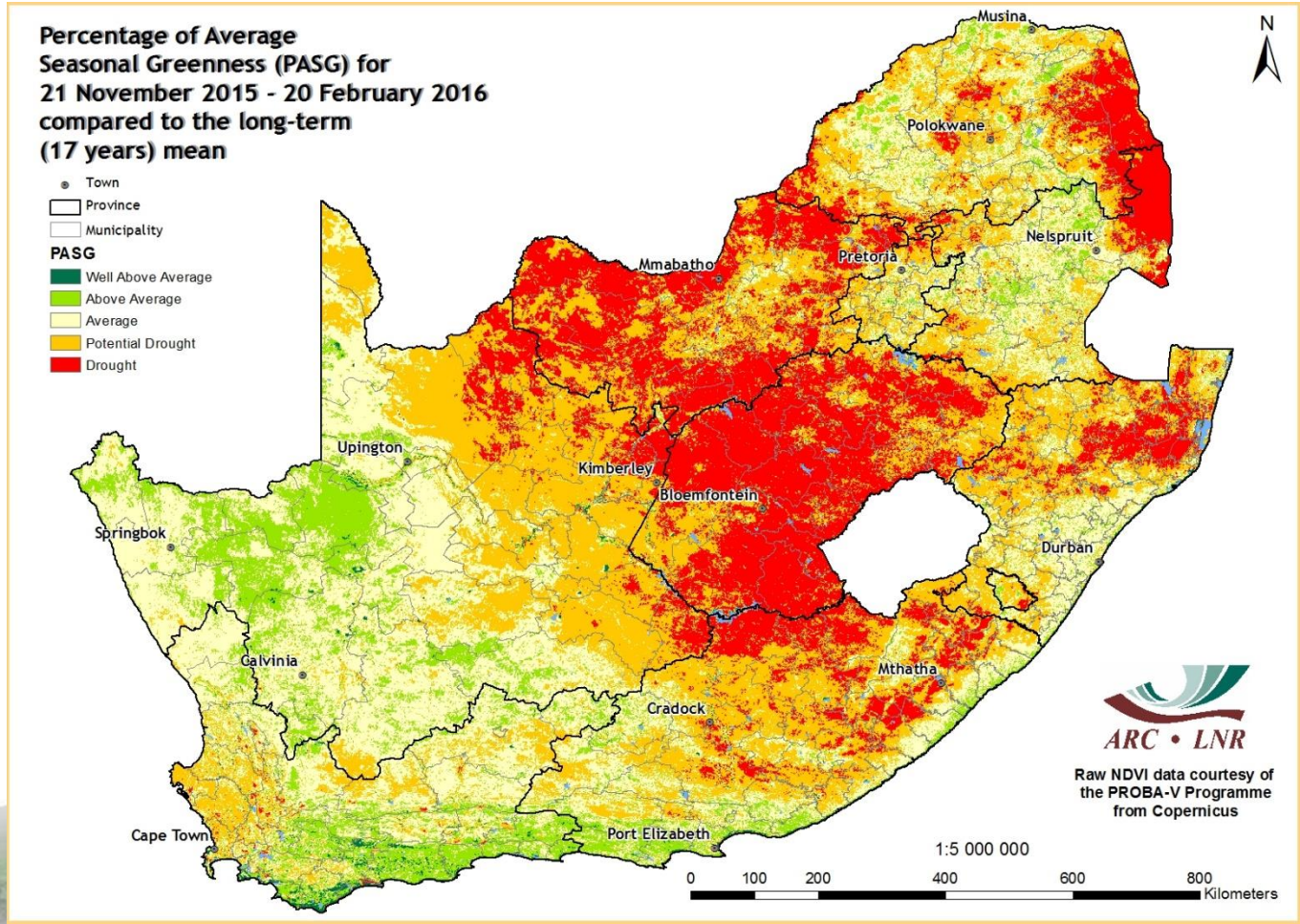
Observations

Cooler conditions with widespread rain over the interior resulted in several station recording above-normal rainfall during 1 – 21 January. The rain was too late over the white maize areas (North West and Free State) and planting was negatively affected. Normal rainfall continued over much of the eastern maize production region during February, but the western maize production region, much of the central parts of the country and the Lowveld, received below-normal rainfall. Above-normal temperatures, resulted in a continuation of drought over those regions.



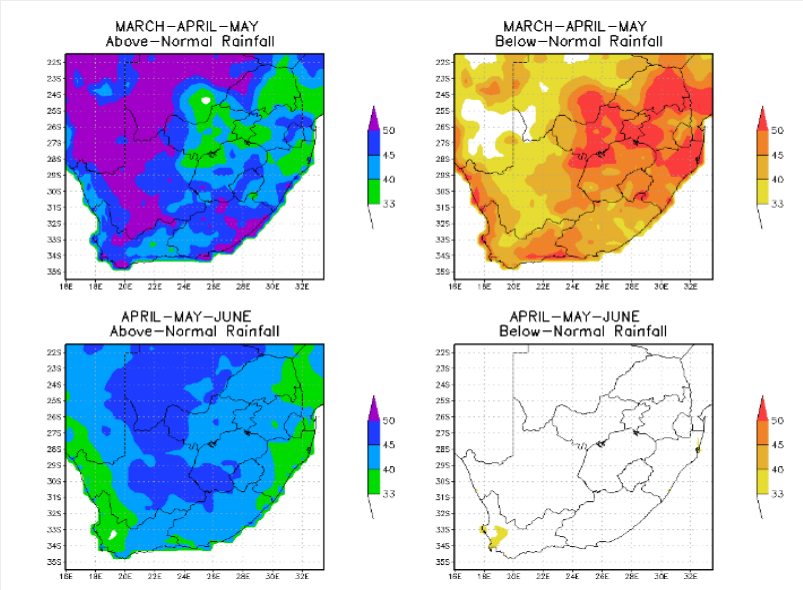
Observations

The Percentage of Average Seasonal Greenness map, based on the vegetation activity and related effect on the Normalized Difference Vegetation Index, shows (in red) the areas most severely affected by the drought conditions. These are especially large parts of the Free State and North West, northeastern parts of the Eastern Cape, as well as the Lowveld of Limpopo and Mpumalanga together with northeastern KwaZulu-Natal



Seasonal Forecasts

- **Rainfall forecast for March - May and April-June by SAWS**

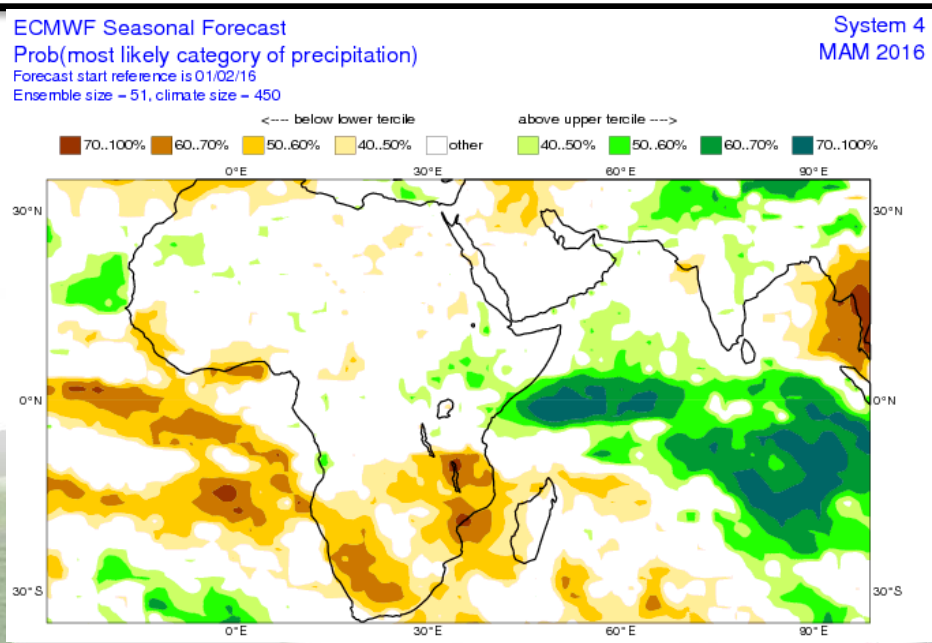


According to the SAWS forecast (Issued in February 2016), large parts of the country have a >40% chance for below-normal rainfall in March - May. The outlook for April – June is more favorable for rain, but rainfall that late in the season will not have a large positive impact for current year vegetation.

Due to the strong El Niño, most seasonal forecasting models predict dry and hot conditions continuing over the summer rainfall region during late summer 2015/16. Example of this tendency is the forecast by European Center for Medium Range Weather Forecasting (ECMWF - below) and the SAWS (left).

Forecast for March - May

According to the ECMWF forecast (Issued in February 2016), for example, there is a 50 – 100% chance for below-normal rainfall over central to western Areas in March to May.



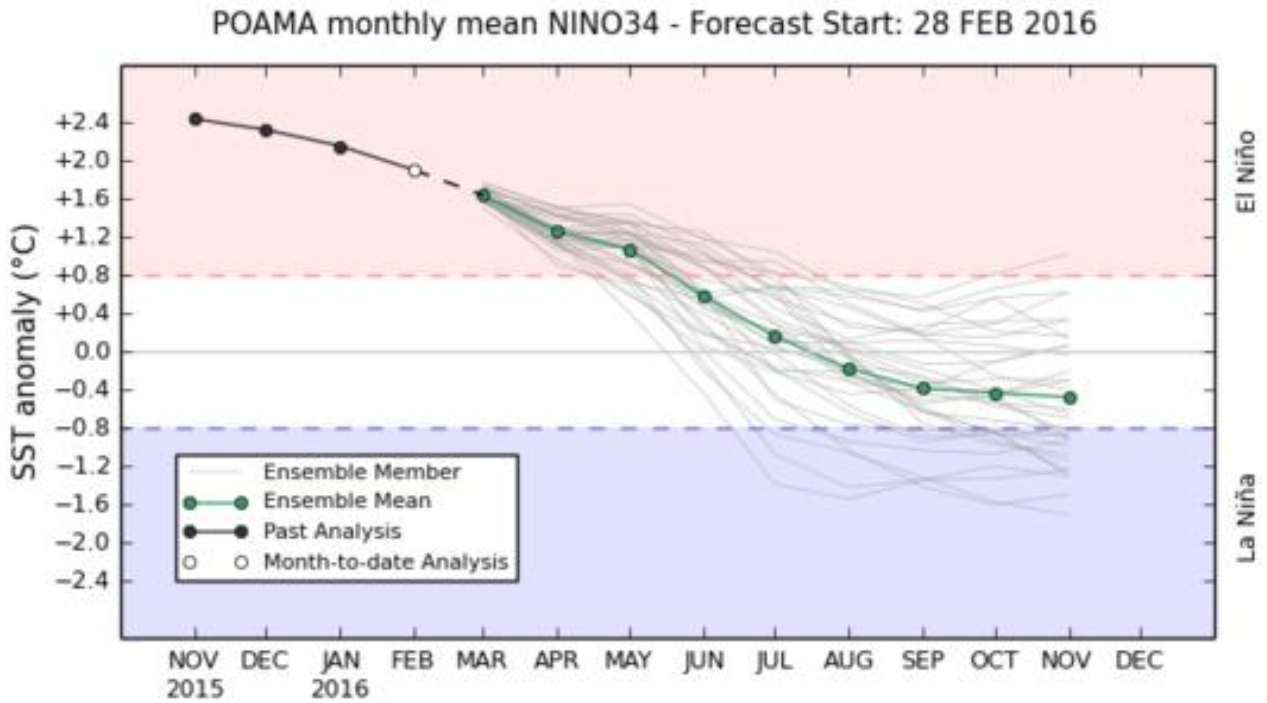
Seasonal Forecasts

Going forward, Coupled Global Forecast Models predict the current event to weaken, with neutral conditions expected by winter.

e.g.: From the Australian Bureau of Meteorology (issued 28 February):

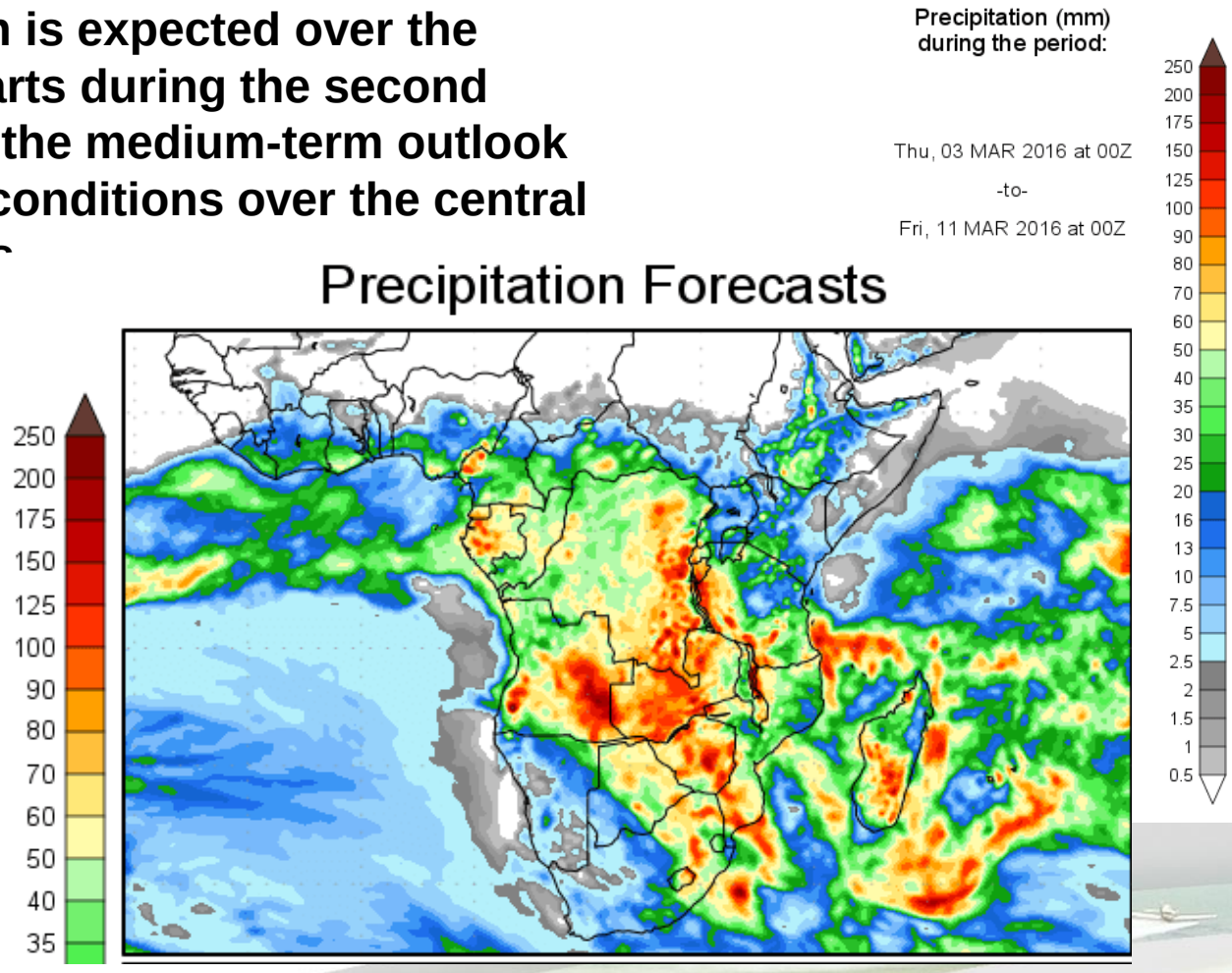
"The 2015–16 El Niño is now at moderate levels, and is likely to end in the second quarter of 2016. History and model outlooks indicate that neutral conditions are slightly favored ahead of La Niña for the second half of 2016."

A forecast for Equatorial Pacific Seas Surface Temperature (SST) anomalies, showing cooling towards neutral conditions, from the Australian Bureau of Meteorology.



Scattered thundershowers during the next few days

While some rain is expected over the northeastern parts during the second week of March, the medium-term outlook still favors dry conditions over the central to western part



Precipitation forecasts from the National Centers for Environmental Prediction.
Normal rainfall derived from Xie-Arkin (CMAP) Monthly Climatology for 1979-2003.
Forecast Initialization Time: 00Z16FEB2016

GrADS: IGES/COLA

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Potential impacts of projected climate change on occurrence of droughts and production potential

Recently the ARC prepared a scientific report for DAFF on "The sensitivity of crop suitability to climate change in South Africa"

Based on the projections the following main points surfaced:

- **The most striking projected change in climate zones over South Africa is the expansion of the hot desert zone**
  - **The expansion of this zone to the east over the central interior of the country is at the expense of western extremities of agricultural land characterized by marginal to sub-optimal suitability for production of maize, soybean, sorghum and sunflower**
- **The researchers succeeded in providing evidence that rising levels of CO2 will impact increasingly on vegetation change over the coming decades and that different crops are not affected to the same degree by climate change**
- **Rising temperature is the main cause of shifts in production areas**
- **These production areas could decrease for most crops (examples include maize, soybean, sorghum, sunflower, potato and Smuts finger grass), increase for other crops (sugarcane, groundnut and cotton) or remain largely unchanged (wheat)**

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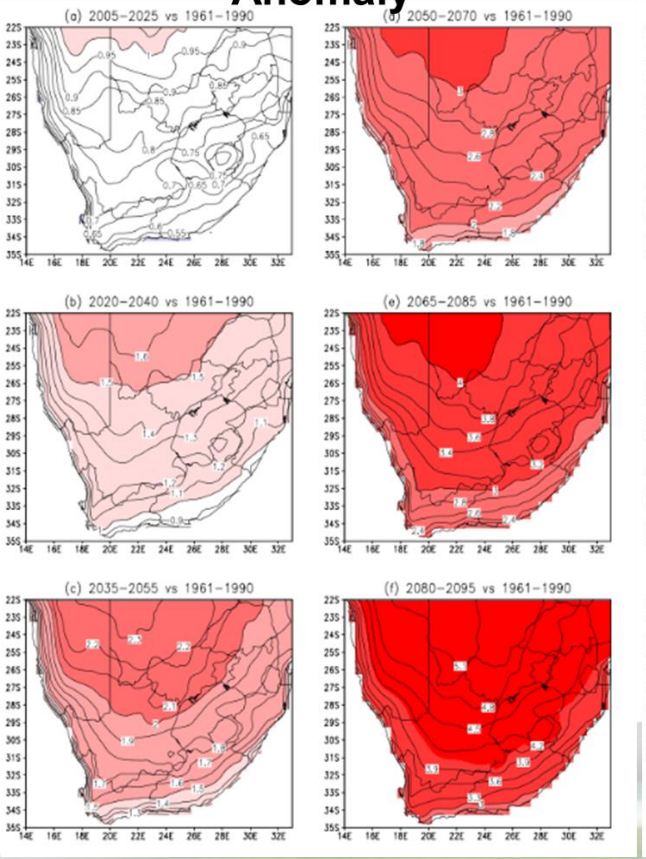
Projected increase in average temperatures is the main driver of a potentially more arid environment in future

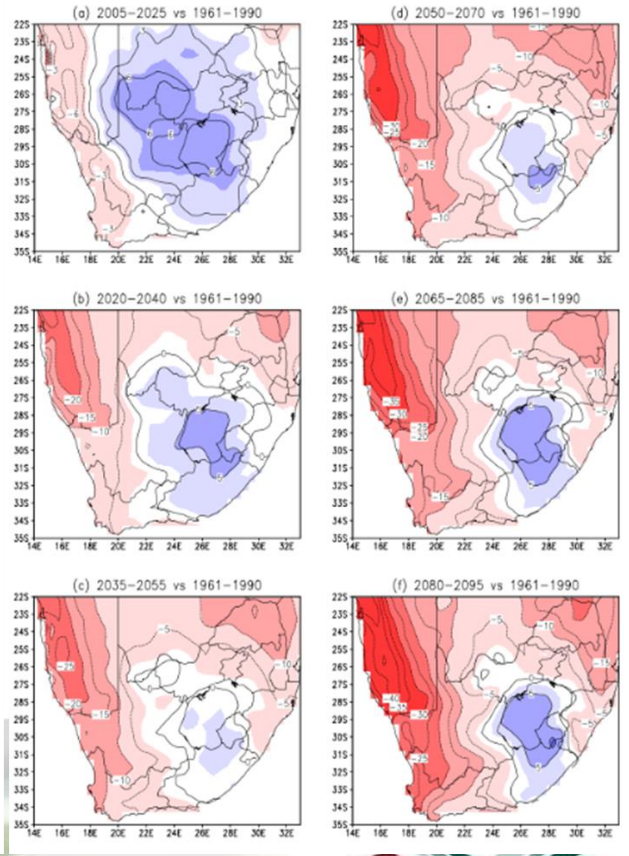
- **Projections based on Climate simulations of the Conformal Cubic Atmospheric Model based on Sea Surface Temperatures and Sea Ice data as simulated by 6 coupled Global Climate Models, A2 ("business as usual" scenario)**

The increase in **red** colour indicates the rise in average temperatures during the specific period. For rainfall maps, **red** color denotes reduced rainfall, while **blue** colour denotes normal to above-normal rainfall

Average Temperature Anomaly



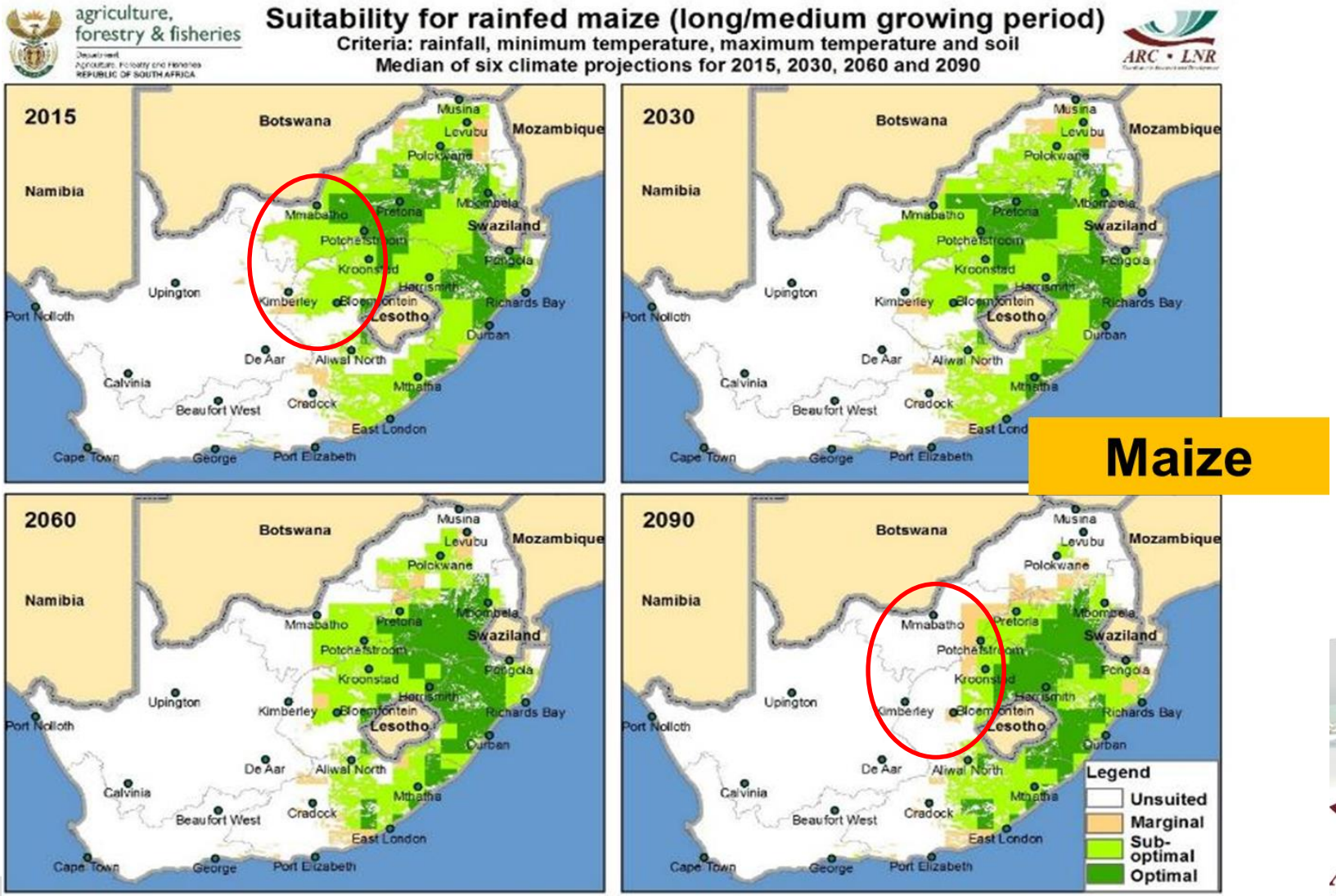
Rainfall Anomaly



GFDL-CM2.0 [The version 2.0 CGCM of the Geophysical Fluid Dynamics Laboratory (GFDL) of the National Oceanic and Atmospheric Administration (NOAA) in the United States]
GFDL- CM2.1 [The version 2.1 CGCM of the Geophysical Fluid Dynamics Laboratory (GFDL) of the National Oceanic and Atmospheric Administration (NOAA) in the United States]
ECHAM5/MPI-Ocean Model [The CGCM from MPI in Germany]
UKMO-HadCM3 (The Met Office Third Hadley Centre Coupled Ocean-Atmosphere GCM - United Kingdom)
MIROC3.2-medres (Model for Interdisciplinary Research on Climate 3.2, medium resolution version, of the Japanese Agency for Marine-Earth Science and Technology)
CSIRO Mark3.0 (The version 3.0 CGCM of the Commonwealth Scientific and Industrial Research Organisation in Australia)

Potential impacts of projected climate change on occurrence of droughts and production potential

- **This is an example of one of the outcomes of the project, where the suitability of climate for maize was considered. The figures below indicate a decrease in the maize production areas**



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Summary

- Impacts from El Niño vary from event to event
- 1998 event was very strong – but had no strong influence on SA weather and crop yields
- This is because El Niño is only one of several influences on our climate. Other influences include Decadal Variability related to various external influences, the Subtropical Indian Ocean Dipole etc...
- Because of normal to below normal rainfall during 2014/15, there are some cumulative deficiencies in water resources
- Very high temperatures put further strain on vegetation, even where rainfall was near normal
- Heat-wave conditions and lack of rainfall resulted in drought conditions during the current summer over the central parts of the country, including the western maize production region (NB for white maize)
- While the eastern maize production areas received sufficient rain during November-December for planting, rain over the western parts since January was too late for maize cultivation in most places
- The current El Niño event is expected to weaken during the next few months, to neutral conditions, with little effect on SA's weather from winter onwards
- While much of the negative impacts during the current El Niño were directly related to high temperatures, projections of future climate conditions indicate an increase in the occurrence of such hot conditions, with a concomitant contraction of the suitable area for maize production over the central summer rainfall region

Mitigating effects of El Nino as the drought worsens

The ARC continues to develop and transfer appropriate technologies to mitigate impacts of drought on agriculture, especially the small holder farmers.

SUNDAY TIMES BUSINESS BY ED STODDARD, 2015-12-23

Southern Africa faces food shortages as El Nino drought worsens

Dry crops.
Image: Getty Images

Southern Africa faces food shortages as drought, exacerbated by the El Nino weather pattern, delays planting and stunts crops across the region, the U.N.'s Food and Agriculture Organization (FAO) has said in an alert.

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ARC RESEARCH RESULTS IN TECHNOLOGIES FOR DROUGHT MITIGATION

- Promotion and deployment of Drought TEGOTM Hybrids.

- Hybrid release and registrations (2014: WE3127 & WE3128 registered; and 8 more hybrids registered in 2015).

South Africa: Grain SA lowers 2016 import estimates from 5 to 3.8 million tonnes of maize: 3 Feb'16

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Mokopane 2006 – On-farm trials (Before WEMA)

Mokopane 2015 - WE3127 (With WEMA)

ARC DELIVERS DROUGHT TOLERANT MAIZE CULTIVARS TO FARMERS

- WE3127 and WE3128 launch by DAFF Deputy Minister & ARC's CEO on 1 Dec'14

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ARC DROUGHT TOLERANT MAIZE SEED PLANTING

- Variety Promotion in 2014/15:- 10 000 x 500g seed packs distributed to smallholder farmers in Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga and North West through the local extension services; to create awareness and product demand.

- DAFF Deputy Minister planting WE3127 with a Jab planter (promoting no till planting).

FARMER'S DAYS HELD IN 2015

- **The drought tolerant hybrids were well received by farmers and they requested seed → very high demand**

Site	Number of Female participants	Number of Male participants	TOTAL
Madikwe (NW) – 19 March	55	27	82
Mooifontein (NW) – 19 May	23	55	78
Polokwane (L) – 27 May	150	150	300
Hamakuya (L) – 29 May	57	40	97
Mooifontein (NW) – 26 June	23	12	35
Mokopane (L) – 22 July	35	30	65
QwaQwa (FS) – 24 July	90	58	148
TOTALS	**433**	**372**	**805**

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FEEDBACK FROM FARMERS WHO GREW WE3127 in 2014/15

a) Smallholder farmers who planted the first WEMA conventional drought tolerant maize hybrids in South Africa the past 2014/15 season, plagued by one of the worst droughts in many years, doubled their yields. The variety, DROUGHTTEGOTM WE3127, is a white hybrid. ARC (Agricultural Research Council) distributed 10 000 seed packs, 500 grams each, free to smallholders in Limpopo, Mpumalanga, North West, Free State and KwaZulu-Natal for them to try out the variety.

b) According to Isaiah Setseta, chairman of the Mokaba Farmers' Association, their yield was 1.14t/ha compared to 0.6t/ha the previous season, with good rains – 100% increase in a season that has been termed the worst in two decades. They only had rain immediately after planting and again during flowering.

c) At Mooifontein, near Lichtenburg, North West, according to Prince Molema, one of four smallholders who planted the drought tolerant maize, their average yield was 2t/ha compared to 1.5t/ha for other commercial hybrids. Average rainfall during the season was 250 mm compared to an average 500 mm in a normal year.

FEEDBACK FROM FARMERS WHO GREW WE3127 in 2014/15

Mokopane (Limpopo): 9 Small Holder Farmers
1.14 t/ha from 0.6 t/ha

Mooifontein (NW):

- **250 mm rainfall**
- **2 t/ha vs 1.5 t/ha**

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Seed company engagement

(i) **Quality Seeds** and **Advance Seeds**: visited WEMA hybrids demo at ARC-GCI, Potchefstroom (May 2015)

- (ii) Meeting with **Jermart Seeds** to discuss seed road maps for WE3127 and WE3128 (28 April 2015)

- **(iii) President & CEOs of ARC** and Senior Management met with CEOs of **Jermart and Capstone** seed companies in Pretoria to discuss **lack of WEMA seed availability for 2015/16** summer season and best way forward.

✓ **Capstone** committed to produce **50 t** of Certified seed

✓ **Jermart** committed to produce **80 t** of Certified seed

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Seed Company Licensing and Product Allocation

- Jermart seeds, Capstone Seeds and Seed Co - signed licenses to market WE3127 and WE3128 hybrids in RSA
- Foundation seed distributed to licensed seed companies:

Genotype	Jermart Seeds	Capstone Seeds	Seed Co
#**CML312/CML442**	455	85	CIMMYT
CKDH0467	200	75	25
CKDHL0378	50	25	0
CML442	50	25	CIMMYT
CML312	10	10	CIMMYT

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Activities

- Since the beginning of the drought the ARC-Animal Sciences has participated in 16 radio and television interviews to advise farmers on how to cope with the drought.
- The advice given to farmers during the radio and television programmes were focussed on the animal health risks associated with the drought and how famers can cope in the short, medium and long term.
- Two popular articles were published
  - Dairy cattle breeding in the era of climate change. 2015. ARC Annual Milk Cattle Bulletin, Vol 19, 24.
  - The adverse effects of the 2015 drought on beef production. 2016. Nufarmer Africa, January/February 2016, 8.
- The animal sciences programme also developed a brochure with information tips for farmers to cope with the drought.

ARC DISSEMINATION OF INFORMATION AND ADVICE TO FARMERS

- 8 farmers days were held to train farmers on fodder flow planning and veld condition assessment in order to match feed supply with animal numbers

Date	Province	Location	Number of farmers
28 Oct 2015	Gauteng	Roodeplaat- ARC campus	30
29 Oct 2015	Gauteng	Irene- ARC Campus	30
11 Nov 2015	North West	Driehoek- Vryburg	160
17 Feb 2016	Mpumalanga	Rietfontein	108
18 Feb 2016	Kwa-Zulu Natal	ST Paul-Umzimkhulu	126
23 Feb 2016	Mpumalanga	Mmametlhake	125
24 Feb 2016	Kwa-Zulu Natal	Gluckstadt - Vryheid	307
25 Feb 2016	Kwa-Zulu Natal	Coronation -Vryheid	445

Key Messages Communicated to Farmers

- Drought brings about higher disease risks as the immune systems of animals are compromised
  - Use of dips and dewormers is recommended to control external and internal parasites
  - Stick to vaccination programme recommended for your area
- High temperatures associated with the current drought affect bull fertility
  - Use of Artificial insemination could be a solution
  - Use of adapted breeds is recommended
- Poor feed availability associated with the current drought affects cow fertility
  - Expect higher incidents of abortions
  - Expect low calving percentages
  - Provide supplementary feeding in the form of hay and/or licks
- Farmers are encouraged to reduce stock numbers
  - Only keep breeding stock to meet the nutritional needs
  - Animals to be fed to maintenance requirements
- Recommended drought feeding strategies
  - Feeding of animals using low quality hay treated with ammonia is encouraged
  - Use of increasing woody plant species (foliage) as an integral part of forage for ruminants

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Managing Crop Production – Options

a) Focus on drought tolerant crops or species with relatively low water requirement per kilogram of dry matter produced and increased yield:
   - Oldman saltbush (Atriplex nummularia)
   - Spineless cactus (Opuntia spp.)
   - American aloe (Agave americana)
   - These examples are important for animal fodder

b) Accelerating the production and distribution of drought tolerant cultivars at mass scale -- That the ARC and DAFF ensure that the service providers, Jermat Seeds and Capstone produce adequate seed lots of the Drought TegoTm maize hybrids for the 2016/2017 maize season, especially for the emerging sector.

c) Use other technologies, such as Hydroponics in periods of drought to produce vegetables and fodder

d) Development of crops optimised for decreased evapotranspiration and increased carbon dioxide concentrations. Product – crops that are both heat and drought tolerant

Medium Term Interventions for Livestock Development

a) Engineering of cattle genomes to introduce stress tolerance genes into breeds that currently have heat and water stress problems
b) Increased focus on genetics and breeding for stress resistance and reduced greenhouse gas emissions
c) Breeding for increased productivity to allow reduction in animal numbers

In Addition

The ARC has interacted and provide advisory services to Provincial Departments of Agriculture on a range of appropriate interventions

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Recommendations

a) Water management, including investment into water saving technologies and infrastructure are essential;

b) Understanding and ensuring effective soil management and appropriate land use with conservation agriculture and precision agriculture – must be implemented and incentivized

c) Need to utilize climate science and integrate into planning and decision making. This will require investments for remote sensing and big data management – radar systems, remote sensing etc;

d) Need increased focus on drought and heat tolerant crops – mass production (immediate), improved yields (research)

e) Immediate effective measures for livestock management, medium term is to ensure seed stock is saved, but also invest in new scientific technologies for vaccine development and animal improvement

Thank You

Comments/Questions?

This presentation is the result of contributions from a range of ARC scientists in collaboration with partners from Universities, the SAWS and other

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