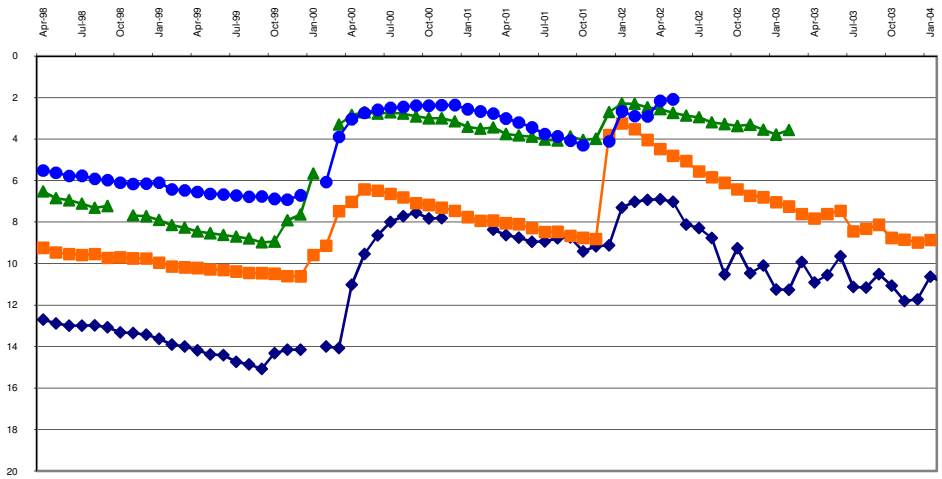
LIMPOPO REGION

DIRECTORATE
WATER REGULATION AND USE

STATUS REPORT ON
GROUNDWATER LEVELS & TRENDS
1 FEBRUARY 2011 – 1 FEBRUARY 2012



H VERSTER

MARCH 2012

Data collection and processing* assisted by:

P F TSHELANE*
K MOREKGURE*
S C MUTHEIWANA
D A TLEANE

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SUMMARY

Rainfall thus far the season varied considerably both in spatial distribution and intensity. The Eastern and South eastern part of Limpopo generally had more rain than the rest of the Province but a part of the western bushveld did receive good rains during December 2011 with some noticeable effect on the groundwater. In total the rainfall received up to now indicate a much drier season than the previous.

Groundwater levels did rise some in response to the rains in some areas but not widespread and generally limited to less than 50 cm. The regions north of the Soutpansberg and further westward still have mostly lower groundwater levels compared to last year. Long-term data available however indicate no need for concern as cycles of declining/rising trends of medium to long-term are natural phenomenon.

A general situation of healthy groundwater status does not lessen the need for sound aquifer management as local circumstances may vary dramatically over small distances due to abstraction.

1. BACKGROUND

Groundwater level behaviour compared to total rainfall recorded over two specific periods is discussed. The period "November 2011 to February 2012" represent the first half of the current wet, or recharge, season. In the second period from February 2011 to February 2012, the current situation compared to a year ago at the same time is discussed.

The distribution of Limpopo's groundwater level monitoring stations from which water level data was obtained is depicted by (FIGURE1)

The distribution of the South African Weather Services rainfall monitoring stations from which rainfall data was obtained is depicted by (FIGURE2)

GRAPH 5 is included to give some perspective on the current situation with the historical.

For reasons such as wet conditions, newly equipped and vandalism, not all stations have data for the whole period.

2. THE PERIOD NOVEMBER 2011 TO FEBRUARY 2012

164 of the 182 stations currently active have water level data available for the whole period. Of these 81 (49.4%) experienced a decline in water level with an overall average of -0.48m down.
Higher water levels were recorded at 83 stations (50.6%) with an overall average of 0.83m up
The overall situation is a slight average rise of 0.36m. This indicate that some recharge did take place early in the rainy season

2.1 HIGHER GROUNDWATER LEVELS IN RELATION TO TOTAL RAINFALL RECEIVED FOR THE PERIOD (FIGURE 3)

Rainfall data for the period 1 November 2011 to 1 February 2012 were used for FIGURE 3. Total rainfall higher than 250mm for the period is limited to three areas, one along and to the east of the escarpment joining with the Njelele drainage northward and a second smaller area around Vaalwater/Modimolle. The third is in the extreme south east corner of the Province with no groundwater monitoring stations except Mica on the northern edge of the area. The areas indicated with higher water levels do not always correspond well with the higher rainfall areas and is mostly spread out wider.

Many complex factors such as the delay in response due to either discharge or recharge in groundwater coupled to the short period of comparison, the intensity of rainfall event rather than the total received, topography, land use etc. all has an effect on recharge.

No rainfall data for the Olifants catchment outside the Limpopo was available and there is a large area with higher levels associated with this drainage from where it enters the Province all the way downstream.

The effect of the high rainfall indicated in the upper Njelele River is clearly visible all the way downstream in the catchment while that recorded southwards along the escarp did not seem to have reached the groundwater yet. It may partly be that the rain was received early in the season for the northern part and late in the season for the southern escarp. The southern and eastern part of the Province had good rains the previous year while little was recorded in the north, this may also in part be indicated in the water level response in that the northern part started with very low levels and recharge is easily noted while water levels south east started near saturation level and was not greatly affected by recent precipitation. In the area around Modimolle & Vaalwater heavy rains were recorded during December. The area also had relative low rainfall the previous season and recent rains were early in the season. The rise in water levels downstream along the Matlabas, Mokolo, Lephalale, Sterk and partly along the Mogalakwena River is clearly visible.

It should be borne in mind that the rise in water levels were mostly very small and in many instance will only present a pulse that drains away normally again if no further rain is received.

3. THE PERIOD FEBRUARY 2011 TO FEBRUARY 2012

Of 182 active monitoring stations, there are 160 with data for the whole period. Of these, 122 (76.25%) indicated lower levels than last year and 38 (23.75%) higher groundwater levels. Overall an average decline of -0.48m was recorded. The fact that 76% of stations currently have lower water levels than the corresponding time last year again highlights the longer-term declining trend in groundwater level that has been identified for a while now.

3.1. HIGHER GROUNDWATER LEVELS IN RELATION TO TOTAL RAINFALL RECEIVED FOR THE PERIOD (FIGURE 4)

The polygons representing areas with higher groundwater levels than last year is relatively small, of note is the area along the Njelele River basin that featured prominently in the previous figure is quite absent now. In is indicative of the fact that the recharge was not very significant to an aquifer that has been subject to little recharge the previous season already. Superimposed on this are the overall longer-term decline and the levels never reached the same level as last year. Opposed to this are the higher water levels along the escarp and draining east along the Olifants and Letaba Rivers. Although good precipitation, as mostly is the case, was recorded here this season, the previous year was much better and levels started of high and the pattern indicated by the grid filled polygon is mostly remnant of this with the current season's rains adding to the outflow along the two major river basins.

The higher water levels indicated more westerly is related to the good rains received this season on the Waterberg mountains to the west of Modimolle, Mookgopong and Mokopane.

4. DISCUSSION ON RAINFALL; NOVEMBER 2011 TO FEBRUARY 2012

The part of the current rainy season discussed in this report is without doubt not a very good one from a groundwater recharge perspective for most of the province. Good precipitation of high intensity has been recorded sporadically and very localised but overall the incidents were mostly of low intensity and limited to a few millimetres at a time. Compared to "normal" rainfall as determined by historical data the current season can be regarded as "below normal"

Two figures, one by the South African Weather Services for October 2011 to February 2012 and the other by the U. S Government Climate Prediction Centre for December 2011 to February 2012 can be seen in FIGURE 5. Both depict the Limpopo as receiving rather below normal rain.

Breaking this up month by month:

- NOVEMBER 2011: FIGURE 6: Above normal rainfall for a small portion in the north east.
- DECEMBER 2011: FIGURE 7: Above normal for the western part accounting for the higher water levels there by February 2012.
- JANUARY 2012: FIGURE 8: Best rainfall in the extreme south east with some above normal in the north east as well as north west.
- FEBRUARY 2012: FIGURE 9: Very dry month.

GRAPH 1 presents the total rainfall received at some stations spread over the whole Province over the past two years. The graph highlights three major aspects:

- Normal rainy season up to April with February normally the driest month in this period.
- The total rainfall recorded during the previous season up to February was much higher than this season, especially for Tzaneen area.
- Highest rainfall recorded for these stations this season were at Hoedspruit and that was mostly recorded in one incident which led to severe flooding in the area.

5. GROUNDWATER LEVELS AND RAINFALL;

EXAMPLES:

B7MICA (GRAPH 2) the response in groundwater level and rainfall is clear. For the 2009-2010 season response was quick after a high rainfall month (January 2010) and continued well after up to September before stabilising and normal discharge/draining began. By this time the next season of rain started and the response was not immediate but the level rose quickly after the high rainfall again in January. A long season was experienced with good rains for 7 consecutive months but stable level was reached by June 2011 and discharge became evident. Rain started in October 2011 but again it needed the high incident in January 2012 to start the level rising sharply.

B8TZANEEN (GRAPH3) the relationship between rainfall and groundwater level is again clear but there is marked delay of 2-3 months in response depending on the rain recorded for the previous months. The 2009-2010 season's rainfall was quite consistent (100 mm +) over four months with the groundwater level starting to rise after the 3rd month but continuing another 3 months after the rains. Despite higher initial rainfall in 2010-2011, the groundwater level only started to respond by the 3rd month. Rainfall so far this season was much less for the area and although some small response is starting to show, the final state will only be clear after some months.

A4NABOOM-VAALWATER (GRAPH 4) the correlation between rainfall and groundwater levels can be seen and the sharp rise after the high rainfall received in December 2011 is prominent.

A8TSHIPISE & A8MABVETE (GRAPH 5) this graph illustrates a situation where rainfall had no, or hardly any, effect on the groundwater levels in the area. Rainfall was mostly quite low as well.

Graphs 2&3 are representative of the areas in the Olifants and Letaba River drainages from the foot of the escarpment and to varying degree eastward thereof.

The situation as in graph 4 only represents that of a small area in the A4 drainage.

At a glance, graph 5 indicates that rainfall had no apparent effect the past 3 seasons. In Figure 2 however the A8 drainage was prominently highlighted as an area with higher water levels in February compared to that in November although in Figure 4 it was not notable any more. Careful scrutiny reveal that the rise in levels were so small that it cannot really be noted on this scale. Two thick blue lines above the each series at the end gives an indication how insignificant the initial rises were. Unfortunately these trends are representative of most of the areas west of the escarpment, as well as to the north of the Soutpansberg, where slow decline of water level is the general trend for some time now.

GRAPH 6: give a clearer indication of the current levels being lower than last year despite the initial rise this season.

6. LONG-TERM PERSPECTIVE

Above discussions on low rainfall, declining trends, poor recharge etc. may lead to wrong conclusions if drawn to quickly without careful consideration to the factors governing groundwater. The movement of groundwater opposed to free flow of surface runoff is a major consideration amongst others. The delays of sometimes months between surface incidents and groundwater response have been discussed earlier in this report and it may even be years. The factors pertaining to infiltration into the subsoil, percolation down to the aquifers and movement within aquifers is very complex and does not fall within the scope of this report. Suffice to say that natural movement of groundwater, especially in the predominant geological setting of the Limpopo, is generally slow. For this reason it is impossible to evaluate or classify natural groundwater conditions by short-term trends or limited time series data.

Despite the impression given by the report on short-term trend over the past year, long-term data suggest that the current trend is part of one of the natural cyclic trends over medium-to long-term and not a reason for concern at this stage. GRAPH 7 give an indication to the current situation compared to the historical and show the current status to be healthy.

7. IMPACT OF ABSTRACTION AND THE IMPORTANCE OF GROUNDWATER MANAGEMENT.

From the previous paragraph it can be said that the true situation cannot be assessed by the short-term trends and some of such may have no long-term effect. It is however also true that sudden and/or steep short –term fluctuations may be indicative of an impact than may have serious consequences over the longer-term although not noticeable in the short-term.

GRAPH 8 illustrates the short-term (Daily) effect of nearby pumping on the groundwater level at A7Beaule. The water level recovers daily to almost rest water level. When no pumping took place for two days in a row, the water level recovered fully. The water level in fact shows a slight rise over the period of 18 days. Only taking this data into account would suggest that there is no real impact as the levels recovers daily.

GRAPH 9 is a long-term graph of the same borehole. The steeper angle of decline since start of pumping can be clearly seen.

The above serve to emphasize the importance of aquifer management through continuous monitoring and evaluation of the aquifer responses against measured abstractions as well as natural events such as recharge. No groundwater resource can be assessed in a glance by looking over the dam wall to check the level. A single hand measurement of a water level has no value without something to compare it with. Knowledge and technology has fortunately developed to such an extent that it has become possible to manage this unseen resource successfully and sustainably. Failing to do so has no basis for excuse anymore.

8. ACKNOWLEDGEMENTS

8.1. info@weathersa.co.za http://www.weathersa.co.za/web/Content.asp?contentID=88 (Rainfall data for Limpopo Province as well as figures 5A, 6, 7, 8, & 9)

8.2 The U. S. National Climate Prediction Centre (Figure 5B)
http://www.cpc.ncep.noaa.gov/products/fews/global/CMORPH/cmorph_dly_africa_south.png

NOAA/ National Weather Service
National Centers for Environmental Prediction
Climate Prediction Center
5200 Auth Road

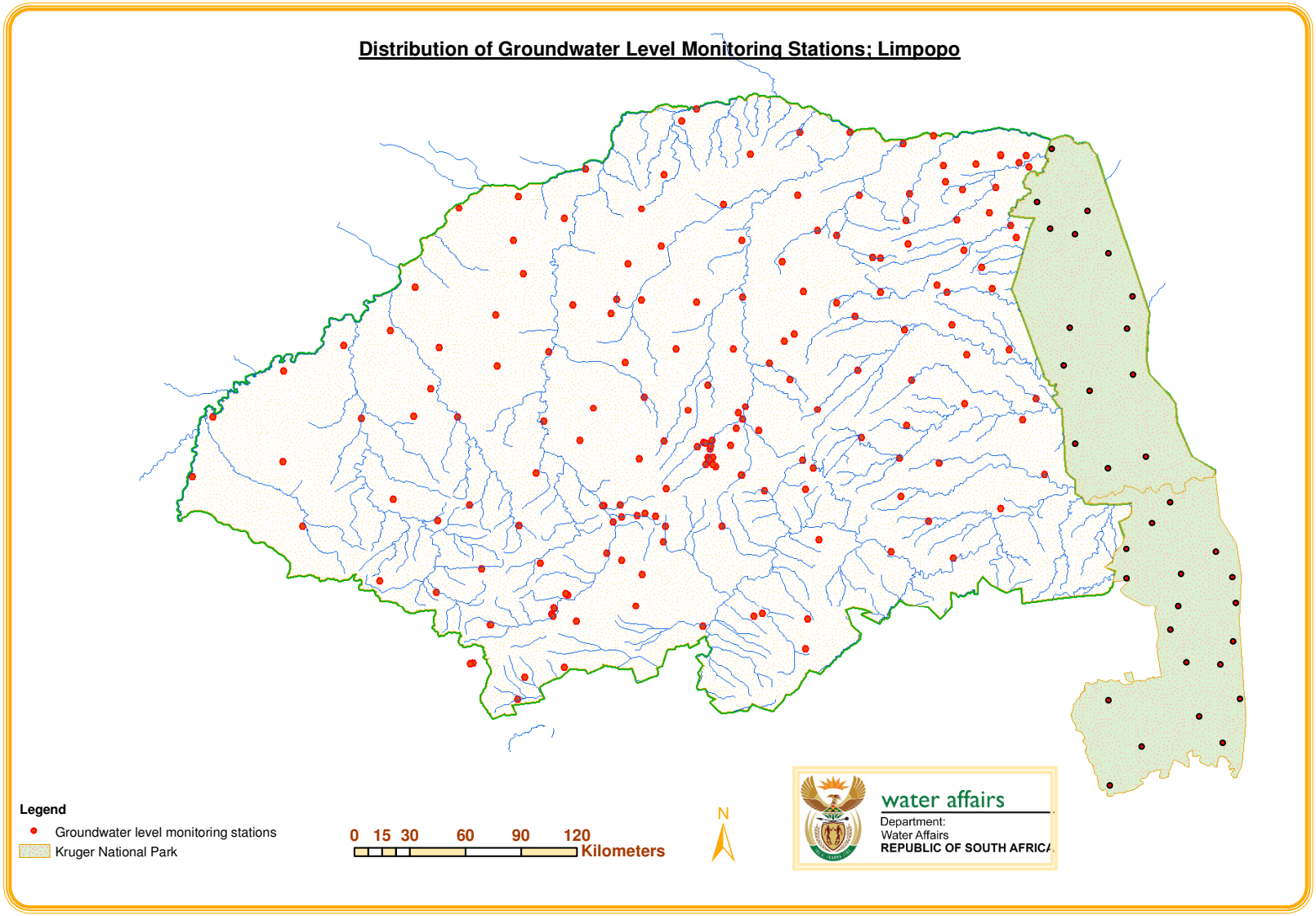

Distribution of Groundwater Level Monitoring Stations; Limpopo
Legend
Groundwater level monitoring stations
Kruger National Park
0 15 30 60 90 120
Kilometers
N
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

FIGURE 1

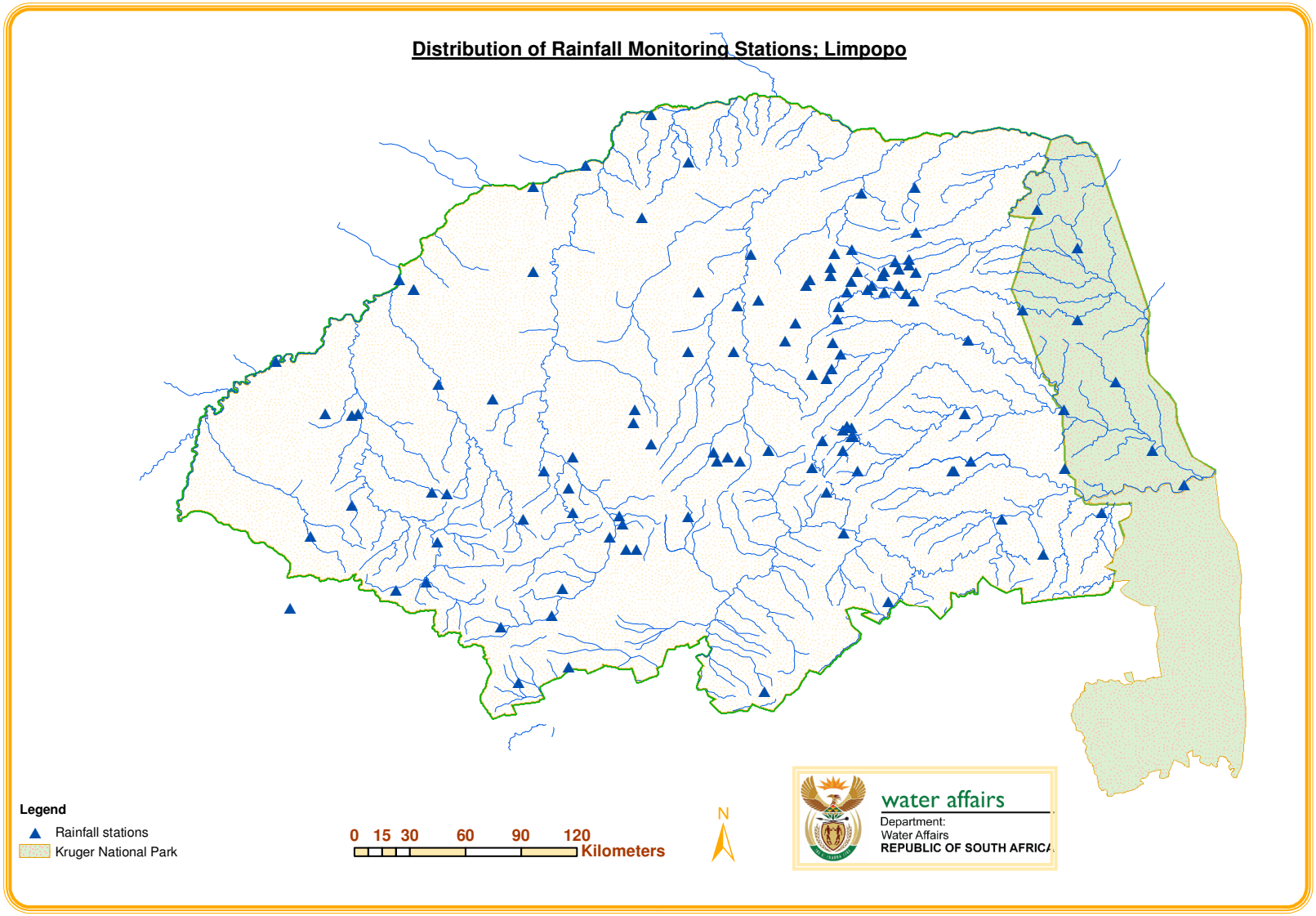

Distribution of Rainfall Monitoring Stations; Limpopo
Legend
Rainfall stations
Kruger National Park
0 15 30 60 90 120
Kilometers
N
water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

FIGURE 2

Spatial distribution of higher groundwater levels from November 2011 to February 2012 versus total rainfall received for the period

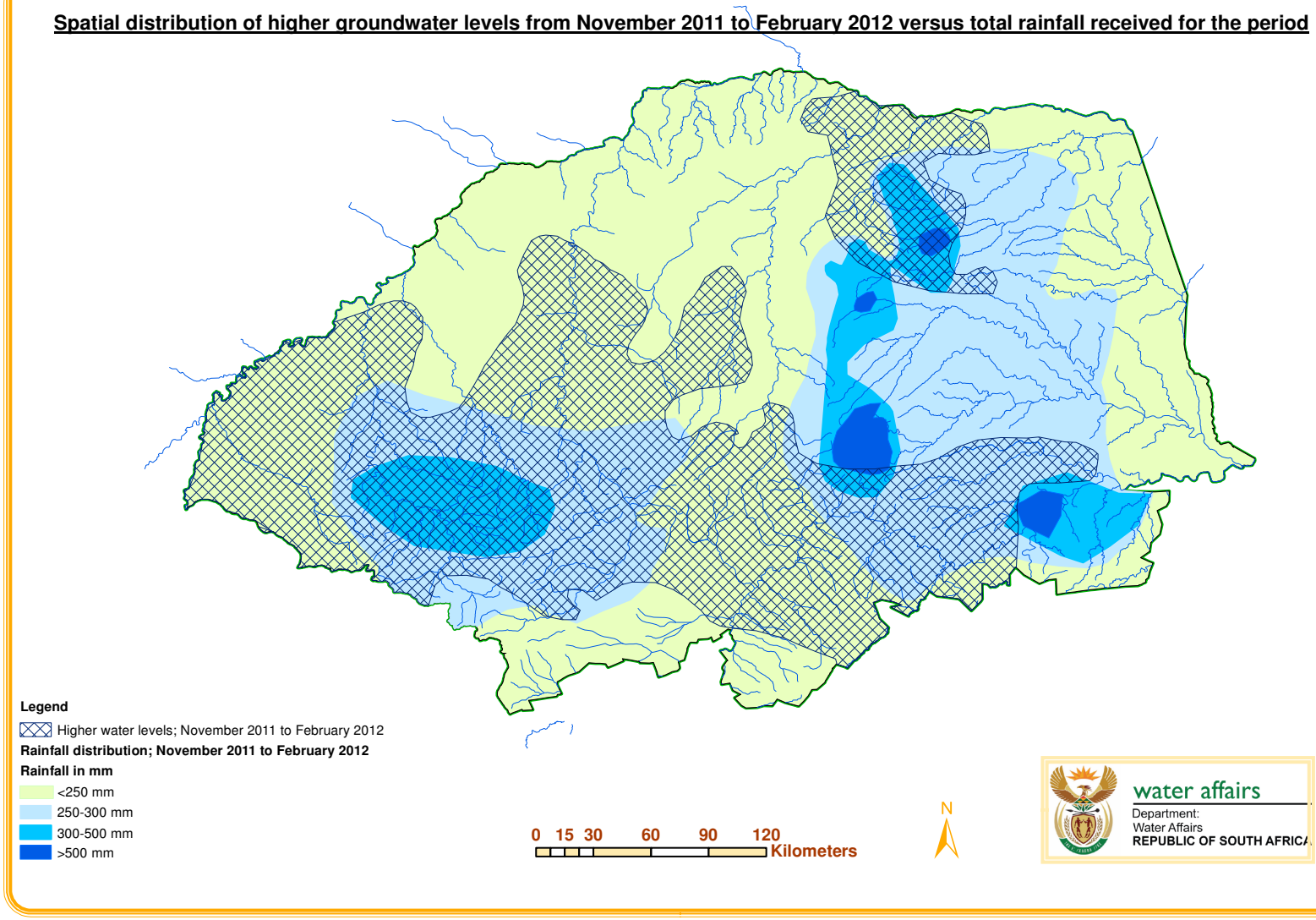


FIGURE 3

Spatial distribution of higher groundwater levels from February 2011 to February 2012 versus total rainfall received for the period

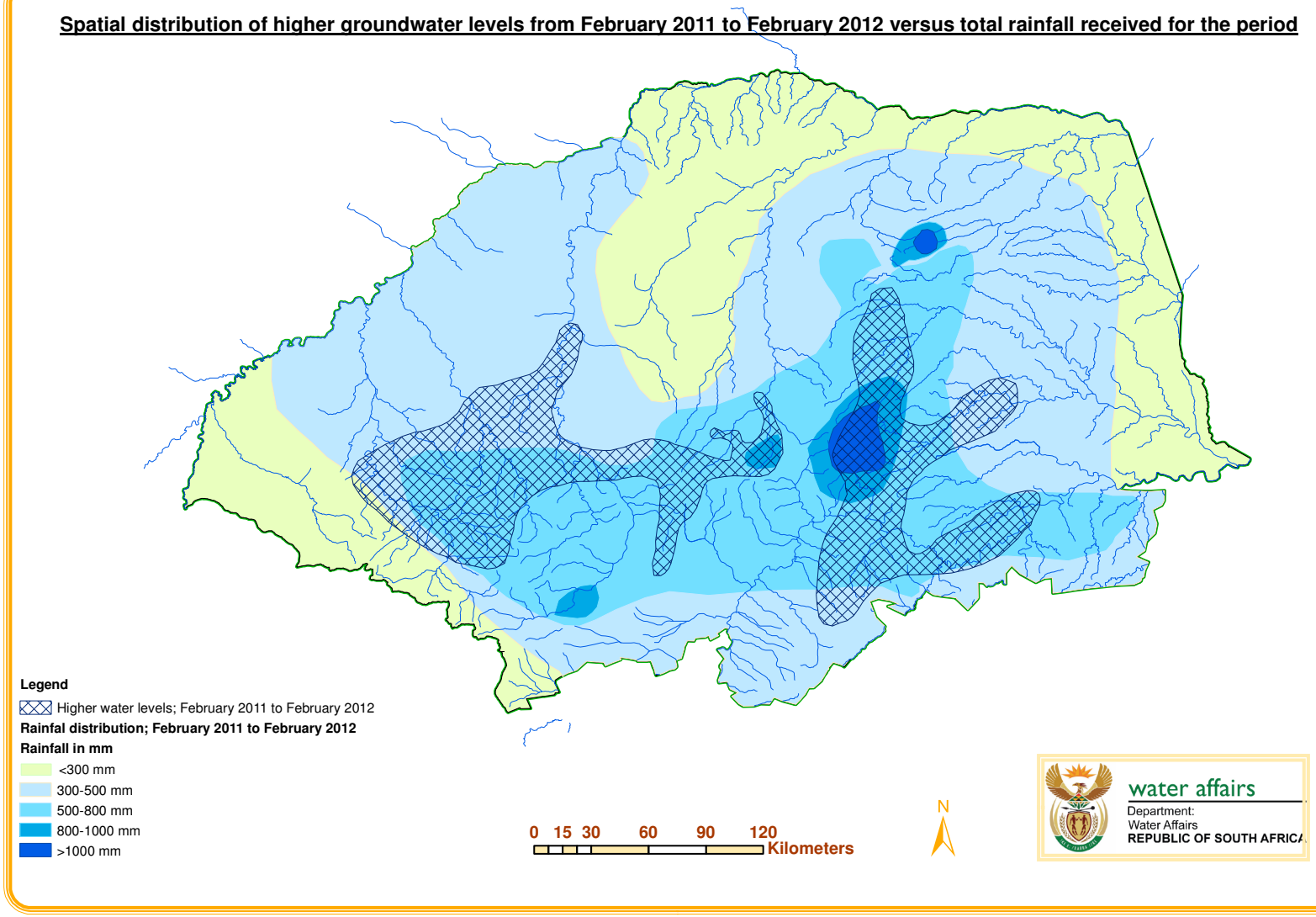
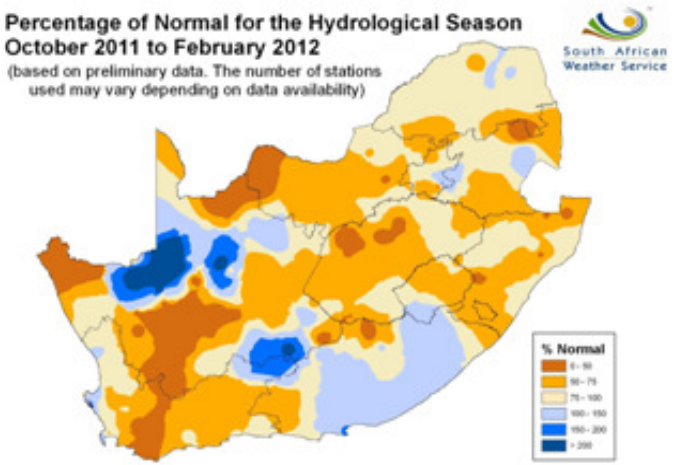
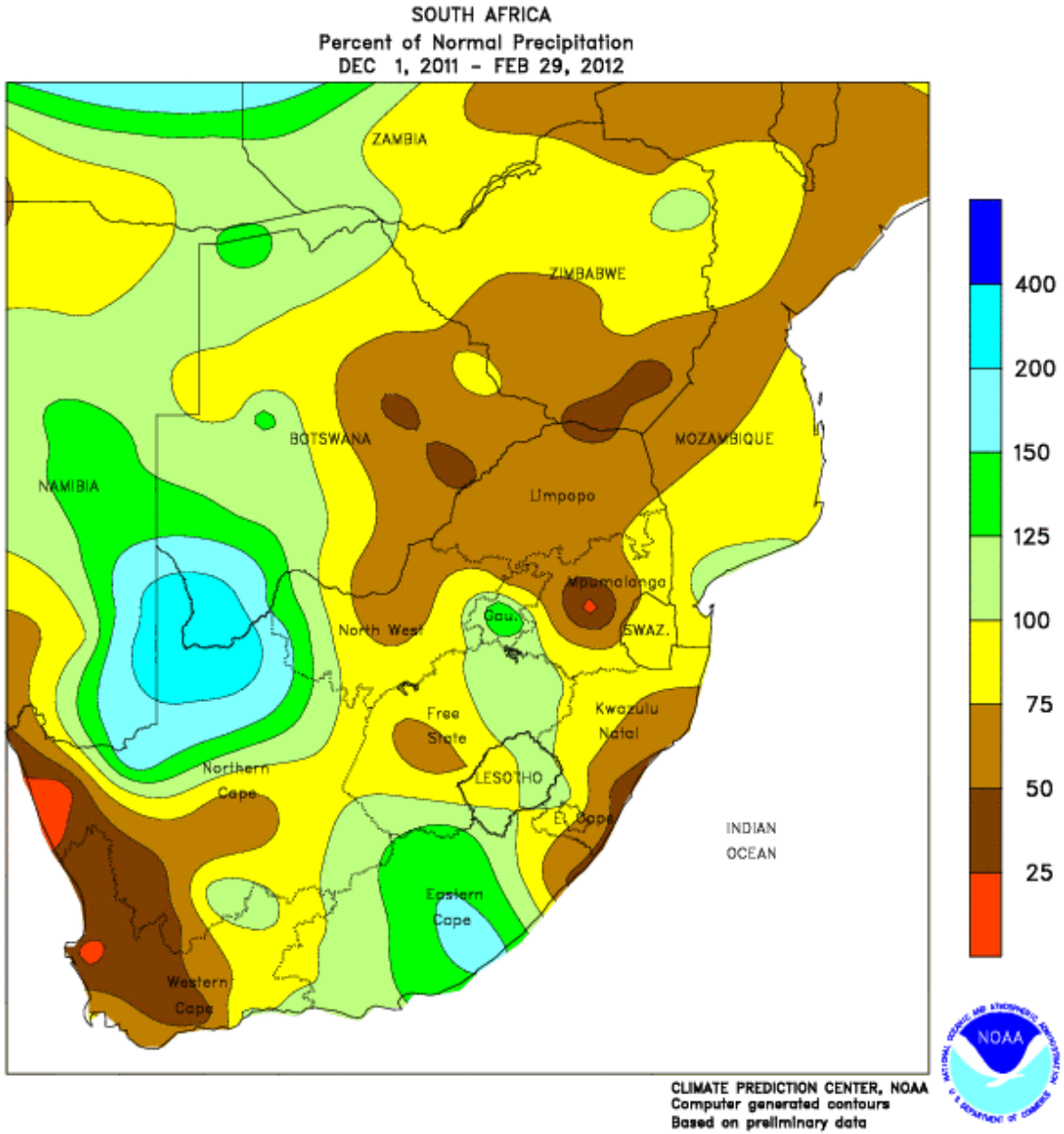


FIGURE 4



A



B

NOAA/ National Weather Service
National Centers for Environmental Prediction
Climate Prediction Center
5200 Auth Road
Camp Springs, Maryland 20746

http://www.cpc.ncep.noaa.gov/products/fews/global/CMORPH/cmorph_dly_africa_south.png

FIGURE 5

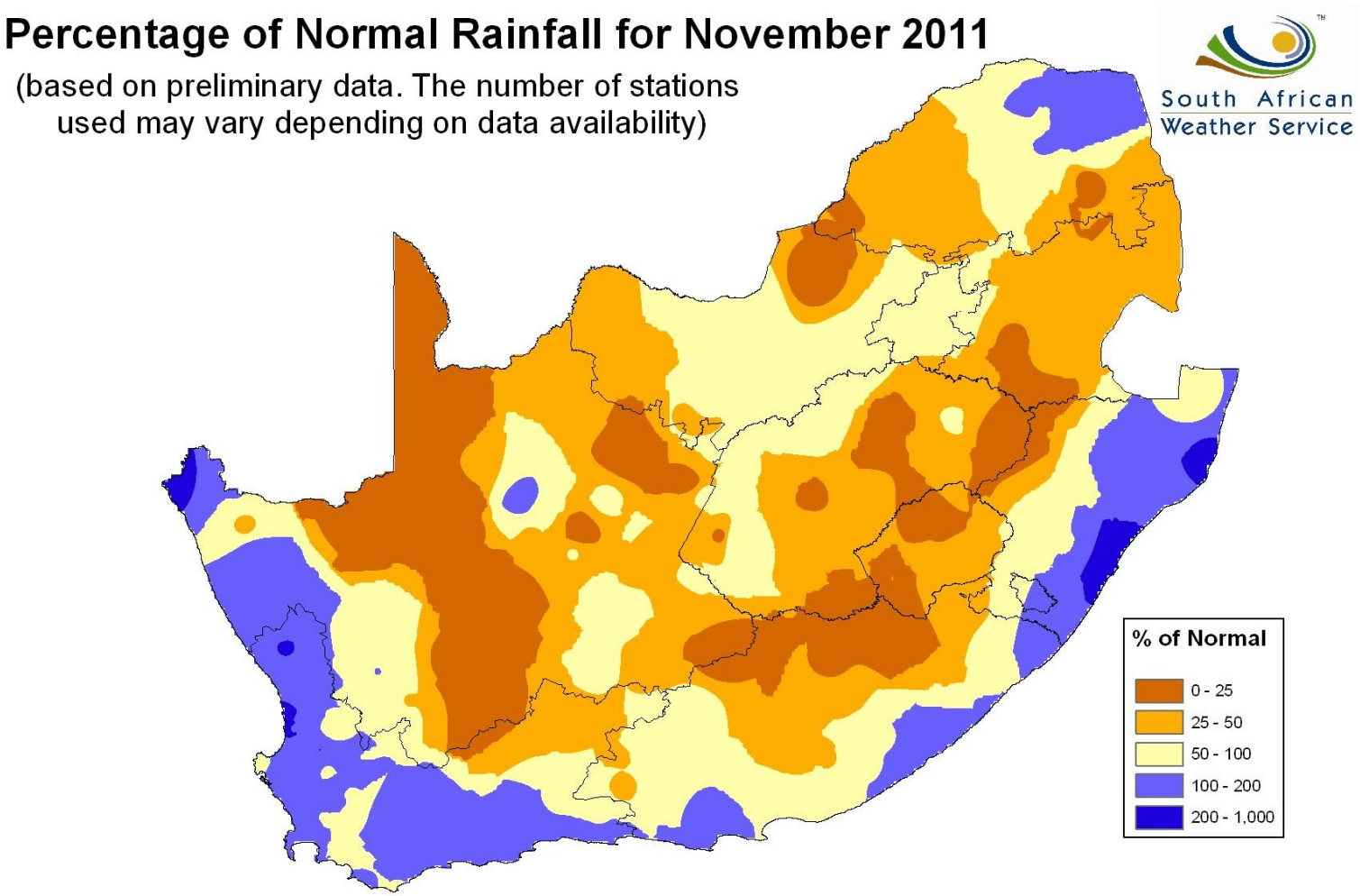

Percentage of Normal Rainfall for November 2011
(based on preliminary data. The number of stations used may vary depending on data availability)
South African Weather Service
% of Normal
0 - 25
25 - 50
50 - 100
100 - 200
200 - 1,000

FIGURE 6

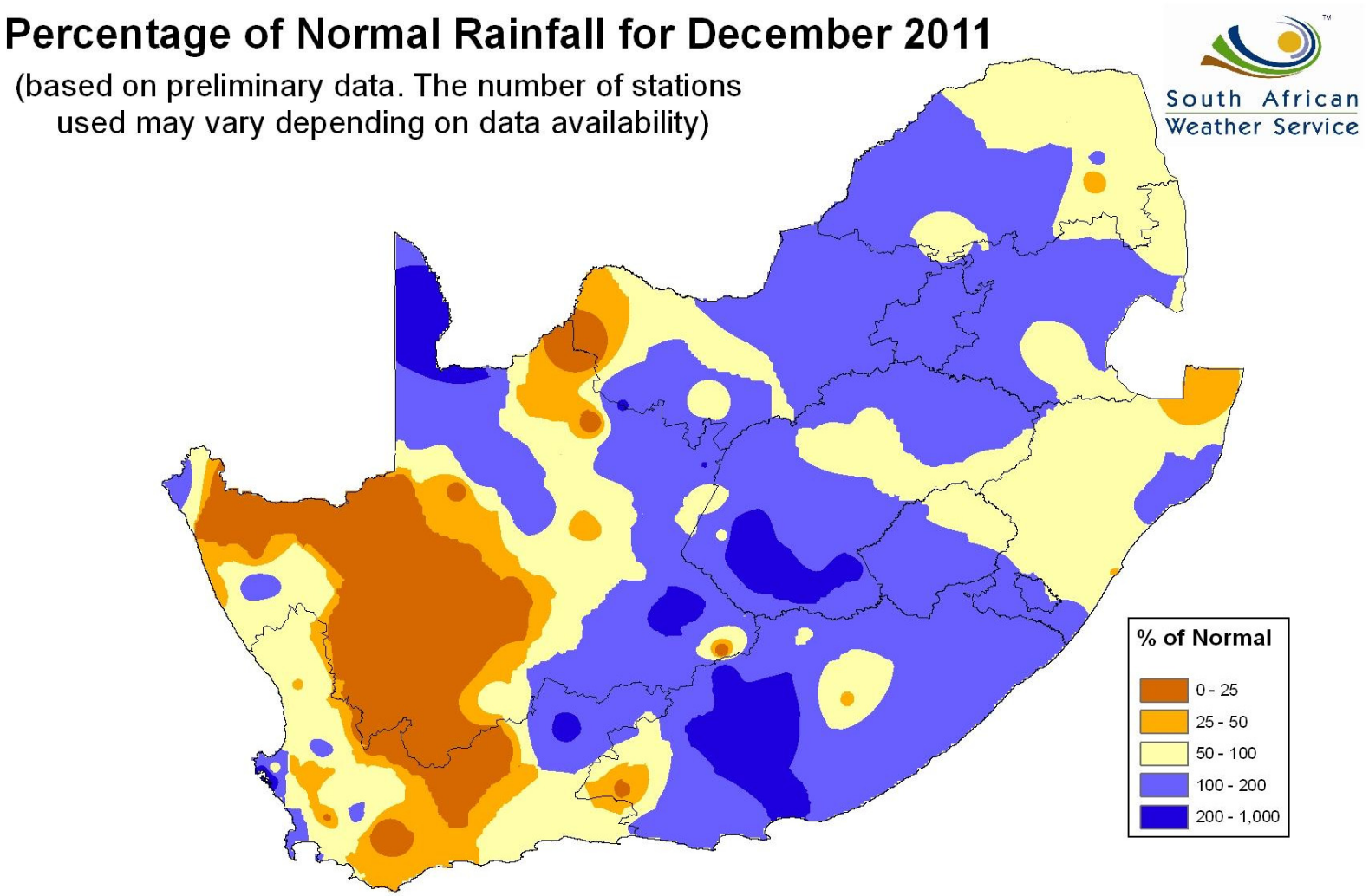

Percentage of Normal Rainfall for December 2011
(based on preliminary data. The number of stations used may vary depending on data availability)
South African Weather Service
% of Normal
0 - 25
25 - 50
50 - 100
100 - 200
200 - 1,000

FIGURE 7

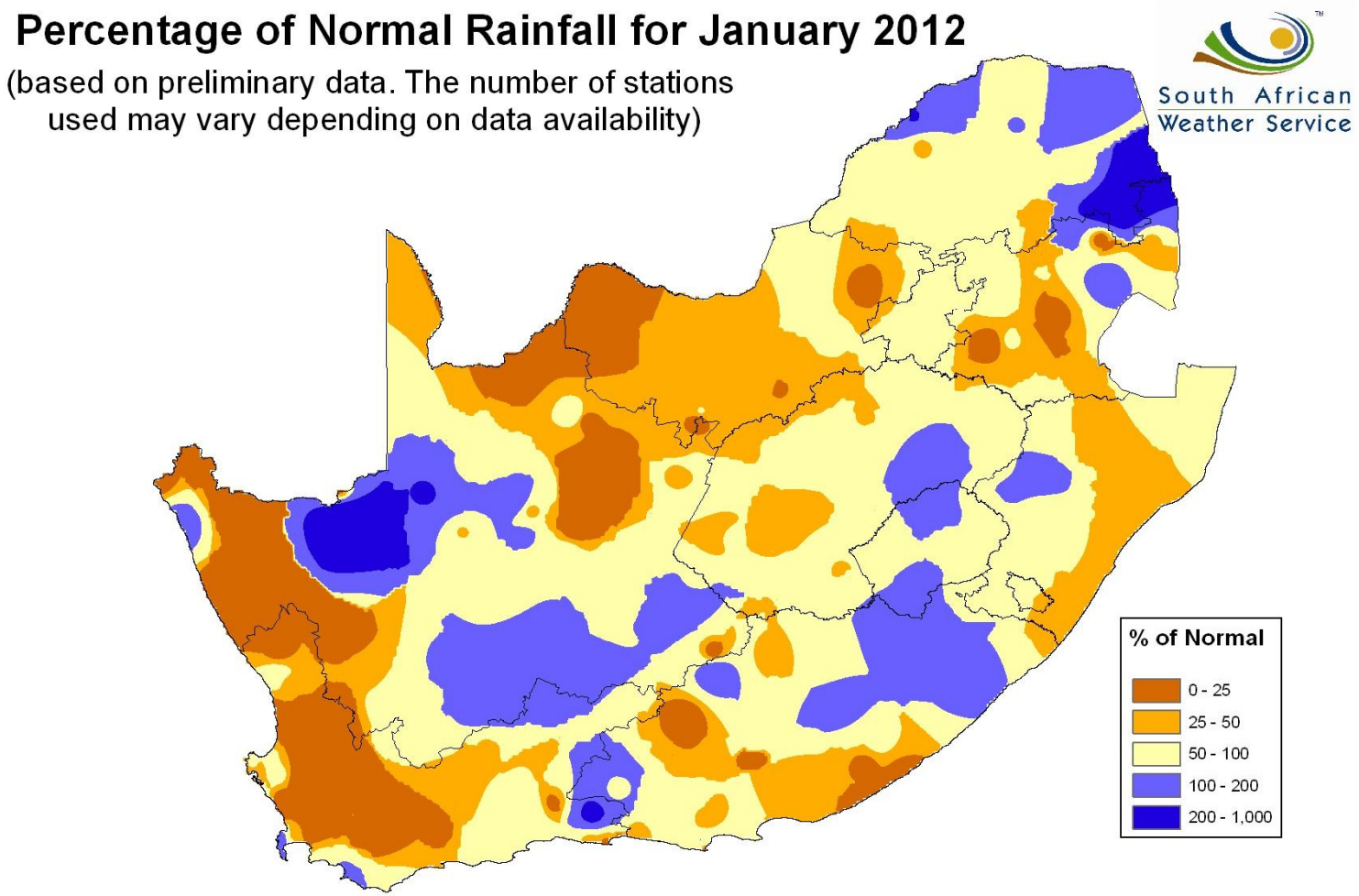

Percentage of Normal Rainfall for January 2012
(based on preliminary data. The number of stations used may vary depending on data availability)
South African Weather Service
% of Normal
0 - 25
25 - 50
50 - 100
100 - 200
200 - 1,000

FIGURE 8

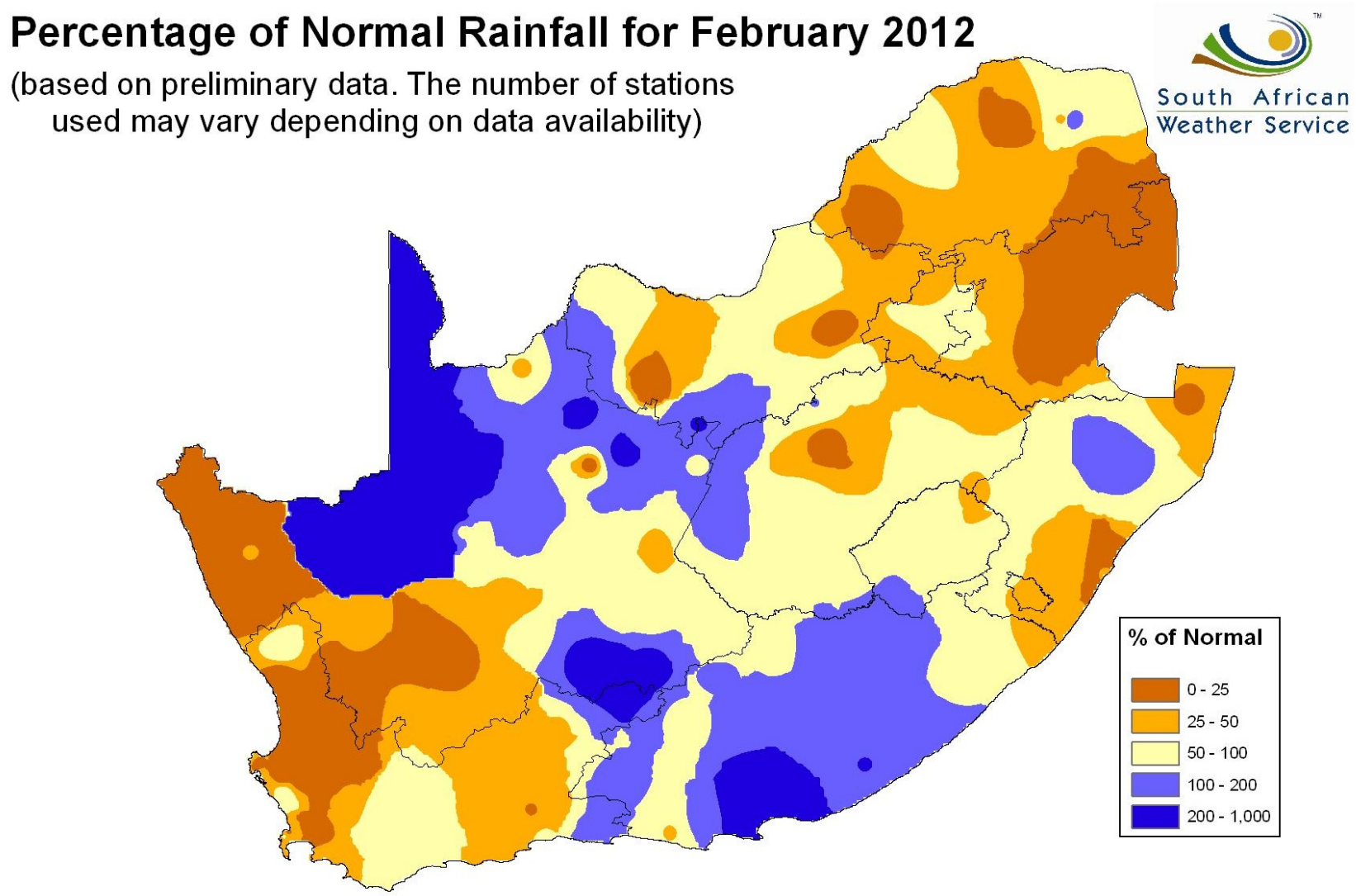
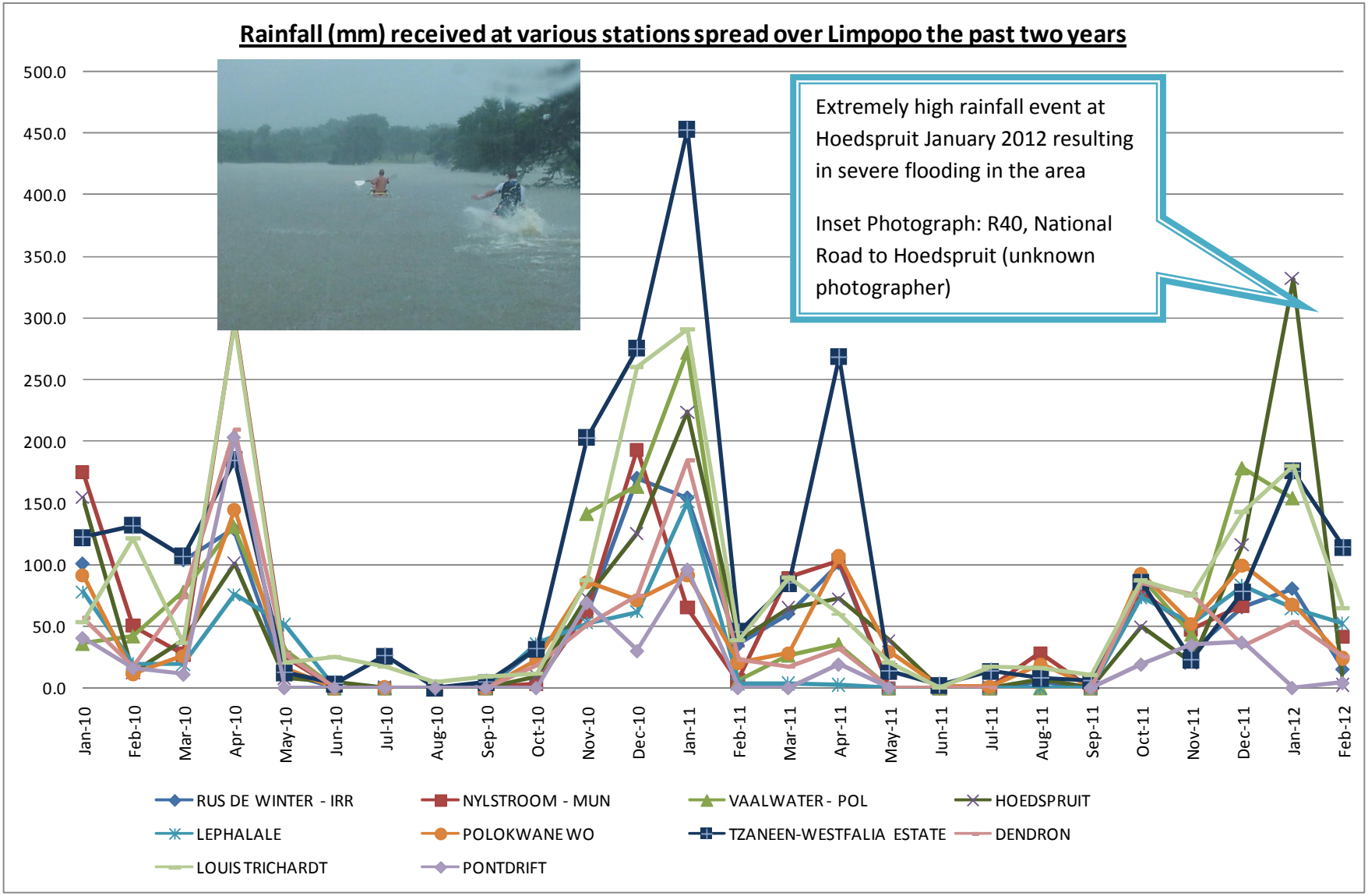
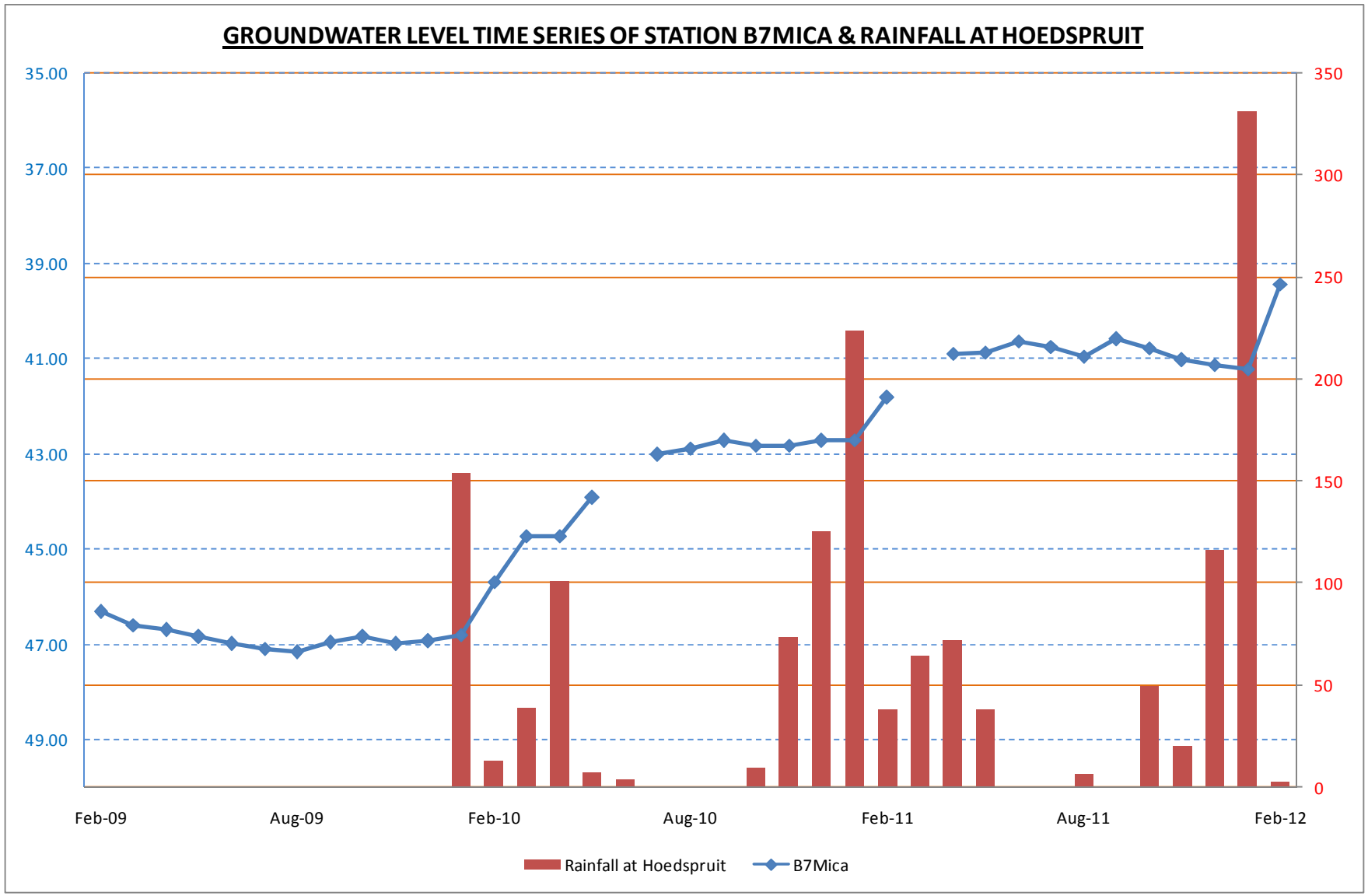

Percentage of Normal Rainfall for February 2012
(based on preliminary data. The number of stations used may vary depending on data availability)
South African Weather Service
% of Normal
0 - 25
25 - 50
50 - 100
100 - 200
200 - 1,000

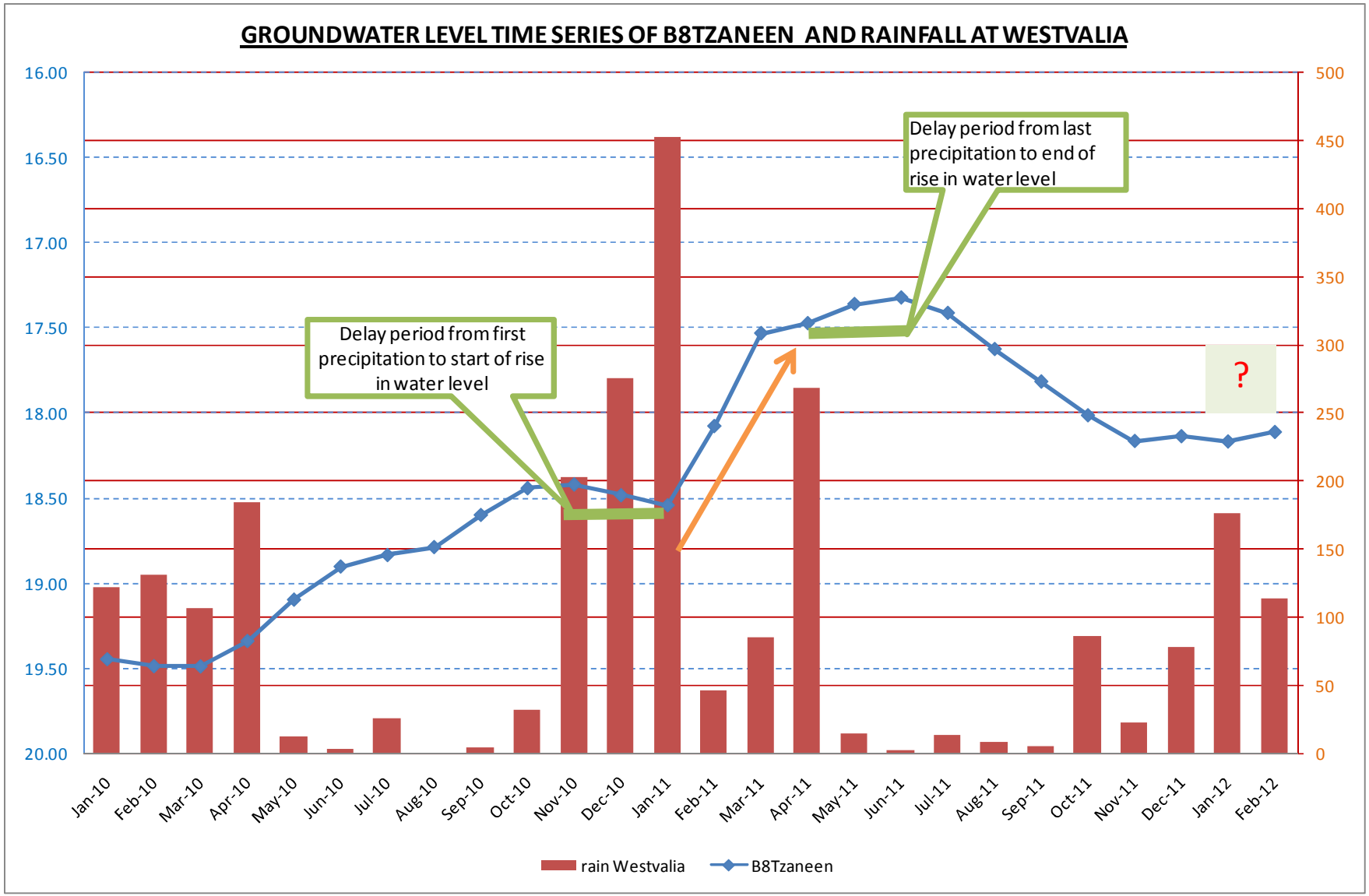
FIGURE 9


Rainfall (mm) received at various stations spread over Limpopo the past two years
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10
Jan-11
Feb-11
Mar-11
Apr-11
May-11
Jun-11
Jul-11
Aug-11
Sep-11
Oct-11
Nov-11
Dec-11
Jan-12
Feb-12
Extremely high rainfall event at Hoedspruit January 2012 resulting in severe flooding in the area
Inset Photograph: R40, National Road to Hoedspruit (unknown photographer)
RUS DE WINTER - IRR
NYLSTROOM - MUN
VAALWATER - POL
HOEDSPRUIT
LEPHALALE
POLOKWANE WO
TZANEEN-WESTFALIA ESTATE
DENDRON
LOUIS TRICHARDT
PONTDRIFT

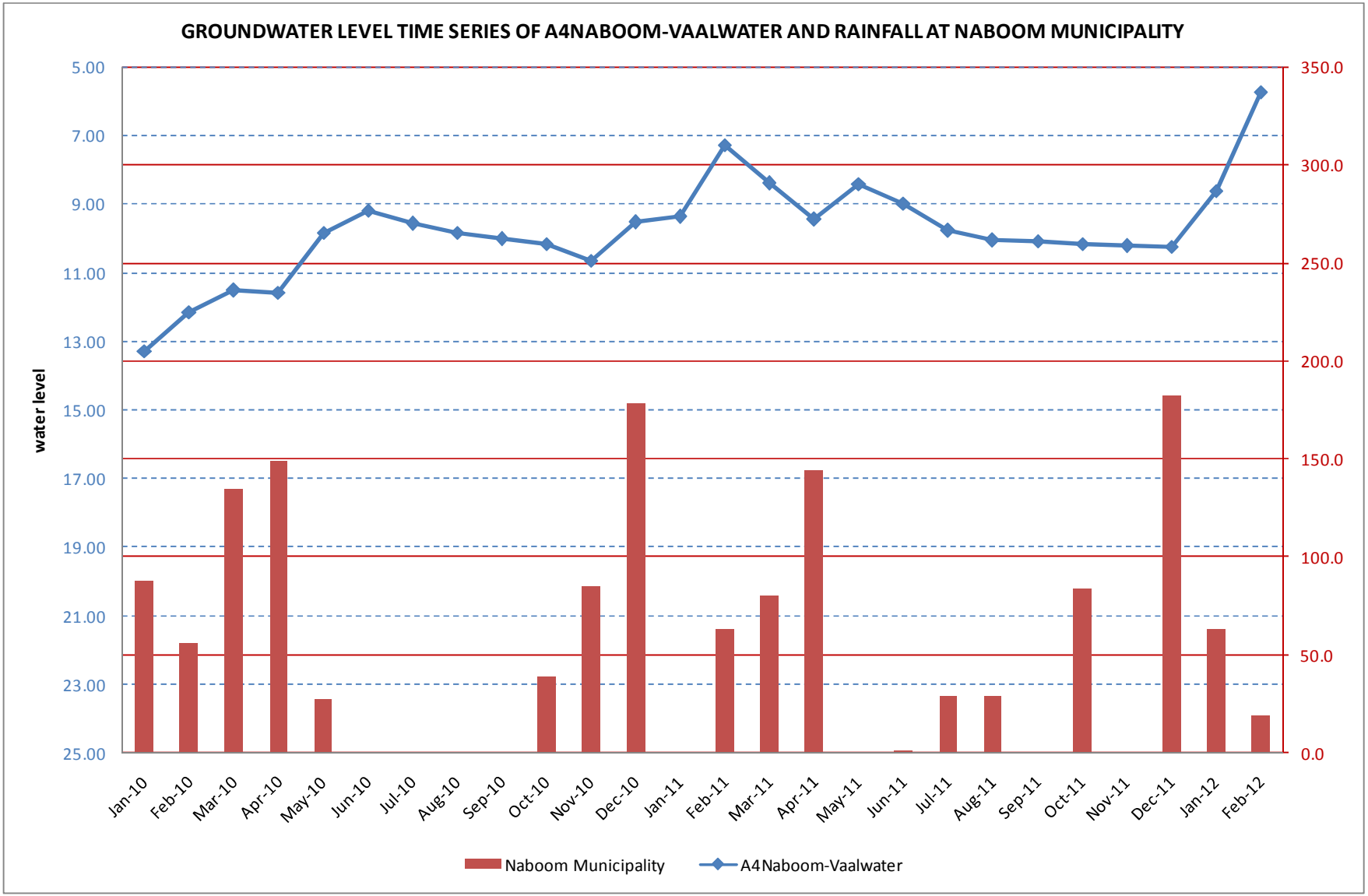
GRAPH 1


GROUNDWATER LEVEL TIME SERIES OF STATION B7MICA & RAINFALL AT HOEDSPRUIT
35.00
37.00
39.00
41.00
43.00
45.00
47.00
49.00
350
300
250
200
150
100
50
0
Feb-09
Aug-09
Feb-10
Aug-10
Feb-11
Aug-11
Feb-12
Rainfall at Hoedspruit
B7Mica

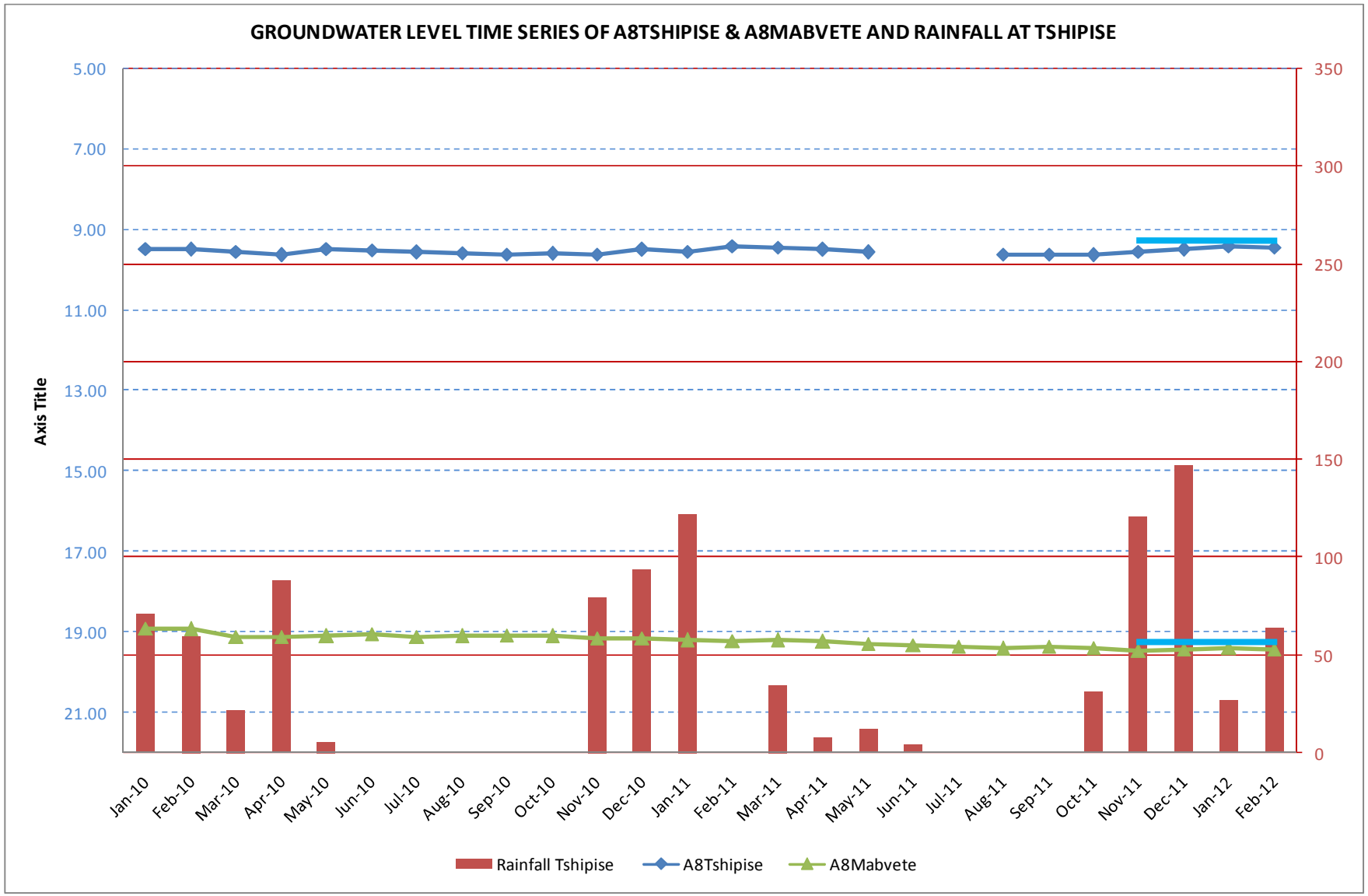
GRAPH 2


GROUNDWATER LEVEL TIME SERIES OF B8TZANEEN AND RAINFALL AT WESTVALIA
16.00
16.50
17.00
17.50
18.00
18.50
19.00
19.50
20.00
500
450
400
350
300
250
200
150
100
50
0
Delay period from last precipitation to end of rise in water level
Delay period from first precipitation to start of rise in water level
?
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10
Jan-11
Feb-11
Mar-11
Apr-11
May-11
Jun-11
Jul-11
Aug-11
Sep-11
Oct-11
Nov-11
Dec-11
Jan-12
Feb-12
rain Westvalia
B8Tzaneen

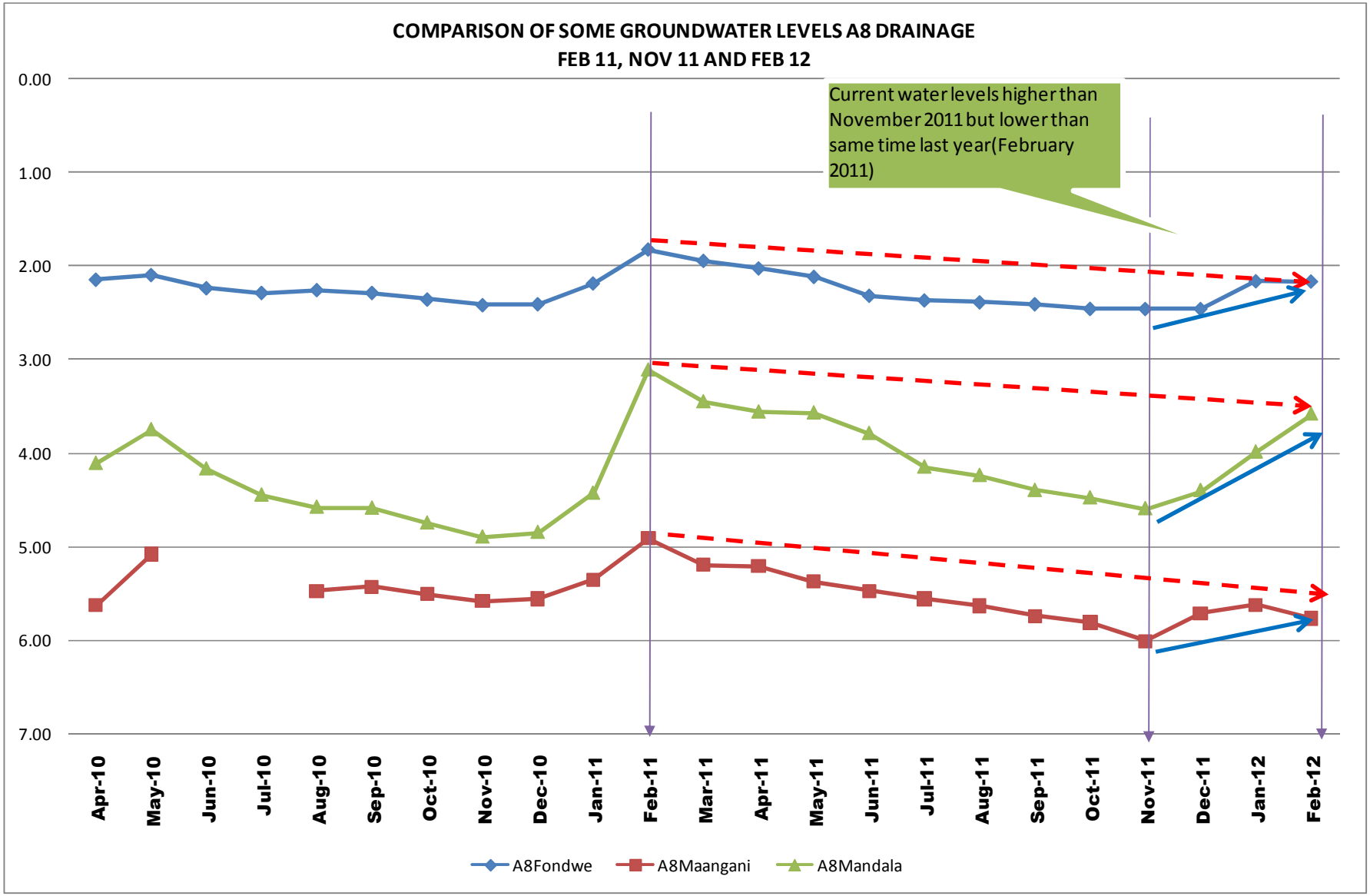
GRAPH 3


GROUNDWATER LEVEL TIME SERIES OF A4NABOOM-VAALWATER AND RAINFALL AT NABOOM MUNICIPALITY
water level
5.00
7.00
9.00
11.00
13.00
15.00
17.00
19.00
21.00
23.00
25.00
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10
Jan-11
Feb-11
Mar-11
Apr-11
May-11
Jun-11
Jul-11
Aug-11
Sep-11
Oct-11
Nov-11
Dec-11
Jan-12
Feb-12
Naboom Municipality
A4Naboom-Vaalwater

GRAPH 4

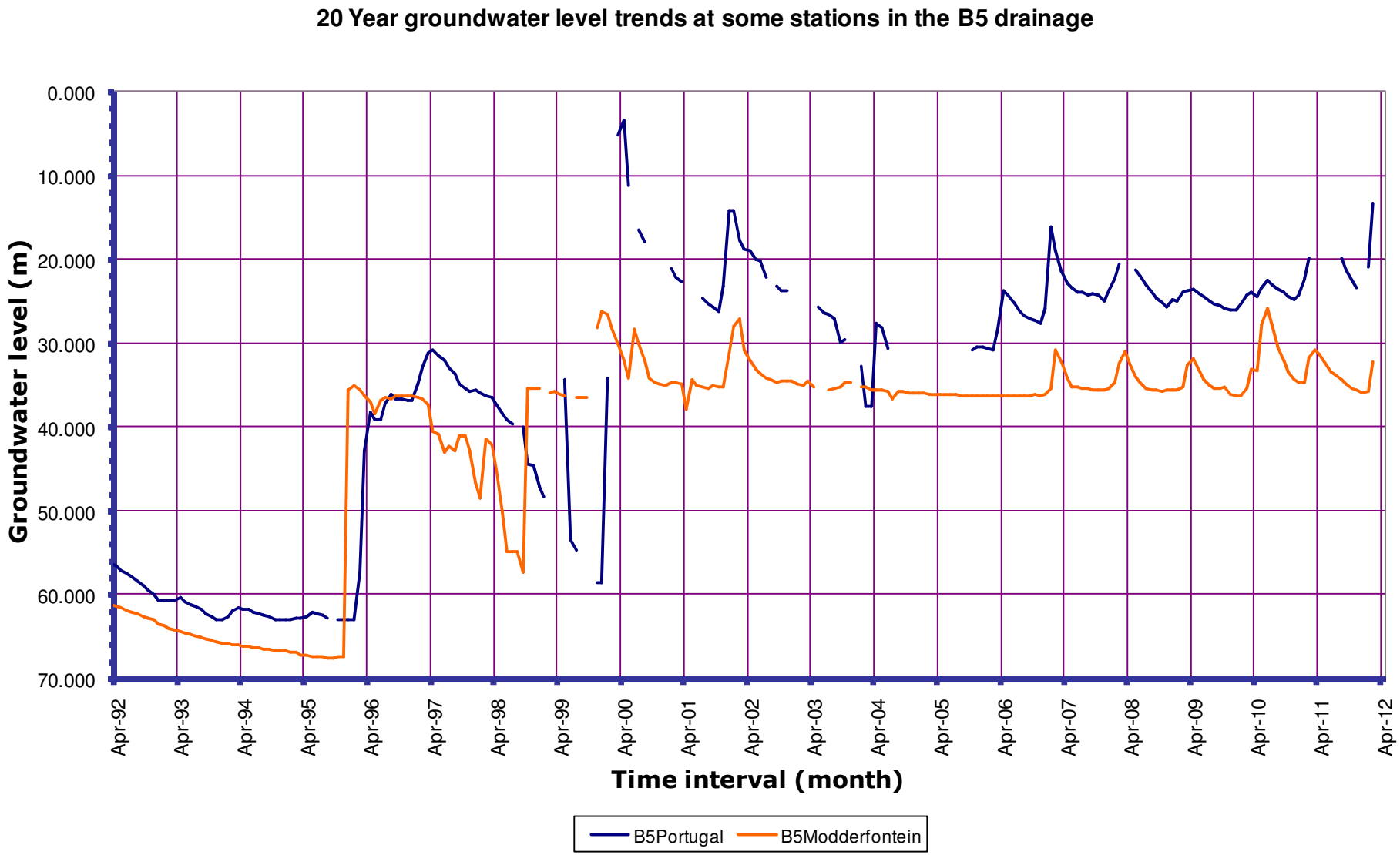

GROUNDWATER LEVEL TIME SERIES OF A8TSHIPISE & A8MABVETE AND RAINFALL AT TSHIPISE
Axis Title
5.00
7.00
9.00
11.00
13.00
15.00
17.00
19.00
21.00
350
300
250
200
150
100
50
0
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10
Jan-11
Feb-11
Mar-11
Apr-11
May-11
Jun-11
Jul-11
Aug-11
Sep-11
Oct-11
Nov-11
Dec-11
Jan-12
Feb-12
Rainfall Tshipise
A8Tshipise
A8Mabvete

GRAPH 5

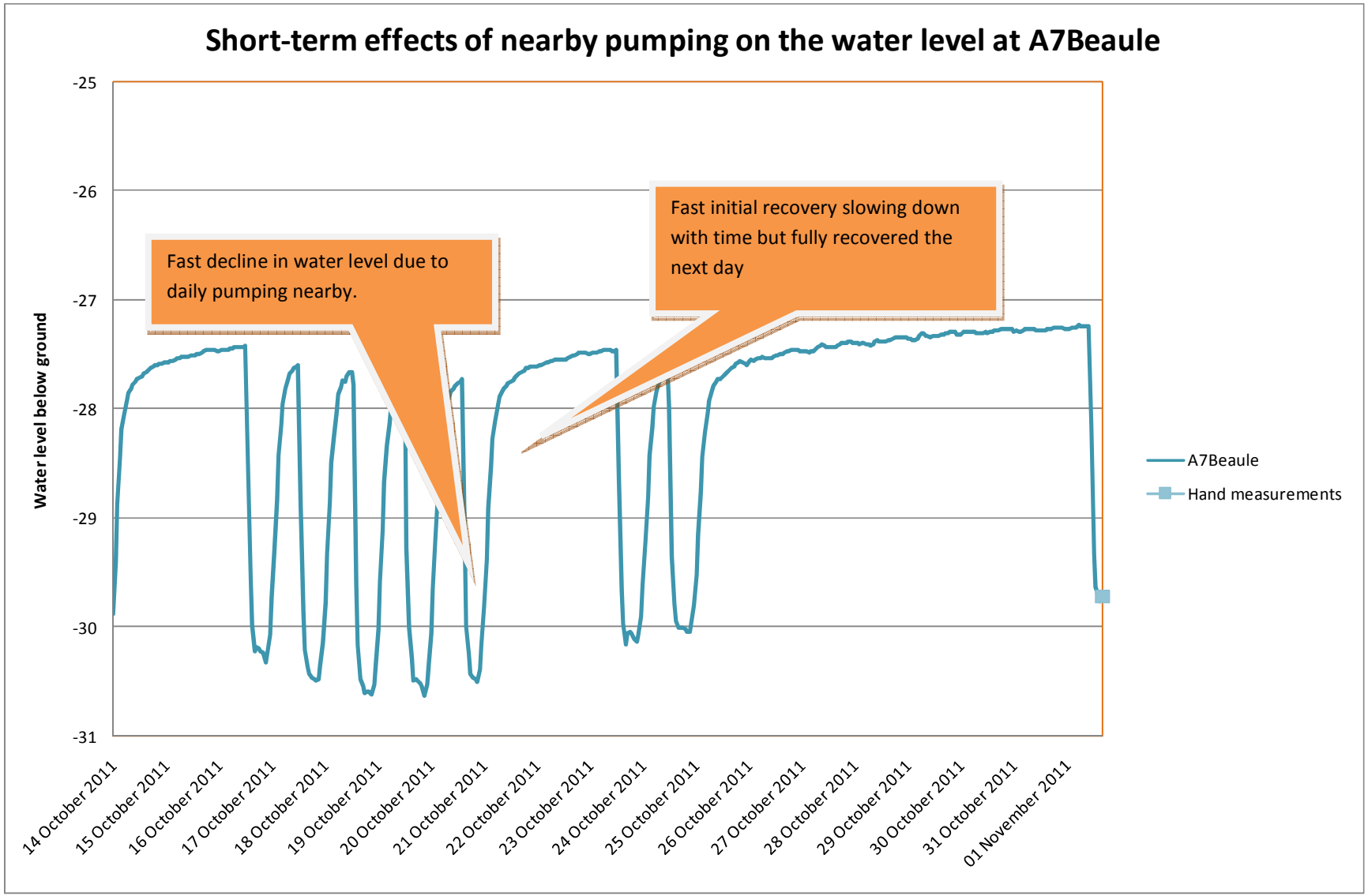

COMPARISON OF SOME GROUNDWATER LEVELS A8 DRAINAGE
FEB 11, NOV 11 AND FEB 12
Current water levels higher than November 2011 but lower than same time last year(February 2011)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10
Jan-11
Feb-11
Mar-11
Apr-11
May-11
Jun-11
Jul-11
Aug-11
Sep-11
Oct-11
Nov-11
Dec-11
Jan-12
Feb-12
A8Fondwe
A8Maangani
A8Mandala

GRAPH 6

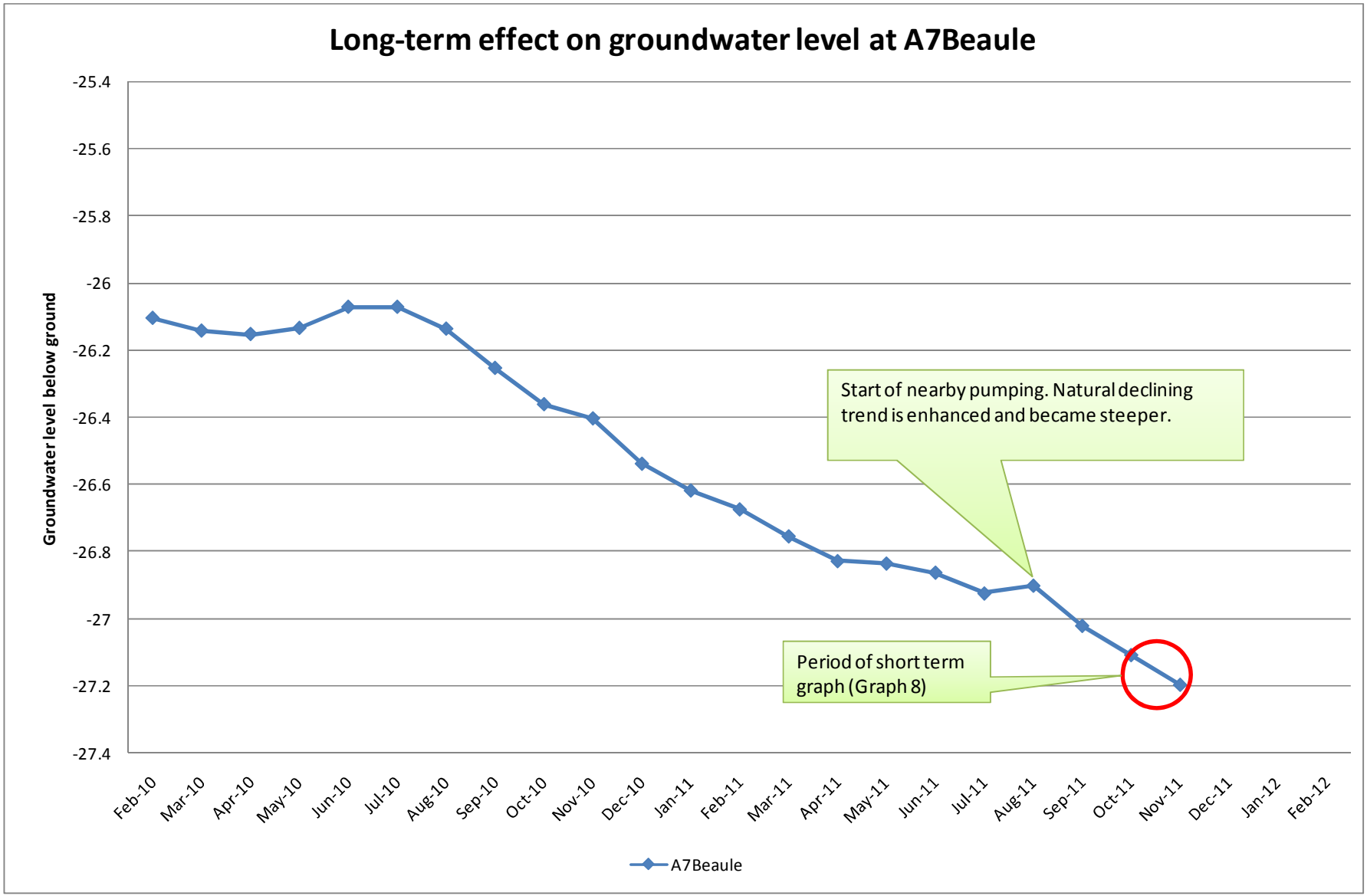
`


20 Year groundwater level trends at some stations in the B5 drainage
Groundwater level (m)
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
Apr-92
Apr-93
Apr-94
Apr-95
Apr-96
Apr-97
Apr-98
Apr-99
Apr-00
Apr-01
Apr-02
Apr-03
Apr-04
Apr-05
Apr-06
Apr-07
Apr-08
Apr-09
Apr-10
Apr-11
Apr-12
Time interval (month)
B5Portugal
B5Modderfontein

GRAPH 7


Short-term effects of nearby pumping on the water level at A7Beaule
Water level below ground
-25
-26
-27
-28
-29
-30
-31
Fast decline in water level due to daily pumping nearby.
Fast initial recovery slowing down with time but fully recovered the next day
A7Beaule
Hand measurements
14 October 2011
15 October 2011
16 October 2011
17 October 2011
18 October 2011
19 October 2011
20 October 2011
21 October 2011
22 October 2011
23 October 2011
24 October 2011
25 October 2011
26 October 2011
27 October 2011
28 October 2011
29 October 2011
30 October 2011
31 October 2011
01 November 2011

GRAPH 8


Long-term effect on groundwater level at A7Beaule
Groundwater level below ground
-25.4
-25.6
-25.8
-26
-26.2
-26.4
-26.6
-26.8
-27
-27.2
-27.4
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Oct-10
Nov-10
Dec-10
Jan-11
Feb-11
Mar-11
Apr-11
May-11
Jun-11
Jul-11
Aug-11
Sep-11
Oct-11
Nov-11
Dec-11
Jan-12
Feb-12
Start of nearby pumping. Natural declining trend is enhanced and became steeper.
Period of short term graph (Graph 8)
A7Beaule

GRAPH 9