Climate Change Series – Effects Mitigation

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1. Introduction

There are two posts that cover methods to mitigate human-caused climate change. This, the first of those, deals with methods to directly mitigate the current and immediate-future effects of climate once they are occurring. The second (and final post of this series) will cover longer range efforts to mitigate the root-cause of climate change, excessive greenhouse gas (GHG) in the world's atmosphere.

2. Effects & Mitigation

Each of the effects in the subsections below start with a brief explanation of the effect, followed by measures that can be taken to mitigate the effect.

2.1. Warming

Greenhouse gasses (GHGs) absorb and retain the energy from solar radiation (light), thus heating up the atmosphere.

Increased warmth (higher than normal daily temperatures) can vary in magnitude, and also typically vary by season. Depending on where you live, the daily peak temperatures are generally highest in early summer to mid-autumn, and these can either be slightly higher than they were before pronounced warming set in (say several decades ago) to 10°F higher or more. In the latter case, work schedules may need to be adjusted for people that work outdoors to avoid working during times of peak temperature (typically mid- to late-afternoon) during the hottest time of the year.

Also, lighter, pale-colored clothing and wide-brim hats can help, if workers need to be in direct sunlight. Demand for mediation in this area will involve, specialized clothing, cooling devices, and "human-replacement systems" (read: robots) and plenty of water for human workers.

2.2. Drought

Increased warming makes droughts more likely by evaporating ground-water and desiccating plants.

The best solution for drought is irrigation. The source of the water used for irrigation most likely be from ground-water (wells), nearby streams, creeks or rivers, and/or large-scale irrigation systems, like the San Joaquin Valley State Water Project.[1]

Also, drought-tolerant species of plants can tolerate drought and require less water when they need to be irrigated.

In the Western US, there are many areas that have limited ground-water availability. For instance, the southern part of my home state (California), and the neighboring states (Arizona and Nevada), have this issue, and thus irrigation is a limited resource. One method to mitigate this problem in Agri-voltaic systems.

[1] https://swc.org/wp-content/uploads/2019/11/SWP_-San-Joaquin-Valley_Factsheet_1.12.23-1.pdf

As Nevada hurtles toward its goal of 100% renewable energy by 2025, rural communities around the state are confronting a parallel crisis: groundwater depletion.[2]

But agrivoltaics, which is the pairing of solar with agriculture, on non-irrigated agricultural land could offer a solution.

The recent study, "Rethinking Water Scarcity, Energy, and Agriculture: Coupling Agrivoltaics with Addressing Groundwater Depletion," published in the Journal of the American Water Resources Association highlighted agrivoltaics as a promising path toward environmental and economic resilience, assuming infrastructure and policy can keep pace.

The study focused on Diamond Valley, a rural farming community in central Nevada that's facing mandatory cuts in groundwater usage. There, decades of over-pumping for agricultural irrigation have dropped aquifer levels by 100 feet in the last 60 years. The court-mandated water limits mean that some farmland will need to come out of production.

Rather than leave that land fallow, the researchers suggested transitioning previously irrigated land to agrivoltaic sites, which "can provide simultaneous benefits of reducing water use while increasing renewable energy generation on already disturbed land."

Diamond Valley is well-situated for dual-use projects, thanks to its high solar irradiation levels, flat topography and proximity to current and future transmission lines that appeal to solar developers. And, the land is privately, not publicly, owned, which means that projects aren't subject to the lengthy environmental impact reviews required by the National Environmental Policy Act. This streamlines development.

Also, your author has an upcoming post on June 24 summarized below.

Land Use for Agriculture and Solar Power: *There are two energy-related applications that each need massive amounts of land. One uses photovoltaic panels to produce renewable electric power and the other grows plants that provide chemical energy to humans and livestock via plant-based food. In many cases these two applications compete for the same land. This is mainly because they both use sunlight for energy (electricity / plant-chemical). However, in many cases they can share the sunlight, ideally by each system only using an optimum amount of the part of the sunlight-spectra on which that system operates most efficiently.*

Photovoltaic (PV) / agricultural systems that share sunlight are most commonly called agrivoltaic systems. There are three major types of agrivoltaic systems:

- *Interleaved arrays and crops*
- *Arrays elevated above crops*
- *Arrays on greenhouses*

[2] Phoebe Skok, PV Magazine, ″How agrivoltaics could solve Nevada's groundwater crisis," May 30, 2025, https://pv-magazine-usa.com/2025/05/30/how-agrivoltaics-could-solve-nevadas-groundwater-crisis/

2.3. Flooding

Floods are not exactly the opposite of drought, as they can cause more intense and immediate damage than droughts. Also, their causes are quite different, although climate change can cause both.

When the atmosphere is warmer it can carry more humidity / water. When a warm, humid cell encounters a significant cold-front and/or increase in elevation, heavy to torrential rain can result, and this can result in localized flooding. If this happens repeatedly over a short time-frame, this can result in wide-spread flooding.

The best mitigation for flooding is planning ahead and implementing flood-control infrastructure, including:

- Making sure that sure that natural or hydro-engineered waterways always have the capacity to carry away water from “50-year floods” or “100-year floods.”
- Reservoirs have the capacity to store water from the above unusual events.
- Adding flood-plains to temporarily store excess flood-water and allow it to seep into the water-table.

2.4. Severe Weather, Including Hail-Storms & Tornados

The scenario described in the prior subsection can also cause weather more damaging than “torrential rains,” like the storms described in this subsection’s title. Also, these storms may be more likely to cause property-damage and loss of life than flooding.

If a region is prone to these storms, assume that you will be hit by these. Although it may not reasonable to build infrastructure capable of withstanding most of these storms, it probably is worth hardening built-infrastructure to withstand all but the worst, and providing hardened shelters for populations to minimize injuries and fatalities.

2.5. Hurricanes

The good news that most of the heat from climate change that starts out in the atmosphere ends up in the oceans. The bad news is that this makes the storms described in this subsection’s title more likely. Hurricanes are one of the most destructive storms, combining extreme winds, flooding and each storm travels hundreds of miles. Since coastal areas frequently have much built infrastructure (think resorts and port-cities), they are particularly vulnerable.

If a given area has experienced hurricanes in the past, especially frequently, they have probably already planned and implemented measures to harden cities and their infrastructure to resist damage from these storms. However, the big “gotcha” here is, with increased warming, new areas will be hit or hit harder by these storms. Recent years have proved that this is already happening.

For areas that feel that they may be in future hurricanes’ bulls-eyes, the following two steps are recommended:

- See Flooding*,* section 2.3
- Visit a city or area government that has experience with these storms for meetings between future bulls-eye’s officials and the experienced officials.

2.6. Wildfire

It wasn't that long ago that wildfires were mostly a western issue in the US, but that has changed dramatically. Although we still have our share of wildfires, especially large ones, these disasters seem to have migrated east and north as warmth and droughts have dried-out vegetation coast-to-coast and northward to Canada and Alaska.

It is clear that every region in in North America will to need to beef-up its fire suppression and firefighting resources as global warming becomes more intense. Steps for doing this are described in the subsections below for my second home in the Sierra-Nevada Mountains, and my primary residence. The first mostly defines mitigation measures, and firefighting using mutual aid, and the second focuses on firefighting in a suburban area using a joint powers authority, also with mutual aid, but also with an amazing light-bulb.

2.6.1. Calaveras County

Fire suppression: Your author has had a second home in a Sierra-Nevada Mountain National Forest for the last 25 years, and we have always had requirements to maintain our property in a pretty fire-resistant state during the fire season (late spring through mid-to-late autumn). This includes:

- Removing dead plants (grass, pine needles, dry leaves, pine-cones, dead-tree limbs, etc.) from our property, house roofs, decks and other surfaces.
- Trimming all low-hanging branches that could provide a fire-ladder into the forest canopy.
- Removing any dry bushes and other plants

Firefighting: In the area around my mountain home in Arnold, Calaveras County, California fire-fighting is taken very seriously. There are (at least) two agencies that are responsible for fighting fires in this area:

- CAL FIRE[3]
- Ebbetts Pass Fire District, Calaveras County[4]

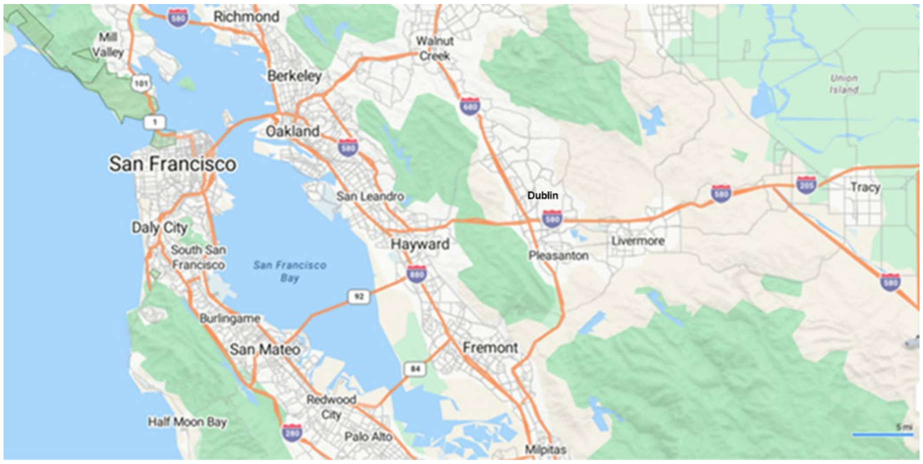
There is also a mutual-aid agreement in place among all of the small fire-fighting organizations in this area. CAL-FIRE is state-wide and can call on resources from all over a given area, particularly in forested areas.

2.6.2. Livermore Valley

Livermore Valley, and thus my primary home is on the eastern side of the San Fracisco Bay Area (see the map on next page). Major cities in my valley are Livermore (pop 88, 000), Pleasanton (pop 75,000) and Dublin (pop 67,000).

In 1996, the Livermore Fire Department and the Pleasanton Fire Department joined forces as a Joint Powers Authority to form The Livermore-Pleasanton Fire Department. The organization uses a joint powers authority (JPA) model with essential support services provided jointly by the cities of Livermore and Pleasanton. [5]

[3] https://www.fire.ca.gov/
[4] https://www.epfd.org/
[5] https://www.lpfire.org/our-history/then-and-now



At the same time, both the Livermore Fire Department and the Pleasanton Fire Department have independent histories serving the area's citizens. Their heritage reaches far into the past and is reflected in our culture even today. We invite you to come along with us on this journey from far past to past to present.

Livermore

Prior to 1958, the City of Livermore had an all-volunteer fire department. That year the city hired Jack Baird as the first full time Fire Chief. They also hired three full time paid firefighters: Charlie Davis, Roy Moore and Charlie Clelland.

Pleasanton

Established in 1888, Pleasanton Fire Department began with twenty volunteers, two hose carts and a Hook and Ladder Company which carried twenty leather fire buckets.

The oldest active member of the Livermore Fire departments is the Centennial Bulb.[6]

T*he Centennial Bulb, the Longest burning Light Bulb in history. Now in its 120th year of illumination. For those of you coming here for the first time, feel free to explore the pages of our amazing little bulb, with pictures, stories, facts, and history.*

We owe a lot to the incandescent light bulb. The incandescent light bulb (ILB) has provided for increased industry and a better society. They replaced dangerous and sooty gas lamps. ILBs lit our factories, offices, schools, hospitals and roads. The discovery led to the development of modern electronic devices. The hot filament was known to emit electrons (Edison effect) which could be collected and controlled. This led to the development of vacuum tubes, radio, television and early electronic computers. Today ILBs are headed toward obsolescence and replacements by LED lamps because ILBs have a low efficacy and are short lived (1,000 hours). Is that really always true? How do we explain the 60-watt Shelby bulb (called the Centennial Bulb) still in continuous operation since 1901 at the fire house in Livermore California? In 2015, it was still operational after one million hours. You can visit the website that shows this bulb still in operation, Livermore's Centennial Light Bulb Livermore's Centennial Light Bulb Cam .

[6] https://www.centennialbulb.org/docs/centennial%20bulb%20report.pdf

Let's check the history. If you are American, Thomas Edison invented the ILB. If you are British, Joseph Swan invented it first. If you go to Wikipedia, they have a citation that lists 22 previous inventors. I personally believe it was the first person to pull a hot glowing piece of metal out of a fire.

If we follow Edison's path, it was a path of much trial and error to find a long-lasting filament. Edison was the prototypical inventor who was not a scientist and lacked a formal education but who knows some science through experimental work as an apprentice and has some scientist and engineers working for him. Edison's first practical filaments were made of processed carbon (carbonized cotton, linen or bamboo) that he turned into carbon fiber in a matrix which is a composite. These carbon fibers may have consisted of layered graphene graphite in a matrix. He was able to make a light bulb but he wanted it brighter and the filament had to be hotter without breaking or evaporating. Carbon has a high melting temperature (3825 K) and a low cost. But the carbon composite would evaporate at much lower temperature than carbon would melt, so he considered other materials. He considered platinum but it was too expensive and a low light output due to a low melting point (2041 K).

Tungsten eventually became the choice because it was less brittle and tolerated small amounts of oxygen better than carbon. It too had a high melting point (3695 K) and a low evaporation rate. He was also able to achieve a greater filament temperature with tungsten than carbon. However, tungsten is extremely difficult to work with because of its hardness. William D. Coolidge invented a complicated process to form tungsten into wires with micrometer diameters. Without this process, it would not have been possible to make the modern tungsten filament lamp…

Final author's comment: Note that reference 6 has much more information on incandescent light bulbs (ILBs), but this is to be expected. It's author, Martin Kykta, is a Physics PhD from UT, Austin, who specializes in ILBs.