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Geography 2

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## Short presentation

Martin Brandt received his PhD from the University of Bayreuth, Germany in 2014. He works as Assistant Professor at the University of Copenhagen since 2015. His major fields are remote sensing and physical Geography and his work concentrates on the monitoring of vegetation dynamics, with a special focus on West Africa and Southern China. Martin Brandt's research is breaking new ground, with 15 manuscripts published in Nature/Science journals between 2018 and 2021 (5 as first author). His recent work, published in Nature, was the first applying deep learning on hundreds of thousands of sub-metre satellite images to map billions of individual tree crowns in desert areas that were often assumed as free of any trees. In 2020, he received an ERC starting grant and an DFF Sapere Aude grant to study trees outside forests at global scale.

## Employment

### Associate Professor

Geography 2

København K, Denmark

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## Research outputs

### Even low levels of tree cover improve dietary quality in West Africa

den Braber, B., Hall, C., Brandt, Martin Stefan, Reiner, Florian, Mugabowindekwe, Maurice & Rasmussen, Laura Vang, 1 Feb 2024, In: PNAS Nexus. 3, 2, pgae067.

### Central African biomass carbon losses and gains during 2010–2019

Zhao, Z., Ciais, P., Wigneron, J. P., Santoro, M., Brandt, Martin Stefan, Kleinschroth, F., Lewis, S. L., Chave, J., Fensholt, Rasmus, Laporte, N., Sonwa, D. J., Saatchi, S. S., Fan, L., Yang, H., Li, X., Wang, M., Zhu, L., Xu, Y., He, J. & Li, W., 2024, In: One Earth. 7, 3, p. 506-519 14 p.

### Changes in vegetation-water response in the Sahel-Sudan during recent decades

Lu, Tingting, Zhang, Wenmin, Abel, Christin, Horion, Stéphanie, Brandt, Martin Stefan, Huang, Ke & Fensholt, Rasmus, 2024, In: Journal of Hydrology: Regional Studies. 52, 10 p., 101672.

### High-resolution canopy height map in the Landes forest (France) based on GEDI, Sentinel-1, and Sentinel-2 data with a deep learning approach

Schwartz, M., Ciais, P., Ottlé, C., De Truchis, A., Vega, C., Fayad, I., Brandt, Martin Stefan, Fensholt, Rasmus, Baghdadi, N., Morneau, F., Morin, D., Guyon, D., Dayau, S. & Wigneron, J. P., 2024, In: International Journal of Applied Earth Observation and Geoinformation. 128, 18 p., 103711.

### Satellite observed aboveground carbon dynamics in Africa during 2003–2021

Wang, M., Ciais, P., Fensholt, Rasmus, Brandt, Martin Stefan, Tao, S., Li, W., Fan, L., Frappart, F., Sun, R., Li, X., Liu, X., Wang, H., Cui, T., Xing, Z., Zhao, Z. & Wigneron, J. P., 2024, In: Remote Sensing of Environment. 301, 19 p., 113927.

### Scattered tree death contributes to substantial forest loss in California

Cheng, Yan, Oehmcke, Stefan, Brandt, Martin Stefan, Rosenthal, L., Das, A., Vrieling, A., Saatchi, S., Wagner, F., Mugabowindekwe, Maurice, Verbruggen, Wim, Beier, Claus & Horion, Stéphanie, 2024, In: Nature Communications. 15, 1, p. 1-13 641.

### **Severe decline in large farmland trees in India over the past decade**

Brandt, Martin Stefan, Gominski, Dimitri Pierre Johannes, Reiner, Florian, Kariryaa, Ankit, Guthula, Venkanna Babu, Ciais, P., Tong, Xiaoye, Zhang, Wenmin, Govindarajulu, D., Ortiz-Gonzalo, Daniel & Fensholt, Rasmus, 2024, (E-pub ahead of print) In: Nature Sustainability.

### **Sub-meter tree height mapping of California using aerial images and LiDAR-informed U-Net model**

Wagner, F. H., Roberts, S., Ritz, A. L., Carter, G., Dalagnol, R., Favrichon, S., Hirye, M. C. M., Brandt, Martin Stefan, Ciais, P. & Saatchi, S., 2024, In: Remote Sensing of Environment. 305, 13 p., 114099.

### **The preservation of old forests in southwest China is closely linked to the presence of ethnic minorities**

Li, Q., Yue, Y., Brandt, Martin Stefan, Chen, Z., Tong, X., Liu, Siyu, Yang, F., Xiao, X. & Wang, K., 2024, In: Applied Geography. 165, 9 p., 103245.

### **Trees on smallholder farms and forest restoration are critical for Rwanda to achieve net zero emissions**

Mugabowindekwe, M., Brandt, M., Mukuralinda, A., Ciais, P., Reiner, F., Kariryaa, A., Igel, C., Chave, J., Mertz, O., Hiernaux, P., Tong, X., Rwanyiziri, G., Gominski, D., Li, S., Liu, S., Gasangwa, I., Hategekimana, Y., Ndoli, A., Nduwamungu, J., Saatchi, S. & 1 others, Fensholt, Rasmus, 2024, In: Communications Earth & Environment. 5, 1, 10 p., 113.

### **Urban Core Greening Balances Browning in Urban Expansion Areas in China during Recent Decades**

Zhang, Xiaoxin, Brandt, Martin Stefan, Tong, Xiaoye, Tong, Xiaowei, Zhang, Wenmin & Fensholt, Rasmus, 2024, In: Journal of Remote Sensing (United States). 4, 10 p., 0112.

### **Beyond tree cover: Characterizing southern China's forests using deep learning**

Li, Q., Yue, Y., Liu, Siyu, Brandt, Martin Stefan, Chen, Z., Tong, Xiaowei, Wang, K., Chang, J. & Fensholt, Rasmus, 2023, In: Remote Sensing in Ecology and Conservation. 9, 1, p. 17-32

### **Deep learning enables image-based tree counting, crown segmentation and height prediction at national scale**

Li, Sizhuo, Brandt, Martin Stefan, Fensholt, Rasmus, Kariryaa, Ankit, Igel, Christian, Gieseke, Fabian Cristian, Nord-Larsen, Thomas, Oehmcke, Stefan, Carlsen, Ask Holm, Junttila, S., Tong, Xiaoye, d'Aspremont, A. & Ciais, P., 2023, In: PNAS Nexus. 2, 4, 16 p., pgad076.

### **Deep learning for mapping water bodies in the Sahel**

de FLEURY, M., Kergoat, L., Brandt, Martin Stefan, Fensholt, Rasmus, Kariryaa, Ankit, Kovács, Gyula Mate, Horion, Stéphanie & Grippa, M., 2023. 1 p.

### **FORMS: Forest Multiple Source height, wood volume, and biomass maps in France at 10 to 30 m resolution based on Sentinel-1, Sentinel-2, and Global Ecosystem Dynamics Investigation (GED) data with a deep learning approach**

Schwartz, M., Ciais, P., De Truchis, A., Chave, J., Otlé, C., Vega, C., Wigneron, J., Nicolas, M., Jouaber, S., Liu, Siyu, Brandt, Martin Stefan & Fayad, I., 2023, In: Earth System Science Data. 15, 11, p. 4927-4945 19 p.

### **Forest Plan - pilot project on mapping of forest resources**

Nord-Larsen, Thomas, Tsatsakis, M., Li, Sizhuo, Avila, Linsey Marie, Brandt, Martin Stefan, Liu, Siyu, Morueta-Holme, Naia, Davison, Charles W. & Fensholt, Rasmus, 2023, Copenhagen: Department of Geosciences and Natural Resource Management, University of Copenhagen. 128 p. (IGN Report; No. March 2023).

### **Global increase in biomass carbon stock dominated by growth of northern young forests over past decade**

Yang, H., Ciais, P., Frappart, F., Li, X., Brandt, Martin Stefan, Fensholt, Rasmus, Fan, L., Saatchi, S., Besnard, S., Deng, Z., Bowring, S. & Wigneron, J. P., 2023, In: Nature Geoscience. 16, 10, p. 886-892

### **Iterative integration of deep learning in hybrid Earth surface system modelling**

Chen, M., Qian, Z., Boers, N., Jakeman, A. J., Kettner, A. J., Brandt, M., Kwan, M. P., Batty, M., Li, W., Zhu, R., Luo, W., Ames, D. P., Barton, C. M., Cuddy, S. M., Koirala, S., Zhang, F., Ratti, C., Liu, J., Zhong, T., Liu, J. & 12 others, Wen, Y., Yue, S., Zhu, Z., Zhang, Z., Sun, Z., Lin, J., Ma, Z., He, Y., Xu, K., Zhang, C., Lin, H. & Lü, G., 2023, In: Nature Reviews Earth & Environment. 4, p. 568-581

## **MAPPING TREE MORTALITY IN CALIFORNIA FROM VERY HIGH RESOLUTION IMAGERY USING DEEP LEARNING**

Cheng, Yan, Oehmcke, Stefan, Brandt, Martin Stefan, Das, A., Rosenthal, L., Saatchi, S., Wagner, F., Vrieling, A., Verbruggen, Wim, Beier, Claus & Horion, Stéphanie, 2023.

## **Mapping and characterising tree mortality in California at individual tree level using deep learning**

Cheng, Yan, Oehmcke, Stefan, Brandt, Martin Stefan, Das, A., Rosenthal, L., Saatchi, S., Wagner, F., Verbruggen, Wim, Vrieling, A., Beier, Claus & Horion, Stéphanie, 2023. 1 p.

## **Mapping tree species diversity of temperate forests using multi-temporal Sentinel-1 and -2 imagery**

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## **Mapping tropical forest degradation with deep learning and Planet NICFI data**

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## **More than one quarter of Africa's tree cover is found outside areas previously classified as forest**

Reiner, F., Brandt, M., Tong, X., Skole, D., Kariyaa, A., Ciais, P., Davies, A., Hiernaux, P., Chave, J., Mugabowindekwe, M., Igel, C., Oehmcke, S., Gieseke, F., Li, S., Liu, S., Saatchi, S., Boucher, P., Singh, J., Taugourdeau, S., Dendoncker, M. & 4 others, Song, X., Mertz, Ole, Tucker, C. J. & Fensholt, Rasmus, 2023, In: Nature Communications. 14, 10 p., 2258.

## **Nation-wide mapping of tree-level aboveground carbon stocks in Rwanda**

Mugabowindekwe, M., Brandt, M., Chave, J., Reiner, F., Skole, D. L., Kariyaa, A., Igel, C., Hiernaux, P., Ciais, P., Mertz, O., Tong, X., Li, S., Rwanyiziri, G., Dushimiyimana, T., Ndoli, A., Uwizeyimana, V., Lillesø, J-P. B., Gieseke, F., Tucker, C. J., Saatchi, S. & 1 others, Fensholt, Rasmus, 2023, In: Nature climate change. 13, p. 91-97

## **Projected Rainfall-Driven Expansion of Woody Cover in African Drylands**

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## **Recent decrease of the impact of tropical temperature on the carbon cycle linked to increased precipitation**

Zhang, Wenmin, Schurgers, Guy, Peñuelas, J., Fensholt, Rasmus, Yang, H., Tang, Jing, Tong, Xiaowei, Ciais, P. & Brandt, Martin Stefan, 2023, In: Nature Communications. 14, 1, 9 p., 965.

## **Reforestation policies around 2000 in southern China led to forest densification and expansion in the 2010s**

Tong, Xiaowei, Brandt, Martin Stefan, Yue, Y., Zhang, Xiaoxin, Fensholt, Rasmus, Ciais, P., Wang, K., Liu, Siyu, Zhang, Wenmin, Mao, C. & Jepsen, Martin Rudbeck, 2023, In: Communications Earth and Environment. 4, 8 p., 260.

## **Reliability of using vegetation optical depth for estimating decadal and interannual carbon dynamics**

Dou, Y., Tian, F., Wigneron, J. P., Tagesson, Håkan Torbern, Du, J., Brandt, Martin Stefan, Liu, Y., Zou, L., Kimball, J. S. & Fensholt, Rasmus, 2023, In: Remote Sensing of Environment. 285, 14 p., 113390.

## **Rural outmigration generates a carbon sink in South China karst**

Chang, J., Yue, Y., Tong, Xiaowei, Brandt, Martin Stefan, Zhang, C., Zhang, Xuemei, Qi, X. & Wang, K., 2023, In: Progress in Physical Geography. 47, 5, p. 655-667

## **Siberian carbon sink reduced by forest disturbances**

Fan, L., Wigneron, J. P., Ciais, P., Chave, J., Brandt, M., Sitch, S., Yue, C., Bastos, A., Li, X., Qin, Y., Yuan, W., Schepaschenko, D., Mukhortova, L., Li, X., Liu, X., Wang, M., Frappart, F., Xiao, X., Chen, J., Ma, M. & 5 others, Wen, J., Chen, X., Yang, H., van Wees, D. & Fensholt, Rasmus, 2023, In: Nature Geoscience. 16, p. 56-62

## **Sub-continental-scale carbon stocks of individual trees in African drylands**

Tucker, C., Brandt, M., Hiernaux, P., Kariyaa, A., Rasmussen, K., Small, J., Igel, C., Reiner, F., Melocik, K., Meyer, J., Sinno, S., Romero, E., Glennie, E., Fitts, Y., Morin, A., Pinzon, J., McClain, D., Morin, P., Porter, C., Loeffler, S. & 10

others, Kergoat, L., Issoufou, B., Savadogo, P., Wigneron, J., Poulter, B., Ciais, P., Kaufmann, R., Myneni, R., Saatchi, S. & Fensholt, Rasmus, 2023, In: Nature. 615, 7950, p. 80-86

#### **The overlooked contribution of trees outside forests to tree cover and woody biomass across Europe**

Liu, Siyu, Brandt, Martin Stefan, Nord-Larsen, Thomas, Chave, J., Reiner, Florian, Lang, Nico, Tong, Xiaoye, Ciais, P., Igel, Christian, Pascual, A., Guerra-hernandez, J., Li, Sizhuo, Mugabowindekwe, Maurice, Saatchi, S., Yue, Y., Chen, Z. & Fensholt, Rasmus, 2023, In: Science Advances. 9, 37, 15 p., eadh4097.

#### **Woody plant decline in the Sahel of western Niger (1996–2017): is it driven by climate or land use changes?**

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#### **A global increase in tree cover extends the growing season length as observed from satellite records**

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#### **A large but transient carbon sink from urbanization and rural depopulation in China**

Zhang, Xiaoxin, Brandt, Martin Stefan, Tong, Xiaowei, Ciais, P., Yue, Y., Xiao, X., Zhang, Wenmin, Wang, K. & Fensholt, Rasmus, 2022, In: Nature Sustainability. 5, p. 321–328 8 p.

#### **Global quantification of the bidirectional dependency between soil moisture and vegetation productivity**

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#### **Globally Increasing Atmospheric Aridity Over the 21st Century**

Fang, Zhongxiang, Zhang, Wenmin, Brandt, Martin Stefan, Abdi, A. M. & Fensholt, Rasmus, 2022, In: Earth's Future. 10, 10, 13 p., e2022EF003019.

#### **Large loss and rapid recovery of vegetation cover and aboveground biomass over forest areas in Australia during 2019–2020**

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#### **Large scale rocky desertification reversal in South China karst**

Yue, Y., Qi, X., Wang, K., Liao, C., Tong, Xiaowei, Brandt, Martin Stefan & Liu, B., 2022, In: Progress in Physical Geography. 46, 5, p. 661-675

#### **Mapping global lake dynamics reveals the emerging roles of small lakes**

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#### **Mapping the Abundance of Multipurpose Agroforestry *Faidherbia albida* Trees in Senegal**

Lu, Tingting, Brandt, Martin Stefan, Tong, Xiaoye, Hiernaux, P., Leroux, L., Ndao, B. & Fensholt, Rasmus, 2022, In: Remote Sensing. 14, 3, 16 p., 662.

#### **Quantifying understory vegetation density using multi-temporal Sentinel-2 and GEDI LiDAR data**

Xi, Y., Tian, Q., Zhang, Wenmin, Zhang, Z., Tong, Xiaoye, Brandt, Martin Stefan & Fensholt, Rasmus, 2022, In: GIScience and Remote Sensing. 59, 1, p. 2068-2083 16 p.

#### **The Carbon Sink Potential of Southern China After Two Decades of Afforestation**

Zhang, X. M., Brandt, Martin Stefan, Yue, Y. M., Tong, Xiaowei, Wang, K. L. & Fensholt, Rasmus, 2022, In: Earth's Future. 10, 12, 13 p., e2022EF002674.

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### **UNSUPERVISED SEGMENTATION OF SMALLHOLDER FIELDS IN MOZAMBIQUE USING PLANETSCOPE IMAGERY**

Picoli, M. C. A., Radoux, J., Tong, Xiaoye, Bey, A., Rufin, P., Brandt, Martin Stefan, Fensholt, Rasmus & Meyfroidt, P., 2022, In: International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives. 43, B3-2022, p. 975-981 7 p.

### **Socio-economic and climatic changes lead to contrasting global urban vegetation trends**

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### **Climatic and non-climatic vegetation cover changes in the rangelands of Africa**

D'Adamo, F., Ogutu, B., Brandt, Martin Stefan, Schurgers, Guy & Dash, J., Jul 2021, In: Global and Planetary Change. 202, 13 p., 103516.

### **Mapping the dynamics of winter wheat in the north china plain from dense landsat time series (1999 to 2019)**

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### **The confounding effect of snow cover on assessing spring phenology from space: A new look at trends on the Tibetan Plateau**

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### **Global-scale assessment and inter-comparison of recently developed/reprocessed microwave satellite vegetation optical depth products**

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### **Responses and feedbacks of African dryland ecosystems to environmental changes**

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### **Carbon loss from forest degradation exceeds that from deforestation in the Brazilian Amazon**

Qin, Y., Xiao, X., Wigneron, J., Ciais, P., Brandt, Martin Stefan, Fan, L., Li, X., Crowell, S., Wu, X., Doughty, R., Zhang, Y., Liu, F., Sitch, S. & Moore, B., 2021, In: Nature climate change. 11, 5, p. 442-448 7 p.

### **Country-scale mapping of individual forest and non-forest trees and shrubs in Africa - the example of Rwanda**

Mugabowindekwe, Maurice, Brandt, Martin Stefan & Fensholt, Rasmus, 2021. 1 p.

### **Eco-engineering controls vegetation trends in southwest China karst**

Zhang, Xuemei, Yue, Y., Tong, Xiaowei, Wang, K., Qi, X., Deng, C. & Brandt, Martin Stefan, 2021, In: Science of the Total Environment. 770, 145160.

### **Response to concerns about the African fire trends controlled by precipitation over recent decades**

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### **Trees outside of forests as natural climate solutions**

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### **50 years of woody vegetation changes in the Ferlo (Senegal) assessed by high-resolution imagery and field surveys**

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### **Accelerating land cover change in West Africa over four decades as population pressure increased**

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### **Vegetation Optical Depth Retrieval from AMSR-E/AMSR2 Observations Using L-MEB Inversion**

Wang, M., Wigneron, J., Sun, R., Ciais, P., Brandt, Martin Stefan, Liu, Y., Frappart, F., Li, X., Liu, X., Fan, L. & Fensholt, Rasmus, 26 Sep 2020, p. 5003-5006. 4 p.

### **An unexpectedly large count of trees in the West African Sahara and Sahel**

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### **Forest management in southern China generates short term extensive carbon sequestration**

Tong, Xiaowei, Brandt, Martin Stefan, Yue, Y., Ciais, P., Jepsen, Martin Rudbeck, Penuelas, J., Wigneron, J. P., Xiao, X., Song, X. P., Horion, Stéphanie, Rasmussen, Kjeld, Saatchi, S., Fan, L., Wang, K., Zhang, B., Chen, Z., Wang, Y., Li, X. & Fensholt, Rasmus, 2020, In: Nature Communications. 11, 1, 10 p., 129.

### **Large scale reforestation of farmlands on sloping hills in South China karst**

Yue, Y., Liao, C., Tong, Xiaowei, Wu, Z., Fensholt, Rasmus, Prishchepov, Alexander V., Jepsen, Martin Rudbeck, Wang, K. & Brandt, Martin Stefan, 2020, In: Landscape Ecology. 35, p. 1445–1458 14 p.

### **Nonlinear dynamics of fires in Africa over recent decades controlled by precipitation**

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### **Recent divergence in the contributions of tropical and boreal forests to the terrestrial carbon sink**

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### **The forgotten land use class: Mapping of fallow fields across the Sahel using Sentinel-2**

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### **Tropical forests did not recover from the strong 2015-2016 El Nino event**

Wigneron, J., Fan, L., Ciais, P., Bastos, A., Brandt, Martin Stefan, Chave, J., Saatchi, S., Baccini, A. & Fensholt, Rasmus, 2020, In: Science Advances. 6, 6, 11 p., eaay4603.

### **Uncovering Dryland Woody Dynamics Using Optical, Microwave, and Field Data—Prolonged Above-Average Rainfall Paradoxically Contributes to Woody Plant Die-Off in the Western Sahel**

Bernardino, P. N., Brandt, Martin Stefan, De Keersmaecker, W., Horion, Stéphanie, Fensholt, Rasmus, Storms, I., Wigneron, J., Verbesselt, J. & Somers, B., 2020, In: Remote Sensing. 12, 14, 21 p., 2332.

### **Changes in rainfall distribution promote woody foliage production in the Sahel**

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#### **Detecting Hardly Visible Roads in Low-Resolution Satellite Time Series Data**

Oehmcke, Stefan, Thrysoe, C., Borgstad, A., Vaz Salles, M. A., Brandt, Martin Stefan & Gieseke, Fabian Cristian, 2019, *Proceedings of the IEEE International Conference on Big Data, Big Data 2019: Special Session on Intelligent Data Mining*. IEEE, p. 2403-2412 9006251,

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