

Proceedings of

**Merensky Young Scientist Seminar:
Valuation and Evaluation of Forest Resources**



jointly organized and implemented by

Chair of Forest Inventory and Remote Sensing
Faculty of Forest Sciences and Forest Ecology
University of Göttingen, Germany

and

Department of Forest and Wood Science
Faculty of AgriSciences
Stellenbosch University, South Africa

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Preface

Stellenbosch University celebrates its 100 year birthday in 2018. Agriculture was one of the first four faculties established in 1918 and merged in 2006 with the Faculty of Forestry to become the current Faculty of AgriSciences. Although the Faculty of Forestry was only established in 1931 the Stellenbosch centennial celebrations provide a good opportunity to give credit to people and organisations who were involved in the establishment of the Forestry Department at Stellenbosch.

One such person was Dr Hans Merensky. Archival records indicate that he was instrumental in establishing the first chair in forestry at Stellenbosch and though his continual support in those early years the then Faculty of Forestry could expand and increase its academic footprint not only in South Africa but world-wide. His involvement included much more than financial support. The Stellenbosch Archive contains many examples of communication between him and the academic staff members on technical matters and research visits to his farm and to forestry schools in Germany.

To honour his contribution the Merensky Young Scientist Seminar was held from 20 to 22 September 2018 in Stellenbosch. The objective of the Seminar is to allow 15 students from Stellenbosch, Venda and Nelson Mandela University as well as 15 students from Göttingen and Dresden Universities in Germany to present their research under the theme of “Valuation and Evaluation of Forest Resources”.

This workshop enabled students from different forestry schools, countries and cultures to experience some of the colloquial academic interaction that Dr Hans Merensky maintained with academics from Stellenbosch and other German universities and where he supported serious young academics in an unprecedented manner. This Seminar is also the sixth joint student exchange event organised since 2010 by the Department of Forest and Wood Science at Stellenbosch and the Chair of Forest Inventory and Remote Sensing at Göttingen University. An example of how this academic interaction, kindled by Dr Merensky, can still have a positive impact on the lives of students.

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Thank you to sponsors

22 September 2018

The Chairpersons

Hans Merensky Foundation and

Hans-Merensky-Stipendien-Stiftung

Dear Sirs,

RE: Hans Merensky Young Scientist Seminar – 20 – 22 September 2018

We, the participants of the 2018 Hans Merensky Young Scientist Seminar, would like to thank you for your support in making this Seminar possible and a great success. This was a wonderful opportunity for us to learn from each other as students in the forestry field in both Germany and South Africa, which allowed for the sharing of experiences and best practice. We made new friends and could share our research ideas and projects with each other at a truly international gathering.

Your support is truly appreciated in the growth of the forest industry both in Germany and South Africa! We trust that future seminars may continue to bring young minds together with the aim of expanding our understanding and collaborations.

Yours sincerely

M. Joubert
Hans Trehs
Christy Klein
Greece Kotoepe
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Table of contents

Preface	4
Thank you to sponsors.....	5
List of participants	8
Hans Merensky – A short history	9
Extended Abstracts	15
Benefits of community participation in forest management in Mpumalanga, South Africa	16
Natural forest resources utilization: a case study of Lambani village, Vhembe district, Limpopo province of South Africa	17
Evaluation of some selected small-scale forest plantations in Limpopo Province, South Africa	19
A conceptual framework for payment for environmental services in plantation forests in South Africa	20
Ethno botanical survey of tree species used by the Venda people in Limpopo Province, South Africa	22
Health and risk assessment of avenue and boulevard trees on University of Venda Campus	23
Monitoring logging operations in plantations using Sentinel-2 satellite data - a pilot study in <i>Eucalyptus grandis</i> plantations in the province Limpopo, South Africa	25
Water-use and water-use efficiency in plantations and indigenous forests in the southern Cape	26
Impact of water holding capacity and soil moisture content on the moisture content of selected European timbers.....	28
Comparative work time and ergospirometry study between the Neheimer and Harzer Planting Procedure and isiePRO	29
A new approach to “Forsteinrichtung”: Combining enterprise level inventories and airborne LiDAR data to develop compartment wise management plans	30
The forest of the Norra Kvill National Park	32
Predator management in Germany	34
Multiple-use forest management.....	35
Forest monocultures, a comparison between South Africa and Germany	37
Possibilities in UAV monitoring on grassland vegetation	39
Forest inventory in Namibia’s dryland forests - a case study.....	41
The technological status of silviculture re-establishment practices in South Africa	42
Unlocking the potential of harvester on board computer data in the South African forestry value chain.....	44

Quantifying financial returns from commercial forestry research trials in the Zululand Region of KwaZulu-Natal	46
The value of six key soil variables for incorporation into a South African forest site classification system	48
The application value of forest site classification and evaluation systems in South Africa	50
Finding value in waste: An economic feasibility assessment for the manufacture of wood polymer composites using invasive alien plant biomass and recycled thermoplastic waste in South Africa	51
The feasibility of Wood Plastic Composite Materials as building materials for RDP houses	53
<i>Eucalyptus</i> and its economic usage possibilities	55
Short rotation coppices in agroforestry system- evaluation of yield and growth rate	56
Wheat yield limiting effect through the reduction of photosynthetic active radiation (PAR) by trees in the agroforestry systems of Georg-August University Göttingen	58
Energy wood from short-rotation plantations in times of climate change	61
Evaluation of the deviation between written and actual dimensions of pine logs in Timbadola Sawmill, Levubu, South Africa.....	62
Programme.....	63

List of participants

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Companie	Lucas	Dresden
Dlamini	Tenele	Stellenbosch
Eyselée	Frederik	Göttingen
Friedrich	Johanna	Göttingen
Fuchs	Hans	Göttingen
Gerbaulet	Max	Göttingen
Ham	Cori	Stellenbosch
Hilliger	Reinhard	Dresden
Kleinn	Christoph	Göttingen
Kossmann	Philipp	Dresden
Long	Leo	Nelson Mandela
Louw	Jos	Nelson Mandela
Magdon	Paul	Göttingen
Mahnken	Mats	Göttingen
Makoto	Munyaradzi	Venda
Mapeto	Tatenda	Nelson Mandela
Mudavanhu	Shepherd	Stellenbosch
Ndotshinyani	Mashanzhi	Venda
Nelwamondo	Charmaine	Stellenbosch
Ojelade	Solomon	Venda
Pancritius	Julian	Göttingen
Rackelmann	Fabian	Göttingen
Ramantswana	Muedanyi	Nelson Mandela
Rollet	Ramavhale	Venda
Sibhakabhaka	Thembisa	Nelson Mandela
Terblanche	Marius	Stellenbosch
Thomé	Pauline	Göttingen
Volmer	Johannes	Göttingen
Wegener	Friedrich	Göttingen

Hans Merensky – A short history

Compiled by Jeanne Roux

Early life

Hans Merensky was born on 16 March 1871 to the German missionary Alexander Merensky and his wife, Marie Liers (Plug 2014). Alexander Merensky schooled his children at their mission station, Botshabelo, near Middelburg in Mpumalanga. He specifically taught them to carefully observe their natural surroundings, including birds, plants, animals and rocks. In Hans Merensky's later years, he attributed his fine observational skills to his father's early teachings about environmental observations (Platinum Metals Review 1971).

In 1882 the Merensky family moved back to Germany, where Hans Merensky completed his school education. He longed for the natural environment and open spaces of South Africa. When the time came for him to choose a career path, he was more inclined towards something that would keep him outdoors. He initially considered forestry, a profession that had been predominant in his family for generations. Before Hans Merensky made his final decision, he was called to complete his military service in the Prussian Army. He once confessed to his good friend, Albrecht von Thaer, that military life was not for him. Upon which von Thaer, who was from a military family and dreamt of becoming a general, replied: "*It depends on what is in your blood*". "*Well, I must have open spaces [in my blood],*" Merensky answered. It is said that Hans Merensky knew from that moment that he wanted to study geology (Lehmann 1989).

Merensky's final months of study was at the University of Berlin. He was a dedicated student and his professors spoke of him as a born geologist. During a field trip Hans Merensky identified a deposit before the professor himself managed to. The professor apparently later said: "*He [Merensky] seems to have a sixth sense about geological deposits*". Merensky passed his final examinations with honours and became a "Bergreferendar" (first stage mining engineer). Nearly nine years after he started with his training, he obtained the title of "Bergassessor" and started work at the Prussian Department of Mining. Soon afterwards he grew tired of the routine and pattern of government service. Lehmann (1989) writes "*He was too inquisitive, too unorthodox, too inclined to be guided by his recurrent 'sixth sense'*". In 1904, Merensky returned to South Africa on a year's study leave to report on the mining activities in South Africa. Not long after his arrival, he left the Prussian Mining Department and started to make a name for himself as an independent geologist and mine engineer (Die Hans Merensky Stigting 1994).

Merensky worked as an independent consulting geologist and mining engineer. It was not long before he secured commissions from a number of mining finance houses in Johannesburg and during his investigations contributed papers to the Geological Society of South Africa and to the *Zeitschrift für praktische Geologie* (Platinum Metals Review 1971). Although Hans Merensky experienced some success in his early years as a geologist and mining engineer, making money on small mining ventures, he lost all his earnings, as well as a large sum of money from friends, family and other acquaintances on the Johannesburg stock market. Furthermore, when the First World War broke out in 1914, Merensky was interned due to his service in the Prussian Army. When the war ended, he was bankrupt, depressed and in poor health (Rocks and Minerals 2002). Hans Merensky, however, finally managed to change his fortune and became the greatest prospector and discoverer of mineral deposits in the history of South Africa (Plug 2014).

Geological discoveries

The first of Merensky's great discoveries was when he discovered vast platinum deposits in the Bushveld Igneous Complex (BIC) along the North West, Limpopo, Gauteng and Mpumalanga provinces in 1924. The Merensky reef, a platinum-bearing layer of almost 160 kilometres long, is one of the richest sources of platinum in the world (Machens 2009). Hans Merensky's second great geological breakthrough came with the discovery of diamonds on the coast of Namibia (then German South West Africa). Although Merensky did not initially discover diamonds in the area, he proved his theory of their origin to be true.

Merensky decided to further investigate the discovery of chrome in the then north-eastern Transvaal. He stated that, *"A country like South Africa cannot live on gold and diamonds alone. In the long run her base minerals will prove far more valuable to her than her precious minerals; they will become the backbone of her prosperity. Nobody can live on champagne and caviar every day of the week. He must go back to bread and butter."* Merensky uncovered a chrome reef of more than 11 km long, and between 1.2 and 2.4 meters thick. Although the chrome was of a lesser standard to other world sources at the time, Merensky believed that the other sources will be depleted, and the necessary technology will be developed, so that the technical difficulties involved in treating his chrome will be eradicated (Lehmann 1989).

His second last great geological discovery was vermiculite. At that stage it was considered an invaluable mineral, often referred to as rotten mica. He, however, realized the importance of the mineral. He knew that it could be used to treat and meliorate soil, as it loosened and aired it (Machens 2009). Merensky's vermiculite discovery was one of the largest in the world and also by far of the most superior quality (Lehmann 1989).

Merensky's last great geological discovery was made at the age of seventy-five. Phosphate, the basis of the country's most important fertilizer, was in very short supply after the Second World War. Up to then, South Africa imported its phosphate supply. When the war broke-out, imports immediately stopped. The discovery was made on pure memory. Hans Merensky, being a farmer himself and worried about the phosphate situation, sent his assistant to where he had discovered vermiculite years ago. He summoned his trustworthy assistant, von Bülow, to bring him a certain stone which he saw about 40 years ago. He described the appearance and gave the exact location of the said stone. The assistant was doubtful, but found the stone with small knobs just where Merensky had said it would be. Merensky started prospecting where the stone was found. Some days he was so weak, he had to be carried between the trenches. But it all paid off. Merensky found a massive phosphate deposit, big enough to provide high quality phosphate for more than a 100 years (Lehmann 1989).

Agriculture and forestry

During Merensky's lifetime, he was not only known as the *'Wizard Geologist'* due to his geological discoveries, but also later nicknamed *'the man who is painting South Africa green'* when he primarily shifted his focus from mining and geology to agriculture and forestry (Lehmann 1989). In 1930, Merensky bought the farm, Westfalia, located outside Tzaneen, South Africa (Lehmann, 1989). The farm was run-down with soil erosion evident everywhere due to overgrazing and other environmental malpractices, water streams were dried up, some of the orchards had died and the crops were poor.

Although Merensky knew little of the practical side of farming, he approached his new project as a scientist. Within ten years, Merensky transformed Westfalia into a vibrant estate. Dr Hugh Bennet, Head of the American Conservation Services wrote to Merensky: *“I am constantly referring to the fact that you are carrying out on your place one of the world’s notable examples of soil conservation. If what you have done, could be extended to the millions of acres, of the various types of land throughout South Africa, and neighbouring African states, the benefit would be, in my opinion, nothing short of boundless”* (Lehmann 1989).

Merensky planted avocado orchards and forestry plantations. Both of these ventures are still carried out by the Hans Merensky Foundation today. *“Trees were Dr Merensky’s greatest love, bearing in mind that he came from a family that had been foresters for five generations, it seemed natural that he should turn back to this side of farming one day”* (Machens 2009). Hans Merensky was the first person in South Africa to experiment with *Eucalyptus saligna*. At that point, the timber was used as mine props. The normal practice was to fell the trees at the age of seven or eight years. Merensky decided to thin some of his *E. saligna* compartments after eight years and sold these trees as mine props. After another five or six years, the same compartments were thinned out once more. The 14 year old trees were now much thicker and could be used for telephone poles or box wood. The remaining trees were left to the age of 20 years. These trees could now be used for saw timber. This experiment was highly successful, as the 20 year old *E. saligna* trees produced good quality timber for flooring, furniture and structural lumber (Lehmann 1989).

Dr Merensky was responsible for building the Merensky Dam outside Tzaneen. The dam is large enough to hold approximately 1,3 million kilolitres of water. This was much more than what Westfalia needed, but Merensky intended for the dam to also serve neighbouring farms. To avoid the silting up of the dam through eroded soil, Merensky leased one of the upstream farms on which erosion was particularly bad. He re-grassed the hillsides and also planted grasses right to the edges of the feeding streams. In the inlet of the dam he established a *vlei* (marsh) with bull-rushes, sedges and water grasses. This served as a natural filter (Lehmann, 1989). Once again Merensky’s forward-thinking paid off. Merensky said the following to his employees in a Christmas speech during an extreme drought: *“... I thank the Chiefs, Indunas and all of you for the assistance in building up this farm. With our water protection we were especially successful. The big Dam gives a supply of water to the factories ... where women and girls can earn extra money, and from our spruit (brook) we supply the Railway engines with water, as all their normal supplies have given in with drought. We can be proud of having enough water for extending our own work, and still be able to help others...”* (Lehmann 1989).

Philanthropy

In Hans Merensky’s biographies we read stories which serve as indications of his positive characteristics and personality traits. We know that he was a very generous man who was keen for younger generations to benefit through his doing. He was also thankful for what South Africa offered him and wanted to pay it back. He loved nature and wanted to conserve it.

Correspondence between Merensky, his estate and Stellenbosch University illustrate his passion for education of younger generations. One example is the assistance he gave to his good friend, Henning von Bülow’s son, Jürgen. Jürgen von Bülow wanted to farm for a living, but his father wanted him to enter the diplomatic world. Merensky, thinking back to his own career path decision, offered to help Jürgen and encouraged him to make his dreams come true. *“If you are really sure that this is the right thing for you, then do it. If you do not know where to farm later, I have just bought a large*

farm in the Transvaal. There is a lot to do in the next few years. If you want, you can come there any time you wish. You can stay for two to three years, then at least you have seen something of the world – that is never wasted time, and then you can decide what you want to do next” (Machens 2009). After von Bülow completed his *Abitur* (high school diploma), Merensky arranged for him to go to London to learn English and thereafter he came to Westfalia. He stayed there until the end of Merensky’s life. He became Merensky’s right-hand on the farm and later also one of the four administrators of his estate.

Another case where we witness Hans Merensky’s willingness to assist young people to get a start in their professional lives, is the story of his Silesian friend, Horst Correns’ son. Horst Correns wrote to Merensky in 1929, asking him if he could somehow help his son. The son was about 22 years old and was working in Hamburg as a salesman in a position with limited future possibilities. Merensky tried to find a suitable position in South Africa, but this was unsuccessful due to the depression. Recommendations sent to friends in Bremen, Hamburg, London and East Africa also did not amount to any positive results. Merensky urged the young man not to give up and promised him that he will find something when the depression is over. Finally the young man started an import-export business in China, but the bank demanded a large start-up deposit, which Merensky lent to him. Two years later the young man was doing very well and offered to pay Merensky back, thanking him for the help. Merensky replied: *“You do not have to thank me. Make your way in the world, and you will give me great pleasure doing so”* (Machens 2009).

Merensky was anxious that his fortune should be used in a constructive manner. At the opening of the Hans Merensky Library at Pretoria University, Merensky said: *“This country has given me so much, that I am only too happy to be allowed to help it to develop in some way, and I am grateful to be able to give back a fraction of what it has given me. I hope this library will be a cornerstone in the building-up of a bigger South Africa for the future generations...”* (Lehmann 1989). Not only did he donate the Pretoria University Library, he also made substantial donations to Stellenbosch University (Lehmann, 1989). Merensky donated an annual £1 000 grant to Stellenbosch University, on the basis that Dr Merensky would pay £1 for each £1 the University raised from other donors. In so doing, he wanted to motivate others who *“...have the interests and ideals of the University at heart*” (Annex “SU2”). This grant was paid for the period of 1934 to 1939 and was aimed at developing the University (UNISA Archive).

Apart from the £1 000 annual grant to develop the University, Merensky also assisted Stellenbosch professors to visit Germany to broaden their knowledge and to strengthen the South African-German relationship (*“... soll das Stipendium zu einer weiteren Stärkung der südafrikanisch-deutschen Kulturbeziehungen beitragen.”*) (UNISA Archive). One of the academics to attend German research and educational institutions was Prof. E.J. Neethling, the first professor to lead the Forestry Chair at Stellenbosch University. Professor Neethling visited the forestry academies of Tharandt (Technical University Dresden), Eberswalde¹ (Brandenburg) and Hannoversche-Münden,² Freiburg and Gießen (US Archives). Professor Neethling specifically mentioned that the contacts he made during his visit was most valuable: *“...the many valuable forestry contacts that I was able to make, contacts on which I can always rely to assist me in any problem of forestry education which may come up. Amongst the greatest values of a visit, like the one I was privileged to make, lies in the building up of such contacts. It is with great educational privilege to me to have been with those men in Germany who are so actively connected with it there”* (UNISA Archives).

¹ Today, the Eberswalde University for Sustainable Development.

² In 1970/71 the research and teaching institutions of forestry in Hannoversch Münden were relocated to Göttingen and forms part of the Georg-August University, Göttingen.

In return, Dr. Hans Merensky also ensured that German professors visit Stellenbosch University, e.g. Professor Obst, a geologist from Hanover. Hans Merensky assisted Prof Obst in a special study on the young crustal movements, soil erosion and change in natural conditions in South Africa (Annex "SU 3"). Professor Obst also conducted a lecture in the time he visited Stellenbosch University (US Archive)". Apart from the grants mentioned above, Merensky also donated the Hans Merensky Physics Block at Stellenbosch University. The erection of the Hans Merensky Physics Block extended the study and research possibilities in natural sciences at Stellenbosch University (Machens 2009).

Hans Merensky's heritage

On 4 May 1949, Merensky signed his last Will and Testament as well as the Hans Merensky Trust Deed, both of which he had planned the details inside for years (Machens 2009). He donated 90% of his South African estate to the Trust when the Trust was erected and another 10% he bequeathed to the trust after his death. Lehmann (1989) states that: "*Merensky's biggest worry was that his life's work should not stop when he died. He wanted his mining ventures and his farming experiments carried to conclusion, so that others could derive the maximum benefit from them*".

According to Machens (2009), Merensky wanted the Trust to be transformed into a foundation, as no-one could predict the economic, political and social conditions under which the Trust would have to operate in the future. On 26 November 1973, the Hans Merensky Trust became the Hans Merensky Foundation. The main objective of the Foundation, just as that of the Trust, is stated in the original Trust Deed: "... *to promote and assist in the development of the resources of South Africa and its neighbouring territories - particularly such natural resources as soil, water, minerals, flora and fauna – and to promote the health and wealth of it's the inhabitants; more specifically by research, experimentation and demonstration and through the correlation and application of scientific knowledge*" (Machens 2009).

The mandate of the Trust and later the Foundation, was divided into core activities (such as research on soil erosion), of which the purpose was defined very carefully, and extended activities, which allowed the Trustees and later the Foundation managers more freedom to decide on what it wanted to do. The Foundation could, therefore, decide to support foreign research on agriculture, forestry, medicine, geology and mining techniques, "*in so far as they served the interests of 'general progress' (a term Merensky liked to use)*" (Machens 2009). Hereby, Merensky hoped to combine the two things which were most important to him: assuring the continuation of his life's work and the fact that South Africa as a whole should benefit from it (Lehmann 1989).

References

- Die Hans Merensky Stigting. 1994. *Die Hans Merensky Stigting*.
- Lehmann, O. 1989. *Look beyond the wind: The life of Dr. Hans Merensky 1871-1952*, Cape Town: Howard Timmins.
- Machens EW. 2009. *Platinum, gold and diamonds: The adventure of Hans Merensky's discoveries*, Pretoria: Protea Boekhuis
- Platinum Metals Review. 1971. "Dr Hans Merensky: Centenary of the discovery of the platinum reef", *Platinum Metals Review* 15(3): 102-107.

Plug C. 2014. *Biographical database of Southern African science: Merensky, Hans (geology)*, S₂A₃ Biographical Database. www.s2a3.org.za Updated: 25 December 2014. [27 October 2017]
Rocks and Minerals. 2002. "Who in mineral Names: Two South Africans Hans Merensky and Cecil John Rhodes", *Rocks and Minerals*77(1): 48-53.

Archived documents

UNISA Archives, *Hans Merensky Papers*, University of South Africa Library, Pretoria.
US Archives, *Hans Merensky*, Stellenbosch University Archives, Stellenbosch.

Extended Abstracts

Benefits of community participation in forest management in Mpumalanga, South Africa

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Rural communities living adjacent to commercial forestry operations are often affected by numerous negative social issues including poverty, unemployment, poor health care, and limited infrastructure. In excess of 61% of forestry land managed by the state owned SAFCOL is under land claim, as per the Restitution of Land Rights Act (Act 22 of 1994). It is unavoidable that forest companies seek active means of engaging and partnering with these communities through a participatory forest management (PFM) approach. This study explores sustainable (i.e. social, environmental and economic), yet tangible benefits of such an approach as perceived by these rural communities, specifically land claimants.

The study was conducted in communities adjacent to SAFCOL Plantations in the Mpumalanga Province of South Africa. Data was collected between May and June 2017 by means of structured questionnaire surveys of 46 randomly selected households within these communities so as to identify and evaluate perceived benefits in terms of forest products, ecosystem services and amenities/ services/ infrastructure provided by SAFCOL.

The results indicated that these communities recognize and obtain numerous social, environmental and economic benefits from the forest resources, ranging from Non-Timber Forest Products such as firewood, through ecosystem services such as improved water quality, to more metaphysical benefits like access to gravesites and the protection of traditions and customs. However, it was found that the utilization of these benefits was most widely differentiated by gender and land claimant status. Whilst males and females benefitted equally, there were distinct preferences between the genders, for example males showed preference in the collection of building material, bush meat and livestock husbandry, and females showed preference in the collection of firewood, medicinal plants and fruit, amongst others. Similarly, it was found overall that non-land claimants benefited more than land claimants. Reasons for this are primarily due to the increased distance at which the land claimants live from the forest resource as compared to non-land claimants. Future land settlement models and community engagement should thus focus on the inclusion of land claimants and increased access for adjacent communities to obtain these forest products and ecosystem services.

References

Restitution of Land Rights Act 22 of 1994. 1997. *Government Gazette*, no. 17804. Pretoria: Government Printers, Pretoria, South Africa.

Natural forest resources utilization: a case study of Lambani village, Vhembe district, Limpopo province of South Africa

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Forest resources are increasingly acknowledged as important for the livelihoods of people residing in close proximity to forests (Yemiru *et al.* 2010). Approximately 1.2 to 1.4 billion people are depending on the forest for their livelihoods (Chao 2012; FAO 2014). In South Africa, savanna woodlands is one of the most extensive vegetation types which covers about one third of the country (Shackleton *et al.* 2002). Much of this population are characterized by high levels of poverty and unemployment, and a continued heavy dependency on a limited and declining natural resource base (May and Vaughan 1999).

These biological resources (plants and animals) play important roles in the livelihoods of many rural dwellers (Mugido and Shackleton 2017). They are extracted by rural people from nearby forests for their livelihoods, either for consumption or as a source of income (Martins, 2014). A practical investigation of dependency on these forest resources may help to improve the level poverty estimates as well as policy planning and execution (Mamo *et al.* 2007).

This study explored the current use pattern of forest resources by local people of Lambani village, Venda region of South Africa and as well documented the various uses of the resources in nearby natural forest resources. This investigation is an attempt to contribute to the growing pool of knowledge on the value of savanna resources in South Africa, most especially their contribution to household, local, and national development. The study showed levels at which natural forest resources, both wood-based and non-timber forest products were being extracted for various uses, level of dependency and proximity to the natural forest and its effect on agricultural practices within and near the forest. Accessibility of the resources by the community members was also investigated. Lists of fruit trees and other resources that are prohibited from harvesting based on different beliefs were documented. This investigation from the survey clearly showed that indigenous forests are important sources of household energy and provide other important livelihood products and services for most rural households. The findings also showed that forests are still playing vital roles in household food security, as well as the need to ensure sustainable management of the forest resources as emphasised by the community members.

References

- Chao S. 2012. Forest people's: numbers across the world. Forests People Program.
- FAO. 2014. State of the world's forests: enhancing the socioeconomic benefits from forests. Food and Agriculture Organization of the United Nations.
- Mamo G, Sjaastad E, Vedeld P. 2007. Economic dependence on forest resources: A case from Dendi District, Ethiopia. *Forest Policy and Economics* 9(8): 916-927.
- Martins C.R. 2014. Access and use of forest resources: Evidence from common property forest management in Swaziland. *Journal: African Journal of Estate and Property Management* 1: 8-17.

- May J, Vaughan, A. 1999. Mistaken identity? Markets and the strategy for poverty alleviation in rural South Africa. *Indicator SA* 16: 67-72.
- Mugido W, Shackleton CM. 2017. The safety net function of NTFPs in different agro-ecological zones of South Africa. *Population and Environment* 39(1): 107-125.
- Shackleton SE, Shackleton CM, Netshiluvhi TR, Geach BS, Ballance A, Fairbanks DHK. 2002. Use patterns and value of savanna resources in three rural villages in South Africa. *Economic Botany* 56(2): 130-146.
- Yemiru T, Roos A, Campbell BM, Bohlin F. 2010. Forest incomes and poverty alleviation under participatory forest management in the Bale Highlands, Southern Ethiopia. *International Forestry Review* 12(1): 66–77.

Evaluation of some selected small-scale forest plantations in Limpopo Province, South Africa.

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Small scale timber farming in South Africa has been on a steady rise in the past few years. Sustainability and viability of small-scale timber growers brings about community socio-economic development and supplies raw materials to the country, however the industry is highly risk orientated as outbreaks of wildfire occur routinely in the dry season, posing significant threat to plantation investment.

Fire is an integral part of plantation forests and proper fire management planning is inevitable as fire directly threatens stock and rotations. Small scale timber growers own smaller portions of land and the application of financially optimal management practices to the forests then proves to be difficult.

According to (Herbohn 2006) the viability and sustainability of timber production among small growers has to be seen in association with two things, mainly the challenges facing small-growers and their ability to deal with such challenges. A questionnaire was conducted and 30% of the respondents agreed that runaway fires were a major problem.

(Mahlangu 2015) conducted research on small scale timber farming in Entembeni Community and concluded that In the case of the immediate environment, theft and runaway fires affected small-growers the most at Entembeni. It was also shown that small-growers do not have effective measures to deal with such shocks. Instead of having some measures in place, small-growers depend on the hope that theft and fire do not occur, and when such shocks do occur, it becomes a major setback.

This study evaluated fire management plans of small timber growers and assessed their preparedness, fire suppression strategies and resources. Ninety percent of the respondents had very little or no annual preparations for the fire season at all, 90% of the respondents only depended on tree branches to suppress fires and all respondents had no water facilities on their farms they sorely depend on fires not occurring at all.

The study illustrated the lack of basic fire prevention, planning and firefighting knowledge by the growers. Sustainability of the small timber growers industry is highly threatened and more affordable approaches needs to be developed to save the industry.

References

- Herbohn J. 2006. Small-scale Forestry – Is it simply a smaller version of Industrial (Large-scale) Multiple Use Forestry?
- Mahlangu I. 2015. Small scale timber farming in Entembeni Community – exploring sustainability and possibilities for leisure and tourism.

A conceptual framework for payment for environmental services in plantation forests in South Africa

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Plantation forests contribute in supplying environmental services (ES) and goods such as carbon sequestration, clean water production and regulation of hydrological cycles (Kanninen 2010; Pokorny *et al.* 2010). ES are the benefits people obtain, enjoy, consume and use from the environment free of charge and play a significant part in the earth's climate directive to filter wastes and pollutants (Pagiola *et al.* 2004). Previously the roles of tree plantations were not clear with concerns relating to ES. With the increasing demand of wood production, plantations have served their production function in a very effective way. Although ES provide benefits, there are concerns about the increasing development of massive plantations. Such concerns include loss of soil productivity, disruption of local water cycles, risks of pests' diseases, and impacts on biodiversity (Maginnis 2006). Payment of environmental service (PES) was designed and introduced to save forests from being exploited (Laurans *et al.* 2012).

PES is an attractive conservation tool used to preserve and restore ES, whereby the user of ES pays the provider to supply the services (Milder *et al.* 2010). Many forestry owners around the world are acting on conserving and restoring important ES through PES (New generation plantation 2015). A conceptual framework of ES provided by commercial plantations and forests, combined with a suitable PES system, is lacking in SA. Therefore, this study aim to define the concepts and review different types of PES schemes. The study will also investigate the positive and negative impacts on ES associated with commercial forestry plantations, identify possible buyers and sellers of ES in commercial plantations, investigate the impact of compensations and penalties on ES in commercial forestry plantations and develop and test a conceptual framework for PES in SA.

A detailed literature study will be done to identify and investigate different types of PES methods used globally. A key informant e-mail survey will be conducted (approximately 30 people) amongst forestry and environmental experts. This will include managers from forestry companies, foresters, environmental managers and academics. This will be followed by a Delphi study among a small number of experts in the field (approximately 5 to 10 experts). Data collected will be used to develop a conceptual framework for PES for commercial forestry plantation in SA. The framework will then be tested on the NCT Enon plantation. Outcomes of the study can be used to assist forestry companies in SA to protect and conserve ES through well-developed PES scheme.

References

- Kanninen M. 2010. Plantation forests: global perspectives. In: *Ecosystem goods and services from plantation forests* (pp. 17-31). Routledge.
- Laurans Y, Leménager T, Aoubid S. 2012. Payments for Ecosystem Services: From Theory to Practice, what are the Prospects for Developing Countries? AFD, *Agence française de développement*.
- Maginnis S, Pollard D. 2006. Forest Plantations: the good, the bad and the ugly. *Arborvitea-IUCN-WWF Forest Conservation Newsletter* 31(1).

- Milder JC, Scherr SJ, Bracer C. 2010. Trends and future potential of payment for ecosystem services to alleviate rural poverty in developing countries. *Ecology and Society* 15(2).
- New Generation Plantations Annual meeting. 2015. Plantations for People: Thinking at a landscape level Think piece.
- Pagiola S, Von Ritter K, Bishop J. 2004. Assessing the economic value of ecosystem conservation.
- Pokorny B, Hoch L, Maturana J. 2010. Smallholder plantations in the tropics—local people between outgrower schemes and reforestation programmes. *Ecosystem goods and services from plantation forests* 140.

Ethno botanical survey of tree species used by the Venda people in Limpopo Province, South Africa

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Indigenous trees play important roles in livelihoods for rural communities. In Africa indigenous trees are commonly used in rural communities for food and livestock feed, as well as for medicinal and construction purposes. However, there is hardly documentation on the uses of indigenous trees by most rural communities around Limpopo Province. Questionnaires were distributed to three rural villages (Ramavhoya, Rabali and Lambani).

It was determined that only 12%, 28% and 60% of rural villagers from Ramavhoya, Rabali and Lambani villages respectively, used indigenous trees for their livelihood. Of all the households interviewed in three villages, most respondents (65%) were females; 5% divorced, 8% widowed and 52% widowed and 35% were men; 10% married, 18% single and 7% refused to disclose their marital status.

The most common uses of indigenous trees in all the three villages were for making crafts, for medicinal purposes, consumption of fruits, brewing of beverages and construction. The most commonly used trees were: Mufula (*Sclerocarya birrea*), Muhuyu (*Ficus sycamores*), Muvhuyu (*Adansoni digitata*), Mushakaladza (*Rhus lancea*), Munii (*Berchemia discolor*), Muramaba (*Strychnos spynosa*) and Musuma/Muthala (*Diospyros mespiliformis*).

Health and risk assessment of avenue and boulevard trees on University of Venda Campus

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Avenue and boulevard trees have been an integral part of South African urban landscape. Although, roads form a small fraction of habitat corridor that trees can grow, trees in this category provide substantial social, environmental and economic benefits to our communities. These include, provision of shade and shelter; cleaning and moistening of air; wind and noise filtering; microclimate stabilization and psychological services. A number of studies have shown the potentials of avenue and boulevard trees in providing environmental and biological benefits (e.g. Smith, 1990; McPherson 1994; Van Druff *et al.* 1995; Neville 1996; Nowak 2002; Agbeja and Adesoye 2003; Chiesura 2004; Van Duijne *et al.* 2008; Agbelade *et al.* 2016; Onyekwelu 2017).

In spite of their many benefits, avenue and boulevard trees can also pose dangers to human lives and damages to properties. As avenue trees grow from young saplings to mature veterans and large biological structures, they are prone to negative impacts by natural agents such as wind, insects, birds, rain storms, temperatures and anthropogenic activities. These agents reduce their health and vigour, and increase at the same time, hazards and risks to human lives, properties and essential services such as access roads, paved paths, electricity poles, street lights, drains and pipes.

Less attention has been paid to hazards and risks from avenue and boulevard trees. Studies on frequency of tree roots intrusion in drains and pipes, pushing up of pavements and tarred roads by tree roots and cracks in building walls as a result of tree roots are scarce. Currently, there are no available statistical data on the health status and risk level of avenue and boulevard trees on University of Venda campus. Coupled with this, is the absence of any clear cut periodic monitoring of this group of trees for health and risk status. Periodic tree health evaluation and risk assessment, especially for mature trees can enhance early detection of decline in tree health and vigour before it becomes too serious to address. This study, therefore aimed at providing baseline information on health and vigour status as well as risk level of avenue trees on University of Venda campus.

A 100% tree survey was conducted in three major streets in the University campus, as part of a bigger project. These streets were chosen based on the density of trees and commuters using them. Data collected include tree diameter at breast height (dbh), crown spread (a measure of shading potential), tree total height, crown length, species, tree health and hazard status. For identification purpose, each tree was tagged according to their street. Tree height was measured using criterion, while dbh and crown spread were measured using measuring tape.

A total of 313 trees were assessed comprising of about 40 different species. The most common species, based on 5% occurrence and above, are *Olea africana* (11.5%), *Schotia brachypetala* (7.7%), *Kigelia africana* (6.4%), *Syagrus romanzoffiana* (5.4%) and *Bolusanthus speciosus* (5.1%). About 66.1% of the trees appear healthy. In terms of risk, 4.7% of the trees were rated high, 17.3% as medium and 78% as low. Basal decay was observed as dominant cause of defects among unhealthy trees. Very urgent intervention is required to remove trees categorized as high hazard trees because of the potential targets.

References

- Agbeja BO, Adesoye PO. 2003. Community Perceptions on Added Values and Conservation of Trees in the University of Ibadan, Nigeria. *Arboricultural Journal The International Journal of Urban Forestry* 27(2): 117-138.
- Agbelade AD, Onyekwelu JC, Apogbona O. 2016. Assessment of Urban Forest Tree Species Population and Diversity in Ibadan, Nigeria. *Environment and Ecology Research* 4(4): 185-192.
- Chiesura A. 2004. The Role of Urban Park for the Sustainable City. *Landscape and Urban Planning* 68: 129-138.
- McPherson EG. 1994. Cooling Urban Heat Islands with Sustainable Landscapes. *In*: HP Rutherford, RA Rowntree, PC Muick (Eds.). *The Ecological City: Preserving and Restoring Urban Biodiversity*, Amherst University of Massachusetts Press.
- Neville LR. 1996. Urban Watershed Management: The Role of Vegetation PhD. Dissertation, SUNY College of Environmental Science and Forestry, Syracuse, NY.
- Norwak DJ. 2002. The Effects of Urban Forests on the Physical Environment. *In*: TB Randrup, CC Konijendijk, T Christophersen, K Nilsson (Eds.). *Urban Forests and Trees*, Springer, Amsterdam, 22-42p.
- Onyekwelu JC. 2017. Biodiversity, Socio-Economic and Cultural Importance of Trees in Emerging Nigerian Urban Entres: A Case Study of Akure City, Nigeria. *Applied Tropical Agriculture* 22(2).
- Smith WH. 1990. *Air Pollution and Forests* Springer – Verlag, New York.
- Van Druff LW, Leedy DL, Stearns FW. 1995. Urban Wildlife and Human Being. *In*: H Sukopp, M Numata, A Huber (Eds.). *Urban Ecology as the Brass of Urban Planning*, SPB Academic Publishing, Amsterdam, 203-211p.
- Van Duijne FH, Van Aken D, Schouten EG. 2008. Considerations in Developing Complete and Quantified Methods for Risk Assessment. *Safety Science* 46: 245-254.

Monitoring logging operations in plantations using Sentinel-2 satellite data - a pilot study in *Eucalyptus grandis* plantations in the province Limpopo, South Africa

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Management planning in forest plantations needs to consider different temporal and spatial resolutions. While strategic planning is oriented on the whole enterprise with time periods of several years to decades planning of biological production operations (e.g. harvest and reforestation) depends on detailed plans on stand level. These plans usually need to be updated on shorter (yearly or monthly) time intervals to enable flexible reactions on unforeseen circumstances.

This article evaluates the information source of high temporal resolution Sentinel-2 satellite images for monitoring logging operations and updating monthly operation plans. First results of a pilot study in *Eucalyptus grandis* plantations of the Northern Timber Company (NFC) – a part of the Hans-Merensky-Holding in the Limpopo province near Tzaneen, South Africa are presented.

Since December 2015 the European Space Agency (ESA) provides free and open data access to a new multispectral satellite system Sentinel-2. Sentinel-2 has a better spatial (10m, 20m, 60m), spectral (13 bands) and temporal resolution (3-5 days) compared to NASA's Landsat-8.

Time series of Sentinel-2 data are processed by an algorithm which was developed as a contribution to a Chilean research project (Sistema alerta temprana, SAT). The algorithm is implemented on the cloud computing platform Google Earth Engine (GEE). Automatically detected monthly clearings are validated by the FAO visual interpretation software tool "Collect Earth" using very high spatial resolution satellite images available in Google and Bing maps (2016-2018) in addition to dense Sentinel-2 time-series.

References

- Cohen WB, Yang Z, Kennedy R. 2010. Detecting trends in forest disturbance and recovery using yearly Landsat time series: 2. TimeSync - Tools for calibration and validation. *Remote Sensing of Environment* 114(12): 2911–2924.
- Food and Agriculture Organization of the United Nations (FAO). 2018. Collect Earth: Open Foris. Available at: <http://www.openforis.org/tools/collect-earth.html> [Accessed February 14, 2018].
- Hardisky MA, Klemas V, Smart RM. 1983. The influence of Soil Salinity, Growth Form, and Leaf Moisture on the Spectral Radiance of *Spartina alterniflora* Canopies. *Photogrammetric Engineering and Remote Sensing* 49(1): 77–83.
- Hollstein A, et al. 2016. Ready-to-use methods for the detection of clouds, cirrus, snow, shadow, water and clear sky pixels in Sentinel-2 MSI images. *Remote Sensing* 8(8): 1–18.
- Wilson EH, Sader SA. 2002. Detection of forest harvest type using multiple dates of Landsat TM imagery. *Remote Sensing of Environment* 80(3): 385–396.

Water-use and water-use efficiency in plantations and indigenous forests in the southern Cape

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In South Africa, the development of a plantation tree industry using fast-growing introduced species was accelerated by the limited extent of indigenous forests. The fact that a significant portion of these intensively managed plantations is within catchments that are valued as freshwater source areas exacerbates this situation (Scott *et al.* 1999). Concerns about the impacts of plantations on the country's limited water resources initiated forest hydrology research and regulation of the industry since 1972 to the current South African National Water Act No 36 of 1998.

The forestry industry's continued efforts to sustainably meet fibre and timber demands for the country's growing economy, yet in a water scarce country, have prompted questions on the water use efficiency of tree production systems as well as the consideration on whether indigenous tree species can provide an additional low water-use form of forestry (Dye *et al.* 2008; Gush and Dye 2009). Single tree water use and water-use efficiencies of three indigenous species (*Ilex mitis*, *Ocotea bullata* and *Podocarpus latifolius*) and two introduced species (*Pinus radiata* and *P. elliotii*) in the southern Cape region of South Africa were quantified. The heat pulse velocity method was used to collect hourly sap flow data over two periods that is from June 2013 to July 2014 (365 days) and November 2015 to October 2017 (700 days).

Hourly weather and soil-water data were concurrently recorded, and tree growth rates were determined for the year. Biophysical water-use efficiency was calculated as the ratio of utilisable biomass gained per volume of water transpired. Patterns of water use through the year were different for the different species. *Pinus radiata* and *P. elliotii* had higher transpiration volumes and water-use efficiency levels than the indigenous species. Both Pine species were measured in the 2015/17 period. Stand transpiration and volume gain for the two species were comparable that is 905 mm and 957 mm and 0.05 m³ and 0.03 m³ for *Pinus radiata* and *Pinus elliotii* respectively and for the 2015/17 measuring period. The most transpiring *P. radiata* tree had a transpiration volume that was 4.7 times that of the most transpiring indigenous tree.

Water use efficiencies (grams of wood per litre of transpired water) ranged from 0.9 to 2.5 g/L for the individual trees of the Pine species. While those for the indigenous species ranged from 0.5 to 1.5 g/L. The higher water-use efficiencies for *P. radiata* corresponded with the higher transpiration rates for the individual trees. Indigenous species' relatively lower water-use efficiencies were more a consequence of slow growth rates and not high water-use rates, this could be attributed to competition for resources in the dense indigenous forest. Potential implications for further hydrological research on the development of water-use efficient tree production systems are discussed.

References

- Dye PJ, Gush MB, Everson CS, Jarman C, Clulow AD, Mengistu M, Geldenhuys CJ, Wise R, Scholes RJ, Archibald S, Savage MJ (eds). 2008. *Water-use in relation to biomass of indigenous tree species in woodland, forest and/or plantation conditions*. WRC Report No. TT361/08. Pretoria: Water Research Commission.
- Gush MB, Dye PJ. 2009. Water use efficiency within a selection of indigenous and exotic species in South Africa as determined using sapflow and biomass measurements. *Acta Horticulturae International Society of Horticultural Science* 846: 323-330.
- Scott DF, Le Maitre DC, van Wyk E. 1999. The effects of forestry on low-flows: further studies on low-flow in wet and dry cycles and in relation to catchments of increasing size. CSIR Report No. ENV/S-C 99059. Pretoria: Council for Scientific and Industrial Research.

Impact of water holding capacity and soil moisture content on the moisture content of selected European timbers

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The present study deals with two topics. At first two different norm methods for measuring soil water holding capacity (WHC) were evaluated comparatively (ENV 807 (2000) vs. ISO 11268-2 (2001)). The results of both methods were concluded in a correlation. The second study deals with the impact of soil WHC and soil moisture content on the moisture of selected European timbers.

For comparing the two norms, the WHC of three base soil types (silica sand, compost and peat) was ascertained for the pure form of the soils as well as for different mixtures. As expected the WHC of the soil mixtures increased with a rising ratio of peat in it and decreased with a rising amount of silica sand. The following evaluation of both norms shows that the method out of ISO 11268-2 (2000) numerous advantages compared to the method used in ENV 807 (2001). As a result, it can be said that the method of ISO 11268-2 (2000) is able to replace the method of ENV 807 (2001) for measuring WHCs of TMCs. Conclusively the measured results of both norm methods were correlated to enable a conversion of their WHC values.

To investigate the impact of soil WHC and soil moisture content on the moisture of timber, a total of 960 specimens of Scots pine sapwood (*Pinus sylvestris* L.), Douglas fir (*Pseudotsuga menziesii*), European beech (*Fagus sylvatica* L.) and English oak (*Quercus robur* L.) were exposed to 48 different terrestrial microcosms (TMC) for three weeks. The specimens were put to 4/5 into the soil. The moisture characteristics of the TMC-soils were varied by two factors. Target-WHCs of 21, 30, 40, 50, 60, 70, 80, 90% were set by mixing three base soil types (silica sand, compost and peat) in varying mixing ratios. Further, the relative soil moisture was adjusted on 30, 50, 70, 80, 85, 120% of their WHC. The soil moisture was kept constant by regular remoistening. Additionally, a vertical analysis of the wood moisture according to the moisture distribution was done and related to the varying moisture factors.

From the results it can be concluded, that the water content of the TMC-soils correlates positively with the wood moisture content of the specimens. However, specification of the absolute soil water content is not suitable. As varying WHCs of the TMC-soils must be considered, it becomes necessary to take the soil water content in relation to its WHC, which had a negative impact on the wood moisture. A decisive factor for the wood moisture was the difference between the actual soil moisture and its WHC (ΔMC_{soil}).

Comparative work time and ergospirometry study between the Neheimer and Harzer Planting Procedure and isiePRO

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German foresters mostly try to cultivate the forest heritage under the concept of permanent forest. By this concept only single trees are used and there are multiple generations of trees on one site. Thus the forest is conserved as a biological production system. A clear cut of a healthy forest area greater than one hectare (State Forest Act Lower Saxony) is subject to approval and mostly related to further requirements (such as reforestation). This means that you try to establish a new stand generation by the idea of natural regeneration. But even if this works fine in many cases, there although are situations in which you have to use planting procedures to achieve the silvicultural objectives. Examples for that might be a reforestation after a storm or a change of tree species.

Since the beginning of reforestation many planting procedures were invented, refined or replaced by more advantageous ones. This Master Thesis draws a comparison between the practiced Neheimer and Harzer planting procedures and the newly developed planting spade isiePRO under circumstances similar as possible. The recordings with four test persons took place in April 2018. These three planting procedures are assessed in three parts. The first part evaluates the productivity of the single procedures. Based on a work-time study the procedures are ranked according to their efficiency, measured in items per hour. In the second part the planting procedures are compared with regard to the physical stress. Therefore the test person carried an ergospirometric instrument. This device calculates the consumption of energy during the planting procedure in kcal per hour by analyzing the test person's breath. For this it compares the in- and exhaled gas with the ambient air. The third and last objective of research is the ergonomic advantage of each procedure. Therefore the participants were filmed with two camcorders oriented in an angle of 90° to determine the frontal and lateral body posture.

First results show an average advantage of ca. 5% of isiePRO over the Neheimer and Harzer planting procedure regarding the efficiency. One suggestion is that the efficiency depends on transcending a training line. The physical stress is divided in three levels: low, moderate and heavy. Over all test persons and daytimes (morning, midday, afternoon) the isiePRO is more advantageous compared to Neheimer and Harzer in 7 of 11 cases (for one case the data could not be reported). The evaluation of the ergonomic comparison continues and there are unfortunately no results available at this moment.

A new approach to “Forsteinrichtung”: Combining enterprise level inventories and airborne LiDAR data to develop compartment wise management plans

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In the 18th / early 19th century, forest taxation (German: “Forsteinrichtung”) became an important part of the forest management and forest science in Germany (e.g. Hartig 1795; Cotta 1804). Even though the taxation system was continuously developed and extended the main principle, that is visual assessment by a well-trained forest expert who visit each compartment, did not change over the last two centuries. There are two limitations with this approach: i) the quality of the information purely depends on the expertise of the forester, and ii) there are no generally accepted methods to quantify the quality of expert taxation. To overcome these limitations sample-based forest inventories were introduced in Germany in the 1980s on the national and enterprise level. These sample-based forest inventories provide detailed estimates of relevant forest variables and allow the quantification of uncertainties by means of sampling theory. However, due to the nature of sampling only small areas (typically <1000 m²) are observed usually on a systematic grid. This provides precise information on larger scales (e.g. at the enterprise level) but if smaller areas are observed (e.g. districts, compartments) the number of samples is limited which leads to large uncertainties. Thus, at the compartment level, which is the primary planning and management unit, the quality of the information provided by sample-based inventories is often not sufficient for planning. Therefore, both inventory systems the sample-based inventories and the expert taxation of the compartments is conducted parallel in many forest enterprises in Germany.

This study investigated the potential of Airborne LiDAR Scanning (ALS) to reduce the effort of conducting two parallel inventories. It was conducted in a private forest enterprise in Northern Germany. The enterprise covers approximately 6000 ha of forest land with ~80% being pine (*Pinus sylvestris*) plantations. In 2018 we conducted a sample-based inventory with $n=942$ samples on a systematic grid. The sampling intensity was adapted to the expected variability in total stand volume (estimated based on previous inventories) in a stratified design. Additionally, multispectral aerial images (R, G, B, NIR, GSD = 4.5 cm) and ALS data with ~12 pls/m² was acquired in summer 2018.

The sample-based inventory data was used to estimate total stand volume at different aggregation levels (district, strata, enterprise). Based on the LiDAR data a high precision digital terrain model (DTM, GSD = 1 m) and a digital canopy height model (CHM, GSD = 0.25 m) was generated. Using template-matching algorithms single trees in the dominate layers are detected from the CHM. By inverting DBH-Height models derived from the sample-based inventories we predicted the DBH of all detected trees based on their species and height which provided a diameter distribution, and volume estimates per compartment.

The first analysis shows promising results and supports the general validity of the new approach of combining sample-based inventories with remote sensing technologies to deliver the required information for forest management planning at the scale of the management units (compartments). The forest information derived from ALS data is different from information collected by an expert taxation. Some of the variables typically assessed in the field (e.g. stem quality, density of regeneration) cannot be derived from ALS data. On the other hand, a high resolution CHM provides

detailed wall-to-wall information on tree heights, vertical structure and canopy cover for the compartment. Such information could be feed into modern forest growth simulators (e.g. Waldplaner (Hansen, 2006), SILVA (Pretzsch *et al.*, 2002)) to develop management plans on the compartment level. In that sense our results indicate that in the long term the combination of sample-based inventories and remote sensing technologies might supersede an additional compartment wise taxation.

References

- Cotta H. 1804. Systematische Anleitung zur Taxation der Waldungen (Vol. 2). Sander.
- Hansen J. 2006. Der WaldPlaner - Ein System zur Entscheidungsunterstützung in einer nachhaltigen Forstwirtschaft. Deutscher Verband Forstlicher Forschungsanstalten - Sektion Forstliche Biometrie und Informatik. Trippstadt 2006, S: 112-119.
- Hartig G L. 1795. Anweisung zur Taxation der Forste, oder zur Bestimmung des Holzertrags der Wälder: Ein Beytrag zur höheren Forstwissenschaft: Nebst einer illuminirten Forst-Charte und mehreren Tabellen. Heyer.
- Pretzsch H, Biber P, Dursky J. 2002. The single tree-based stand simulator SILVA: construction, application and evaluation. *Forest Ecology and Management*. 162(1): 3-21.

The forest of the Norra Kvill National Park

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The Norra Kvill national park is located in the province of Småland in southern Sweden and currently comprises 114 ha. It serves as a vivid example of the ecological succession that results from depriving a forest of natural forest fires, although they had always been part of the natural disturbance regime. Norra Kvill has been growing without human interference and without any wild fires for more than 150 years and was thus profoundly altered.

According to Niklasson *et al.* (2001), from 1400 to the late 18th century the area had been burning on regular intervals, on average every nine years. After that, regular fires ceased allowing a fundamental shift in biodiversity.

When the natural disturbance regime is intact, a typical forest in southern Sweden is dominated by Scots pine (*Pinus sylvestris*), whose sprouts require the light and open structures created by fires to grow. Having a thick and heat resistant bark, pines are well adapted to frequent fires. The ground is covered with dwarf shrubs, grasses, lichens and mosses which are highly flammable but let the fire move through them quickly, hardly heating the ground below and hence protecting roots and soil.

After the cessation of fires, Norway spruce (*Picea abies*) has been spreading over Norra Kvill. The dispersal is still in progress today and has been creating a far more shadowy forest making it almost impossible for young shoots of pine to grow. What is more, the typical bushes and grasses are increasingly replaced by moist mosses. Most species that are directly or indirectly dependent on fires have become rare and are substituted by species characteristic for spruce dominated late succession forests. However, the developing habitat provides in turn a valuable environment for multiple endangered and ecologically important species, in particular insects and fungi.

Currently, Norra Kvill has both original pine dominated parts and spruce invaded areas due to some recently incorporated areas of the park where recent loggings preserved the original species composition. Over all, pine trees still dominate in number, however most of them are 200-470 years old. One can observe countless indicators of a healthy and diverse forest: large amounts of dead trees of different ages and fallen logs in different stages of decay occur all over the park, providing living space for an exceptional high number of insects.

Clearly, the initial intention of conserving Norra Kvill in its natural state was not achieved by protecting the forest from human disturbances as well as from natural ones. However, it is difficult to reintroduce wild fires because their suppression has been going on for too long and the subsequent spruce dispersal in some parts of the park is too advanced to be turned around by simply setting the forest on fire. It would suffer severe damage with so many meanwhile tall spruces allowing flames to reach the pine trees' crowns, and without the ground covered in shrubs the soil and roots are not well protected anymore.

A careful burning program is needed to achieve a balance between conserving the ecosystem of Norra Kvill in its natural state wherever possible and also incorporating the newly developed spruce dominated habitat.

References

- Niklasson M, Drakenberg B. 2001). "A 600-year tree-ring fire history from Norra Kvills National Park, southern Sweden: implications for conservation strategies in the hemiboreal zone." *Biological Conservation* 101(1): 63-71.

Predator management in Germany

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“The wolves are back“ – These are the words which dominate the media and public discussions when it comes to the topic of conservation in Germany. Predators were always present in Germany, especially in the pre-modern decades. Industrialisation and population growth led to a great habitat loss for many species. Some shifted their habitats to still existing areas of wilderness, mostly in eastern Europe. Others adapted to the change of conditions by discovering ways to profit from the presence of humans. Coexistence between wild animals and humans in urban areas and agricultural landscapes is more or less common today. To get to that point it took centuries of management work.

Currently, there are four main predator species occurring in Germany, the Raccoon (*Procyon lotor*), Red fox (*Vulpes vulpes*), Lynx (*Lynx lynx*) and the European Wolf (*Canis lupus lupus*). These are the species which made it necessary to establish a predator management plan for Germany. Most of all the wolf has become increasingly present in the media recently. Eaten cattle, killed pets and human encounters led to the point where citizens began to lose their positive way of thinking about the returnees. In a densely populated country like Germany, which is about 3.5 times smaller than South Africa but has about 26 Million more inhabitants sharing the limited space, conflicts between returning predators and humans have been increasing dramatically. One has to distinguish between direct and indirect conflicts. Direct conflicts are for instance humans getting harmed either economically or emotional or concerning the health of family and friends. In such situations acceptance seems to reach its limits. However, in terms of acceptance it is also important to draw a clear line between the general public mostly living in towns and those who are directly influenced by the presence of predators in their back yard.

In order to ensure the further coexistence of humans and predators, a prudent and farsighted management is crucial. There are different ways of approaching the challenge and each case needs to be handled individually. The field of predator management is characterised by three parts: taking action, prevention as well as aftercare and seeking the dialogue with farmers, hunters and other people affected. Since 2010 there is a new approach from conservationists aiming to support predators in finding new habitats and in conflict prevention. It is called “UZVR” – “Unzerschnittene verkehrsarme Räume“ (uncut low-traffic areas) and combines the knowledge of how landscapes are used in different areas and which hurdles may await predators when entering them. UZVR serves as a basis of knowledge to create management plans which ensure the coexistence of humans and predators.

References

- Michler, Michler. 2012. Ökologische, ökonomische und epidemiologische Bedeutung des Waschbären (*Procyon lotor*) in Nationale Strategie zur Biologischen Vielfalt. 2012. Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit
- Wolfsmanagement in Deutschland. 2017. Wolfgang Köck, Lisa Kuchta

Multiple-use forest management

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Silvicultural management has been practiced over centuries and changed according to the needs. While some approaches focus in the production of timber others focus in conservation, recreation etc. With the change of public demands during the middle of the 20th century, the concept of multiple-use forest management (MFM) evolved and is now considered as part of the sustainable forest management concept (Deal 2015; Kraus and Krumm 2013). Pancel and Köhl (2016) defined MFM as a forest management with the intention to meet simultaneously two or more objectives.

To fulfil these objectives two ways are common, the segregative and the integrative. The segregative approach tries to meet the objectives on a landscape level by separating the objectives spatially, while the integrative approach is focused in providing multiple goods in one individual management unit (stand level). The complexity of MFM should be kept on an economical acceptable level. This is easier to be achieved using the segregative approach or applying an integrative system, where the fixed costs of forestry operations are low and the implementation of MFM is not too complex. Integration of forest products and services is more feasible for forests of the Northern Hemisphere and small scale forestry (García-Fernández *et al.* 2008).

It has been proved that MFM and its diversification strategies ensures a more resilient system, not only coping with environmental changes (Kraus and Krumm 2013) but also providing a viable strategy to maximize the diversity and number of income opportunities (V́ctor M. Toledo *et al.* 2003). Furthermore, non-timber forest products (NTFPs) were considered a promising way to combine conservation with development objectives (Haladik 1993). However, NTFPs harvesting is labour intensive and good inventories and future planning for extraction is difficult. In addition, adequate knowledge of technical and managerial capacity (different for each NTFP) is lacking. Another factor influencing the feasibility of applying MFM is that not every place has good market opportunities or that NTFPs species are absent in the area (Nasi *et al.* 2011).

The segregative approach is more appropriate in nature conservation e.g. protected forest areas. On the other hand, the integrative approach considers the economic, social, and ecological components of sustainable forest management at the same time and place (Boncina 2011). MFM is not always easy to applicate due to many site-specific variables, however, where feasible it proved to be the most sustainable forestry practice, without proper disadvantages even in economic terms.

References

- Boncina A. 2011. Conceptual approaches to integrate nature conservation into forest management. A Central European perspective. *The International Forestry Review* 13: 13–22.
- Deal R. 2015. Multiple-use Forestry: Time for a Change in Federal Forest Management 1.
- García-Fernández C, Ruiz-Pérez M, Wunder S. 2008. Is multiple-use forest management widely implementable in the tropics? *Forest Ecology and Management* 256: 1468–1476.
- Haladik CM. 1993. Tropical forests, people and food: Biocultural interactions and applications to development. UNESCO, 852 p.

- Kraus D, Krumm F. 2013. Integrative approaches as an opportunity for the conservation of forest biodiversity, 283 p.
- Nasi R, Putz F, Pacheco P, Wunder S, Anta S. 2011. Sustainable Forest Management and Carbon in Tropical Latin America. The Case for REDD+. *Forests* 2: 200–217.
- Pancel L, Köhl M. 2016. *Tropical forestry handbook*. Springer.
- Víctor M, Toledo B, Leni C, Patricia M, María O. 2003. The Multiple Use of Tropical Forests by Indigenous Peoples in Mexico: A Case of Adaptive Management. *Conservation Ecology*. <https://www.ecologyandsociety.org/vol7/iss3/art9/>.

Forest monocultures, a comparison between South Africa and Germany

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In a globalized world it's important for the young generations to become and stay connected and share their knowledge. The aim of this presentation is, to look at the similarities and differences in the management of forest monocultures in South Africa and Germany. Both countries have large areas of forest monocultures as a basis for many wood industries (pulp, paper, furniture). However, a remarkable difference is, that on the plantations in South Africa exotic genera are grown, while in Germany mainly native species are utilized. The plants in South Africa are from Australia, America and Europe (FAO 2010). They planted different genera of *Eucalyptus*, *Pinus* and *Acacia mearnsii*, because the native plants were growing too slowly (FSA 2017). In Germany, the forests and plantations were planted with native species. The area of the German monoculture forests is about 2.5 million ha. The main genera are *Pinus sylvestris*, *Picea abies* and *Fagus sylvatica* (BWI 3 2012). The big difference between both countries is the way to manage a forest with just one kind of tree species. Besides the species also the management of monocultural plantation differs: In South Africa trees are planted in blocks at the same time in a fixed spacing. The harvesting is by felling the trees in blocks (DAFF 2018). In Germany clear cutting is allowed only, if it's approved by the responsible authority (BWaldG 1975). Furthermore, clear cuts are strictly forbidden under the Forest Stewardship Council certification scheme. According to FSC (2013), trees must be harvested in little groups or by selecting single trees. Due to this single tree selection system the complexity of forest structure increases with multiple layers of different tree heights. Felling of trees opens the forest canopy, where new trees can be planted, or natural regeneration occurs (Brang 1995). Also, in South Africa the Forest Stewardship Council Certification is important. In 2012 more than 1.5 Mha of plantation forestry were certified (gov.za 2018).

The main species of the German forests have long rotation periods. Many different factors determine the best moment to harvest the trees. The shortest periods have spruce (75 – 105 years) and pine (80 – 115 years) (Krahl – Urban 1952). Another possibility to get biomass are short rotation plantations. The favorite plants are fast growing trees, which are able for stump sprout. The main species are *Salix* and *Populus*. These plantations are only for wood production. The quality and form of the stem is not important. Because of the stump sprout, the harvest periods are between one and 15 years. However, under the German law they are considered agricultural crops and not forest. Therefore, they are mainly planted on agricultural lands, where they compete with the food crops (Knust 2009). Both countries use their monocultures as a basis for their wood industry. But in their management programs and their chosen species are differences.

References

- Brang P. 1995. Experimentelle Untersuchungen zur Ansamlungsökologie der Fichte im zwischenalpinen Gebirgswald. *Research Collection*. ETH Zurich.
- BWald G. 1975. Federal Ministry of Justice and Consumer Protection, Germany. Accessed on August 23. [<https://www.gesetze-im-internet.de/bwaldg/BWaldG.pdf>].

- BWI 3. 2012. Federal Ministry of Food and Agriculture, Germany. Accessed on August 24. [<https://bwi.info/inhalt1.3.aspx?Text=1.08%20Beimischung%20in%20der%20Hauptbestockung&prRolle=public&prInv=BWI2012&prKapitel=1.08>].
- DAFF. 2018. Department: Agriculture, Forestry and Fisheries. Accessed on September 06 [<http://www.daff.gov.za/daffweb3/Branches/Forestry-Natural-Resources-Management/Forests/Commercial-Plantation/>].
- FAO. 2010. Food and Agriculture Organization of the United Nations. Accessed on August 22 [<http://www.fao.org/forestry/country/18316/en/zaf/>].
- FSA. 2017. Forestry South Africa. Accessed on August 22. [<http://forestryexplained.co.za/infographics/homepage/introducing-our-timber-plantations/>]
- FSC. 2013. Forest Stewardship Council. FSC im Wald – ein Leitfadens für Praktiker, page: 17
- Gov.za. 2018. Republic of South Africa. Accessed on Sept.06. [<https://www.gov.za/about-sa/forestry>]
- Knust C. 2009. Kurzumtriebsplantagen–Stand des Wissens. Anbau und Nutzung von Bäumen auf landwirtschaftlichen Flächen, 1-9.
- Krahl – Urban J. 1952. Die maximale Wertholzleistungsfähigkeit in Eichenbeständen. *Forstwissenschaftliches Centralblatt*, 71(5-6): 142

Possibilities in UAV monitoring on grassland vegetation

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This short presentation gives an overview of the different possibilities in UAV monitoring with two different drones, eBee and a custom-made octocopter, in the context of our work within the Biodiversity Exploratories in May 2018. There are many prominent advantages in UAV based remote sensing compared to conventional monitoring techniques. Not only the low disturbance of the environment and the chance of large-scale observation but also it enables user-controlled image acquisition and bridges the gap in scale and resolution between ground observations and imagery acquired from conventional manned aircraft and satellite sensors (D'Oleire-Oltmanns *et al.* 2012).

Nowadays there are a lot of varying applications in UAV based remote sensing, for example in forestry, agriculture, geology and city planning. The main implementations are mapping, monitoring of different damages and recording of land cover, land use and forest degradation (Klein *et al.* 2018).

For a distinction between vegetation and non-vegetational structures it is important that the surfaces have different reflective properties (Koller 2016). The reflective characteristics of vegetation enable this differentiation due to the cellular structure of leaves. Originally the idea to use UAV for the purpose of vegetation monitoring in the Biodiversity Exploratories results from the analysis of aircraft-based photographs showing different reflective properties of vegetation. Consequently giving the opportunity of drawing conclusions about biodiversity on research plots regarding the whole project.

The Biodiversity Exploratories are a long-term project funded by the German research community. The plots are located in three regions of Germany: Schorfheide – Chorin, Hainich and Schwäbische Alb. It is a project offering the possibility to study interdisciplinary questions of biodiversity and collaborate with other departments such as botany, entomology, climatology and others. In our case we worked together with botanists in order to evaluate the diversity of species on grassland plots.

To acquire more complex layers of grassland structure imagery we used different cameras installed on two drones, *eBee classic* from the company *Sensefly* with the multispectral *Parrot Sequoia* camera and the *Sensefly S.O.D.A.* camera. Additionally, a custom-made octocopter with a *Cubert* hyperspectral camera. Different camera types enable the measuring of multiple parameters – hyperspectral ones capture high resolution pictures by processing reflecting light and infrared cameras collect emitted thermal radiation over vegetation.

References

- D'Oleire-Oltmanns S, Marzloff I, Peter K D, Ries J B. 2012. Unmanned Aerial Vehicle (UAV) for Monitoring Soil Erosion in Morocco. Domain: open access remote sensing. [<http://www.mdpi.com/journal/remotesensing>].
- Jean-Christophe Zufferey. Solutions / drones / eBee classic. Domain: Sensefly Parrot Group. 2017. [https://www.sensefly.com/app/uploads/2018/05/senseFly_S.O.D.A._EN.pdf].14.09.2018].
- Kleinn et. al. 2018. Einführung in die Fernerkundung. (Vorlesung, 05.07.2018). Göttingen: Georg August Universität Göttingen. Unpublished.
- Koller L. 2016. Fernerkundliche Detektion von Vegetationseinheiten, Leibnitz Universität Hannover,

- Patrick Chambon. Business solutions / parrot – professional / parrot -sequoia. Domain: Parrot. 2018. URL:<https://www.parrot.com/business-solutions-de/parrot-professional/parrot-sequoia#parrot-sequoia-details> 14.09.2018].
- Fischer M. Exploratorien zur funktionellen Biodiversitätsforschung. Ziele und Hintergrund. Domain: biodiversity-exploratories. 2018. [<http://www.biodiversity-exploratories.de/ziele/> . 14.09.2018].
- Ralf Ott. Pflanzenvielfalt aus der Luft bestimmen. Domain: Südwestpresse, [<https://www.swp.de/suedwesten/landkreise/alb/pflanzenvielfalt-aus-der-luft-bestimmen-27129428.html> .14.09.2018].

Forest inventory in Namibia's dryland forests - a case study

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For decades the area covered by forest in Namibia shows a decreasing trend from 10.6 % in 1990 to 8.4% in 2015 (FAO 2015). This trend indicates the need for protection and appropriate management of the remaining forested land to ensure that the forest resources may be used in the future. Consequently, information about the state of the forests is required. This investigation represents a case study that investigates the forest structure and management of two forests in Northern Namibia. Two managed forest areas were investigated on concentric sample circles that were established along transects orthogonally placed to access roads. The studied forests differ in management since one of the forests is managed by the local community whereas the other is managed by the state forest administration. In total 33 sample plots were placed in each of the approximately 10,000 ha sized forests. On these sample sites, tree attributes, regeneration structure and management indicators were assessed to raise information describing the forest structure and management.

The overall very open dryland forests in the study area exhibit very low mean basal areas from 6.9 to 3.5 m²/ha (Schul, 2015). Results of a comparison between the two forests show that the community forest exhibits a lower mean number of stems per hectare and a lower mean basal area, while the mean diameter at breast height is similar (ibid.). Regarding regeneration, major differences were found in the abundance while small differences were found in the diversity of tree regeneration. The community forest shows a larger abundance of tree regeneration. Management indices considered are the estimated degrees of influence by harvesting and influence by livestock. A comparison indicates larger differences only in the influence of livestock on the forest resources that is considerably smaller in the community forest than in the state forest.

In summary, the community managed forest shows fewer adult trees suggesting an increased usage of timber in comparison to the state managed forest. Additionally, the regeneration in the community forest is more abundant which may be linked to the decreased livestock pressure on the forest resources found in the community forest. The outcome of this study illustrates a specific case of forest structure in Namibia and may not be generalized for the whole country. Nevertheless, the concept of community managed forest in contrast to state managed forest can be found throughout Namibia. Additional replications of this study in other parts of the country may enhance the information of forest resources, the difference between community and state forest, as well as the linked management intensity and practices to derive an appropriate management of the remaining forest resources of Namibia.

References

- FAO. 2015. Global Forest Resource Assessment 2015. Desk Reference. Food and Agriculture Organization of the United Nations. Rome
- Schulz R. 2015. Comparison of forest structures between two forest management concepts in northern Namibia. Bachelor Thesis. Georg-August-Universität Göttingen.

The technological status of silviculture re-establishment practices in South Africa

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Plantation re-establishment forms a vital part of silviculture as a whole because it deals with the creation of an ideal environment when planting, direct sowing of seeds and natural seeding (Evans and Turnbull 2004). For many years re-establishment activities within South Africa have been manually orientated with any innovation and development geared towards manual methods (Steenkamp 2017). However, in recent years silviculture mechanisation has been driven by labour challenges such as an aging rural workforce, increasing labour costs, high labour turnover, and problematic health issues relating to productivity, quality challenges of manual and unskilled labour, poor ergonomic practices and safety challenges associated with the use of sharp tools (da Costa 2013; McEwan and Steenkamp 2014). The study as a whole comprises of four parts: (i) a review of silvicultural re-establishment practices globally; (ii) an assessment of the technological status of re-establishment practices (residue management, preparation of a planting position, planting, fertilising and weeding) in South Africa; (iii) identification of local and global change drivers influencing the modernisation of re-establishment activities and (IV) a forecast of re-establishment technology that is likely to emerge and or adopted in future (5-20 years) in South Africa and other countries practising plantation forestry. This specific presentation is based on the second part of the study.

An e-mail questionnaire was distributed amongst 40 contractors, 10 grower companies and 44 small-scale timber growers, within the different provinces where commercial forestry is practiced in South Africa. The contractors were firstly contacted telephonically and informed about the study and if they agreed to participate the questionnaire was e-mailed to them for completion. The general managers from grower companies were contacted via e-mail requesting their participation in the study; they were also requested to provide a contact person within the company to facilitate data collection. The survey, a first of its kind was designed and administered following the techniques used in conducting the Forest Engineering technical survey (Brink and Warkostch 1989; Brink 1998; Brink 2001; Längin and Ackerman 2007). The feedback from the completed questionnaires was captured and descriptive statistics were used to describe the basic features of the data.

The results showed that the total area re-planted by respondent contractors and grower companies was $\pm 37\,337$ ha per year; with the main genera being eucalypt, pine and *Acacia* species. The predominant activities conducted prior to planting comprised of: burning (78%); marking for pitting by using the baseline method (71%); preparation of a planting position by using a roadpick (57%) and pre-plant chemical weeding with a knapsack (70%). Furthermore, 45% of planting and 77% of blanking operations were carried out manually with a trowel. Post planting activities such as fertilizing and weeding were respectively executed through spot manual fertilizer application (61%) and chemical application with a knapsack (43%). Overall the results indicated that typical re-establishment activities are still dominated by manual methods. This study is a baseline for future, periodic surveys that can be used to analyse trends and identify areas for improvement in re-establishment activities in South Africa.

References

- Brink MP, Warkostch PW. 1989. Forest technical survey. Stellenbosch: University of Stellenbosch
- Brink MP. 1998. South African forest technical survey. Stellenbosch University, South Africa.
- da Costa D. 2013. Modernising and the effect on Silviculture. Presented at Focus on Forest Engineering conference, Pietermaritzburg, 6 November.
- Evans J, Turnbull J. 2004. Plantation forestry in the tropics, 3rd ed. New York: Oxford University Press.
- Längin D, Ackerman P. 2007. South African Forest Engineering Survey Final Report – November.
- McEwan A, Steenkamp J. 2014. Silviculture modernization in the South African forestry industry. Proceedings of the second international congress of silviculture, 26th - 29th November, Florence.
- Steenkamp J. 2017. Modernisation of Silviculture is imminent and unstoppable. SA Forestry magazine October pp23-24

Unlocking the potential of harvester on board computer data in the South African forestry value chain

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Modern Forest Harvesters are highly specialized and technologically advanced machines. The development of the StanForD (Standard for Forest Communication) system has seen the unlocking of a vast array of data generated by the on-board computing systems of modern harvesters and forwarders. This software is used by most major manufacturers of purpose built machines and attachments (Skogforsk 2012). StanForD facilitates the detailed recording of a full enumeration of standing trees in terms of diameter at 10 cm intervals up the stem which provides detailed measurements on stem form and taper.

South Africa is undergoing a rapid shift to mechanized cut-to-length harvesting operations (Ackerman *et al.* 2016). Many of these machines currently have the StanForD protocol enabled which allows them to collect very detailed tree and operational information. However, this data output is not being fully utilized because of issues regarding its accuracy; namely the calibration of the on-board computing system to accurately measure and calculate both DBH and under bark volume (Brewer *et al.* 2018). There are preset functions for calculating under bark volume in the standard Stanford protocol but these are not set up for South African conditions or species.

The objective of this study is to determine the current scope of CTL harvesting systems in South Africa and implement a suitable bark deduction method for *P. patula* for South African conditions on a harvester. As a first step, *P. patula* bark thickness up the stem was modelled with historical mensuration data collected in areas where the harvesting machines were operational. This data was then used to calibrate and populate bark deduction tables present on the Ponsse Opti system for two bark deduction methods; namely length based and diameter class length-based methods. It is hoped that the evaluation of the two different methods compared to the control (physically measured under bark diameters) can be used to evaluate the potential of using bark deduction methods for more accurate timber volume determination.

This is the first time in South Africa that a study was undertaken to model bark thickness with the goal of implementing bark deduction methods for harvesters. Furthermore, the study will also use photogrammetry to measure under bark diameter for the control measurements, this is a novel approach as most previous harvester calibration studies used manual measurements that have been documented to have errors (Strandgard 2009).

The importance of this work lies in the fact that these machines provides us with detailed measurements of every tree and log produced. Therefore, improving the quality of measurements by the application of the correct bark deduction method we provide ourselves with the opportunity to utilize this data for a whole range of precision forestry driven applications (Olivera and Visser 2016).

References

- Ackerman P, Williams C, Ackerman S, Nati C. 2016. Diesel Consumption and Carbon Balance in South African Pine Clear-Felling CTL Operations : a Preliminary Case Study. *Croatian Journal of Forest Engineering* 38(1): 65–72.
- Brewer J, Talbot B, Belbo H, Ackerman P, Ackerman S. 2018. A comparison of two methods of data collection for modelling productivity of harvesters: Manual time study and follow-up study using on-board-computer stem records. *Annals of Forest Research* 61(1):109–124.
- Olivera A, Visser R. 2016. Using the harvester on-board computer capability to move towards precision forestry. *New Zealand Journal of Forestry Science* 60(4): 3–7.
- Skogforsk. 2012. Standard for Forest Data and Communication. (March): 1–106.
- Strandgard M. 2009. Evaluation of Manual Log Measurement Errors and Its Implications on Harvester Log Measurement Accuracy. *International Journal of Forest Engineering* 20(2): 9–16.

Quantifying financial returns from commercial forestry research trials in the Zululand Region of KwaZulu-Natal

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The South African forestry industry is limited by the availability of suitable plantation forest land. This restriction drives the need for ever increasing wood production from the same land area (Morris, 2008), at low cost to ensure global competitiveness (Pallet and Sale 2002). Therefore intensive forest management activities have to be justified against the return produced and research recommendations are also increasingly scrutinise for value and relevance.

Reitz *et al.* (2015) highlight the need to incorporating economic analysis into research findings and the quantification of research benefits along the forestry supply chain. Financial analyses is generally use to determine if research (investment) projects will maximize profits based on the cash flow of costs and returns (Cubbage *et al.* 2013), while considering the time value of money (Ham and Jacobson 2012).

This study investigated site-specific financial returns of research field trials conducted at the Institute of Commercial Forestry Research (ICFR). A review of publications and reports pertaining to on site specific fertiliser (FR), residue management (RM) and vegetation and coppice management (VCM) trials was conducted. These trials were located in the Zululand region of KwaZulu-Natal.

Trail recommendations were translated into silvicultural input costs and compared against reported changes in timber volume and value brought about through these recommendations. This was done by means of discounted cash-flow (DCF) models.

The results from this study indicated financial returns in FR research trials ranging between R49 201 and R273 524 ha⁻¹ based on Land Expectation Values (LEVs) and 10 to 29% in Internal Rate of Returns (IRR). However, for mid-rotation FR research trials there were no financial gains. Financial returns for RM research trials declined through successive rotations, possibly due to soil compaction and the specific residue management techniques. Lastly, the financial returns for VCM research trials (vegetation management) and coppice management research trial returns were highly depended on cost-effective coppice reduction techniques.

The study illustrated the interaction between input costs of research recommendations and corresponding volume output. Costly silvicultural interventions might increase financial gain by increasing output volume and value but it might not necessarily increase profitability.

It was evident that financial returns from research results were very site-specific and estimated gains should be consider as such. Reported research trial findings have to have sufficient site, input (treatment) and output (result) information for financial analyses to be carried out with DCF models.

References

- Cubbage F, Davis R, Frey G, Behr DC. 2013. Financial and Economic Evaluation Guidelines for Community Forestry Projects in Latin America. Washington, DC: *Program on Forests (PROFOR)*.
- Ham C, Jacobson M. 2012. Financial decision making in forestry projects. *In: Bredenkamp BV, Upfold SJ (Ed.). South African Forestry Handbook, 5th Edition. The Southern African Institute of Forestry*, page: 491-500.
- Morris AR. 2008. Realising the benefits of research in Eucalyptus plantation management. *Southern Forests: a Journal of Forest Science* 70(2): 119-129.
- Pallett RN, Sale G. 2002. Operational gain: Measuring the capture of genetic gain. *The Southern African Forestry Journal* 195(1): 33-38.
- Rietz DN, Ackerman SA, Titshall LW. 2015. Silvicultural research requirements of the South African commercial forestry industry: A qualitative assessment through stakeholder consultation. *ICFR Bulletin 03/2015. Institute for Commercial Forestry Research, Pietermaritzburg, South Africa.*

The value of six key soil variables for incorporation into a South African forest site classification system

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The intensive nature of management practices in the exotic monoculture plantations of South Africa requires reliable decision support systems. Recent socio-economic developments, the need for optimal forest productivity, as well as increasing awareness of broader ecosystem values and environmental risks, highlight the importance of a unified approach to forest site classification and evaluation. Forest site classification involves the stratification of landscapes according to homogenous conditions of geology, topography, climate and soil, and requires a mapping function for spatial definition. Site evaluation, on the other hand, deals with the interpretation of such data for specific applications such as site-species matching, site quality prediction and growth and yield modelling, nutrient management, risk assessment and best operational practice for general silviculture.

This paper highlights the value of specific soil characteristics and its application value for a range of silviculture and management aspects related to site-specific forestry. A limited set of six soil variables are proposed for ecological mapping of forest landscapes at high-resolution operational-level scales. The variables proposed are parent material, soil classification, effective soil depth, depth limiting material, topsoil organic matter and topsoil texture. The significance and relevance of these selected variables to plantation forestry are as follows:

- **Parent material:** This variable is fundamental to our understanding of soil formation. It influence soil chemistry, depth of weathering and soil texture. This, in turn, relates to soil characteristics such as soil water storage, water availability, natural nutrient status, risk for soil erodibility and compactibility and microbial properties. It is an important variable for prediction of site quality and site-species matching. It influences forest nutrition, site resilience and sustainability, as well as site ecology in complex ways.
- **Soil Classification:** This involves the ordering of soil bodies into a hierarchy of classes, based on similarities / differences in diagnostic properties. It emphasizes the role of soil in providing range of ecosystem services, and improves our understanding of soil genesis, dynamics and behaviour. It has made an important contribution to creating order in the interpretation of a variable soil environment.
- **Effective Soil Depth & Depth Limiting Material:** Soil depth is generally related to degree of weathering, landscape age as well as parent material. It influences moisture storage and nutrient supplying potential, which is important in country where soil moisture is often at a deficit. Many studies indicated this variable as the most important growth factor dictating tree growth. It is also important for determining soil resilience against disturbance, and influences decision making for species choice, risk determination, nutrient management, yield prediction and soil amelioration techniques.
- **Topsoil Organic Matter:** Soil organic matter (SOM) has an influence on a range of physical, chemical and biological properties. It is a precondition for sustainable land utilization and an important indicator of soil quality. SOM reach equilibrium levels associated with specific ecological conditions, and is generally low in South Africa due to warm and dry conditions. It is relevant to forest managers in terms of productivity, resilience, fertilization and carbon sequestration.

- Topsoil Texture: This is a permanent feature of soils determined by parent material and weathering intensity, and is not subject to change under management actions. It has an important influence on nutrient and water balances, as well as aggregate formation and stability, soil strength, porosity and aeration. The extent of physical damage to soil following mechanized operations, as well as time to recovery, are related to soil texture. Texture determines survival rates and initial growth following plantation establishment, as well as successes of using soil-amended hydrogels. However, there are many knowledge gaps regarding extent and persistence of negative impacts on soil properties as function of soil texture.

The selected variables can be related to soil moisture and nutrient supply, and are based on site ecological principles, in support of sustainable forest productivity. All six variables can be spatially defined as part of soil mapping procedure. When used singularly or in combination in decision support systems, it has wide application value. It is also proposed that the selected variables are simple and robust enough for national use. This paper will contribute to unity of purpose and understanding of forest site classification and evaluation in South Africa, and will promote management frameworks and decision support systems with desired environmental, economic and social benefits.

The application value of forest site classification and evaluation systems in South Africa

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The afforested area of intensively managed exotic fast-growing species in South Africa (*Pinus*, *Eucalyptus*, *Acacia*) cover approximately 1.26 million ha of land. Opportunities to expand on this will be limited in the future. A shortage of forest products is therefore predicted for the future. Accurate, scientifically based decision support systems to support sustainable forest management and efficient utilization of limited resources are therefore required. Forest site classification and evaluation can play a fundamental part in decision making at the compartment, plantation and regional level.

Forest site classification and evaluation has been used with success in the South African forestry industry, with a long history of research and technological development. However, there are still several challenges facing the existing systems within the industry. These include limited unity in understanding regarding the value of site classification and evaluation systems. Secondly, there is a lack of agreement in terms of criteria, scale and nomenclature used across boundaries of land ownership. Lastly, since a standard National Forest Site Classification System has never been developed, it limits meaningful strategic communication regarding research, planning, and design as well as the application of research results across complex forest landscapes.

A study was conducted to investigate the perceptions of forest stakeholders (including researchers, planners and managers) regarding their understanding and valuation of forest site classification and evaluation systems. The study included an analysis of shortcomings in existing systems, as well as a future vision in terms of implementing a National Forest Site Classification System and research priorities. A total of 51 respondents participated, involving employees from the most important role players in the local industry.

The preliminary results of the study showed that there is limited understanding of the concept with managers, planners and researchers, on average, scoring 1.03/3, 1.67/3 and 2.08/3 respectively. However, all three groups assigned high scores towards the value (4.72/5, 4.78/5 and 4.54 respectively) and the importance of developing a standardized National Forest Site Classification System, with scores of 4.59/5, 3.89 and 4.33/5 respectively. Furthermore, several shortcomings on existing systems used in South Africa were also outlined, along with the research priorities relevant to this discipline.

It was apparent that, firstly, site classification and evaluation is important to users and its value is recognised. Also, the development of a National Forest Site Classification system is strongly supported. Moreover, several shortcomings in existing company-specific systems have been highlighted. The suggested research priorities should be taken into account. If this study is completed successfully, it can make a significant contribution towards creating an awareness on this topic, provide guidelines to academic institutions for curriculum development, enhance unity in the development of decision support systems for a range of applications in the local industry, and ultimately support sustainable site-specific forestry.

Finding value in waste: An economic feasibility assessment for the manufacture of wood polymer composites using invasive alien plant biomass and recycled thermoplastic waste in South Africa

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Invasive alien plants (IAPs) and thermoplastic waste pose environmental concerns both for South Africa and internationally (Williamson 1996; Richardson and Van Wilgen 2004; Mudavanhu *et al.* 2017). As a result, the government of South Africa, through its Department of Environmental Affairs: Natural Resource Management programme (DEA:NRM), has allocated substantial resources towards the control of IAPs (Van Wilgen *et al.* 2012; WfW Programme 2000). On the other hand, recycling of thermoplastic waste activities have been spearheaded from both a private and public sector perspective. Despite the substantial financial resources devoted by the government through the Working for Water programme, the budgeted amount is far from adequate. Moreover, the rate of recycling thermoplastics and other forms of municipal solid waste is very low, with the national rate at 9.8% for South Africa (DEA 2012; WC-DEA&DP 2013).

Regardless of the negative environmental concerns posed by IAPs and thermoplastic waste, they can also be used to manufacture wood polymer composites (WPCs). A custom built system dynamics model was used in this study to assess the costs and benefits of using the invasive *Acacia saligna* for the production of wood polymer composites (WPCs) in the Western Cape Province of South Africa under four management scenarios. An integrated economic cost benefit analysis that included externality costs (i.e. carbon sequestration potential loss) and benefits (i.e. water savings) as well as the private costs and benefits incurred in the production of WPCs was undertaken.

The results emanating from this study showed a cumulative net present value (NPV) for clearing *Acacia saligna* and making WPCs that amounts to approximately –ZAR122.1 million for the baseline scenario (no WPC production). In addition, the cumulative NPV is estimated to be ZAR144.4 million for Scenario 2 (WPC production with a 20% co-finance), ZAR172.7 million for Scenario 3 (50% co-finance) and ZAR211.2 million for Scenario 4 (100% co-finance).

This study showed that it is economically feasible to use *Acacia saligna* biomass and recycled thermoplastic waste as raw materials in the manufacture of WPC products. As a result the use of IAPs biomass and recycled thermoplastic waste should be viewed as an alternative way in which the private sector can be incentivised to help augment the current state budget, which is by far not enough to tackle the problem of IAPs. In addition, increasing the rate of recycling of thermoplastic waste and using the aforementioned to make value added products is also warranted and will help reduce environmental impacts posed by thermoplastic waste.

References

Department of Environmental Affairs (DEA). 2012. National waste information baseline report. Pretoria, Department of Environmental Affairs.

- Mudavanhu S, Blignaut JN, Vink N, Crookes D, Meincken M, Effah B, Murima D, Nkambule N. 2017. An assessment of the costs and benefits of using *Acacia saligna* (Port Jackson) and recycled thermoplastics for the production of wood polymer composites in the Western Cape province, South Africa. *African Journal of Agricultural and Resource Economics* 12(4): 322–365.
- Richardson DM, Van Wilgen B. 2004. Invasive alien plants in South Africa: how well do we understand the ecological impacts? *South African Journal of Science* 100: 45–52.
- Van Wilgen BW, Forsyth GG, Le Maitre DC, Wannenburgh A, Kotzé JDF, Van den Berg E. 2012. An assessment of the effectiveness of a large, national-scale invasive alien plant control strategy in South Africa. *Biological Conservation*, 148: 28–38.
- Western Cape Department of Environmental Affairs and Development Planning (WC-DEA&DP). 2013. State of environment outlook report for the Western Cape Province: land chapter. Reference number: E02.CPT.00330. Cape Town, Western Cape Provincial Government.
- Williamson M. 1996. *Biological Invasions*. London, Chapman and Hall.
- Working for Water (WfW) Programme. 2000. Working for Water Annual Report 1999/2000. Cape Town: WFWP.

The feasibility of Wood Plastic Composite Materials as building materials for RDP houses

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Wood plastic composites (WPCs) are a mixture of two primary components, biomass and thermoplastics in varying ratios (Schwarzkopf & Burnard, 2016), which provides an alternative to solid wood products. These composites are a fairly new concept in South Africa, introduced into the local market in the early 2000's. The most common application of WPC is for outdoor decking, indoor furniture, window and door frames (Mudavanhu, et al., 2017), however as WPC production capacity rises there are new products and markets being developed (Smith & Wolcott, 2006). Out of the nine known companies selling WPC products in South Africa, only two manufacture their products locally and focus mostly on decking and outdoor furniture which opens an opportunity for other structures to be manufactured.

The aim of this project is to determine the potential viability of utilising WPC made from waste materials to develop affordable building materials for the RDP housing system in South Africa. The raw materials for the WPCs produced in this project are sourced from invasive trees and recycled low density polyethylene (LDPE). Both of these are considered waste materials, as the invasive trees need to be eradicated and South Africa-like most societies –produces plenty of plastic waste. The most widely recycled plastic types in South Africa are LDPE and High-density polyethylene (HDPE), as they form most packaging materials and plastic bags and are thus readily available (PlasticsSA, 2018).

For the purposes of the study, only the Western Cape was considered in order to minimize exorbitant transport and production costs. The biomass was obtained from the invasive tree species commonly found along the Berg River in Paarl namely: *Acacia mearnsii* (Black wattle), *Acacia saligna* (Port Jackson) and *Eucalyptus camaldulensis* (Red gum).

WPC materials used for the construction of RDP houses need to comply with the National Home Builders Registration Council (NHBRC) just as the currently used building materials (Greyling, 2009). The South African National Standards, specifically SANS 10400, is used as a guideline in building construction, as well as other standards such as International Organization for Standardization (ISO).

The objectives of this project are to:

- Determine the financial feasibility of producing WPCs from invasive trees and recycled LDPE for RDP housing. The WPCs need to be produced at the same price or less as the currently utilised building materials, in order to replace them.
- Determine the type and cost of the current building materials used and the building standards they need to meet.
- Determine whether there are standards that the WPCs need to comply with and their advantages over the current building materials.
- Determine whether the RDP occupants would accept WPCs in their home since they are made from heterogeneous raw materials.

References

- Greyling C. 2009. The RDP Housing System In South Africa, Pretoria: University Of Pretoria.
- Mudavanhu S. 2017. An assessment of the cost and benefits of using *Acacia saligna* (Port Jackson) and recycled thermoplastics for the production of wood polymer composites in the Western Cape province, South Africa. *African Journal of Agricultural and Resource Economics* 12(4): 322-365.
- PlasticsSA 2018. Plastics SA. [Online] Available at: <http://www.plasticsinfo.co.za/> [Accessed 13 May 2018].
- Schwarzkopf MJ, Burnard M D. 2016. Wood-Plastic Composites- Performance and Environmental Impacts. *In*: A. Kutnar, SS Muthu, eds. Environmental Impacts of Traditional and Innovative Forest-based Bioproducts. Ljbljanica: Springer Singapore, pp. 19-43.
- Smith PM, Wolcott, MP. 2006. Opporutunities for Wood/Natural Fiber-Plastic Composites in Residential and Indutrial Application. *Forest Products Journal* 56(3): 4-11.

***Eucalyptus* and its economic usage possibilities**

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Eucalyptus is one of South Africa's prominent tree species on commercial plantations, beside pine and wattle (South African Government 2013). *Eucalyptus* in general, cultivated in plantations makes up 41.8 % (511 722 ha) of the country's plantation area (Department of Agriculture, Forestry and Fisheries & Forestry and Natural Resources Management Branch 2014). Red *Eucalyptus* (*Eucalyptus camaldulensis*), like all eucalypts, is foreign to southern Africa and is considered an "alien species". Despite countless positive characteristics of this tree species (e.g. fast growing), one of the main negative aspects of Red *Eucalyptus* is its high competitive strength, which leads to the displacement of indigenous flora (Marais *et al.* 2016). Invasive stands separate to plantations established through unintentional spreading of seeds are a threat to the diverse indigenous vegetation of the Cape Region. Because of the high competitive strength of the *eucalyptus* it suppresses this vegetation. As reaction from the government to this invasive problem the "Working for Water" program was started. This program deals with invasive stands by clearing them completely to reduce the competitive pressure on the surrounding and indigenous vegetation (Department of Environmental Affairs, n.d.). The program recovers costs by finding alternative uses for the cleared timber. As a result, the harvested wood comes in different dimensions compared to the wood from plantations. To be able to have an optimal use, it is important to know which products can be made from *eucalyptus*. Based on its characteristics three main uses for *eucalyptus* exist, which also subsequently led to *eucalyptus* being brought to South Africa. Firstly its use as processed timber which has its importance until today. Secondly its use as fuelwood and derivatives there of (e.g. charcoal). Lastly the use for ornamental purposes (Palgrave *et al.* 2002). Today however, its use is not limited to the afore mentioned applications. One use is in interior construction for framings or panels and can be processed into plywood or veneer. Furthermore, use in honey production where the tree acts as a food source for bees, as well as medical uses (EUCLID - Centre for Plant Biodiversity Research 2006). To conclude, there is a necessity for clearing invasive *eucalyptus* stands which leads to further economic opportunities. Optimization through product variety is an important consideration in complete utilization of the range of dimensions and qualities of the wood coming from clearing operations of invasive stands.

References

- Coates Palgrave K, Drummond RB, Moll EJ, Coates Palgrave M. 2002. *Trees of southern Africa* (3rd New ed. / revised and updated by Meg Coates Palgrave). Cape Town: Struik Publishers.
- Department of Agriculture, Forestry and Fisheries, & Forestry and Natural Resources Management Branch (Eds.). 2014/2015. *Report on Commercial Timber Resources And Primary Roundwood Processing in South Africa*. http://www.nda.agric.za/doaDev/sideMenu/ForestryWeb/webapp/Documents/Timber%20Statistics%20Report%202014_2015%20Final.pdf.
- EUCLID - Centre for Plant Biodiversity Research. 2006. *Factsheet - Eucalyptus camaldulensis var. obtusa*. http://chabg.gov.au/cpbr/cd-keys/euclid3/euclidsample/html/Eucalyptus_camaldulensis_var._obtusa.htm.
- Marais B, Drew D, Ham C. 2016. Report compiled for the Department of Environmental Affairs, 11.
- South African Government. 2013, 2014. *Forestry*. <https://www.gov.za/about-sa/forestry>.

Short rotation coppices in agroforestry system- evaluation of yield and growth rate

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Short Rotation Coppices (SRC) in agroforestry systems are increasingly being considered for biomass production (Jung 2013). To estimate the profitability of the SRC, it is important to evaluate the yield. This work describes the yield evaluation and in addition the determination of the growth rate of SRC in an agroforestry system to better visualize the development of yield formation and thus to support appropriate decisions in practice. The agroforestry area considered in the work is located in east of Göttingen's part Weende. On the agroforestry field, four SRC alleys were created in the spring of 2011. Willow and poplar cuttings and poplar wickers were planted. The procedures and results described below refer only to the three longer alleys, which were planted with 1 104 poplar cuttings ("Max 1" clones). The three considered SRC alleys have a total area of 1 215 m² (Lamersdorf 2018). The smallest SRC alley is not considered because no correct data basis exists for it.

To determine the yield, the regression method was selected. For this method, the diameter at breast height (DBH) and the dry weight of individual shoots need to be determined. Other parameters can be used, but according to Röhle (Röhle 2013), this does not lead to an improvement of the results. Hence, no further parameters were considered. At the end of May 2018, ten percent of the poplars were measured. The diameter of all shoots of a plant were measured at breast height (1.3 m). The shoots, which have not reached this height, were ignored in the measurements. This affected relatively thick, but flat grown shoots as well as occasional whole plants. In addition to the measurements, losses of plants were noted. To estimate the dry weight, initially a total of 15 shoots whose diameter were evenly distributed over the thickness spectrum were harvested. These were deflated and weighed. Twelve pieces of different thick shoots were split and dried at 103 ° C until an absolutely dry state was reached. Based on the obtained data, a biomass function was created which describes the dry weight of a shoot. The function was used, in combination with the measured data, to estimate the total dry biomass of the area.

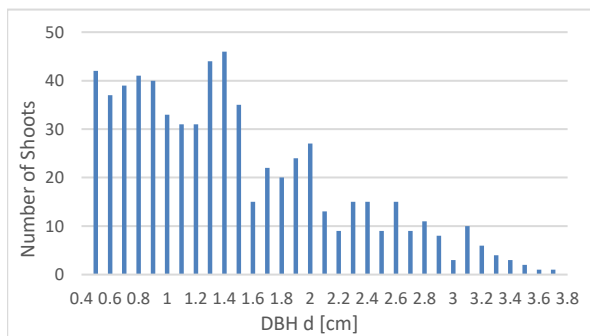


Figure 1: Distribution of measured DBH

In addition to the evaluation of the total dry biomass, and thus the theoretical yield of the area at the considered time, the growth rate was estimated. However, only the two largest areas were considered for the calculation and losses were not included. Two measurements and the time shortly after the last harvest, at the end of January 2017, were evaluated to determine the growth rate. The first DBH measurement was performed on May 7th and 8th, 2018. The second measurement took place

on May 31, 2018. The result of the diameter measurement is shown in Figure 1. It can be seen that there were considerably more thin shoots than thick shoots. The thinnest shoots had a diameter of 0.5 cm. The thickest shoot had a BHD of 3.7 cm. Six losses were observed.

With the data set of the drying, an average dry biomass of 39.06 percent was calculated. With this rate, the dry weight of individual shoots, required for determining the biomass function, was

calculated by multiplying the rate with the wet weight of the shoots. To obtain a biomass function that describes the course of the points, and thus the relationship of the dry biomass to the DBH, as accurately as possible; two compensation functions of the point course were considered. An exponential function and a power function with their respective coefficient of determination R^2 were estimated (Figure 2). Since the power function with 0.95 possesses a, albeit small, higher coefficient of determination; and thus describes the course of the points more accurately than the exponential function, this function was selected for the allometric biomass function of the individual shoots (formula 1).

$$bm = 0,1035 \cdot d^{2,0158} \quad (\text{formula 1})$$

Here bm stands for the dry biomass of a shoot and d for the DBH of the shoot. Using formula 1 and the DBH data, bm_G , the dry biomass of all shoots with a common BHD (formula 2) can be calculated by multiplying formula 1 by the number of shoots of d and 10, so that 100 percent of the poplars are considered again.

$$bm_G = 0,1035 \cdot d^{2,0158} \cdot \text{number of shoots}(d) \cdot 10 \quad (\text{formula 2})$$

To obtain the total dry biomass of all shoots, bm_G was calculated for each occurring DBH and then summed. However, the result of about 1 860 kg of dry biomass does not take the failures into consideration. Since the failures refer to whole plants, the dry weight of a plant (1.7 kg) had to be determined, multiplied by the number of failures and then subtracted from the dry biomass. The calculated total dry biomass of 1 850 kg corresponds to a yield of 15.21 ton/ha. To determine the growth rate, it was assumed, that there was a dry biomass of 0 kg on the considered areas directly after the last harvest. The total dry biomass at the time of the first and second measurements was calculated by the method previously described. Accordingly, there was an increase of 778 kg of dry biomass in the period from the end of January 2017 to 8th May 2018 and from 8th May to 31 May 2018 an increase of 584 kilograms. This corresponds to a growth rate of around 75%.

The results obtained with the regression method are estimates. To get accurate results, the harvesting method would have to be used to determine the yield. Here, the entire area is harvested, weighed, and a sample is dried. With this obtained data, the dry biomass is calculated (Röhle 2013). However, as this method has a completely destructive approach, it is not recommended for determining the yield before the intended harvest. However, when applied during harvesting, it is possible to classify and evaluate previously estimated yields by the regression method in addition to accurate yield determination. The regression method has proven to be a viable method for determining SRC yields. The workload and the extracted number of shoots are here in a reasonable frame. Estimated yields are estimates, but they can be considered as realistic.

References

- Jung. 2013: Presentation "KUP/Agroforst – Verfahren und Technik, Probleme und Chancen"
 Lamersdorf. 2018: Demofläche ÖSM
 Röhle. 2013: "Site-based yield estimation and biomass calculation in short rotation coppice plantations".

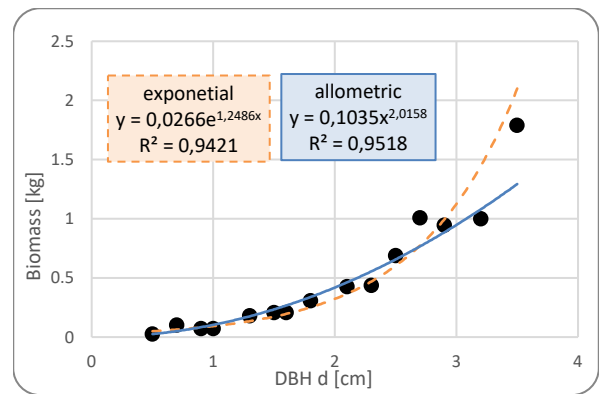


Figure 2: Graphs of exponential (dotted line) and allometric (filled line) biomass function of clone Max 1 in Göttingen

Wheat yield limiting effect through the reduction of photosynthetic active radiation (PAR) by trees in the agroforestry systems of Georg-August University Göttingen

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In May 2018, field measurements of radiation and temperature were carried out to determine the effect of short rotation coppices (SRC) with *Salix* and *Populus* on the yield of wheat in a mixed agroforestry system. The dependent variable was the dry matter of the whole wheat plant. Measurements were taken in 72 test areas (0.25 m² each) at one, five, and ten meter intervals to the north and south of four SRC strips on a wheat field. The photosynthetic active radiation (PAR) denotes the radiation in the range 0.4 to 0.7 μm, which is essential for the growth of a plant. Due to the west-east orientation of the short rotation coppices on the agroforestry system, strong shading effects are to be expected. Therefore, the available PAR near a row of trees must be lower. In addition, this paper examines how the tree population influences the Leaf Area Index (LAI) values of wheat plants. The LAI is defined as leaf area per soil surface.

As a main hypothesis, it was finally tested whether a potentially low PAR in the wheat stock reduces the crop yield or not. The measurements confirmed this suspicion: The yield next to the SRC in the northern direction is significantly lower than at a distance of five or ten meters due to lower radiation and water availability. To determine the PAR in the wheat stock, the device Ceptometer Accu PAR LP 80 was utilized. First, the incoming radiation above the wheat plants was recorded in each of the 72 test areas. Subsequently, a second measurement was implemented at a height of 2 cm above the soil. The software of the Ceptometer Accu PAR LP 80 automatically calculates the LAI using a coefficient for the species-specific leaf growth of the wheat. Finally, the collected data for PAR was evaluated statistically with the program R-Studio.

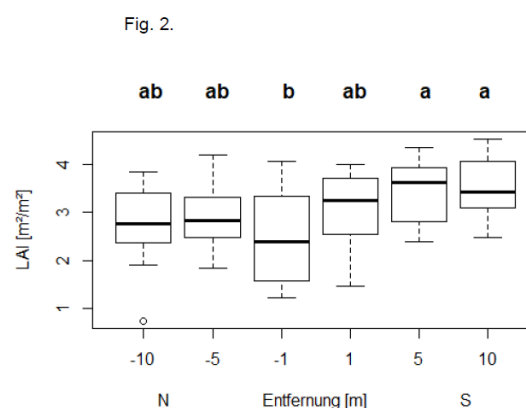
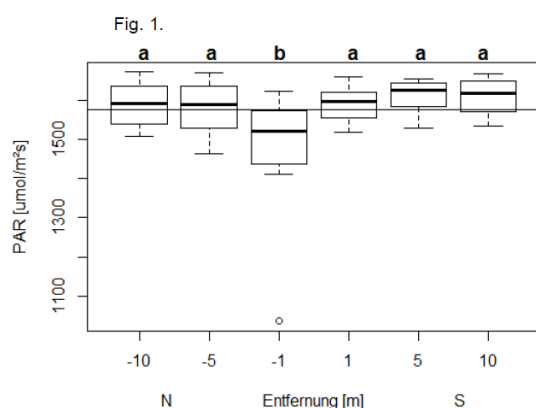


Figure 1 and 2: PAR above the wheat population with increasing distance to the SRCs in northern (-) and southern direction (+). Figure 2: Results of the LAI measurement by the Ceptometer/Accu LP80 with increasing distance to the SRCs in northern (-) and southern direction (+).

The first important finding from the measurements with the Ceptometer Accu PAR LP 80 is that the PAR at one meter distance to the SRC in the northern direction is clearly reduced. The variance analysis (ANOVA) with R-Studio showed that there is a significant correlation between the distance and PAR ($p = 0.0017^{**}$).

The influence of shading is shown by the calculated LAI values. In addition to good water availability, PAR determines the formation of the wheat leaf area (Mu *et al.*, 2010). A comparison of the values at one meter distance to the north in Figures 1 and 2 suggests that the available PAR affects the LAI value. Buckley *et al.* (1999) confirm this assumption. The LAI values are clearly lower at a distance of one meter to the north and show a higher variance (Figure 2). A second variance analysis confirms the significant influence of the distance on the LAI ($p = 0.003^{**}$). During the further statistical evaluation, it was tested how the reduced LAI influences the wheat yield at different distances. The main hypothesis of this study was confirmed by an ANOVA test. The LAI influences the yield highly significantly ($p = 0.0031^{***}$). This means that the yield losses near a row of trees can be explained well by the low LAI value. Figure 3 shows the yield as a function of the leaf area index of all six distances (one, five, and ten meters) to the north and south.

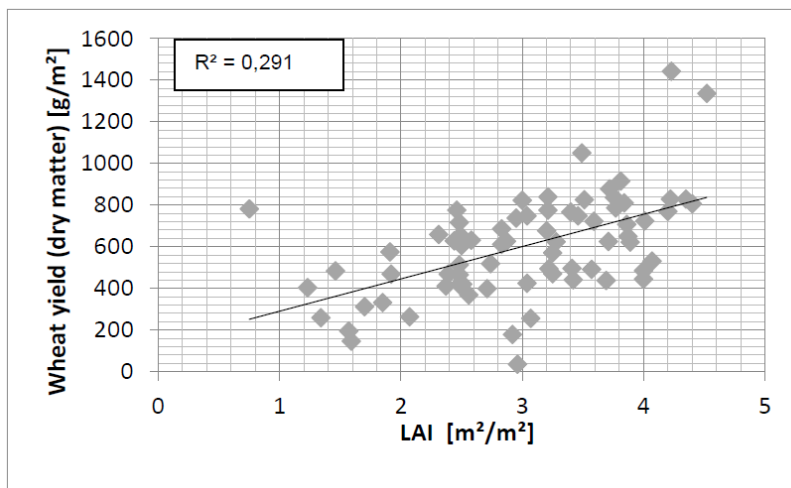


Figure 3: Linear regression of wheat yield (dry matter of the whole plants) depending on the LAI. All 72 measuring points in north and south direction are shown.

The R^2 (0.291) of the regressions equation shows how exact the yield can be explained by the LAI. Therefore, the leaf area is controlling the wheat yield. The yield can be explained to about 30% by the influence of the LAI. The reduced leaf growth near the SRC on the northern side results in the lower PAR. The shading appears decisive here, but it cannot be named as the only factor. This paper did not analyze the impact of water availability or further bio recourses on the LAI. The shading by the trees leads to wheat yield losses. Shading effects cause to a reduced formation of leaf area, which was determined only at one meter distance north of the SRC. After the analysis of solar radiation, it would be suggestive to plant SRC strips from north to south. The period of shading would be shortened. In the actual agroforestry system in Göttingen, the decreased yields must be reduced by plant-farming measures and compensated by the timber yield.

References

- Chirko, C.P., Gold, M.A., Nguyen, P.V. and Jiang, J.P. (1996) Influence of direction and distance from trees on wheat yield and photosynthetic photon flux density (Q_p) in a Palownia and wheat intercropping system. Elsevier. *Forest Ecology and Management* 83 (1996):171-180.
- David S. Buckley, J. G. Isebrands, Terry L. Sharik; Practical Field Methods of Estimating Canopy Cover, PAR, and LAI in Michigan Oak and Pine Stands, *Northern Journal of Applied Forestry*, Volume 16, Issue 1, 1 March 1999, 25–32.
- Mu, H., Jiang, D., Wollenweber, B., Dai, T., Jing, Q. and Cao, W. (2010) Long-term Low Radiation Decreases Leaf Photosynthesis, Photochemical Efficiency and Grain Yield in Winter Wheat. *J. Agronomy & Crop Science* 196 (2010):38-47

Energy wood from short-rotation plantations in times of climate change

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The product from short-rotation plantations are usually wood chips. They have a much better ecological balance sheet than other agricultural products. The ratio between invested energy to energy-output can be up to 1:55. Common agricultural products like corn reach a ratio between 1:5 to 1:17, depending on the environment, the harvesting method, the transportation distance, the water content of the chips before transport, fertilising and watering of the plants.

Wood chips are also nearly CO₂ neutral. On the one hand it's a renewable raw material and on the other hand most of the invested energy like the drying of the chips comes from renewable energy like wind power, water power or wood heatings from „wood garbage“ like bark. That reduces the produced CO₂ per ton to 30 kg.

In times of climate change it's also important that extreme weather is getting more common. But for short rotation plantations this has no relevant effect, because extreme good and extreme bad weather changes over the rotation-time of 3 to 10 years so often that the effects level off.

From an economical view are short-rotation plantations suitable for agricultural areas with weak earnings. That means especially areas with a farmland number lower 30 and a precipitation over 400mm per year. The main factor is a good precipitation, because research has shown, that watering and fertilising are not economical.

After 20 years lowers the yield power and the plantations need to be recreated. So all economical calculations refer to this period. Comparing willow and poplar, willow shows better results because the rotation time is only 3 years, instead of 5. It follows, that willow has a faster capital reflux: Willow 9 years and poplar 15 years (3 rotations each).

Both values, economic and ecologic, depend on many factors and are very different from plantation to plantation and from country to country. It is possible that the plantation is very good from an ecological view because many work can also be done manually but it makes no sense from an economical view. That makes it necessary that the use of short rotation plantations were planned very well.

References

- Dipl.Ing. Dr. Christian Rakos. 2018. Energiebilanz von Holzpellets, propellets.at.
Janine Schweier. 2013. Erzeugung von Energieholz aus Kurzumtriebsplantagen auf landwirtschaftlichen Marginalstandorten in Südwestdeutschland, Uni Freiburg.
Reeg T, et al. 2009. Anbau und Nutzung von Bäumen auf landwirtschaftlichen Flächen, Wiley-VCH
Blick T, et al. 2016. Zur Ökologie von Kurzumtriebsplantagen, LWF Wissen 79.

Evaluation of the deviation between written and actual dimensions of pine logs in Timbadola Sawmill, Levubu, South Africa

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Log yard inventory is very important to forest managers and sawmills. It is needed as an indicator of mill efficiency; for calculation of raw material cost; and for planning purposes. Studies have shown that lumber recovery is closely related to some tree characteristics (Kellogg and Warren 1984; and Oberg 1989). Also, studies have evaluated lumber recovery in relation to log characteristics (Shi *et al.* 1990; Zheng 1989; Zhang and Tong 2005). However, inaccurate information on log input and lumber output can lead to erroneous projections (Keegan *et al.* 2010). Studies on quality and accuracy of written labels on logs are scarce.

This study was carried out to investigate the deviation between the written and actual dimensions of pine logs in Timbadola sawmill. Measurements of 286 logs were carried out in July, 2018 for log length, log diameter at thin end and log diameter at large end. The written dimension on the logs (i.e. length and diameter at thin end) were also recorded. The data collected were analyzed using descriptive statistics and paired t-test to compare the actual and written dimension.

The results of the analysis showed that actual dimensions were significantly higher than the written dimensions. For the actual dimension, log diameter at the thin end ranged between 12 and 48.25 cm; while log length ranged between 2.65 and 6.90 m. For the written dimension, log diameter at the thin end ranged between 13 and 49 cm; while log length ranged between 2.7 and 6.6 m. The coefficient of variation which is a measure of true variation, indicated higher variations among the written dimensions (0.275 for log diameter and 0.3 for log length) compared to the actual dimension (0.266 for log diameter and 0.296 for log length). The operation of labelling logs need to be reviewed because such written dimensions are being used for future planning and the determination lumber recovery.

References

- Keegan CE, Morgan TA, Blatner, Daniels JM. 2010. Trends in Lumber Processing in the Western United States. Part II: Overrun and Lumber Recovery Factors. *Forest Products Journal* 60 (2): 140-143p
- Kellogg RM, Warren WG. 1984. Evaluating Western Hemlock Stem Characteristics in Terms of Lumber Value. *Wood Fiber Science* 16: 583-597.
- Oberg JC. 1989. Impacts on Lumber and Panel Products, Proceedings of Southern Plantation Wood Quality Workshop, June 6-7, 1989, Athens, Georgia.
- Shi R, Steele PH, Wagner FG. 1990. Influence of Log Length and Taper on Estimation of Hardwood BOF Position. *Wood Fiber Science* 22: 142-148
- Zhang S, Tong Q. 2005. Modeling Lumber Recovery in Relation to Selected Tree Characteristics in Jack Pine Using Sawmill Simulator Optitek. *Annals of Forest Science* 62: 219-228.
- Zheng Y, Wagner FG, Steele PH, Ji ZD. 1989. Two-dimensional Geometric Theory for Maximizing Lumber Yield from Logs. *Wood Fiber Science* 21: 91-100.

Programme

Thursday - DAY ONE

- 9:00 - 9:15 Opening
9:15 - 9:30 Welcome: *Pierre Ackerman*
- 9:30 - 10:00 Welcome – international and post graduate office overview: *Robert Kotze*

Session 1

- 10:00 - 10:20 Benefits of community participation in forest management in Mpumalanga, South Africa
Leo Long
- 10:20 - 10:40 Natural forest resource utilization in Limpopo Province of South Africa
Solomon Ojelade
- 10:40 - 11:00 Evaluation of some selected small-scale forest plantations in Limpopo Province, South Africa
Munyaradzi Makoto
- 11:00 - 11:30 Coffee/tea break**
- 11:30 - 11:50 A conceptual framework for environmental payment in South Africa plantations
Charmaine Nelwamondo
- 11:50 - 12:10 Ethno botanical survey of tree species used by Venda people in Limpopo Province, South Africa
Ramavhale Rollet
- 12:10 - 12:30 Health and risk assessment of avenue and boulevard trees on University of Venda Campus
Peter Adesoye
- 12:30 – 13:40 Lunch break**

Session 2

- 13:40 – 14:00 Monitoring of logging operations in (South African) forest plantations using Sentinel-2 Satellite images
Hans Fuchs
- 14:00 - 14:20 Water-use and water-use efficiency in plantations and indigenous forests in the southern Cape
Tatenda Mapeto
- 14:20 – 14:40 Impact of water holding capacity and soil moisture content on the moisture content of selected European timbers
Friedrich Wegener

14:40 – 15:00 Comparative work time and ergospirometry study between the Neheimer and Harzer Planting Procedure and isiePRO
Max Gerbaulet

15:00 – 15:20 Coffee/tea break

15:20 – 15:40 A new approach to “Forsteinrichtung”: Combining enterprise level inventories and airborne LiDAR data to develop compartment wise management plans
Paul Magdon

15:40 – 16:00 The forest of the Norra Kivill National Park
Pauline Thomé

16:00 - 16:20 Predator management in Germany
Philippe Ackermann

16:20 - 16:50 Moderated discussion

18:00 - 20:00 Welcome dinner

Friday, 21.09.2018 - DAY TWO

9:00 - 17:00 Visit to Jonkerhoek Nature Reserve and discussion of land use changes

Saturday, 22.09.2018 - DAY THREE

8:30 - 8:50 Housekeeping announcements

Session 3

8:50 - 9:10 Multiple-use forestry management
Reinhard Hilliger

9:10 – 9:30 Forest monocultures, a comparison between South Africa and Germany
Lucas Companie

9:30 - 9:50 Possibilities in the use of UAV monitoring on grassland vegetation
Johanna Friedrich

9:50 - 10:10 Forest inventory in Namibia's dryland forests - a case study
Mats Mahnken

10:10 - 10:30 The technological status of silviculture re-establishment practices in South Africa
Muedanyi Ramantswana

- 10:30 - 10:50 Unlocking the potential of harvester on board computer data in the South African forestry value chain
Marius Terblanche
- 10:50 - 11:20 Coffee/tea break**
- 11:20 - 11:40 Quantifying financial returns from commercial forestry research trials in the Zululand region of Kwazulu-Natal
Cori Ham
- 11:40 - 12:00 The value of soil information for the development of a National Forest Site Classification System
Josua Louw
- 12:00 - 12:20 The application value of forest site classification and evaluation systems in South Africa
Thembisa Sibhakabhaka
- 12:20 - 12:40 Finding value in waste: An economic feasibility assessment for the manufacture of wood polymer composites using invasive alien plant biomass and recycled thermoplastic waste in South Africa
Shepherd Mudavanhu
- 12:40 - 13:00 The feasibility of using Wood Plastic Composite Materials as building materials for RDP houses
Tenele Dlamini
- 13:00 - 13:40 Lunch break**
- Session 4**
- 13:40 - 14:00 Eucalyptus and its economic usage possibilities
Philipp Kossmann
- 14:00 - 14:20 Agroforestry in Germany with a focus on the evaluation of short rotation coppices
Fabian Rackelmann & Julian Pancritius
- 14:20 - 14:40 Agroforestry: crop yield-limiting competition for soil water and light?
Frederik Eyselée
- 14:40 - 15:10 Coffee/tea break**
- 15:10 - 15:30 Energy wood from short-rotation plantations in times of climate change
Johannes Volmer
- 15:30 - 15:50 Evaluation of the deviation between written and actual dimensions of pine logs in Timbadola Sawmills Levubu, Limpopo
Mashanzhi Ndotshinyani
- 15:50 - 16:30 Moderated discussion and Closing

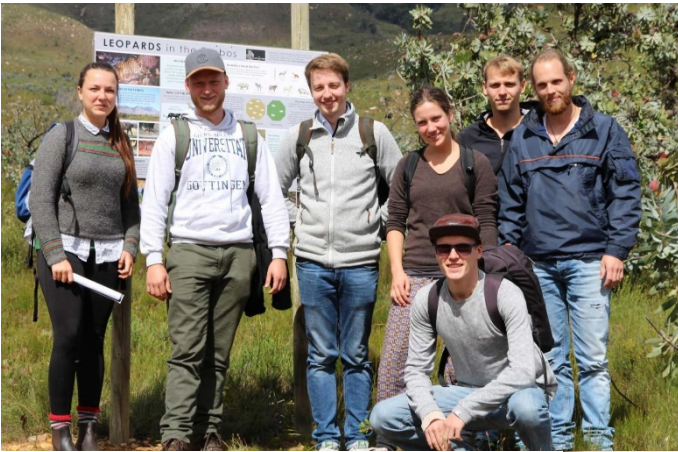


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**Thank you to all the sponsors, delegates, organisers
and caterers who made this event memorable**

