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Assignment #2
1/15/18

The island of Maui is located in the middle of the Pacific Ocean between 20 and 21 degrees North latitude approximately 2,500 miles southwest from Los Angeles, CA and 4,100 miles southeast from Japan. It is located near the southeastern end of the larger Hawaiian Archipelago that stretches 1,500 miles to the northwest (Fig.1). Maui's balmy subtropical climate, characterized by uniform temperatures, moderate humidity, and cool breezes, is the result of four interconnected and contributing factors: 1) latitude, 2) the Pacific Ocean, 3) atmospheric circulation, and 4) mountainous terrain (UH Hilo, 1998 and Ziegler, 2002).

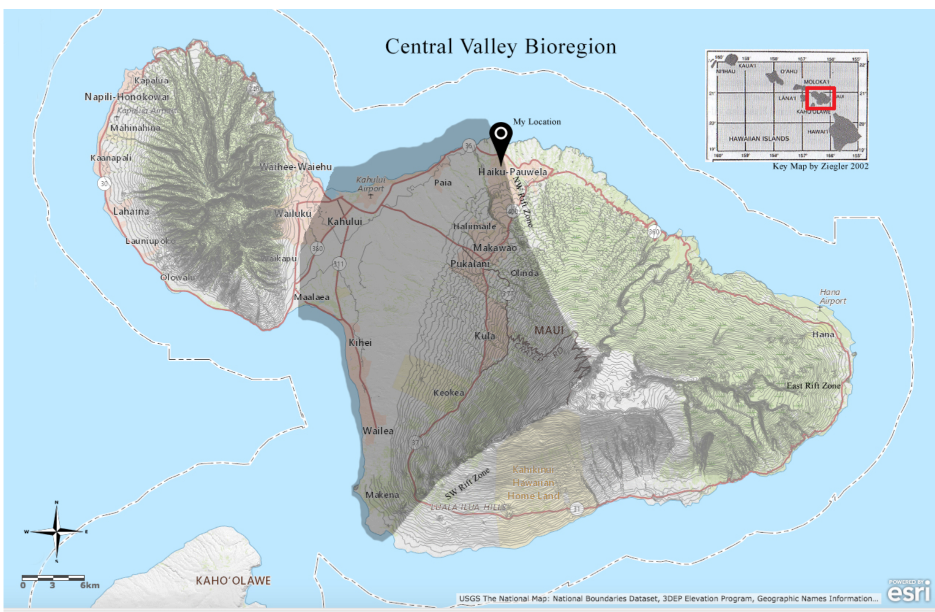

Figure 1 The Central Valley Bioregion is defined by the NW and SW geological rift zones. The climatic influences of wind, precipitation, and temperature on this area contribute greatly to its character (ArcGIS Online, 2017).

Maui's proximity to the equator results in minimal seasonal differences within average length of day and annual variation in mean monthly temperatures. Twice per year the sun is directly above Maui and results in the longest days between May and July, lasting a little over 13 hours; while in December, the sun descends to 45 degrees above the horizon and results in a daytime length of just under 11 hours, a difference of only 2 ½ hours (Ziegler, 2002, p. 69). The annual variation in mean monthly temperatures at sea level varies 9°F, while diurnal variations can change by as much as 10°-15°F (UH Hilo, 1998, p. 49). Temperature decreases with elevation by roughly 3.3°F for every 1,000 feet of elevation gained through a process known as adiabatic cooling. Ricklefs (2000) defined this function as a "decrease in temperature, which is caused by the expansion of air with lower atmospheric pressures at higher altitudes" (p. 149). Therefore, the adiabatic cooling between sea level and the 10,023 foot summit of East Maui's Haleakalā results in a 33°F drop in temperature. This drastic variation in temperature makes Maui one of the most spatially diverse areas on Earth (UH Hilo, 1998, p. 49).

The Pacific Ocean and its prevailing currents play a significant role in maintaining equable temperatures on Maui. The high latent heat capacity of water allows the ocean to readily "release and absorb large amounts of heat to and from air passing over it without its own average temperature changing substantially" (Ziegler, 2002, p. 70). This physical property has the effect of dampening the seasonal and daily temperature effects of solar radiation on the island. The North Pacific Current influences temperature on the island as well. As it travels clockwise in the North Pacific Basin, it picks up cold water from the Bering Sea and carries it south to Maui. Ziegler reasoned, "Cooler trade winds moving over the eastern loop of the current gradually warm to about the same sea temperature, and warmer ones cool to it, subsequently serving to provide the archipelago with an equable ambient temperature" (p. 70).

Maui's climatic patterns are derived from the atmospheric circulation systems present in the equatorial and subequatorial regions and the seasonal north to south shifting of the solar equator (the latitude which lies 90 degrees below the sun at any given time). Bailey's (1995) hierarchical ecoregional classification system places Maui, whose climate is "largely controlled by equatorial and tropical air masses," in the "Humid Tropical Domain" that is characterized by seasonally variable heavy annual rainfall. The effects of regional air mass circulations found at this latitude create a two-period seasonality, *kau wela* or the dry season in May-October and *ho'oilo* or the wet season in November-April (Ziegler, 2002, p. 69). The general components responsible for this idealized pattern of seasonality are the Intertropical Convergence Zone (ITCZ), the Hadley Cell, the North Pacific High, the Aleutian Low, and the Coriolis effect (Fig.2).

The ITCZ is the low-pressure belt that stretches across the middle of the globe and seasonally coincides with the solar equator that shifts between 5.3°S in the Austral Summer and 7.2°N in the Boreal Summer (Donohoe et al., 2013, p. 3601). As the sun heats the equatorial air, it becomes less dense and rises into the atmosphere carrying evaporated moisture from the ocean below; the rising air mass spreads to the north, cools, condenses, and descends in an area of high-pressure, generally 30° north from its origin, only to travel southward across the ocean's surface until it converges with the Southern Ocean Hadley Cell (traveling northward across the ocean's surface) and begin the process over again at the ITCZ (Ricklefs, 2000, p. 139). This circulating air mass is called the Hadley Cell.

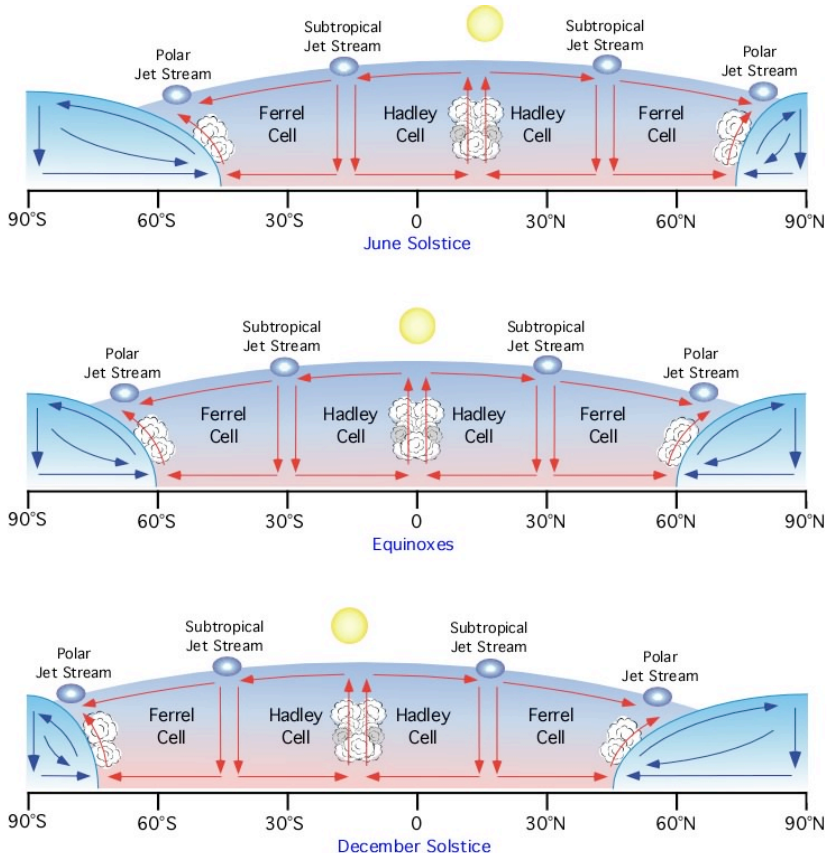

Figure 2 - The ITCZ moves southerly during the Austral Summer and northerly during the Boreal summer. This is a direct result of the movement of the solar equinox. (image retrieved from http://www.physicalgeography.net/fundamentals/7u.html)

The descending air mass of the Hadley Cell results in a massive high-pressure system to the north of the archipelago called the North Pacific High (NPH). It is the NPH winds deflected to the southwest by the Coriolis effect that generates the consistent northeasterly trade winds, which dominate the Hawaiian climatic pattern during the dry season (Ziegler, 2002, p. 71).

As the solar equator seasonally moves southward, due to the Earth's rotation around the sun and corresponding tilt of its axis, so to does the ITCZ, Hadley Cell, and NPH. It is this southerly movement that weakens the NPH and allows the Aleutian Low and its corresponding Westerlies from the north to herald in Maui's wet season and its variable wind patterns (UH Hilo, 1998, p. 53).

Precipitation levels on Maui range from 10 to 399 inches and result from the orographic mountain effect (generated by the trade wind inversion layer) as well as the wet season frontal passages, Kona storms, thunderstorms, and hurricanes that "either enhance the orographic pattern or produce widespread, uniform rainfall" (Ziegler, 2002, pp. 72-79). As the NE trade winds travel over the ocean's surface, they accumulate evaporated moisture and carry it to Maui's windward shores, are then deflected upslope, and cool and condense at the temperature inversion layer (between 5,000 and 7,000 feet in altitude) that is formed by anomalously descending warmer Hadley Cell air (Ziegler, pp. 76-79). When the moisture-laden air mass cools and condenses, it releases precipitation that supplies "the bulk of Hawai'i's water resources (UH Hilo, 1998, p. 59).

However, the entirety of the island does not reap the benefits of the water cycle that occurs on the windward side of the island (Fig. 3). The steep terrain and inversion layers on East and West Maui prohibit the moisture-laden air from passing over the summits and nourishing the dry, leeward sides of Maui. This rain shadow effect accounts for the drastic disparity in rainfall amounts totaling 399 inches annually on West Maui and less than 15 inches in Kihei and Lahaina on the leeward side; they receive their annual precipitation from other rain producing mechanisms (UH Hilo, p. 56).

Disturbances in the climatic patterns exist in the form of El Nino Southern Oscillation (ENSO), La Nina, and hurricane events. An exploration into the incompletely understood complexities and mechanisms of these events are beyond the scope of this assignment. However, as they relate to Hawai'i, Ziegler (2002) stated, "an El Nino episode [with corresponding warmer surface waters] typically causes lower than usual rainfall and fosters the development of hurricanes" (p. 84). Conversely, a La Nina event with its colder surface waters generates higher than average rainfall and less hurricanes.

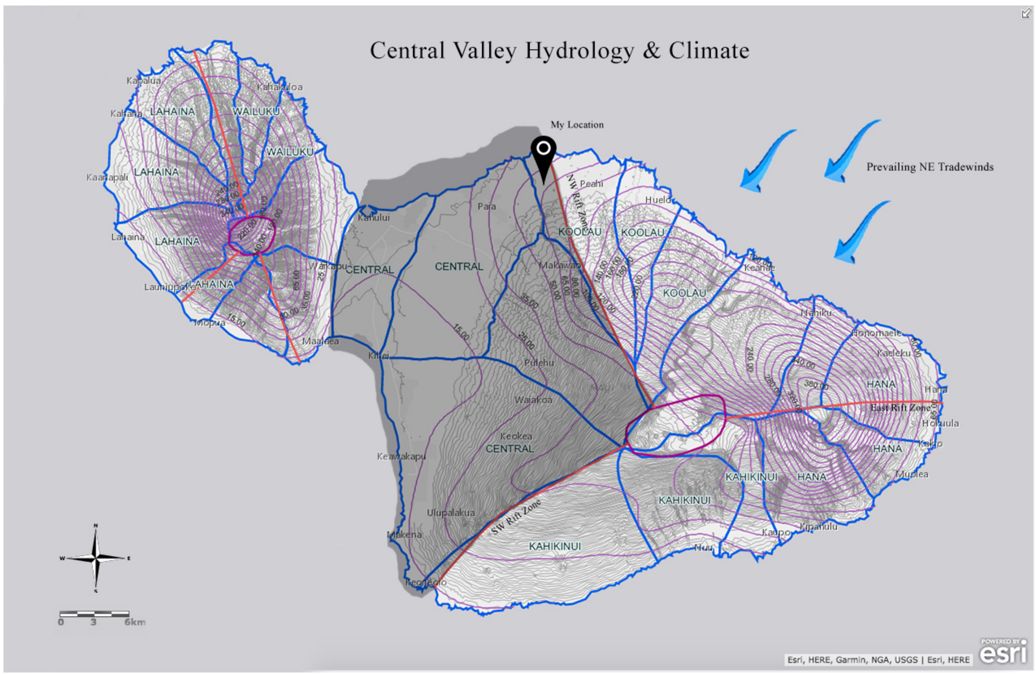

Figure 3 – The prevailing northeast trade winds generate high levels of rainfall, (maroon isohyets), on the windward side of Maui while the leeward side receives considerably less due to the rain shadow and orographic rain pattern (map created using ArcGIS Online, 2017).

Climate, precipitation, temperature, and topography combine together and create the basis for distinguishing local vegetative patterns and habitats. According to Bailey's framework, I reside in the "Hawaiian Islands Province of the Rainforest Division of the Humid Tropical Domain." What's missing from this geographic address is the fourth, most intimately scaled category of "Section" which has not been created for the State of Hawaii, (McNab et al., 2005). Whittaker's classification places Maui in the "Tropical Rainforest category and Holdridge's scheme considers Maui a "Rainforest" (as cited in figs. 8-26 & 8-27, Ricklefs, 2000, p. 160 & 159). While correct in a general sense, it is interesting that these broadly scaled categories do not account for the local variations in precipitation due to rain shadow and inversion effects.

Maui is a unique place in the world filled with tremendous biodiversity due to its isolated location and spatial diversity. The climatic patterns that have contributed over thousands of years have and will continue to shape the biotic communities as they evolve on the island. Humanity's influence in these processes cannot be overstated and deserve equal consideration in the exploration of the island's ecology. However, it is important to understand the fundamental factors that have contributed thus far.

References

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