Palaeontological Impact Assessment for the proposed clearing for agriculture on portion 2 of Mooifontein 292 JT, Mpumalanga Province

Desktop Study

For

Henwood Environmental Solutions (Pty) Ltd

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Prof Marion Bamford
Palaeobotanist
P Bag 652, WITS 2050
Johannesburg, South Africa
Marion.bamford@wits.ac.za

Expertise of Specialist

The Palaeontologist Consultant is: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 30 years research; 22 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Henwood, Environmental Solutions (Pty) Ltd, Nelspruit, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

Henwood Environmental Solutions (Pty) Ltd has been contracted to carry out an EMPr for the proposed clearing of land for agricultural purposes, on the on portion 2 of Mooifontein 292 JT about 25 km west of Nelspruit, Mpumalanga Province. The site lies on ancient rocks of the Malmani Group…… Onverwacht Group (2640 – 2500 Ma). Microfossils (bluegreen algae, less than 10 microns in diameter) have been reported from the same aged sediments in two separate basins to the west, so there is a very small chance that microfossils could occur in chert bands, if chert occurs on the site. It is recommended that since only soils and vegetation would be disturbed, therefore, there would be impact on the fossil heritage. As far as the palaeontological heritage is concerned the project can continue and no further assessment is required.

Table of Contents

1. Background

Henwood Environmental Solutions has been appointed to carry out the EIA and WULA for a proposed clearing of land for agriculture on portion 2 of Mooifontein 292 JT, Mpumalanga Province. The National Heritage Resources Act (Act 25 of 1999) and the National Environmental Management Act (Act 107 of 1998) requires that the proposed development must be preceded by the relevant impact assessment, in this case for palaeontology.

The proposed activity will entail the clearing of land of vegetation and the planting of crops.

Figure 1: Detailed map from Google Earth of the proposed area to be cleared on portion 2 of the Farm Mooifontein 292 JT, about 25km west of Nelspruit. Map supplied by Henwood Environmental.

This report is the palaeontological impact assessment for the project.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014)

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	**Relevant section in report**
Details of the specialist who prepared the report	Appendix A
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix A
A declaration that the person is independent in a form as may be specified by the competent authority	Page 1

An indication of the scope of, and the purpose for which, the report was prepared	Section 1
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section ii **Error! Reference source not found.**
An identification of any areas to be avoided, including buffers	N/A
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4
Any mitigation measures for inclusion in the EMPr	n/a
Any conditions for inclusion in the environmental authorisation	n/a
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	n/a
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	N/A
A description of any consultation process that was undertaken during the course of carrying out the study	N/A
A summary and copies if any comments that were received during any consultation process	N/A
Any other information requested by the competent authority.	N/A

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance;
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected.

3. Geology and Palaeontology

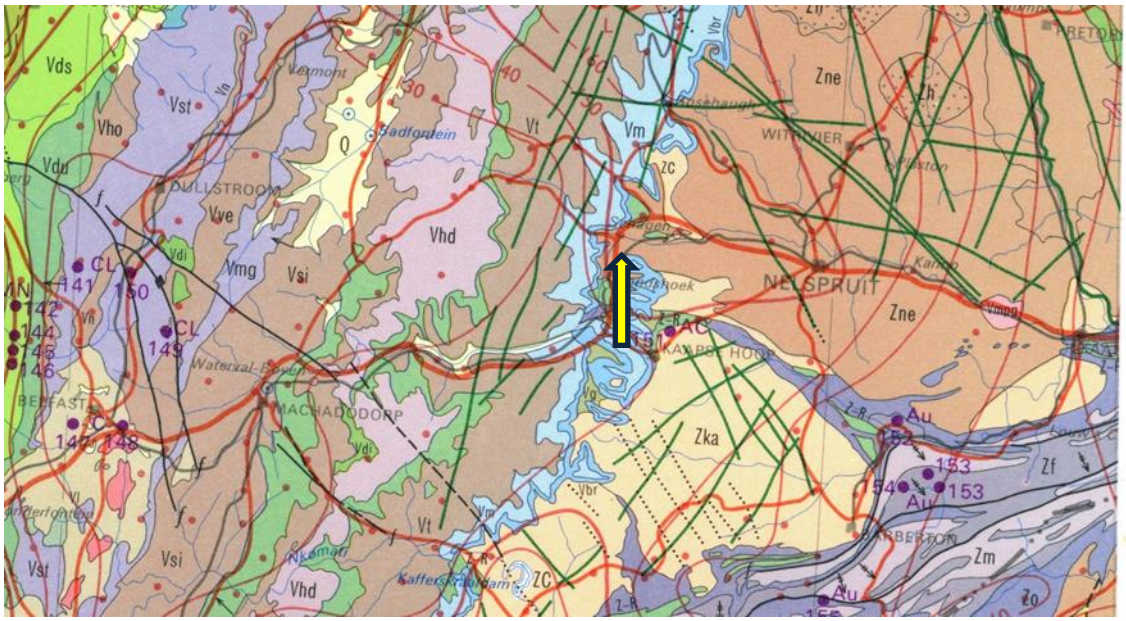

Figure 2: Geological map of the area around the farm Mooifontein, Mpumalanga Province where the proposed clearing will take place. The proposed site is indicated by the yellow arrow. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 1 000 000 map 1984.

Table 2: Explanation of symbols for the geological map and approximate ages (Erikssen et al., 2006; Johnson et al., 2006; Marshall, 2006). SG = Supergroup; Fm = Formation.

Symbol	Group/Formation	Lithology	Approximate Age
Vsi	Silverton Fm, Pretoria Group	Basalt, tuff, shale	Ca 2150 Ma
Vhd	Dwaalheuvel, Strubenkop and Daspoort Fms; Pretoria Group	Andesite, sandstone, shale	
Vh	Hekpoort Fm, Pretoria Group	Basaltic andesite, pyroclastic rocks	2224 Ma

Symbol	Group/Formation	Lithology	Approximate Age
Vti	Timeball Hill and Rooihoogte Fm, Pretoria Group	Shale, quartzite, conglomerate, breccia, diamictite	Ca 2420 Ma
Vm	Malmani subgroup, Chuniespoort Group	Dolomite, quartzites, shales, breccias	2642 – 2500 Ma
Vbr	Black Reef Fm	Quartzite, conglomerate, shale, basalt	>2642 Ma
Vg	Godwan Group	Clastic sedimentary and lesser volcanic rocks, massflow diamictites and pyroclastic rocks	
Z-R	Unnamed ultrabasic rocks	Ultrabasic volcanic rocks	
Rmp	Mpuluzi Batholith (Mpuluzi Suite)	granites	Ca 3303 Ma
Zne	Nelspruit Batholith (Nelspruit Suite)	Gneiss, porphyritic granite	Ca 3303 Ma

i. Geology

The rocks in this region are amongst the oldest rocks in the world. To the south east in a northeast – southwest orientation are the oldest rocks, those of the Barberton Greenstone Belt. To the west in a more north-south orientation are the Bushveld Complex rocks of the Chuniespoort and Pretoria Groups, while in between are the granite batholiths and plutons of the mid Archean.

The Black Reef Formation (quartzite) underlies the Chuniespoort Group and represents a widespread but thin upward fining sequence that was laid down in fluvial and then shallow marine conditions (Erikssen et al., 2006). The overlying Malmani Subgroup (lower part of the Chuniespoort Group) comprises five thick formations of stromatolitic and oolitic dolomites, shales, quartzites and erosional breccias. The depositional model for the Malmani Subgroup is that of a tidal palaeoenvironment, ranging from supratidal flat stromatolitic mats to intertidal columnar stromatolites, and with a subtidal zone composed of giant stromatolitic domes (Erikssen et al., 2006). The project area is partly on the Malmani Subgroup rocks and partly on the Black Reef Formation.

The Malmani Subgroup in the Transvaal Basis is divided into five formations based on the content of the cherts, the morphology of the stromatolites, the intercalated shales and erosion surfaces. Overlying the Black Reef Formation are, from bottom to top, the Oaktree Formation, Monte Christo, Lyttleton, Eccles and Frisco Formations. These are predominantly dolomitic.

The Hekpoort Formation (Pretoria Group) is of subaerial volcanic origin with very thick basaltic andesitic lava in the south but thin in the northeast.

ii. Palaeontological context

Batholiths and plutons do not preserve any fossils as they are igneous in origin. These particular ones, the Mpuluzi and Nelspruit batholiths, are also too old to preserve fossils even if any life forms were around as they are over 3300 Ma. At this time there were only single-celled algae or bacteria present (Knoll, 1984).

To the west are rocks of the Pretoria Group. There are two models proposed for the formation of the Pretoria Group. One is that sedimentation occurred in a shallow marine setting. The other model proposes that deposition occurred in a closed basin, but there are no invertebrate fossils to support the model. More recent workers have suggested that initially there was a closed basin (Rooihooghte to Strubenkop Formations) followed by alternating transgressive and regressive cycles in a shallow marine setting (Erikssen et al., 2006), or deep marine (Erikssen et al., 2012).

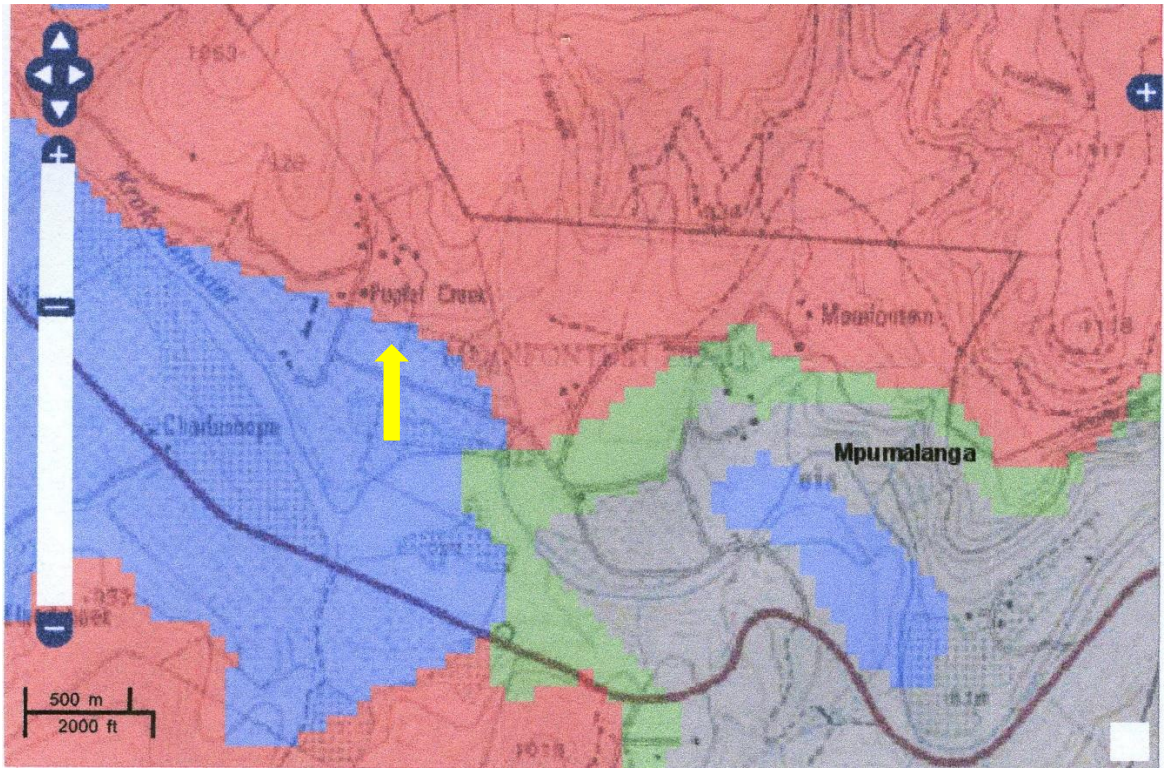

Figure 3: SAHRIS Palaeosensitivity map for the area west of Nelspruit, along the N4 highway. The proposed site to be cleared is indicated by the yellow arrow.. Colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

Trace fossils, in the form of microbial mats that have formed on or preserved ripple marks, have been found in the Daspoort and Magaliesberg Formations (underlying and overlying the Silverton Formation, respectively; Erikssen et al., 2012; Parizot et al., 2005) but the authors did not provide localities. According to the authors the trace fossils would have formed on the shores of the sea (Erikssen et al., 2012), but no body fossils have been found as the rocks are too old. To date no microbial mats have been reported from the Malmani Subgroup but stromatolites do occur. There are no fossils in the Hekpoort Formation as it is volcanic.

The Black Reef Formation and Malmani Subgroup banded ironstone and dolomites, although formed by the chemical activities of ancient algae, photosynthesis and oxygen production, are not known to have preserved fossil algae near Nelspruit.

Based in the geology of the area there is a very small chance that microfossils may occur in the stromatolites and cherts of the Malmani because they occur in rocks of the same age but in the Prieska and Ghaap Plateau sub-basins. This is indicated by the SAHRIS palaeosensitivity map (Figure 3) which shows that the northern half of the farm is highly sensitive but the southern part has low sensitivity. However, there are no records of fossils from this region in South Africa.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

TABLE 3A: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY	**H**	Definite/ Continuous
	M	Possible/ frequent

(of exposure to impacts)	**L**	Unlikely/ seldom

TABLE 3B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	**H**	-
	M	-
	L	There is none to an extremely small chance of fossils being found here
	L+	-
	M+	
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	The spatial scale is extremely small.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	
	L	There is none to an extremely small chance of finding fossils in the cherts in the rocks but they are microscopic and would NOT be visible to the naked eye.

Based on the nature of the project, the surface soils will be excavated to a depth of 1-2 metres to remove vegetation and tree stumps. Since there is no chance of finding fossils in the soils and granites there would be no impact on the fossil heritage. There is no chance of finding fossils BEFORE excavations commence or during these shallow soil excavations. Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low to nil.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the gneisses, schists, granites and basalts are typical for the country and, except for the cherts, do not contain any fossil plant, insect, invertebrate and vertebrate material. No fossils have been reported from the stromatolites of the Malmani Subgroup and there is no chance of finding fossils in the Black Reef Formation, in the Hekpoort Formation or in the plutons and batholiths in the area. In general soils do not preserve fossils and if they did their origin would be unknown which greatly reduces the significance of the fossils

6. Recommendation

The rocks of volcanic origin would not preserve fossils. The stromatolites have been formed by algae but rarely are algae preserved in stromatolites or dolomites. None has been recorded from the west part of the Pretoria Group. Based on these criteria no further palaeontological assessment is required. As far as the palaeontological heritage is concerned the proposed clearing of vegetation for agriculture can proceed.

7. References

Erikssen, P.G., Altermann, W., Hartzer, F.J., 2006. The Transvaal Supergroup and its precursors. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. pp 237-260.

Johnson, M.R., van Vuuren, C.J., Visser, J.N.J., Cole, D.I., Wickens, H.deV., Christie, A.D.M., Roberts, D.L., Brandl, G., 2006. Sedimentary rocks of the Karoo Supergroup. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J., (Eds). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria. Pp 461 – 499.

Knoll, A.H., Bergmann, K.D., Strauss, J.V., 2016. Life: the first two billion years. Philosophical Transactions of the Royal Society B 371, 20150493.

Kremer, B., Kazmierczak, J., 2017. Cellularly preserved microbial fossils from ca 3.4 Ga deposits of South Africa: A testimony of early appearance of oxygenic life? Precambrian Research 285, 117-129.

Plumstead, E.P., 1969. Three thousand million years of plant life in Africa. Geological Society of southern Africa, Annexure to Volume LXXII. 72pp + 25 plates.

Appendix A – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
May 2018

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) Academic qualifications

Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) Professional qualifications

Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) Membership of professional bodies/associations

Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees

All at Wits University

Degree	Graduated/completed	Current
Honours	5	2
Masters	8	1
PhD	10	2
Postdoctoral fellows	7	3

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 2-8 students per year.

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – onwards, Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –
Cretaceous Research: 2014 -

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells

- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells

xi) Research Output

Publications by M K Bamford up to January 2018 peer-reviewed journals or scholarly books: over 120 articles published; 5 submitted/in press; 8 book chapters.
Scopus h index = 24; Google scholar h index = 26;
Conferences: numerous presentations at local and international conferences.

xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)