

**Ambio**

**Electronic Supplementary Material**

**This supplementary material has not been peer reviewed.**

**Title: Assessing ecosystem service trade-offs and synergies: the need for a more mechanistic approach**

## Appendix S1

### Papers selected for the literature review database

1. Ai, J.Y., X. Sun, L. Feng, Y.F. Li, and X.D. Zhu. 2015. Analyzing the spatial patterns and drivers of ecosystem services in rapidly urbanizing Taihu Lake Basin of China. *Frontiers of Earth Science* 9: 531-545.
2. Alarcon, G.G., Y. Ayanu, A.C. Fantini, J. Farley, A. Schmitt, and T. Koellner. 2015. Weakening the Brazilian legislation for forest conservation has severe impacts for ecosystem services in the Atlantic Southern Forest. *Land Use Policy* 47: 1-11.
3. Albizua, A., A. Williams, K. Hedlund, and U. Pascual. 2015. Crop rotations including ley and manure can promote ecosystem services in conventional farming systems. *Applied Soil Ecology* 95: 54-61.
4. Allen, K.E. 2015. Trade-offs in nature tourism: contrasting parcel-level decisions with landscape conservation planning. *Ecology and Society* 20.
5. Anderson-Teixeira, K.J., B.D. Duval, S.P. Long, and E.H. DeLucia. 2012. Biofuels on the landscape: Is "land sharing" preferable to "land sparing"? *Ecological Applications* 22: 2035-2048.
6. Anderson, B.J., P.R. Armsworth, F. Eigenbrod, C.D. Thomas, S. Gillings, A. Heinemeyer, D.B. Roy, and K.J. Gaston. 2009. Spatial covariance between biodiversity and other ecosystem service priorities. *Journal of Applied Ecology* 46: 888-896.
7. Armenteras, D., N. Rodriguez, and J. Retana. 2015. National and regional relationships of carbon storage and tropical biodiversity. *Biological Conservation* 192: 378-386.
8. Bai, Y., Z.Y. Ouyang, H. Zheng, X.M. Li, C.W. Zhuang, and B. Jiang. 2012. Modeling soil conservation, water conservation and their tradeoffs: A case study in Beijing. *Journal of Environmental Sciences-China* 24: 419-426.
9. Bai, Y., H. Zheng, Z.Y. Ouyang, C.W. Zhuang, and B. Jiang. 2013. Modeling hydrological ecosystem services and tradeoffs: a case study in Baiyangdian watershed, China. *Environmental Earth Sciences* 70: 709-718.
10. Balbi, S., A. del Prado, P. Gallejones, C.P. Geewan, G. Pardo, E. Perez-Minana, R. Manrique, C. Hernandez-Santiago, and F. Villa. 2015. Modeling trade-offs among ecosystem services in agricultural production systems. *Environmental Modelling & Software* 72: 314-326.

11. Baral, H., R.J. Keenan, J.C. Fox, N.E. Stork, and S. Kasel. 2013. Spatial assessment of ecosystem goods and services in complex production landscapes: A case study from south-eastern Australia. *Ecological Complexity* 13: 35-45.
12. Baraloto, C., P. Alverga, S.B. Quispe, G. Barnes, N.B. Chura, I.B. da Silva, W. Castro, H. da Souza, I.D. Moll, J.D. Chilo, H.D. Linares, J.G. Quispe, D. Kenji, H. Medeiros, S. Murphy, C.A. Rockwell, A. Shenkin, M. Silveira, J. Southworth, G. Vasquez, and S. Perz. 2014. Trade-offs among forest value components in community forests of southwestern Amazonia. *Ecology and Society* 19.
13. Bartomeus, I., V. Gagic, and R. Bommarco. 2015. Pollinators, pests and soil properties interactively shape oilseed rape yield. *Basic and Applied Ecology* 16: 737-745.
14. Biber, P., J.G. Borges, R. Moshammer, S. Barreiro, B. Botequim, Y. Brodrechtova, V. Brukas, G. Chirici, R. Cordero-Debets, E. Corrigan, L.O. Eriksson, M. Favero, E. Galev, J. Garcia-Gonzalo, G. Hengeveld, M. Kavaliauskas, M. Marchetti, S. Marques, G. Mozgeris, R. Navratil, M. Nieuwenhuis, C. Orazio, I. Paligorov, D. Pettenella, R. Sedmak, R. Smrecek, A. Stanislovaitis, M. Tome, R. Trubins, J. Tucek, M. Vizzarri, I. Wallin, H. Pretzsch, and O. Sallnas. 2015. How Sensitive Are Ecosystem Services in European Forest Landscapes to Silvicultural Treatment? *Forests* 6: 1666-1695.
15. Boreux, V., C.G. Kushalappa, P. Vaast, and J. Ghazoul. 2013. Interactive effects among ecosystem services and management practices on crop production: Pollination in coffee agroforestry systems. *Proceedings of the National Academy of Sciences of the United States of America* 110: 8387-8392.
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17. Briner, S., R. Huber, P. Bebi, C. Elkin, D.R. Schmatz, and A. Gret-Regamey, A. 2013. Trade-Offs between Ecosystem Services in a Mountain Region. *Ecology and Society* 18.
18. Brittain, C., N. Williams, C. Kremen, and A.M. Klein. 2013. Synergistic effects of non-Apis bees and honey bees for pollination services. *Proceedings of the Royal Society B-Biological Sciences* 280.
19. Butler, J.R.A., G.Y. Wong, D.J. Metcalfe, M. Honzak, P.I. Pert, N. Rao, M.E. van Grieken, T. Lawson, C. Bruce, F.J. Kroon, and J.E. Brodie. 2013. An analysis of trade-offs between multiple ecosystem services and stakeholders linked to land use and water quality management in the Great Barrier Reef, Australia. *Agriculture Ecosystems & Environment* 180: 176-191.

- 20.** Cademus, R., F.J. Escobedo, D. McLaughlin, and A. Abd-Elrahman. 2014. Analyzing Trade-Offs, Synergies, and Drivers among Timber Production, Carbon Sequestration, and Water Yield in *Pinus elliotii* Forests in Southeastern USA. *Forests* 5: 1409-1431.
- 21.** Carswell, F.E., N.W.H. Mason, J.M. Overton, R. Price, L.E. Burrows, and R.B. Allen. 2015. Restricting new forests to conservation lands severely constrains carbon and biodiversity gains in New Zealand. *Biological Conservation* 181: 206-218.
- 22.** Castro, A.J., B. Martin-Lopez, E. Lopez, T. Plieninger, D. Alcaraz-Segura, C.C. Vaughn, and J. Cabello. 2015. Do protected areas networks ensure the supply of ecosystem services? Spatial patterns of two nature reserve systems in semi-arid Spain. *Applied Geography* 60: 1-9.
- 23.** Chung, M.G., H. Kang, and S.U. Choi. 2015. Assessment of Coastal Ecosystem Services for Conservation Strategies in South Korea. *PLOS ONE* 10.
- 24.** Classen, A., M.K. Peters, S.W. Ferger, M. Helbig-Bonitz, J.M. Schmack, G. Maassen, M. Schleuning, E.K.V. Kalko, K. Bohning-Gaese, and I. Steffan-Dewenter. 2014. Complementary ecosystem services provided by pest predators and pollinators increase quantity and quality of coffee yields. *Proceedings of the Royal Society B-Biological Sciences* 281.
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- 27.** Cordingley, J.E., A.C. Newton, R.J. Rose, R.T. Clarke, and J.M. Bullock, J.M. 2015. Habitat Fragmentation Intensifies Trade-Offs between Biodiversity and Ecosystem Services in a Heathland Ecosystem in Southern England. *PLOS ONE* 10.
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- 36.** Dymond, J.R., A.G.E. Ausseil, J.C. Ekanayake, and M.U.F. Kirschbaum. 2012. Tradeoffs between soil, water, and carbon - A national scale analysis from New Zealand. *Journal of environmental management* 95: 124-131.
- 37.** Eigenbrod, F., B.J. Anderson, P.R. Armsworth, A. Heinemeyer, S.F. Jackson, M. Parnell, C.D. Thomas, and K.J. Gaston. 2009. Ecosystem service benefits of contrasting conservation strategies in a human-dominated region. *Proceedings of the Royal Society B-Biological Sciences* 276: 2903-2911.
- 38.** Ewing, P.M., and B.C. Runck. 2015. Optimizing nitrogen rates in the midwestern United States for maximum ecosystem value. *Ecology and Society* 20.
- 39.** Felipe-Lucia, M.R., and F.A. Comin. 2015. Ecosystem services-biodiversity relationships depend on land use type in floodplain agroecosystems. *Land Use Policy* 46: 201-210.
- 40.** Felipe-Lucia, M.R., F.A. Comin, and E.M. Bennett. 2014. Interactions Among Ecosystem Services Across Land Uses in a Floodplain Agroecosystem. *Ecology and Society* 19.

41. Fezzi, C., A.R. Harwood, A.A. Lovett, and I.J. Bateman. 2015. The environmental impact of climate change adaptation on land use and water quality. *Nature Climate Change* 5: 255-260.
42. Forouzangohar, M., N.D. Crossman, R.J. MacEwan, D.D. Wallace, and L.T. Bennett. 2014. Ecosystem Services in Agricultural Landscapes: A Spatially Explicit Approach to Support Sustainable Soil Management. *Scientific World Journal*.
43. Frank, S., C. Furst, and F. Pietzsch. 2015. Cross-Sectoral Resource Management: How Forest Management Alternatives Affect the Provision of Biomass and Other Ecosystem Services. *Forests* 6: 533-560.
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46. Garcia-Fayos, P., and E. Bochet. 2009. Indication of antagonistic interaction between climate change and erosion on plant species richness and soil properties in semiarid Mediterranean ecosystems. *Global change biology* 15: 306-318.
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48. Gimona, A., and D. van der Horst. 2007. Mapping hotspots of multiple landscape functions: a case study on farmland afforestation in Scotland. *Landscape Ecology* 22: 1255-1264.
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- 51.** Grossman, J.J. 2015. Ecosystem service trade-offs and land use among smallholder farmers in eastern Paraguay. *Ecology and Society* 20.
- 52.** Haase, D., N. Schwarz, M. Strohbach, F. Kroll, and R. Seppelt. 2012. Synergies, Trade-offs, and Losses of Ecosystem Services in Urban Regions: an Integrated Multiscale Framework Applied to the Leipzig-Halle Region, Germany. *Ecology and Society* 17.
- 53.** Haines-Young, R., M. Potschin, and F. Kienast. 2012. Indicators of ecosystem service potential at European scales: Mapping marginal changes and trade-offs. *Ecological Indicators* 21: 39-53.
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- 55.** Harmackova, Z.V., D. Vackar. 2015. Modelling regulating ecosystem services trade-offs across landscape scenarios in Trebonsko Wetlands Biosphere Reserve, Czech Republic. *Ecological Modelling* 295: 207-215.
- 56.** Holt, A.R., M. Mears, L. Maltby, and P. Warren. 2015. Understanding spatial patterns in the production of multiple urban ecosystem services. *Ecosystem Services* 16: 33-46.
- 57.** Jessop, J., G. Spyreas, G.E. Pociask, T.J. Benson, M.P. Ward, A.D. Kent, and J.W. Matthews. 2015. Tradeoffs among ecosystem services in restored wetlands. *Biological Conservation* 191: 341-348.
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- 61.** Kirchner, M., J. Schmidt, G. Kindermann, V. Kulmer, H. Mitter, F. Pretenthaler, J. Rudisser, T. Schauppenlehner, M. Schonhart, F. Strauss, U. Tappeiner, E. Tasser, and E. Schmid. 2015. Ecosystem services and economic development in Austrian agricultural landscapes - The impact of policy and climate change scenarios on trade-offs and synergies. *Ecological economics* 109: 161-174.

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- 69.** Lavorel, S., and K. Grigulis. 2012. How fundamental plant functional trait relationships scale-up to trade-offs and synergies in ecosystem services. *Journal of Ecology* 100: 128-140.
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- 76.** Maes, J., M.L. Paracchini, G. Zulian, M.B. Dunbar, and R. Alkemade. 2012. Synergies and trade-offs between ecosystem service supply, biodiversity, and habitat conservation status in Europe. *Biological Conservation* 155: 1-12.
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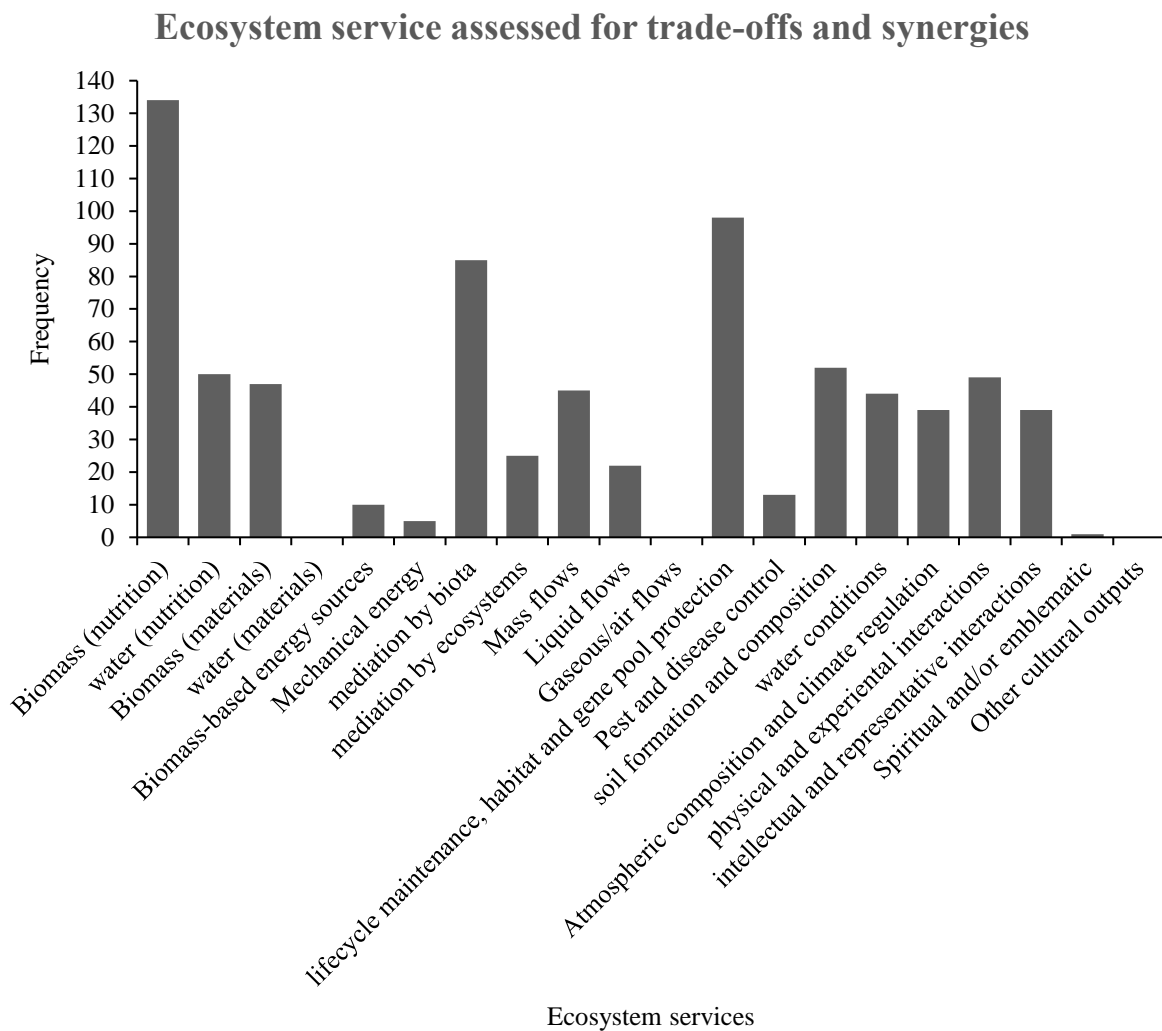
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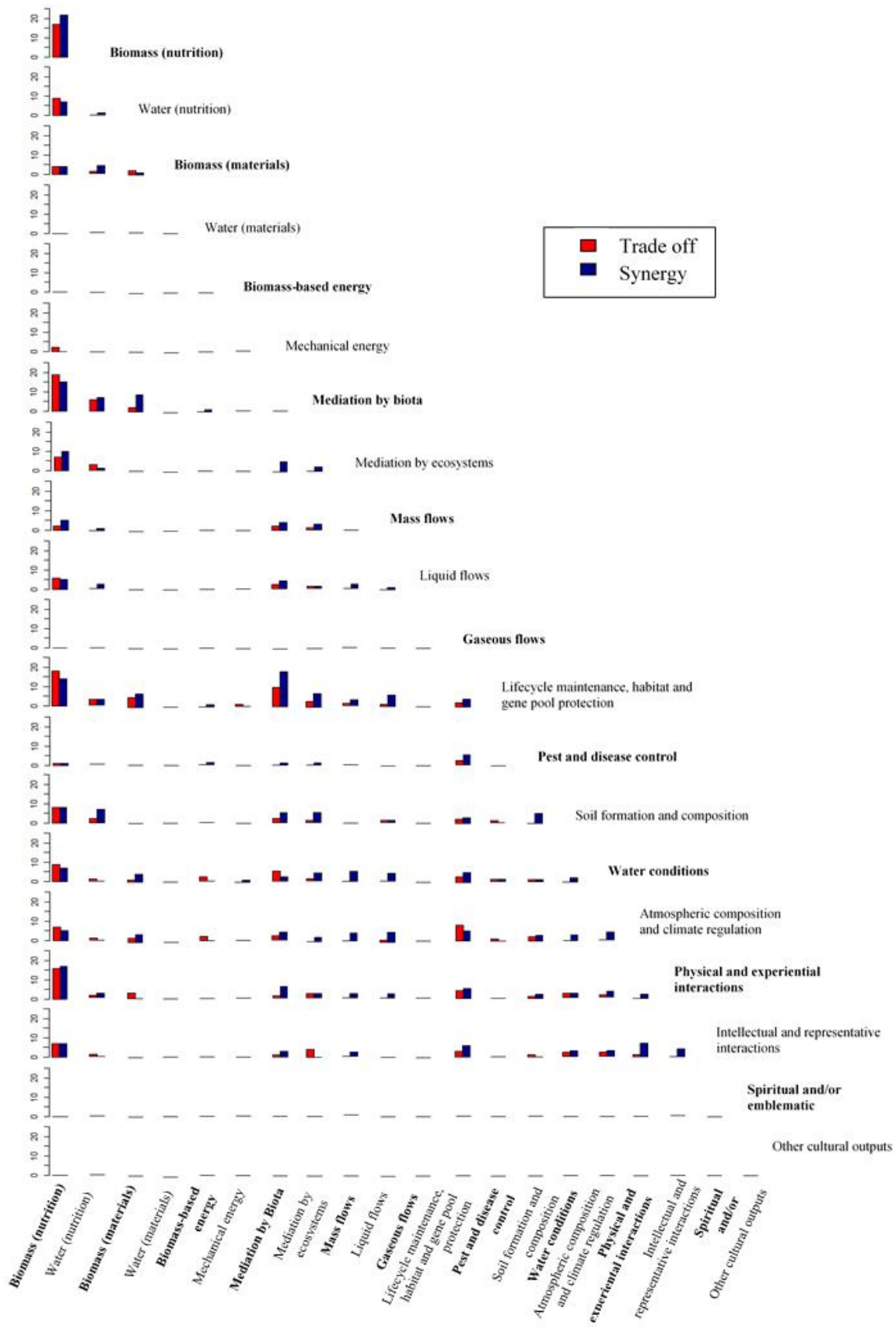


## Appendix S2

### Supplementary graphics of the results



**Figure S1.** Recorded number of ecosystem services assessed for trade-offs and synergies in the literature review database. Ecosystem service groups as defined by CICES classification V4.3 (<http://cices.eu/>)



**Figure S2.** The number trade-offs and synergies identified between ecosystem services in the literature database. Ecosystem service groups as defined by CICES classification V4.3 (<http://cices.eu/>)