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Satellite remote sensing of plant functional diversity

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III. Acknowledgements

In a week from writing this, I am running the Vietnam Mountain Marathon in Mộc Châu. PhD pursuits have often been compared to resembling a trail marathon: it's a long journey on lonely winding uphill roads. I will soon find out to what extent this metaphor is accurate. While every PhD project is different, my journey has largely felt like a lonesome and daunting struggle. Nevertheless, looking back at the entire journey I realize there were many people along the way to hand me the much-needed metaphorical water and motivation to keep pushing. I want to start by thanking Peter and Nadia for allowing me to embark on this PhD journey. I think now it is safe to admit that I arrived at the starting line pretty much untrained for this distance. I had little to no experience in the fields of biology, conservation, remote sensing, or any coding knowledge. You trusted me to quickly acquire those skills. Joris provided major guidance and help in developing these skills for which I am very thankful.

So many people have played a crucial role in helping me stay positive and luminous, no matter how dim the progress. First off, I want to thank my friends, family, brothers, and sisters, that have made me feel at home in Leiden; Sandesh, Jessie, Aydin, and everybody from LUSV who embraced me like a family in Leiden, Guangchao and crew as a true inspiration for living a balanced life, Riccardo, Marco, Luca, Francesco (pampering me with Italian cuisine and *fratellanza*), Daniel and Bea. I am very grateful to my brother Mucahid as a friend and brave guide in this academic landscape. I want to thank my friends in Vietnam that provided many of my most cherished memories, gave me a place to escape, and uplifted my spirit on every visit. I want to especially thank my brother Phát and his family, and my comrade Khôi. Special acknowledgments to chị Hòa, Bình, Trang, for all your inspiration and support, as well as the larger group of STI and HCMIRG. I want to thank my extended family, my grandparents, Anne, Andre for their inspiration and support. Special thanks to Christian (and Andrea) for being a great friend and a very valuable academic sparring partner. I have learned so much from you and always felt inspired through our conversations on Skype or in the mountains of Zerne. The world needs to get ready for all our future collaborations!

I want to thank the many people within CML that supported me on a daily basis with tea breaks, healthy office vibes, and the preparations leading up to the defense. Special thanks to Sammy and Suzanna, Kevin, the RS group, Nuno, Maarten, Glenn, Emily, and all my dear office mates over the years: Anne, Bertram, Georgios, Bill, Yingji, Laura, and Sam. You have been wonderful to me. I want to thank my co-authors of the manuscripts and publications. I want to give a special thank you to Niels, you saved me literally when got injured in the forest of the Montesinho national park doing fieldwork sampling, but also figurately, by saving my PhD by helping me build a very impressive field data validation dataset. Thank you Myrthe, it felt like a true victory to play my first competitive basketball again after 2,5 years of rehab post-injury. I want to thank KNAW for financial support for the Montesinho field campaign. I want to thank Amie and Famoussa among others for a wonderful time in Ghana and of course my brother Nathan in Accra for always supporting me. I want to thank the reviewers for rejecting multiple versions of my papers initially and firing up my motivation. I would like to acknowledge the synergy of events that helped align a path for me to accomplish the PhD journey with many lessons that truly shaped me into who I am today as a more resilient and balanced person.

I left my final and most important thank you to my family (Wil, Otto, and Elke) because these words involve the deepest and whole of my heart. I am so thankful for you and how you have supported me in every possible way and surrounded me with unconditional love. Perseverance, being resilient, and having the curiosity to learn more and adapt, all started with you. Netherlands, Australia, or Austria, inside or outside academia, I believe I would have been able to make it anywhere with the mindset and support that you have given me. My love and gratitude are infinite. The doctor's title will be in front of my name, but honestly, you deserve it just as much so considered it a shared title! Special thanks to Elke and Ross for the beautiful dissertation cover.

Lastly, a little warning to those who want to pursue a PhD; do not seek academic titles, money, and possession for the sake of it as those will never satisfy. What I value in hindsight is the strength and resilience I have shown and developed through the many adversities I faced over these years. Hustle-and-grind culture might be toxic, and I paid its price, so be aware. Yet, in the end, it still was the perseverance and hard work that led me to obtain my PhD title.

I am thankful for everyone that stuck with me when the soil remained bare no matter how many seeds I planted and the water I gave. First seedlings have sprouted and an even bigger harvest is coming soon, let's celebrate together and keep empowering each other to grow. I am forever grateful, also to the many people I failed to mention here. Thank you all from the bottom of my heart.

IV. Curriculum Vitae

Leon T. Hauser was born in Subiaco, Perth, Western Australia and moved to the Netherlands with his younger sister and parents timely before enjoying his formal education. After completing his Latin school at Gymnasium Camphusianum in Gorinchem, he enrolled in a bachelor's studies in 'Human Geography' at Utrecht University. After graduation and a brief return to Australia, Leon proceeded with a joint research master's programme in 'Sustainable Development' shared between Basel University and Utrecht University matching his interest in sustainable societal transition. Leon wrote his master thesis at the Alterra Green World Research Centre in Wageningen on how farm management shapes the Dutch rural landscape through the presence of semi-natural landscape elements and biotopes combining insights from aerial photography and farmer interviews.

Following M.Sc. graduation with cum laude distinction in 2013, Leon engaged in consultancy projects related to urban agriculture and invasive water species infestations. In late 2014, Leon took up a role as an 'Environmental Research Officer' at the Space Technology Institute based in Hanoi, Vietnam, funded by the Australian Department of Foreign Affairs and Trade. The projects within Leon's portfolio focused on the monitoring of coastal land use changes in relation to market and policy decisions. The assignment resulted in numerous collaborations with ministries and national research institutes, publications in SCOPUS-listed journals and presentations at international conferences and the OECD headquarters.

Halfway into 2016, Leon returned to the Netherlands in pursuit of a PhD at the Institute of Environmental Sciences, Leiden University. He researched and developed physics-based scalable methods for Sentinel-2 to map plant biodiversity patterns over large geographic extents. During his doctoral candidacy, Leon was involved in instructing computer lab courses in GIS and Environmental Biology. His PhD project has resulted in four manuscripts of which two were published in 'Remote Sensing of the Environment' (IF: 10.2) and oral presentations at the EGU in Vienna (2019) and the World Biodiversity Forum in Davos (2020). Before finishing his PhD, Leon commenced a postdoctoral research position within the Institute of Environmental Sciences of Leiden University funded and supported by the Centre for Sustainability and ACCEZ (Accelerating the Circular Economy in Zuid-Holland) with a focus on quantitative ecosystem services modelling for agricultural land-use scenarios.

Coming September, Leon will start a postdoctoral position at the Remote Sensing Laboratories of the University of Zurich (Switzerland) linking satellite-based ratings of company footprints in biodiversity and water to support sustainable finance. At the same time, Leon has received a European Space Agency (ESA) grant for Initial Support for Innovation (EISI) to further develop satellite-based biodiversity metrics into applicable data products in supply chain management and life-cycle assessment (www.biodiv-watch.space).

V. Publications

Peer-reviewed journals:

Hauser, L. T., Timmermans, J., Soudzilovskaia, N. A., & P. M. van Bodegom (2022). *Linking Land Use and Plant Functional Diversity Patterns in Sabah, Borneo, through Large-Scale Spatially Continuous Sentinel-2 Inference*. *Land*, 11(4), 572. <https://doi.org/10.3390/land11040572>

Nguyen An Binh, **Hauser, L.T.**, Pham Viet Hoa, Giang Thi Phuong Thao, Nguyen Ngoc An, Huynh Song Nhut, Tran Anh Phuong & J. Verrelst (2022). *Quantifying mangrove leaf area index from Sentinel-2 imagery using hybrid models and active learning*. *International Journal of Remote Sensing*, pp. 1-22. <https://doi.org/10.1080/01431161.2021.2024912>

Bayrak, M.M., Marks, D., **Hauser, L.T.**, & D. Marks (2022). *Disentangling the concepts of global climate change, adaptation, and human mobility: a political-ecological exploration in Vietnam's Mekong Delta*. *Clim. Dev.* 0, 1–10. <https://doi.org/10.1080/17565529.2022.2028596>

Hauser, L.T., Timmermans, J., van der Windt, N., Sil, Â.F., César de Sá, N., Soudzilovskaia, N.A., & P.M. van Bodegom (2021). *Explaining discrepancies between spectral and in-situ plant diversity in multispectral satellite earth observation*. *Remote Sens. Environ.* 265, 112684. <https://doi.org/10.1016/j.rse.2021.112684>

Hauser, L.T., Féret J.B., Nguyen An Binh, Van der Windt, N., Timmermans J., Sil A., Soudzilovskaia N.A., & P.M. van Bodegom (2021). *Towards scalable estimation of plant functional diversity from Sentinel-2 imagery: In-situ validation in a heterogeneous (semi-) natural landscape*. *Remote Sensing of Environment*, Volume 262, 1 September 2021, 112505. <https://doi.org/10.1016/j.rse.2021.112505>

De Sá, N.C., Baratchi, M., **Hauser, L.T.**, & P.M. van Bodegom (2021). *Exploring the Impact of Noise on Hybrid Inversion of PROSAIL RTM on Sentinel-2 Data*. *Remote Sens.* 13(4), 1–20. <https://doi.org/10.3390/rs13040648>

Hauser, L.T., Nguyen An Binh, Pham Viet Hoa, Nguyen Hong Quan & J. Timmermans, (2020). *Gap-free annual monitoring of mangrove forest dynamics in Ca Mau province, Vietnamese Mekong delta using the Landsat-7-8 Archives and post-classification temporal optimization*. *Remote Sens.* 2020, 12(22), 3729. <https://doi.org/10.3390/rs12223729>

Pham Viet Hoa, Nguyen Vu Giang, Nguyen An Binh, Nguyen Minh Hieu, Nguyen Trang Thi Quynh & **L.T. Hauser**, (2017). *Mangrove Species Discrimination in Southern Vietnam Based on in-situ Measured Hyperspectral Reflectance*. *International Journal of Geoinformatics*, 13(3).

Hauser, L.T., Nguyen Vu Giang, Nguyen An Binh, Dade, E., Nguyen Minh Hieu, Nguyen Thi Quynh Trang, Vu Huu Long, Tong Thi Huyen Ai, & Pham Viet Hoa (2017). *Uncovering the spatio-temporal dynamics of land cover change and fragmentation of mangroves in the Ca*

Mau peninsula, Vietnam using multi-temporal SPOT satellite imagery (2004-2013). Applied Geography, 86, pp. 197–207. <http://doi.org/10.1016/j.apgeog.2017.06.019>

Hauser, L.T., Van Der Sluis, T. & Giezen, M., (2016). *The Role of Farm Management Characteristics in Understanding the Spatial Distribution of Landscape Elements: A Case Study in the Netherlands*. Rural Landscapes: Society, Environment, History. 3(1), pp.7. <http://doi.org/10.16993/rl.14>

Conferences:

Invited speaker at World Biodiversity Forum, 23-28 February, 2020. Davos, Switzerland. Session: ‘Remote Sensing for Biodiversity Monitoring’.

Invited speaker at SENSE Symposium, 11 October 2019, University of Twente. Session: ‘Innovative research techniques in Environmental Sciences’.

Invited speaker at 11th International Convention of Asia Scholars. 16-19 July 2019, Leiden University, Leiden, The Netherlands. Session: ‘Engaging with Vietnam’.

Hauser, L.T. (2019), *Vietnam’s Voyage into Space; Motives and Pathways Towards building a New Satellite Technology Powerhouse*. 11th International Convention of Asia Scholars. Leiden University, Leiden, The Netherlands

Invited speaker at European Geosciences Union General Assembly, 7–12 April 2019, Vienna, Austria. Session: ‘Remote sensing of interactions between vegetation and hydrology’.

Hauser, L.T., Timmermans, J., Soudzilovskaia, N.A. & P.M. van Bodegom (2019). *Mapping plant functional diversity across land use types and along elevation through satellite remote sensing*. 21st EGU General Assembly, EGU2019, Proceedings from the conference held 7-12 April, 2019 in Vienna, Austria.

Invited speaker at Data to Decisions: Valuing the Societal Benefit of Geo-Spatial Information: A workshop organized by the GEOValue community in collaboration with OECD, NASA, and USGS. March 10-11, 2016, OECD, Paris, France.

Invited speaker at 6th DAAD and VNU international conference for ‘Remote Sensing and GIS Application and Integration’, 6-9 Oct. 2015, Hanoi

Hauser L.T. et al. (2015), *Spectral Discrimination of Common Mangrove Species in the Ca Mau Peninsula, Vietnam; Using a large sample-set of hyperspectral in-situ canopy data*. Proceedings of the 6th DAAD and VNU international conference for ‘Remote Sensing and GIS Application and Integration’, 6-9 Oct. 2015, Hanoi; Vietnamese National University, pp. 649-656. DOI: 10.13140/RG.2.1.4535.3683

Invited speaker at International Conference on “Conservation, Sustainable Community Livelihood and Climate Change Mitigation”. December 2013, Chinese University of Hong Kong, Hong Kong.