**Telescoping into the US to analyze dynamic multi-sector hotspots and inter-sectoral linkages.**

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**Abstract**

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Google Sheet for Temp Work: <https://docs.google.com/spreadsheets/d/1HxYzOf6g8Y_wH81eNUUbniznkPPFiEqX9247wKY-hso/edit#gid=1426711730>

# Introduction

## Literature Review:

**Dynamic Hotspot Analysis**

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| **Study** | **Definition** | **Theme** | **Positives** | **Negatives** |
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**Hotspot Analysis**

Ed Byers [1]

<https://iopscience.iop.org/article/10.1088/1748-9326/aabf45/meta>

RAND 2016 [2]

<https://www.prgs.edu/pardee-initiative/food-energy-water/about.html>

<https://www.rand.org/pubs/tools/TL165.html>

Inas 2017 Water–food–energy nexus index: analysis of water–energy–food nexus of crop’s production system applying the indicators approach

<https://link.springer.com/article/10.1007/s13201-017-0551-3>

Karan 2018 Quantitative modeling of interconnections associated with sustainable food, energy and water (FEW) systems

<https://www.sciencedirect.com/science/article/pii/S0959652618322649>

Nexus Indicator.

Venghaus 2019 From a few security indices to the FEW Security Index: Consistency in global food, energy and water security assessment

<https://www.sciencedirect.com/science/article/pii/S2352550919301587>

Miner 2019 Parts Unmapped: Linear Multi-variate Analysis of Food, Water, and Temperature Requirements for Regional Stability

<https://apps.dtic.mil/dtic/tr/fulltext/u2/1081507.pdf>

Zhang 2019 Understanding the tele-coupling mechanism of urban food-energy-water nexus: Critical sources, nodes, and supply chains

<https://www.sciencedirect.com/science/article/pii/S0959652619321973>

Tashtoush 2019 A review of the water–energy–food nexus measurement and management approach

<https://link.springer.com/article/10.1007/s42108-019-00042-8>

Mc Grane 2018 Scaling the nexus: Towards integrated frameworks for analysing water, energy and food

<https://rgs-ibg.onlinelibrary.wiley.com/doi/abs/10.1111/geoj.12256@10.1111/(ISSN)1475-4959.Geography_and_the_Water-Energy-Food_Nexus>

Vinca et al.

NEST

Endo, Makoto

<https://www.mdpi.com/2073-4441/7/10/5806/htm>

**Multi-Scale (Inter-links)**

Veldhuis (2017) Integrated approaches to the optimisation of regional and local food–energy–water systems

<https://www.sciencedirect.com/science/article/pii/S2211339817300242>

Abulibdeh & Zaidan (2020) [3]

* Uses WEF index from RAND 2018.

Cremades et al. (2019) [4]

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[3–33]

[1] E. Byers, M. Gidden, D. Leclère, J. Balkovic, P. Burek, K. Ebi, P. Greve, D. Grey, P. Havlik, A. Hillers, N. Johnson, T. Kahil, V. Krey, S. Langan, N. Nakicenovic, R. Novak, M. Obersteiner, S. Pachauri, A. Palazzo, S. Parkinson, N.D. Rao, J. Rogelj, Y. Satoh, Y. Wada, B. Willaarts, K. Riahi, Global exposure and vulnerability to multi-sector development and climate change hotspots, Environmental Research Letters. 13 (2018) 055012. https://doi.org/10.1088/1748-9326/aabf45.

[2] H.H. Willis, D.G. Groves, J.S. Ringel, Z. Mao, S. Efron, M. Abbott, Developing the Pardee RAND Food-Energy-Water Security Index: Toward a Global Standardized, Quantitative, and Transparent Resource Assessment, (2016).

[3] A. Abulibdeh, E. Zaidan, Managing the water-energy-food nexus on an integrated geographical scale, Environmental Development. (2020) 100498. https://doi.org/10.1016/j.envdev.2020.100498.

[4] R. Cremades, H. Mitter, N.C. Tudose, A. Sanchez-Plaza, A. Graves, A. Broekman, S. Bender, C. Giupponi, P. Koundouri, M. Bahri, S. Cheval, J. Cortekar, Y. Moreno, O. Melo, K. Karner, C. Ungurean, S.O. Davidescu, B. Kropf, F. Brouwer, M. Marin, Ten principles to integrate the water-energy-land nexus with climate services for co-producing local and regional integrated assessments, Science of The Total Environment. 693 (2019) 133662. https://doi.org/10.1016/j.scitotenv.2019.133662.

[5] T.R. Albrecht, A. Crootof, C.A. Scott, The Water-Energy-Food Nexus: A systematic review of methods for nexus assessment, Environmental Research Letters. 13 (2018) 043002. https://doi.org/10.1088/1748-9326/aaa9c6.

[6] M. Bazilian, H. Rogner, M. Howells, S. Hermann, D. Arent, D. Gielen, P. Steduto, A. Mueller, P. Komor, R.S.J. Tol, K.K. Yumkella, Considering the energy, water and food nexus: Towards an integrated modelling approach, Energy Policy. 39 (2011) 7896–7906. https://doi.org/10.1016/j.enpol.2011.09.039.

[7] L. de Strasser, A. Lipponen, M. Howells, S. Stec, C. Bréthaut, A Methodology to Assess the Water Energy Food Ecosystems Nexus in Transboundary River Basins, Water. 8 (2016) 59. https://doi.org/10.3390/w8020059.

[8] A. Endo, I. Tsurita, K. Burnett, P.M. Orencio, A review of the current state of research on the water, energy, and food nexus, Journal of Hydrology: Regional Studies. 11 (2017) 20–30. https://doi.org/10.1016/j.ejrh.2015.11.010.

[9] P. Gober, Hidden Vulnerabilities in the Water-Energy-Land-Food (WELF) Nexus, in: P. Gober (Ed.), Building Resilience for Uncertain Water Futures, Springer International Publishing, Cham, 2018: pp. 61–89. https://doi.org/10.1007/978-3-319-71234-5\_4.

[10] M.D. Ibrahim, D.C. Ferreira, S. Daneshvar, R.C. Marques, Transnational resource generativity: Efficiency analysis and target setting of water, energy, land, and food nexus for OECD countries, Science of The Total Environment. 697 (2019) 134017. https://doi.org/10.1016/j.scitotenv.2019.134017.

[11] N. Johnson, P. Burek, E. Byers, G. Falchetta, M. Flörke, S. Fujimori, P. Havlik, M. Hejazi, J. Hunt, V. Krey, S. Langan, N. Nakicenovic, A. Palazzo, A. Popp, K. Riahi, M. van Dijk, M.T.H. van Vliet, D.P. van Vuuren, Y. Wada, D. Wiberg, B. Willaarts, C. Zimm, S. Parkinson, Integrated Solutions for the Water-Energy-Land Nexus: Are Global Models Rising to the Challenge?, Water. 11 (2019) 2223. https://doi.org/10.3390/w11112223.

[12] T. Kahil, S. Parkinson, Y. Satoh, P. Greve, P. Burek, T.I.E. Veldkamp, R. Burtscher, E. Byers, N. Djilali, G. Fischer, V. Krey, S. Langan, K. Riahi, S. Tramberend, Y. Wada, A Continental-Scale Hydroeconomic Model for Integrating Water-Energy-Land Nexus Solutions, Water Resources Research. (2017) 7511–7533. https://doi.org/10.1029/2017WR022478@10.1002/(ISSN)1944-7973.HESSS4.

[13] M. Kurian, R. Ardakanian, eds., Governing the Nexus: Water, Soil and Waste Resources Considering Global Change, Springer International Publishing, 2015. https://doi.org/10.1007/978-3-319-05747-7.

[14] Y. Lechón, C. De La Rúa, H. Cabal, Impacts of Decarbonisation on the Water-Energy-Land (WEL) Nexus: A Case Study of the Spanish Electricity Sector, Energies. 11 (2018) 1203. https://doi.org/10.3390/en11051203.

[15] J. Liu, V. Hull, H.C.J. Godfray, D. Tilman, P. Gleick, H. Hoff, C. Pahl-Wostl, Z. Xu, M.G. Chung, J. Sun, S. Li, Nexus approaches to global sustainable development, Nature Sustainability. 1 (2018) 466–476. https://doi.org/10.1038/s41893-018-0135-8.

[16] A. Nauditt, Discussion of “Challenges in operationalizing the water–energy–food nexus” <sup/>, Hydrological Sciences Journal. 63 (2018) 1866–1867. https://doi.org/10.1080/02626667.2018.1545096.

[17] J.P. Newell, B. Goldstein, A. Foster, A 40-year review of food–energy–water nexus literature and its application to the urban scale, Environ. Res. Lett. 14 (2019) 073003. https://doi.org/10.1088/1748-9326/ab0767.

[18] L. Nhamo, B. Ndlela, C. Nhemachena, T. Mabhaudhi, S. Mpandeli, G. Matchaya, The Water-Energy-Food Nexus: Climate Risks and Opportunities in Southern Africa, Water. 10 (2018) 567. https://doi.org/10.3390/w10050567.

[19] T. Oki, S. Yano, N. Hanasaki, Economic aspects of virtual water trade, Environ. Res. Lett. 12 (2017) 044002. https://doi.org/10.1088/1748-9326/aa625f.

[20] A.K. Opejin, R.M. Aggarwal, D.D. White, J.L. Jones, R. Maciejewski, G. Mascaro, H.S. Sarjoughian, A Bibliometric Analysis of Food-Energy-Water Nexus Literature, Sustainability. 12 (2020) 1112. https://doi.org/10.3390/su12031112.

[21] G. Rasul, B. Sharma, The nexus approach to water–energy–food security: an option for adaptation to climate change, Climate Policy. 16 (2016) 682–702. https://doi.org/10.1080/14693062.2015.1029865.

[22] C. Ringler, A. Bhaduri, R. Lawford, The nexus across water, energy, land and food (WELF): potential for improved resource use efficiency?, Current Opinion in Environmental Sustainability. 5 (2013) 617–624. https://doi.org/10.1016/j.cosust.2013.11.002.

[23] F. Saladini, G. Betti, E. Ferragina, F. Bouraoui, S. Cupertino, G. Canitano, M. Gigliotti, A. Autino, F.M. Pulselli, A. Riccaboni, G. Bidoglio, S. Bastianoni, Linking the water-energy-food nexus and sustainable development indicators for the Mediterranean region, Ecological Indicators. 91 (2018) 689–697. https://doi.org/10.1016/j.ecolind.2018.04.035.

[24] S.A. Sarkodie, P.A. Owusu, Bibliometric analysis of water–energy–food nexus: Sustainability assessment of renewable energy, Current Opinion in Environmental Science & Health. 13 (2020) 29–34. https://doi.org/10.1016/j.coesh.2019.10.008.

[25] C.A. Scott, M. Kurian, J.L. Wescoat, The Water-Energy-Food Nexus: Enhancing Adaptive Capacity to Complex Global Challenges, in: M. Kurian, R. Ardakanian (Eds.), Governing the Nexus, Springer International Publishing, Cham, 2015: pp. 15–38. https://doi.org/10.1007/978-3-319-05747-7\_2.

[26] C.A. Scott, M. Kurian, J.L. Wescoat, The Water-Energy-Food Nexus: Enhancing Adaptive Capacity to Complex Global Challenges, Governing the Nexus: Water, Soil and Waste Resources Considering Global Change. (2015) 15–38. https://doi.org/10.1007/978-3-319-05747-7\_3.

[27] G.B. Simpson, G.P.W. Jewitt, The Development of the Water-Energy-Food Nexus as a Framework for Achieving Resource Security: A Review, Frontiers in Environmental Science. 7 (2019). https://doi.org/10.3389/fenvs.2019.00008.

[28] J. Sušnik, C. Chew, X. Domingo, S. Mereu, A. Trabucco, B. Evans, L. Vamvakeridou-Lyroudia, D. Savić, C. Laspidou, F. Brouwer, Multi-Stakeholder Development of a Serious Game to Explore the Water-Energy-Food-Land-Climate Nexus: The SIM4NEXUS Approach, Water. 10 (2018) 139. https://doi.org/10.3390/w10020139.

[29] A. Vinca, S. Parkinson, E. Byers, P. Burek, Z. Khan, V. Krey, F.A. Diuana, Y. Wang, A. Ilyas, A.C. Köberle, I. Staffell, S. Pfenninger, A. Muhammad, A. Rowe, R. Schaeffer, N.D. Rao, Y. Wada, N. Djilali, K. Riahi, The Nexus Solutions Tool (NEST): An open platform for optimizing multi-scale energy-water-land system transformations, Geoscientific Model Development Discussions. (2019) 1–33. https://doi.org/10.5194/gmd-2019-134.

[30] K. Wallington, X. Cai, The Food–Energy–Water Nexus: A Framework to Address Sustainable Development in the Tropics, Tropical Conservation Science. 10 (2017) 194008291772066. https://doi.org/10.1177/1940082917720665.

[31] D.J. White, K. Hubacek, K. Feng, L. Sun, B. Meng, The Water-Energy-Food Nexus in East Asia: A tele-connected value chain analysis using inter-regional input-output analysis, Applied Energy. 210 (2018) 550–567. https://doi.org/10.1016/j.apenergy.2017.05.159.

[32] X. Zhang, H.-Y. Li, Z.D. Deng, C. Ringler, Y. Gao, M.I. Hejazi, L.R. Leung, Impacts of climate change, policy and Water-Energy-Food nexus on hydropower development, Renewable Energy. 116 (2018) 827–834. https://doi.org/10.1016/j.renene.2017.10.030.

[33] X. Zhu, Climate Impacts on the Water-Food Nexus, Theses and Dissertations. (2020). https://preserve.lehigh.edu/etd/5625.

# Methodology

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# Results & Discussion

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# Conclusions

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# Acknowledgments

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# Data availability statement

All data that support the findings of this study are included as part of the supplementary information.

# References