

Assignment: Global environmental change - land surface greening

Mode

Partner work allowed: yes, maximum groups of three.

Create a text document of 3-5 pages (A4, 11 pt) that answers the content points listed below. You may structure the document along the given questions or as you like. Make sure that references in your text are correctly cited and that each statement is referenced. Ideally, your responses are complemented by a figure from original sources for each point. The document may be handed in as a Word, [RMarkdown](#), or [Quarto](#) document that can be added to the repository of the LES textbook (<https://geco-bern.github.io/les/>).

Present this work in a presentation of 30 min.

Supervised by Laura Marqués.

Content points

1. What is global greening and how is it detected?
 - (Piao et al., 2020)
2. Which variables are commonly used to measure greening trends?
 - (Zhu et al., 2013)
3. Does the evidence always show consistent global greening trends?
 - (Frankenberg et al., 2021; Wang et al., 2020)
4. What are the drivers of the greening trend in different regions?
 - (Chen et al., 2019; Zhu et al., 2016)
5. What are the feedbacks of global greening on the climate system?
 - (Piao et al., 2020)
6. How does global greening reflect changes in photosynthesis and transpiration?
 - (Donohue et al., 2013)

References

Chen, C., Park, T., Wang, X., Piao, S., Xu, B., Chaturvedi, R. K., Fuchs, R., Brovkin, V., Ciais, P., Fensholt, R., Tømmervik, H., Bala, G., Zhu, Z., Nemani, R. R., and Myneni, R. B.: China and India lead in greening of the world through land-use management, *Nat Sustain*, 2, 122–129, <https://doi.org/10.1038/s41893-019-0220-7>, 2019.

Donohue, R. J., Roderick, M. L., McVicar, T. R., and Farquhar, G. D.: Impact of CO₂ fertilization on maximum foliage cover across the globe's warm, arid environments: CO₂ FERTILIZATION AND FOLIAGE COVER, *Geophys. Res. Lett.*, 40, 3031–3035, <https://doi.org/10.1002/grl.50563>, 2013.

Frankenberg, C., Yin, Y., Byrne, B., He, L., and Gentile, P.: Comment on “Recent global decline of

CO₂ fertilization effects on vegetation photosynthesis,” *Science*, 373, eabg2947, <https://doi.org/10.1126/science.abg2947>, 2021.

Piao, S., Wang, X., Park, T., Chen, C., Lian, X., He, Y., Bjerke, J. W., Chen, A., Ciais, P., Tømmervik, H., Nemani, R. R., and Myneni, R. B.: Characteristics, drivers and feedbacks of global greening, *Nat Rev Earth Environ*, 1, 14–27, <https://doi.org/10.1038/s43017-019-0001-x>, 2020.

Wang, S., Zhang, Y., Ju, W., Chen, J. M., Ciais, P., Cescatti, A., Sardans, J., Janssens, I. A., Wu, M., Berry, J. A., Campbell, E., Fernández-Martínez, M., Alkama, R., Sitch, S., Friedlingstein, P., Smith, W. K., Yuan, W., He, W., Lombardozzi, D., Kautz, M., Zhu, D., Lienert, S., Kato, E., Poulter, B., Sanders, T. G. M., Krüger, I., Wang, R., Zeng, N., Tian, H., Vuichard, N., Jain, A. K., Wiltshire, A., Haverd, V., Goll, D. S., and Peñuelas, J.: Recent global decline of CO₂ fertilization effects on vegetation photosynthesis, *Science*, 370, 1295–1300, <https://doi.org/10.1126/science.abb7772>, 2020.

Zhu, Z., Bi, J., Pan, Y., Ganguly, S., Anav, A., Xu, L., Samanta, A., Piao, S., Nemani, R. R., and Myneni, R. B.: Global Data Sets of Vegetation Leaf Area Index (LAI)3g and Fraction of Photosynthetically Active Radiation (FPAR)3g Derived from Global Inventory Modeling and Mapping Studies (GIMMS) Normalized Difference Vegetation Index (NDVI3g) for the Period 1981 to 2011, *Remote Sensing*, 5, 927–948, <https://doi.org/10.3390/rs5020927>, 2013.

Zhu, Z., Piao, S., Myneni, R. B., Huang, M., Zeng, Z., Canadell, J. G., Ciais, P., Sitch, S., Friedlingstein, P., Arneth, A., Cao, C., Cheng, L., Kato, E., Koven, C., Li, Y., Lian, X., Liu, Y., Liu, R., Mao, J., Pan, Y., Peng, S., Penuelas, J., Poulter, B., Pugh, T. A. M., Stocker, B. D., Viovy, N., Wang, X., Wang, Y., Xiao, Z., Yang, H., Zaehle, S., and Zeng, N.: Greening of the Earth and its drivers, *Nature Clim. Change*, 6, 791–795, 2016.