Notes on developments in 2018 and 2019 – More to Worry About and Prepare for…For friends at 2019 Universities Council on Water Resources. From John Wiener, J.D., Ph.D., research associate at the University of Colorado but NOT representing CU, NCAR/UCAR or any organization. john.wiener@colorado.edu . https://ibs.colorado.edu/wiener . All postings are intended to help and be used. Latest presentation: 2 different audience versions of 2018 with new updates and very soon, **WOTUS ROUND-UP of recent resources on the Waters of the US issues**. Apologies for density here; the goal is to help friends find resources. Tip: expensive articles are *sometimes* free by inter-library loan; usually abstracts are free and can be good leads to authors' other work. Some journals also provide reference lists with abstracts– goldmine. Use author's names and professional affiliations for home pages with publication lists.

WATERS OF THE US: The repeal of the "substantial nexus" of a source of pollution and a water flow as basis for jurisdiction was said to provide certainty for abused farmers, but it severely limits control of pollution not flowing on the surface; e.g. toxic coal ash, and mining wastes. Colorado Geological Survey reports "*an estimated 23,000 abandoned mine sites on both public and private land.*" http://coloradogeologicalsurvey.org/geologic-hazards/abandoned-mine-lands/ [Heap leaching: mercury or cyanide to leach ore. Sites not all known; They were sometimes small and not near a single mine, as several may have been needed for profits after moving mills, and they may be concealed by sediments and overgrowth.] There is also industrial waste, sometimes under impervious cover and relatively immobilized by what was formerly adequate storm drainage. See: https://www.nytimes.com/2019/06/07/nyregion/south-street-seaport-mercury.html?action=click&module=Well&pgtype=Homepage&section=New%20York but note lack of mention of sea level rise plus acid precipitation and sea water, suggesting that Hg mobilization is inevitable without remediation. How many other such places are there along rivers and harbors and coasts? Just things are getting ugly what new surprises will appear in your places?

2018 and 2019 – the newspapers are doing very well on extreme events, but… still too shy about climate change! TV networks, radio and print chain newspapers may not be allowed to use "climate change", by their owners. Two remarkable resources for following some of the changes are:

THE BIG ASSESSMENTS: Clearly, the **Fourth National Climate Assessment** is big news. Released 23 November 2018. https://www.globalchange.gov/nca4. Ag is Chap 4.There was some media coverage, but not much detail. And, volume 2, the big assessment soft-pedaled, in my opinion, the most important part of volume 1, the **Climate Science Special Report**: https://science2017.globalchange.gov/ : Chap. 15 on "tipping points". Vol 2 has "key messages" and both volumes have summaries, so this note will focus on new information since the Fourth National Climate Assessment. A lot of new economics, e.g. Besley, Timothy and Avinash Dixit, 2018, **Environmental Catastrophes and Mitigation Policies in a Multiregion World.** Proceedings of the National Academy of Science. Published ahead of print, 25 Sep 18: www.pnas.org/cgi/doi/10.1073/pnas.1802864115; (about that money problem – we could do right!); Lemoine, D. et al, 2016, **The Economics of Tipping the Climate Dominoes**. Nature Climate Change 6: 514-519, DOI: 10.1038/NCLIMATE2902 . **Intergovernmental Panel on Climate Change**: 2018: **Special Report on Global Warming of 1.5°C** – what that will do and what going warmer will risk. https://www.ipcc.ch/sr15/ .

EVERYONE'S COASTAL PROBLEM: Where will the money go? We'll all be bitten by the costs of Coastal flooding, and loss of real estate value: S Jevrejeva, et al., **Flood damage costs under the sea level rise with warming of 1.5 °C and 2 °C**. *Environmental Research Letters*, 2018; 13 (7): 074014 DOI: 10.1088/1748-9326/aacc76; and Cleetus, R., Union of Concerned Scientists, **Underwater: Rising Seas, Chronic Flooding and the Implications for US Coastal Real Estate**, using Zillow real estate values. https://www.ucsusa.org/sites/default/files/attach/2018/06/underwater-analysis-full-report.pdf ; Garner, Andra J., Michael E. Mann, Kerry A. Emanuel, et al., **Impact of Climate Change on New York City's Coastal Flood Hazard: Increasing Flood Heights from the Preindustrial to 2300 CE.** Proceedings of the National Academy of Sciences (2017) 114 (45): 11861-11866. www.pnas.org/cgi/doi/10.1073/pnas.1703568114 . **But it gets worse:** Altman, Jan, et al. 2015, **Poleward Migration of the Destructive Effects of Tropical Cyclones during the 20th Century**. Proceedings of the National Academy of Sciences, (2018) 115 (45): 11543-11548. www.pnas.org/cgi/doi/10.1073/pnas.1808979115 Rahmstorf, Stefan, 2017, **Rising Hazard of Storm Surge Flooding**. Proceedings of the National Academy of Sciences, (2017) 114 (45): 11806-11808. www.pnas.org/cgi/doi/10.1073/pnas.1715895114 ; Anderson, Tiffany R., et al., 2018, **Modeling Multiple Sea Level Rise Stresses Reveals up to Twice the Land at Risk Compared to Strictly Passive Flooding Methods**. Scientific Reports 8 article number 14484 DOI:10.1038/s41598-018-32658-x ; Regeuro, Borja G., et al., 2019, **A Recent Increase in Global Wave Power as a Consequence of Oceanic Warming**. Nature Communications 10, Article number 205; https://doi.org/10.1038/s41467-018-08066-0 (Wave height is on top of storm surge which is on top of sea level.)

RIVERINE/FLUVIAL FLOODING PLUS COASTAL FLOODING: Moftakhari, Hamed R. et al., 2017, **Compounding Effects of Sea Level Rise and Fluvial Flooding**. Proceedings of the National Academy of Sciences (2017) 114: (37): 9785-9790. DOI: 10.1038/NCLIMATE2923 ; Piecuch, Christopher G., et al., 2018, **River-discharge Effects on United States Atlantic and Gulf Coast Sea-level Changes**. Proceedings of the National Academy of Sciences, (2018) 115 (30): 7729-7734. www.pnas.org/cgi/doi/10.1073/pnas.1805428115. **And it gets worse…for inland flooding… Are your folks ready?**

FLOODS: SNOW ON RAIN: SNOWPACK AND MELT: Musselman, Keith N., and 7 others, 2018, **Projected Increases and Shifts in Rain-on-snow Flood Risk over Western North America**. Nature Climate Change 8: 808-812. https://doi.org/10.1038/s41558-018-0236-4 ; Huning, Laurie S, and Amir Agha Kouchak, 2018, **Mountain Snowpack Response to Different Levels of Warming**. Proceedings of the National Academy of Sciences. (2018) 115 (43): 10932-10937. www.pnas.org/cgi/doi/10.1073/pnas.1805953115 ; Harpold, Adrian A., and Paul D. Brooks, 2018, **Humidity Determines Snowpack Ablation Under a Warming Climate**. Proceedings of the National Academy of

Sciences, 115 (6): 1215-1220. www.pnas.org/cgi/doi/10.1073/pnas.1716789115; **Intense Precipitation**: an item for your management: Witze, Alexandra, 2018, **Why Extreme Rains are Gaining Strength as the Climate Warms.** Nature (News feature, 20 Nov 18) 563: 458-460. doi: 10.1038/d41586-018-07447-1 Dottori, Francesco, and 10 others, 2018, **Increased Human and Economic Losses from River Flooding with Anthropogenic Warming.** Nature Climate Change https://doi.org/10.1038/s41558-018-0257-z Giuntoli, Ignazio, et al., 2018, **Uncertainties in Projected Runoff over the Conterminous United States**. Climatic Change. https://doi.org/10.1007/s10584-018-2280-5 Diffenbaugh, Noah S. and 10 others, 2017**, Quantifying the Influence of Global Warming on Unprecedented Extreme Climate Events**. Proceedings of the National Academy of Science. www.pnas.org/cgi/doi/10.1073/pnas.1618082114 PNAS | May 9, 2017 | vol. 114 | no. 19 | 4881–4886; Neelin, J. David and 3 others, 2018, **Global Warming Precipitation Accumulation Increases Above the Current-Climate Cutoff Scale**. Proceedings of the National Academy of Science. 1258–1263 | PNAS | February 7, 2017 | vol. 114 | no. 6 www.pnas.org/cgi/doi/10.1073/pnas.1615333114; Tullos, Desiree, 2018**, Opinion: how to Achieve Better Flood-risk Governance in the United States**, Proceedings of the National Academy of Science. www.pnas.org/cgi/doi/10.1073/pnas.1722412115 PNAS | April 10, 2018 | vol. 115 | no. 15 | 3731–3734.

FOOD SECURITY AND AG:– An interesting report on research priorities from the **InterAcademy Partnership** (130 academies of science etc., world-wide): http://www.interacademies.org/48898/Opportunities-for-future-research-and-innovation-on-food-and-nutrition-security-and-agriculture-The-InterAcademy-Partnerships-global-perspective; the press release: http://www.interacademies.org/48945/Global-food-systems-are-failing-humanity-and-speeding-up-climate-change . Who cares? See **World Resources Institute**: https://www.wri.org/publication/creating-sustainable-food-future ; **United Nations Food and Agriculture Organization** "**Conflict-driven hunger worsens**" – http://www.fao.org/news/story/en/item/1178080/icode/ and see "**The State of Food Security and Nutrition in the World 2018**" http://www.fao.org/publications/card/en/c/I9553EN . **Relevance**: We are subject to world commodity markets, but also trade wars and the dominance of US production by very few (as in, 3 or 4) firms in almost every sector except the high-risk parts of cattle raising. Most recent I know of on that: James M. MacDonald, et al., 2018, **Three Decades of Consolidation in U.S. Agriculture**, EIB-189, U.S. D.A., ERS, March 2018 https://www.ers.usda.gov/webdocs/publications/88057/eib-189.pdf? – rather understated. **Meanwhile, we are killing ag productivity and the flexible and innovative small farms very quickly… See Farms Under Threat, American Farmland Trust** for - best-yet land quality metrics and application, and precise measure of loss of ag land – very dismaying! https://www.farmland.org/. It is not apparently known how increased intensity of precipitation, longer frost-free time, earlier snow melt, increased acidity of precipitation, increased frequency and intensity of fires and subsequent floods will affect water quality and mobilize mining and leaching wastes. Effects on water quality treatment needs and irrigation uses are not apparently known, but food safety rules and certifications may affect requirements for irrigation water.

FIRE AND WATER QUALITY: Charles Rhoades, of the U.S. Forest Service in Fort Collins has been conducting the first long-term observations of water quality after a major fire, and has published his 10 year findings; his 15 year findings are in progress. Rhoades, C.C. et al., 2012, Water Quality Effects Following a Severe Fire. Fire Management Today 72(2): 35-59. (Published by U.S.F.S.: www.fs.fed.us/fire/fmt .) Some toxics are still elevated years after the initial sediment etc. pulse.

What would help? (1) Agricultural Resilience through **diversification and support** which need not be in cash; see https://ibs.colorado.edu/wiener (2) **Erosion and soil quality** improvement through cover crops – experiment with what mix works best for you. (3) **Watershed defense** against flooding. (4) Control expenses by a **benefit co-op for big expense** ("benefit" means can if done right prevent hijacking by money). Use for equipment economically maintained as a fleet, (city shops and mechanics?) and suitable for rotations across farms. (4) Design **better farming** without working in squares and struggling to make the world be uniform – it is not and does not want to be. Work with what is there for better outputs, lower inputs. (5) **Urban areas should manage 3 flows** (a) sewage; (b) urban storm water, and (c), using floodways, relatively clean water passed through to downstream irrigation and small storage for ag use and for aquifer recharge, and augmentation credits. (People love the off-road child-safe paths. Creates real estate values; higher property tax base from this huge amenity.) Good introduction to Green Infrastructure for local governments: Trust for Public Land: https://www.tpl.org/sites/default/files/cloud.tpl.org/pubs/water_building_green_infrastructure.PDF. More and more cities are defending their water supplies, increasingly using water rates as well as bonding. (See Trust for Public Land: Watershed Protection: Making the Case https://www.tpl.org/how-we-work/research/watershed-protection-making-case#sm.0016t3cpt1du7f2gvzs2c5um3f25t and Land and Water Publications https://www.tpl.org/how-we-work/research/land-water-publications#sm.0016t3cpt1du7f2gvzs2c5um3f25t. And Earth Economics: http://www.eartheconomics.org/urbangi. Remember: Riverine flood Hazard Mitigation for cities pays back 7 to 1; be sure your local governments know! See Multi-Hazard Mitigation Council: https://cdn.ymaws.com/www.nibs.org/resource/resmgr/docs/NIBS_MitigationSaves_Interim.pdf. (Often called "Mitigation Saves 2.0".)

Finally: keeping score: (1) http://columbiaclimatelaw.com/resources/climate-deregulation-tracker/ and https://blogs.ei.columbia.edu/2017/01/25/tracking-the-undoing-of-climate-change-measures/ (2) https://eelp.law.harvard.edu/2018/07/tracking-the-trackers/ and https://eelp.law.harvard.edu/our-trackers/ ; (3) https://www.brookings.edu/interactives/tracking-deregulation-in-the-trump-era/; (4) https://policyintegrity.org/deregulation-roundup