SYLLABUS
Department of Earth Sciences - ERTH 620: Coastal Geology
Spring, 2021, Tuesday & Thursday 1:30-2:45pm

Instructor: Chip Fletcher
Contact information: fletcher@soest.hawaii.edu; 808-294-0386 (*text me, or call!*)
Office location: ~~POST 802~~ *Most days I work from home, at least as long as the COVID thing lasts.*
Office hours: T/Th 3-4:30pm (basically after class, but I'll make an appointment to meet anytime if you contact me)

I. Catalog Course Description: Geological history and geologic framework of the Hawaiian shoreline. Modern climate change, paleoclimate, sea level change. Modern coastal management and problems in the coastal environment. Coastal planning. Repeatable one time, credit earned one time. (Spring only) 3 credits

II. Course Assignments, Assessment and Grading
a. 3 exams, 30% ea.
b. Attendance mandatory, Class participation, *In-class presentations* 10%
c. Graduate students are required to give a *class presentation for 10 mins* on some aspect of our course. Clear your topic with me.

III. Calendar – Course calendar and content may change.
Holidays Jan 18 MLK Day**;** Feb 15 Presidents Day; Mar 15-19 Spring Break; Mar 26 Kuhio Day**;** Apr 2 Good Friday

	Week of	Weekly Topic
a.	**Week of**	**Weekly Topic**
b.	Jan 11	Ocean, Atmo Circulation
c.	Jan 18	Paleoclimate, Eemian
d.	Jan 25	Last Interglacial Cycle
e.	Feb 1	Holocene/Kapapa Std
f.	Feb 7	Kaena Point Field Trip – 8am
g.	Feb 8	Exam 1
h.	Feb 15	Beaches/Reefs
i.	Feb 22	Coastal Zone Management
j.	Mar 1	Sea Level Rise
k.	Mar 8	Sea Level Rise
l.	Mar 11	Exam II
m.	Mar 15	Spring Break
n.	Mar 22	Climate Change
o.	Mar 28	Goat Island Field Trip – 8am
p.	Mar 29	Climate Change
q.	Apr 5	Climate Change
r.	Apr 12	Climate Change
s.	Apr 19	Climate Change
t.	Apr 25	Kailua Bay Field Trip – 8am
u.	Apr 26	Climate Change
v.	May 4	Exam III

IV. Course Information, Policies and Resources
a. **Attendance policy:** Attendance is mandatory.
b. **Participation:** Participation is mandatory.
c. **Electronic devices:** Not allowed during tests. Allowed during lecture for note-taking.
d. **Statement on Disability: KOKUA Program**:
If you have a disability and related access needs, please contact the KOKUA program (UH Disabled Student Services Office) at 956-7511, KOKUA@hawaii.edu, or go to Room 013 in the Queen Lili'uokalani Center for Student Services. Please know that I will work with you and KOKUA to meet your access needs based on disability documentation.
e. **Academic Integrity and Ethical Behavior: Office of Judicial Affairs:**
Cheating, plagiarism, or other forms of academic dishonesty are not permitted within this course and are prohibited within the System-wide Student Conduct Code (EP 7.208). Examples include fabrication, facilitation, cheating, plagiarism, lying when caught cheating, and use of improper materials including cell phones, tablets,

computers, or any electronic device during a test or other grading opportunity. Any incident of suspected academic dishonesty will be reported to the Office of Judicial Affairs (OJA) for review and possible adjudication. Additionally, the instructor may take action in regards to the grade for the deliverable or course as they see fit. OJA provides the following: In cases of suspected or admitted academic dishonesty, the instructor involved shall attempt to resolve the matter with the student. Actions may include allowing the student to redo the assignment or giving a failing or reduced grade for the course. Instructors are encouraged to bring the matter to the attention of the departmental chairperson and/or academic dean of the instructor's school or college, and provide an informational report to the Student Conduct Administrator. Additionally, an instructor may formally refer any case of academic dishonesty to the Student Conduct Administrator for action under the Student Conduct Code. The Student Conduct Administrator or designee shall pursue such cases to determine appropriate disciplinary actions if, after a preliminary investigation, it is their determination that sufficient information exists to establish that an act of academic dishonesty took place.

f. **Office of Title IX** (see below)
g. **Department of Public Safety**: (808)956-6911 (Emergency) / (808)956-8211 (Non-Emergency) www.hawaii.edu/security

V. Course Content and Learning Objectives

a. **Course Content:** This course takes a deep dive into the cumulative impacts of climate change, and human use of Earth resources. We will see the results of the extractive model of capitalism based on perpetual growth. Topics we discuss read like a list of how to *not* live on a planet when it is your only option for survival: industrial agriculture, habitat loss, biodiversity loss, emerging infectious disease, extreme weather, sea-level rise, pollution, greenhouse gas sources, UNFCCC, IPCC reports, natural climate change, paleoclimate, coastal processes, beach processes, coastal management, and geologic aspects of Hawaii‘s fringing reefs. We also delve into SOLUTIONS. Over the course of the semester we will visit a range of topics that are tied, one way or another, to the massive changes that human practices of extractive resource use and growth economics have had on planet Earth.
b. **Field Trips:** This course includes physically demanding field trips, if you are not comfortable hiking in the Sun, wading or kayaking in the ocean, its ok to skip if we talk first. Everyone is expected to attend field trips, unless excused. Field trips include: Ka‘ena Pt., Goat Island, Popoi‘a and Mokulua islands.
c. **Mānoa Institutional Learning Objectives for Undergraduate Students:** Institutional Learning Objectives (ILOs) encompass the UH Mānoa undergraduate experience as a whole—academic and co-curricular. It is through the combined efforts of faculty, students, staff, and administrators that students achieve the ILOs.
    i. **Know—Breadth and Depth of Knowledge**
    Students develop their understanding of the world with emphasis on Hawai’i, Asia, and the Pacific by integrating general education knowledge (arts and humanities, biological sciences, languages, physical sciences, social sciences, technology); Specialized study in an academic field; and Understanding of Hawaiian culture and history.
    ii. **Do—Intellectual and Practical Skills**
    Students improve their abilities to think critically and creatively; Conduct research; and Communicate and report.
    iii. **Value—Personal and Social Responsibility**
    Students demonstrate excellence, integrity, and engagement through: Continuous learning and personal growth; Respect for people and cultures, in particular Hawaiian culture; Stewardship of the natural environment; and Civic participation in their communities.
d. **Department of Earth Sciences Learning Objectives for Undergraduate Students:** The Department of Earth Sciences has established the following undergraduate student learning objectives.

i. Students can **explain the relevance** of Earth Sciences to human needs, including those appropriate to Hawai‘i, and be able to discuss issues related to geology and its impact on society and planet Earth.
ii. Students can **apply technical knowledge** of relevant computer applications, laboratory methods, and field methods to solve real-world problems in geology and geophysics.
iii. Students **use the scientific method** to define, critically analyze, and solve a problem in earth science.
iv. Students can **reconstruct, clearly and ethically**, geological knowledge in both oral presentations and written reports.
v. Students can **evaluate, interpret, and summarize the basic principles** of Earth Science, including the fundamental tenets of the sub-disciplines, and their context in relationship to other core sciences, to explain complex phenomena in geology and geophysics.

VI. Recommended Reading

a. Honolulu Climate Change Commission
   i. Climate Change Brief: https://resilientoahu.org/climate-change-commission/#guidance
   ii. Sea Level Rise Guidance: https://resilientoahu.org/climate-change-commission/#guidance
b. UH-SOEST Coastal Geology Group Publications: http://www.soest.hawaii.edu/coasts/index.php/publications/
   i. #80 Fletcher, C.H., *et al.* (2008) Geology of Hawaii Reefs. Chapter 11 in “Coral Reefs of the U.S.A.”, Springer, p. 435-488.
   ii. #123 Anderson, T., *et al.* (2018) Modeling multiple sea level rise stresses reveals up to twice the land at risk compared to strictly passive flooding methods. *Nature Scientific Reports* 8: 14484 DOI:10.1038/s41598-018-32658-x
   iii. #122 Summers, A., *et al.* (2018) Failure to protect beaches under slowly rising sea level. *Climatic Change* 151, 427-443 (2018). https://doi.org/10.1007/s10584-018-2327-7
c. **Fletcher (2010) Living on the Shores of Hawai‘i,** UH Press: https://uhpress.hawaii.edu/product/living-on-the-shores-of-hawaii-natural-hazards-the-environment-and-our-communities/
d. **Fletcher (2019) Climate Change, 2nd Edition: What the Science tells us:** https://www.wiley.com/en-us/Climate+Change%3A+What+The+Science+Tells+Us%2C+2nd+Edition-p-9781119399391
e. **Recent Climate Change Reports**
   i. Fourth National Climate Assessment (2017) v1, Climate Science Special Report https://science2017.globalchange.gov
   ii. Fourth National Climate Assessment (2018) v2, Impacts, Risks, and Adaptation in the U.S. https://nca2018.globalchange.gov
   iii. IPCC: Global Warming of 1.5^{o}C (2018) https://www.ipcc.ch/sr15/
   iv. IPCC: Climate Change and Land (2019) https://www.ipcc.ch/report/srccl/
   v. IPCC: Special Report on the Ocean & Cryosphere in a Changing Climate (2019) https://www.ipcc.ch/srocc/home/
   vi. Honolulu Climate Change Commission White Papers. https://www.resilientoahu.org/about-the-commission/
f. Recommended Websites
   i. Carbon Brief: https://www.carbonbrief.org/
   ii. Real Climate: http://www.realclimate.org/
   iii. Yale Program on Climate Change Communication: http://climatecommunication.yale.edu/

UHM TITLE IX SYLLABUS INFORMATION

The University of Hawai‘i is committed to providing a learning, working and living environment that promotes personal integrity, civility, and mutual respect and is free of all forms of sex discrimination and gender-based violence, including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence, and stalking. If you or someone you know experiences any of these, UHM has staff and resources on campus to support and assist you. Staff also can direct you to resources in the community. Here are some of your options:

If you wish to remain **ANONYMOUS**, speak with someone **CONFIDENTIALLY**, or would like to receive information and support in a **CONFIDENTIAL** setting, contact:

Lesbian, Gay, Bisexual, Transgender (LGBT) Student Services
Lesbian, Gay, Bisexual, Transgender and Intersex (LGBTI) Student Services strives to maintain a safe and inclusive campus environment that is free from harassment and discrimination. The office provides direct services to students of the University of Hawai‘i at Mānoa to confidentially discuss or seek advocacy and support for mistreatment due to their actual or perceived sex, gender identity, gender expression, or sexual orientation.

Cameron Miyamoto
Queen Lili‘uokalani Center for Student Services 211
2600 Campus Road
Honolulu, HI 96822
(808) 956-9250
email: lgbtq@hawaii.edu
http://manoa.hawaii.edu/lgbt/

Office of Gender Equity
The Office of Gender Equity offers direct services to victims and survivors of sexual harassment and sexual assaults. Brief descriptions of services offered are available here.

Jenna Friedman
Queen Lili‘uokalani Center for Student Services 210
2600 Campus Road
Honolulu, HI 96822
(808) 956-9499
email: geneq@hawaii.edu
www.manoa.hawaii.edu/genderequity

Prevention, Awareness, and Understanding (PAU) Violence Program
Prevention, Awareness, and Understanding (PAU) Violence Program exists to inspire, educate, and empower students and campus communities to build safe living-learning environments, end interpersonal violence, and encourage holistic well-being in ways that are supportive, collaborative, student-centered, and strengths-based. PAU Violence Program staff provides direct services to all University of Hawai‘i at Mānoa students including crisis response, safety planning, academic support, and referrals to campus and community resources.

Jennifer Barnett
Leslie Cabingabang
Queen Liliʻuokalani Center for Student Services 211
2600 Campus Road
Honolulu, HI 96822
(808) 956-8059
uhmpau@hawaii.edu

Student Parents At Mānoa (SPAM)
Student Parents At Mānoa (SPAM) seeks to increase the visibility of and resources for student parents at UH Mānoa as they pursue education while parenting. SPAM staff provide advocacy, support, and referrals for pregnant and parenting students to help them succeed in their educational goals.

Teresa Bill
2600 Campus Road
Queen Liliʻuokalani Center for Student Services 211
Honolulu, HI 96822
(808) 956-8059
gotkids@hawaii.edu
http://manoa.hawaii.edu/studentparents/

Counseling and Student Development Center (CSDC)
The Counseling and Student Development Center (CSDC) offers support to UHM students, staff, and faculty to assist with personal, academic, and career concerns. All services are confidential and most are free of charge for Mānoa students. They also offer free consultation to faculty and staff on personal and student-related issues as well. CSDC office hours are from 8:00 a.m. to 4:30 p.m., Monday through Friday. They also offer immediate walk in appointments for urgent or emergency/crisis services during their regular daily hours.

Queen Liliʻuokalani Center for Student Services 312
2600 Campus Road
Honolulu, HI 96822
(808) 956-7927
uhmcsdc@hawaii.edu
www.manoa.hawaii.edu/counseling

University Health Services Mānoa (UHSM)
The University Health Services Mānoa (UHSM) is staffed by physicians, nurse clinicians, nurses, and other support staff, and offers a wide range of medical services and programs to UH Mānoa students, with many of the services also available to UH Mānoa faculty and staff and students from other UH campuses. Services include general medical care on a walk-in basis; women's health, sports medicine, psychiatry, and dermatology clinics by appointment; pharmacy and clinical laboratory; and student training, employment and volunteer opportunities.

1710 East West Road
Honolulu, Hawaii 96822

Honolulu, HI 96822
(808) 956- 8965
www.hawaii.edu/shs/

[or]

If you wish to remain **ANONYMOUS**, speak with someone **CONFIDENTIALLY**, or would like to receive information and support in a **CONFIDENTIAL** setting, contact the confidential resources available here:

http://www.manoa.hawaii.edu/titleix/resources.html#confidential

If you wish to **REPORT** an incident of sex discrimination or gender-based violence including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence or stalking as well as receive information and support, contact:

Dee Uwono
Director and Title IX Coordinator
Hawai'i Hall 124
2500 Campus Road
Honolulu, HI 96822
(808) 956-2299
t9uhm@hawaii.edu

As a member of the University administration, I am **required to immediately report** any incident of sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and I cannot guarantee confidentiality, you will still have options about how your case will be handled. My goal is to make sure you are aware of the range of options available to you and have access to the resources and support you need. For more information regarding sex discrimination and gender-based violence, the University's Title IX resources and the University's Policy, Interim EP 1.204, go to: http://www.manoa.hawaii.edu/titleix/

Additional Readings
Impacts of Global Warming and Climate Change

1) The Economist, September 21, 2019
2) Marra, J.J., and Kruk, M.C. (2017) State of Environmental Conditions in Hawai'i and the U.S. Affiliated Pacific Islands under a Changing Climate: https://coralreefwatch.noaa.gov/satellite/publications/state_of_the_environment_2017_hawaii-usapi_noaa-nesdis-ncei_oct2017.pdf.
3) https://www.forbes.com/sites/sergeiklebnikov/2019/10/24/stopping-global-warming-will-cost-50-trillion-morgan-stanley-report/#502a8f8651e2
4) Tavares, K., Fletcher, C.H. & Anderson, T.R. 2020. Risk of shoreline hardening and associated beach loss peaks before mid-century: O'ahu, Hawai'i. Nature Scientific Reports, 10: 13633. DOI:10.1038/s41598-020-70577-y
5) Habel, S., Fletcher, C., Anderson, T., & Thompson, P. 2020. Sea-Level Rise Induced Multi-Mechanism Flooding and Contribution to Urban Infrastructure Failure. Nature Scientific Reports, 10: 3796 DOI:10.1038/s41598-020-60762-4

6) Kane, H. H., & Fletcher, C. H. (2020). Rethinking reef island stability in relation to anthropogenic sea level rise. Earth's Future, 8, e2020EF001525. https://doi.org/10.1029/2020EF001525
7) Summers, A., Fletcher, C.H., Spirandelli, D. et al. Failure to protect beaches under slowly rising sea level. Climatic Change 151, 427–443 (2018). https://doi.org/10.1007/s10584-018-2327-7
8) Anderson, T., Fletcher, C., Barbee, M., Romine, B., & Lemmo, J. 2018. Modeling multiple sea level rise stresses reveals up to twice the land at risk compared to strictly passive flooding methods. Nature Scientific Reports 8: 14484 DOI:10.1038/s41598-018-32658-x
9) Kane, H. H., Fletcher, C. H., Cochrane, E. E., Mitrovica, J. X., Habel, S., Barbee, M. 2017. Coastal plain stratigraphy records tectonic, environmental, and human habitability changes related to sea-level drawdown, ʻUpolu, Sāmoa. Quaternary Research, 87, 246–257 doi:10.1017/qua.2017.2
10) Romine, B.M., Fletcher, C.H., Frazer, L.N., and Anderson, T.R., 2016. Beach erosion under rising sea-level modulated by coastal geomorphology and sediment availability on carbonate reef-fringed island coasts. Sedimentology. DOI 10.1111/sed.12264
11) Marcott, S.A. (2013) A Reconstruction of Regional and Global Temperature for the Past 11,300 Years, Science, 08 Mar: 1198-1201.
12) Schellnhuber, H.J., et al. (2016) Why the right climate target was agreed in Paris, Nature Climate Change, v. 6, July
13) Centre for Research on the Epidemiology of Disasters, UN International Strategy for Disaster Reduction: http://reliefweb.int/report/world/human-cost-weather-related-disasters-1995-2015
14) NOAA, Weather Disasters, US (2019) https://www.ncdc.noaa.gov/billions/time-series
15) Lehmann, J., et al. (2015) Increased record-breaking precipitation events under global warming, Climatic Change, doi: 10.1007/s10584-015-1434-y
16) Does Global Warming Make Hurricanes Stronger? http://www.realclimate.org/index.php/archives/2018/05/does-global-warming-make-tropical-cyclones-stronger/
17) Kitzberger T, et al.(2017) Direct and indirect climate controls predict heterogeneous early-mid 21st century wildfire burned area across western and boreal North America. PLoS ONE 12(12). https://doi.org/10.1371/journal.pone.0188486
18) Abatzoglou, J.T., Williams, A.P. (2016) Impact of anthropogenic climate change on wildfire across western U.S. forests. Proceedings of the National Academy of Sciences; 201607171 doi: 10.1073/pnas.1607171113
19) Dai, A. (2011) Characteristics and trends in various forms of the Palmer drought severity index during 1900–2008, Journal of Geophysical Research 116.
20) Giambelluca, T.W., Diaz, H.F., Elison Timm, O., Takahashi, M., Frazier, A.G., and Longman, R. 2011. Regional climate trends in Hawaiʻi. American Geophysical Union Fall Meeting, San Francisco, December 2011.
21) Trauernicht, C., E. et al. 2015 The contemporary scale and context of wildfire in Hawaii. Pacific Science 69:427-444
22) https://www.nesdis.noaa.gov/content/marine-heat-wave-reminiscent-blob-lingers-us-west-coast?utm_source=Social%20Media&utm_medium=Twitter&utm_campaign=Marine%20Heatwave%20Article%20020191008
23) https://www.wunderground.com/cat6/Hawaiis-Warmest-Summer-Record-and-Alaskas-Second-Warmest
24) McKenzie, M.M., Giambelluca, T.W., and Diaz, H.F. Accepted. Regional temperature trends in Hawaiʻi: a century of change, 1917-2016. International Journal of Climatology.
25) The IMBIE team (2018) Mass Balance of the Antarctic Ice Sheet, Nature, 558, pages219–222, https://doi.org/10.1038/s41586-018-0179-y
26) Trusel, et al., 2018 Nonlinear rise in Greenland runoff in response to post-industrial Arctic warming, 104, Nature, v564, 6 December: https://doi.org/10.1038/s41586-018-0752-4
27) Cheng, L., et al. (2019) How fast are the oceans warming? Science, 2019 DOI: 10.1126/science.aav7619
28) Cheng L. J. Zhu, and J. Abraham (2015) Global upper ocean heat content estimation: recent progress and the remaining challenges. Atmospheric and Oceanic Science Letters, 8. DOI:10.3878/AOSL20150031

29) Glecker, P.J., et al. (2016) Industrial era global ocean heat uptake doubles in recent decades. Nature Climate change. doi:10.1038/nclimate2915
30) Habel, S., et al. (in review) Compound Flooding Related to Sea-Level Rise and Urban Infrastructure. Scientific Reports.
31) Habel, S., et al. (2019) Comparison of a simple hydrostatic and a data-intensive 3D numerical modeling method of simulating sea-level rise induced groundwater inundation for Honolulu, Hawai'i, USA. Environ. Res. Commun. 1, 041005. doi:10.1088/2515-7620/ab21fe
32) Habel, S. et al. (2017) Development of a model to simulate groundwater inundation induced by sea-level rise and high tides in Honolulu, Hawai'i. Water Res. 114, 122–134. doi:10.1016/j.watres.2017.02.035
33) Summers, A., et al. (2018) Failure to protect beaches under slowly rising sea level, Climatic Change, https://doi.org/10.1007/s10584-018-2327-7
34) Anderson, T.R. et al. (2018) Modeling multiple sea level rise stesses reveals up to twice the land at risk compared to strictly passive flooding methods. Scientific Reports (open access): https://www.nature.com/articles/s41598-018-32658-x
35) Chunwu, Z et al (2018) Carbon dioxide levels (CO2) this century will alter the protein, micronutrients, and vitamin content of rice grains with potential health consequences for the poorest rice-dependent countries, Science Advances, May 23, v. 4, no. 5.
36) Myers, S.S., et al. (2014) Increasing CO_2 threatens human nutrition, Nature, 510, 139-142, doi: 10.1038/nature13179.
37) Smith, M.R., and Myers, S.S. (2018) Impact of anthropogenic CO2 emissions on global human nutrition, Nature Climate Change 8, 834-839
38) Deutsch, C.A., et al. (2018) Increase in crop losses to insect pests in a warming climate, Science, 31 August, v. 361, Iss. 6405, p. 916-919
39) Springmann, M. et al. Global and regional health effects of future food production under climate change: a modelling study. The Lancet, March 2, 2016 DOI: 10.1016/S0140-6736(15)01156-3.
40) Feng et al, 2015 Constraints to nitrogen acquisition of terrestrial plants under elevated CO_2, Global Change Biology, DOI: 10.1111/gcb.12938
41) Dangerous new hot zones are already appearing: https://www.washingtonpost.com/graphics/2019/national/climate-environment/climate-change-world/
42) Mora C, et al. (2017) Global risk of deadly heat. Nature Climate Change 7, 501-506
43) Pew Research: http://www.pewresearch.org/fact-tank/2016/08/03/nearly-1-in-100-worldwide-are-now-displaced-from-their-homes/
44) Kelley, C.P., et al. (2015) Climate change in the fertile crescent and implications of the recent Syrian drought, PNAS, Mar. (11), 3241-3246.
45) Jonkers, et al (2019) Global change drives modern plankton communities away from the pre-industrial state. Nature; DOI: 10.1038/s41586-019-1230-3;
46) Cheng LJ&Zhu J (2018) 2017 was the warmest year on record for the global ocean. Adv. Atmos. Sci.
47) Friedrich T et al (2012) Detecting Regional Anthropogenic Trends in Ocean Acidification against Natural Variability, Nature Climate Change.
48) Takamitsu, et al (2017) Upper Ocean O trends: 1958-2015, GRL
49) Heron, S.F., et al. (2016) Warming trends and bleaching stress of the worlds coral reefs 1985-2012, Scientific Reports, 6, DOI:10.1038/srep38402
50) Yates, K. K., et al. (2017) Divergence of seafloor elevation and sea level rise in coral reef ecosystems, Biogeosciences, 14, 1739-1772, https://doi.org/10.5194/bg-14-1739-2017, 2017.
51) Farquharson, et al. (2019) Climate change drives widespread and rapid thermokarst development in very cold permafrost in the Canadian High Arctic, Geophysical Research Letters, https://doi.org/10.1029/2019GL082187

52) Summary for policymakers of global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 6 May (2019) http://www.ipbes.net/sites/default/files/downloads/spm_unedited_advance_for_posting_htn.pdf?utm_source=Nature+Briefing&utm_campaign=ef727151d6-briefing-dy-20190507&utm_medium=email&utm_term=0_c9dfd39373-ef727151d6-43423877
53) Seibold, S., et al. (2019) Arthropod decline in grasslands and forests is associated with landscape-level drivers, Nature 574, 671-674 (Oct. 30)
54) Bar-On, Y.O, Phillips, R., Milo, R. (2018) The biomass distribution on Earth, PNAS, 201711842; DOI:10.1073/pnas.1711842115
55) https://www.iea.org/newsroom/news/2019/may/renewable-capacity-growth-worldwide-stalled-in-2018-after-two-decades-of-strong-e.html
56) World Energy Outlook, International Energy Agency, https://www.iea.org/weo/
57) Global Energy Outlook 2019, The Next Generation of Energy: https://media.rff.org/documents/GEO_Report_7-19-19.pdf
58) Energy Information Administration (2019) https://www.eia.gov/todayinenergy/detail.php?id=41493
59) Global Carbon Project: https://www.globalcarbonproject.org
60) Bloomberg News, Morgan-Stanley Report: https://www.bloomberg.com/news/articles/2019-10-24/-50-trillion-is-needed-to-stop-global-warming-morgan-stanley
61) https://climatecrocks.com/2019/07/03/battery-costs-shocking-the-system/
62) https://e360.yale.edu/features/why-chinas-renewable-energy-transition-is-losing-momentum

Coastal Geologic Framework Studies in Hawai‘i and across the Pacific

1) Dickinson, W.R. (2001), Paleoshoreline record of relative Holocene sea levels on Pacific islands, Earth Science Reviews., 55, 191 - 234.
2) Dickinson, W. R. (2004), Impacts of eustasy and hydro-isostasy on the evolution and landforms of Pacific atolls, Paleogeography, Paleoclimatology, Paleoecology., 213, 251 – 269.
3) Dickinson, W.R. (2009), Pacific Atoll Living: How Long Already and Until When?, GSA Today., 19, 4 – 10
4) Easton, W.H., and Olson, E.A., 1976. Radiocarbon profile of Hanauma Reef, Oahu, Hawaii. Geol. Soc. Amer. Bull., v. 87, p. 711-719.
5) Felton, E.A., Crook, K.A.W., and Keating, B.H., 2000, The Hulopoe gravel, Lanai, Hawaii: New sedimentological data and their bearing on the "giant wave" (megatsunami) emplacement hypothesis: Pure and Applied Geophysics, v. 157p. 1257-1284.
6) Fletcher, C.H., and Jones, A.T., 1996. Sea-level highstand recorded in Holocene shoreline deposits on Oahu, Hawaii: Journal of Sedimentary Research, v. 66, p. 632-641.
7) Fletcher, C.H., and Sherman, C.E., 1995. Submerged shorelines on O'ahu, Hawai'i: archive of episodic transgression during the deglaciation? Journal of Coastal Research, S.I. no. 17, p. 141-152.
8) Fletcher, C.H., Murray-Wallace, C., Glenn, C., Popp, B., Sherman, C. (2005) Age and Origin of Late Quaternary Eolianite, Kaiehu Point (Moomomi), Molokai, Hawaii. Journal of Coastal Research, SI 42, p. 97-112.
9) Fletcher, C.H., Romine, B.M., Genz, A.S., Barbee, M.M., Dyer, M., Anderson, T.R., Lim, S.C., Vitousek, S., Bochicchio, C., and Richmond, B.M., National assessment of shoreline change: Historical shoreline change in the Hawaiian Islands: U.S. Geological Survey Open-File Report 2011–1051, 55p
10) Fletcher, C.H., Bochicchio, C., Conger, C.L., Engels, M., Feirstein, E.J., Grossman, Grigg, R., E.E., Harney, J.N., Rooney, J.J., Sherman, C.E., Vitousek, S., Rubin, K., Murray-Wallace, C.V., Geology of Hawai‘i Reefs. Chapter 11 in “Coral Reefs of the U.S.A.”, Springer, p. 435-488.
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