ZIMBABWE HYDROLOGICAL OUTLOOK FOR 2015/16 SEASON

1.0 INTRODUCTION

This report provides the **Hydrological Forecast for the 2015/16 season** and is based on the rainfall forecast (2015/16 season) issued out by the Meteorological Service Department (MSD) on the 3rd of September 2015.

1.1 Main objective

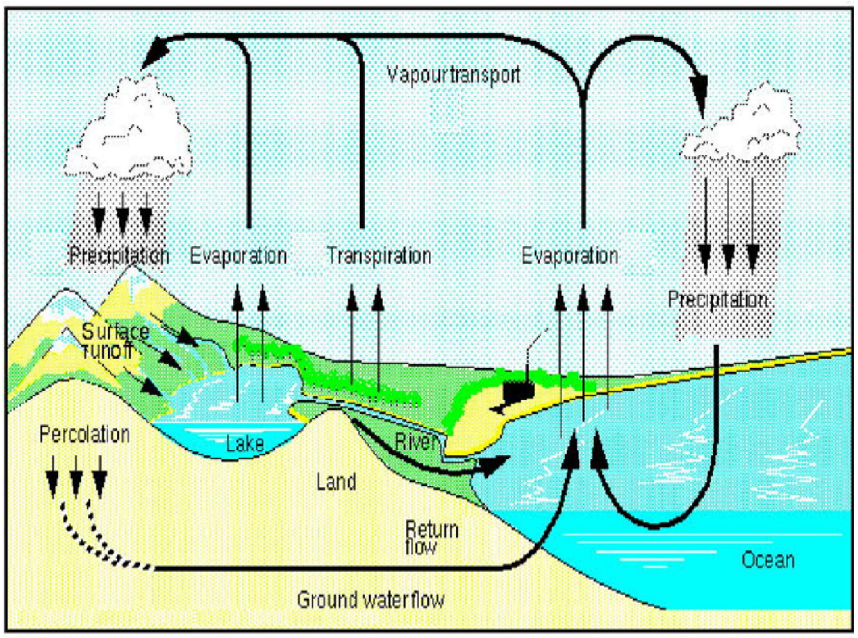
The main objective of the report is to predict the likely hydrological conditions of the country for the 2015/16 season based on the 2015/16 rainfall forecast.

1.1.1 Specific objectives

- To determine the expected flows in each catchment for the 2015/16 season
- To determine the expected dam levels in each catchment by the end of the rain season (March).
- To provide the implications of the forecast for planning and management purposes.

2.0 BACKGROUND

The **water cycle**, also known as the **hydrological cycle** describes the continuous movement of water on, above and below the surface of the earth. The figure below illustrates the hydrological cycle.



In hydrology, a **water balance** is used to help manage the water supply and predict where there may be water shortages. A water balance equation can be used to describe the flow of water in and out of a system.
A general water balance equation is:

$P = Q + E +/- \triangle S$ where

- P is precipitation
- Q is runoff
- E is evapotranspiration
- $+/- \triangle S$ is the change in storage (in soil or the bedrock)

2.1 RAINFALL FORECAST FOR THE 2015/16 SEASON

According to the Meteorological Service Department (MSD), the country is divided into 3 homogeneous rainfall regions (Region 1, 2 and 3).

Region 1 for the OND covers mainly Harare Province, much of Mashonaland East, Mashonaland West, Mashonaland Central, north eastern parts of Midlands and northern half of Manicaland. Catchment wise Region 1 covers the whole of Manyame and Mazowe Catchment, greater parts of Sanyati and greater parts of Save Catchment.

Region 2 covers mainly Matebeleland North Province, parts of Midlands Province and a small proportion of Matabeleland South Province. Catchment wise, it covers most parts of Gwayi Catchment, parts of Sanyati catchment and a smaller part of Mzingwane Catchment.

Region 3 covers greater parts of Matebeleland South Province, Masvingo, parts of Midlands, the extreme southern parts of Manicaland, extreme southern parts of Mashonaland East. Catchment wise it covers, the whole of Runde catchment, greater parts of Mzingwane, parts of Save, parts of Sanyati and Gwayi.

During the JFM period Regions 1 and 2 become larger while Region 3 shrinks becoming smaller than the size of the same region during the OND period. The regions receive more rainfall during the JFM period than during the OND period. This is because during the JFM period the Inter-tropical Convergence Zone reaches its south-most position to increase rainfall activity over Zimbabwe.

2.2 2015/16 FORECAST FOR ZIMBABWE

- **Region 1** Harare, much of Mashonaland East, Mashonaland West , Mashonaland Central, northeastern parts of Midlands , parts Manicaland

Below normal rainfall expected

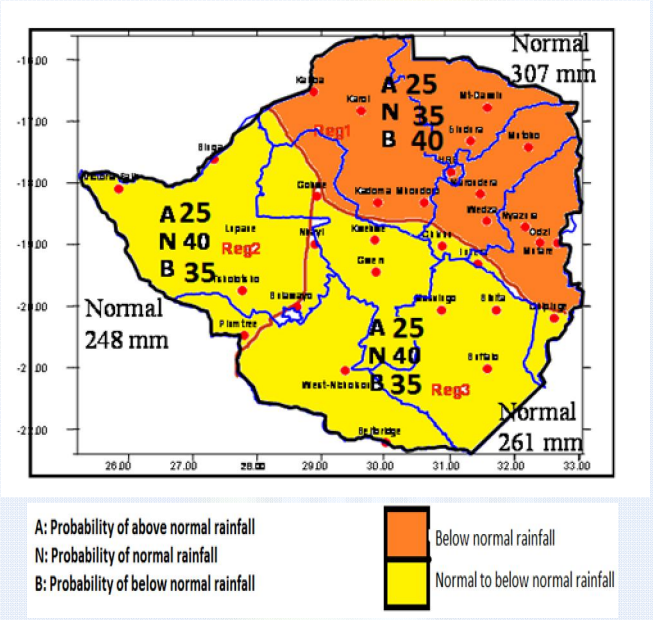
- **Region 2 & 3**

Region 2 The bulk of Matabeleland North, parts of Midlands and parts of Mashonaland West.

Region 3 Masvingo, the bulk of Midlands, the extreme southern parts of Manicaland and the bulk of Matabeleland South.

Normal to below normal rainfall expected

Homogeneous Zones (Oct- December 2015)



- **Region 1 & 2**

Region 1 Harare, much of Mashonaland East, Mashonaland West , Mashonaland Central, northeastern parts of Midlands , parts Manicaland

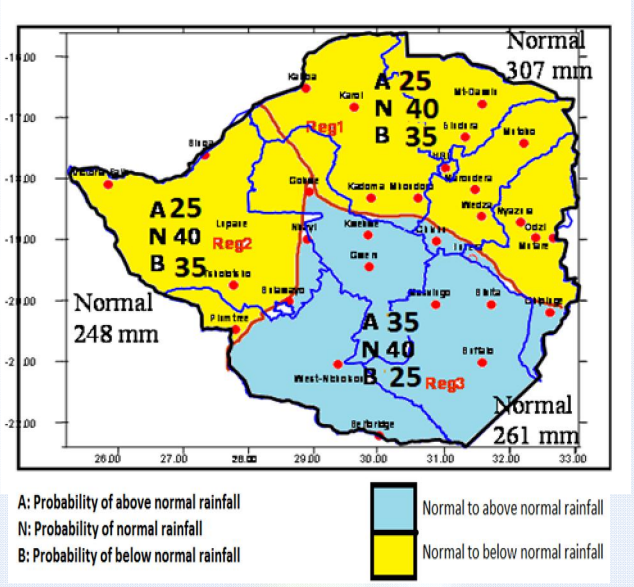
Region 2 The bulk of Matabeleland North, parts of Midlands and parts of Mashonaland West.

Normal to below normal rainfall expected

- **Region 3** Masvingo, the bulk of Midlands, the extreme southern parts of Manicaland and the bulk of Matabeleland South.

Normal to above normal rainfall expected

Homogeneous Zones (Nov-Dec 2015-Jan 2016)



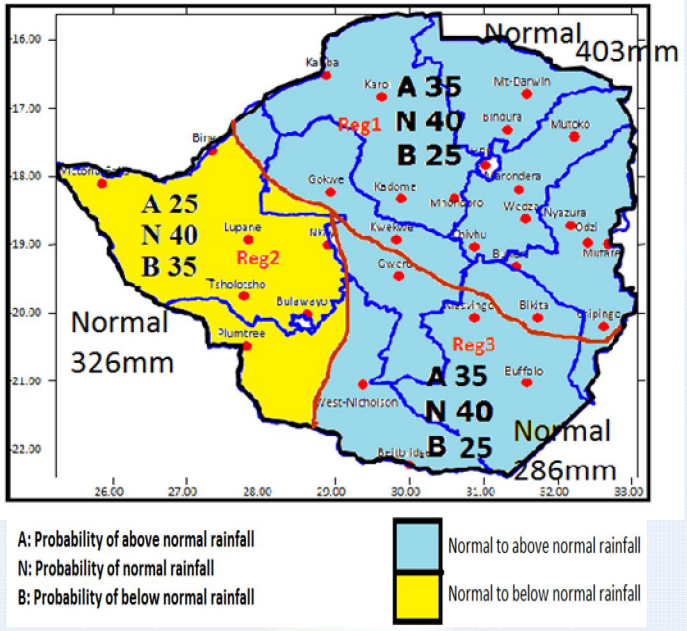
Homogeneous Zones (Dec 2015-Jan-Feb 2016)

- **Regions 1 & 3** Region1 Mashonaland Provinces, Harare, most of Manicaland, northern parts of Masvingo and northern parts of Midlands.
- Region 3 Most of Masvingo, the extreme southern parts of Manicaland, southeast Matebeleland South and the southern parts of Midlands

Normal to above normal rains are expected.

Region 2 Most of Matabeleland North, northwest Matebeleland South, Bulawayo,

Normal to below normal rains are expected.



Homogeneous Zones (Jan- March 2016)

- **Region 1** Mashonaland Provinces, Harare, most of Manicaland, northern parts of Masvingo and northern parts of Midlands.

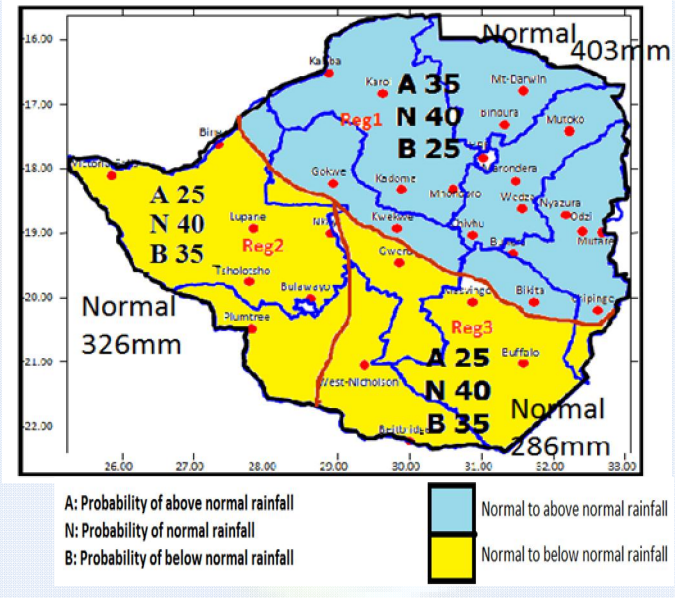
Normal to above normal rains are expected.

- **Regions 2 and 3**

Region 2 Most of Matabeleland North, northwest Matebeleland South, Bulawayo.

Region3 Most of Masvingo, the extreme southern parts of Manicaland, southeast Matebeleland South and the southern parts of Midlands

Normal to below normal rains are expected.



2.4 Interpreting the rainfall forecast (MSD)

- The seasonal forecast for any region is given in terms of possibilities of each of the categories; below normal (B), normal rainfall (N) and A (above normal rainfall) occurring expressed as percentages. The category with the highest percentage will be the **most favoured** by the forecast. The probabilistic approach implies that the other categories may also be experienced and should not be completely ignored.

  Normal rainfall (N)
- According to MSD this is when an area receives between 75% and 125% of its long term average in a sub-season (OND or JFM). Simply put, this will be a good season based on the cumulative amount received in a sub-season.

  Below normal (B)
- This is when an area receives below 75% of its long term average for the sub-season. Basically, based on amount of rainfall received in a sub-season this will be a bad season.

  Above normal (A)
- This is when an area receives more than 125% of its long term mean for a particular sub-season.

3.0 METHODOLOGY FOR ESTIMATING RUNOFF FROM RAINFALL

The rainfall-runoff relationship was used to estimate the flows/runoff from the rainfall forecast. Barlow's equation for estimating runoff **(Q = K x R x A** where Q is runoff; K-runoff coefficient, R is Rainfall and A is catchment area) was used to come up with the runoff figures. The equation was chosen because it is commonly used to estimate runoff from large catchments and was successfully used to estimate runoff in the Save Catchment during the WAPCOS IWRM strategy (2012). The detailed procedure below was used to come up with the results.

- Delineate the 3 rainfall regions for both OND and JFM on the catchment map manually.
- Determine the areas falling into the different rainfall regions per catchment for both the 1st half and 2nd half of the rainfall season.
- Calculate the rainfall –runoff coefficient per each subzone using the corresponding values for rainfall and runoff from the Blue Book (Assessment of Surface Water Resources and Guidelines for Planning 2007).
- Weight the runoff coefficients to come up with the weighted coefficient for each catchment.

- Calculate the Gross Mean Annual runoff (MAR) for each catchment using the Barlow's equation.
- Determine the total storage volume in each catchment.
- Determine water demand during the rainy season in each catchment.
- Determine storage coefficient for each catchment.
- Determine the volume of stored water lost through seepage/ infiltration and evaporation in each catchment during the period.
- Estimate the storage levels as at the 1st of October 2015.

  After determining the expected flows for the catchments the following was done;
- The inflow amounts were multiplied by the storage coefficient to determine the actual amount of water flowing into the respective catchment reservoirs. It must be noted that most of dams are located (concentrated) in the upper reaches of the catchments. Only Runde, Mzingwane and Manyame Catchment show fairly distributed dams to capture as much flow as possible.
- The inflows into the reservoirs are added to the existing storage volume (as at 1 October 2015) to determine the available total volume in the catchment during the rainy period.
- Subtract the water demand and evaporation volume from the available total volume to determine the volume of water available by the end of March.
- Express the available volume as a percentage of the total volume to determine the expected water levels by the end of March.

4.0 Results and Discussions.

This chapter presents the results of the hydrological forecast. Table 1 below shows the estimated flows and storages from the rainfall forecast.

Table 1: Summary of Estimated Flows and Storage level derived from the Rainfall forecast

	Scenario 1 Minimum			Scenario 2 Maximum		
Catchment	Expected Inflows (ML)	Inflows into reservoir (Minimum)	Expected Storage at end of March(%)	Expected Inflows (ML)	Inflows into reservoir (Maximum)	Expected Storage at end of March(%)
Gwayi	729,260.9	94,074.66	44.5	1,450,640.3	187,132.6	82.7
Manyame	1,500,456.0	417,126.76	85.3	2,810,880.6	781,424.8	99.3
Mazowe	2,044,488.9	251,472.13	83.5	3,830,045.1	471,095.5	95.8
Mzingwane	742,714.1	257,721.80	60.4	1,485,428.3	515,443.6	80.3
Runde	776,647.7	353,374.71	34.3	1,507,746.2	686,024.5	47.7
Sanyati	1,960,056.7	423,372.24	89.6	3,493,562.1	754,609.4	97.0
Save	2,495,526.5	304,454.23	57.8	4,477,378.8	546,240.2	78.3
Total	**10,249,150.7**	**2,101,596.53**	**65.1**	**19,055,681.4**	**3,941,970.7**	**84.0**

4.1 Gwayi Catchment

The catchment is expected to have normal to below normal rainfall for the period OND and JFM.

The expected flows for the catchment will be in the range of 729,260.9 ML to 1,450,640.3 ML. The expected dam levels by the end of March 2015 would be at least 44.5%. It must be noted that though the catchment will receive flows that can easily fill up the dams, most of the dams in the catchment are mainly concentrated in the upper reaches meaning a greater percentage of the inflows (87.1%) will not be captured by the inland dams.

4.1.1 Implications of the forecast

- Water available for domestic and irrigation purposes will be limited in post rain season. There is need to urge water users to utilise the available water resources efficiently and take all measures to conserve their supply.
- Chances of flooding in the flood prone area of Tsholotsho are relatively low for the upcoming season.

4.2 Manyame Catchment

Below normal rainfall conditions are expected in the catchment for OND while normal to above normal conditions are expected for the JFM period.

It is expected that the flows generated by the catchment will be at least 1,500,456 ML and the dam levels in the catchment are expected reach at least 85.3% by end of March. Chances of most dams spilling in the catchment are high. The dam levels as at the 4th of September stood at 92.5% full highlighting the underutilisation of the dams. Apart from the use of water for Urban, Industrial and Mining (UIM) purposes in major towns and cities in the catchment, most of the irrigation dams are underutilised resulting in above normal levels even before the onset of the rains.

The catchment is expected to generate excess runoff particularly during JFM which might lead to flooding in the flood prone areas like Muzarabani. Even though normal to above normal rainfall conditions usually generates a lot of runoff, it should be highlighted that the dams in the catchment are not well distributed to capture all the runoff generated from rainfall. Only 27.8% of the whole catchment is covered by dams.

4.2.1 Implications of the forecast

- Adequate water available for domestic and irrigation purposes.
- Chances of flooding in areas like Muzarabani and Chidodo are high during JFM due to excess runoff. The communities are urged to be very alert of the situation on the ground and get rainfall updates and warnings through radios, newspapers etc.

4.3 Mazowe Catchment

Below normal rainfall conditions are expected in the catchment for OND while normal to above normal conditions are expected for the JFM period.

The expected flows generated in the catchment will be at least 2,044,488.9ML, most of which will flow outside the country untapped due to distribution of the dams in the catchment. Most of the dams in the catchment are located in the upper reaches of the catchment. The dams cover only 22.3% of the whole catchment area. The dam levels on average are expected to be between 83.5% and 95.9% by the end of March 2015. As at the 4th of September the dam levels in the catchment stood at 82.7% full on average.

4.3.1 Implications of the forecast

- The water supply situation for the catchment would be fairly adequate for both domestic and irrigation purposes. However problems of water supply for domestic purposes might arise from the water supply stations with limited storage capacity like Mutoko.

4.4 Mzingwane Catchment

The expected rainfall conditions for the catchment are normal to below normal rainfall for both the OND and JFM period.

Mzingwane Catchment is expected to have inflows in the range between 742,714.1 ML and 1,485,428.3 ML. Approximately 34.7% of the flows generated in this catchment will be captured by the catchment dams due to their distribution. As at the 4th of September, the dam levels in the catchment stood at 64.6% full on average. By the end of March the dam levels are expected to be in the range of 60.4% to 80.3% full on average.

4.4.1 Implications of the forecast

- The largely normal to below normal rainfall predicted will not be very favourable to the catchment water supply dams as they will remain relatively low compromising the water security in the region particularly for the City of Bulawayo.
- Chances of flooding in the low-lying areas of Chikwakwala are relatively low. However, the large Limpopo catchment area outside our borders can induce floods within the country. The authorities should be alert on the activities in the catchment outside our borders.

4.5 Runde Catchment

The rainfall forecast for the Runde Catchment is expected to be normal to below normal for the OND period; the same for the JFM period.

The catchment is expected to generate flows ranging between 776,647.7ML and 1,507,746.2ML. Approximately 46% of the runoff generated in the catchment will be captured by the dams due to their distribution. By end of March the dam levels are expected to be between 34.3% and 47.7% full on average. As at the 4th of September 2015, the dam levels in the catchment stood at 47.2% full on average.

4.5.1 Implications of the forecast

- The largely normal to below normal rainfall predicted will be unfavourable to the catchment's key irrigation dams like Mutirikwi as the dams need significant inflows to boost water demand for irrigation purposes. Efficient use of the current storage volumes is envisaged especially in October to Mid December.
- Chances of flooding in the catchment particularly the Malapati area are very slim unless a cyclone event occurs.

4.6 Sanyati Catchment

The bulk of the catchment is expected to have below normal rainfall during OND period. For the JFM period, the bulk of the catchment will receive normal to above normal rainfall whilst the southern and the western part of the catchment will have normal to below normal rainfall.

The Sanyati Catchment is expected to generate between 1,960,056.7 to 3,493,562.1 ML of runoff. The greater proportion of the flows will not be captured by the inland dams as they only cover 21.6% of the catchment area. However, Kariba Dam will capture most of the excess flows from this catchment.

The dam levels are expected to reach at least 89.6% full on average by the end of March. As at the 4th of September the dam levels in the catchment stood at 80.1% full on average.

4.6.1 Implications of the forecast

- Generally the forecast is favourable for both domestic and irrigation purposes in this catchment.
- There are moderate chances of flooding in the Gokwe area especially in the JFM period.

4.7 Save Catchment

The greater part of the Save Catchment is expected to have below normal rainfall during the OND period. During the JFM the northern parts of the catchment are expected to have normal to above normal rainfall while the southern parts of the catchment will receive normal rainfall with a bias towards below normal.

Save Catchment is expected to have flows in the range 2,495,526.5 ML to 4,477,378.8ML. Much of the flows generated in the catchment would be lost due to the distribution of the dams which cover only 12.2% of the catchment.

On average the dam levels are expected to be in the range 57.8% to 78.3% full on average by end of March. As at the 4th of September, the dam levels stood at 67.3% full on average.

4.7.1 Implications of the forecast

- Generally the forecast is not very favourable for irrigation purposes in this catchment particularly for the Chisumbanje estates.
- Chances of flooding risk in the low-lying areas of Middle Sabi are high especially during the second half of the season (JFM). This is because most of the upstream areas will experience normal to above normal rainfall therefore inducing high flows that can affect the downstream areas.

4.8 National Outlook

The country is expected to generate between 10,249,150.7ML and 19,055,681.4ML of runoff. It should be noted that the bulk of the runoff generated would be lost due to the national coverage of the dams. Only 24% of the country's total area is covered by the dams. Most of the country's dams are located on the upper reaches of the catchment areas. By the end of March 2015 the dam levels on average are expected to be between 65.1% and 84% full on average.

5.0 Conclusions and Recommendations

Generally the forecast shows unfavourable conditions for water resources management for most of the catchments. The 2015/16 season is coming after an extremely good 2014/15 season which resulted in high storage levels in most of the catchment dams except Runde. As a result, the 2015 runoff season is starting when most of the catchments still have good storage levels in the dams particularly for Manyame, Mazowe and Sanyati.

- It has been observed that a greater part of the flows generated are not being captured by the dams. This is due to the fact that large carry over dams which have been proposed for quite a long time have not been constructed to capture as much of the flows as possible. These dams include the Condo (Save), Nyatana (Mazowe), Kudu (Sanyati), Gwayi-Shangani etc. These dams will not only help in ensuring improved water security but also help to mitigate against extreme weather conditions like drought and floods which are expected to increase in frequency as a result of climate change.

- It is advisable for the catchments to use the yield figures for allocation of water to ensure that dams are assured of a significant volume most of the time to secure the supply.