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Direct Disaster Losses: A Case Study of Los Angeles and California Wildfire

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Abstract: ***Natural disasters, particularly wildfire, floods and cyclones, are biggest threats, causing substantial economic losses. While tangible losses are calculated post-disaster events, indirect losses impacting the broader economy are frequently overlooked. This study aims to compute direct losses for Los Angeles and California wildfire, severely affected, resulting in a direct economic loss of 122 billion dollars. In this study, the complete remote sensing techniques have been employed to assess the direct losses. The Earth Engine version of the Fire Information for Resource Management System (FIRMS) dataset contains the LANCE fire detection product in rasterized form. The near real-time (NRT) active fire locations are processed by LANCE using the standard MODIS MOD14/MYD14 Fire and Thermal Anomalies product. Each active fire location represents the centroid of a 1km pixel that is flagged by the algorithm as containing one or more fires within the pixel. The data are rasterized as follows: for each FIRMS active fire point, a 1km bounding box (BB) is defined; pixels in the MODIS sinusoidal projection that intersect the FIRMS BB are identified; if multiple FIRMS BBs intersect the same pixel, the one with higher confidence is retained; in case of a tie, the brighter one is retained. The image collection ee. Image Collection("FIRMS") has been processed considering bands " T21" (The brightness temperature of a fire pixel using MODIS channels 21/22) and "confidence" (A detection confidence intended to help users gauge the quality of individual active fire pixels. The confidence estimate ranges between 0% and 100% for all fire pixels within the fire mask. The confidence field should be used with caution; it is likely that it will vary in meaning in different parts of the world.)***

Keywords: Natural disaster, Wildfire, direct economic loss, Remote Sensing and GIS

1. Introduction

California is a very large state with an area of approximately 100 million acres. About 33% is classified as forestland. About 58% of our forests are dominated by conifers. The mixed conifer type (mostly Douglas-fir, ponderosa pine, sugar pine, Jeffrey pine, incense-cedar, and white fir) covers about 7.8 million acres.

The Angeles National Forest covers a total of 700,176 acres (1,094.0 sq mi; 2,833.5 km2), protecting large areas of the San Gabriel Mountains and Sierra Pelona Mountains. It is located just north of the densely inhabited metropolitan area of Greater Los Angeles.

Wildfires (also known as bushfires, brush fires or forest fires) are large, uncontrolled and potentially destructive fires that can affect both rural and urban areas. They can spread quickly, change direction and even 'jump' across large distances when embers and sparks are carried by the wind. Four out of five wildfires are started by people, but dry weather, drought, and strong winds can create a recipe for the perfect disaster—which can transform a spark into a weeks- or months-long blaze that consumes tens of thousands of acres. Another possible cause of forest fires is lightning.

No single factor produces wildfires; rather, they occur when fire thresholds (ignitions, fuels, and drought) are crossed. Anomalous weather events may lower these thresholds and thereby enhance the likelihood and spread of wildfires. Climate change increases the frequency with which some of these thresholds are crossed, extending the duration of the fire season and increasing the frequency of dry years. (Juli G Pausas et al).

As per the U.S. Fire service, around 700 wildfires occur every year, which burn down roughly 7 million acres of land. The wildfires are so severe that they can burn at a temperature that is more than 2000 degrees Fahrenheit and can reach up to 50 meters high. Shockingly, this temperature is twice as hot as Venus.

Causes of Wildlife Disasters

For a fire to start, three elements have to be present: oxygen, fuel, and heat, which is universally known as the fire triangle. This can also be an answer for how do wildfires start? The main causes of Wildfires are as follows:

1) Human Causes

Carelessness is the basic nature of humans, which leads to many disastrous events. While camping, they sometimes forget to put off the fire, or during a bike ride or hike walk in forests they might leave cigarette butts - the effects of which result in wildfires and disasters and animals have to pay the price.

2) Natural Causes of Wildfires

The wildfires that happen due to completely natural resources comprise 10% of the total wildfires. The two main natural can strike causes are:

- Lightning: The researchers believe that most of the time the wildfire is triggered because of lighting. It can produce a spark and can strike trees, rocks and power cables, or anything that comes in the way leading to harsh destruction.
- Volcanic Eruption: During a volcanic eruption, the hot magma which is present in the earth's crust is expelled out, which further flows into the surrounding fields or lands and starts wildfires, again knocking down everything.

Effects of Wildlife Disasters

1) Forest Degradation

Hundreds and thousands of trees and vegetation are wiped out because of a forest fire. Forest fires across the globe reduce the quality of soil fertility, biodiversity, and ecosystems every year.

2) Air Pollution
All plants depend upon the atmosphere for respiration. We breathe in carbon dioxide and breathe out oxygen. Due to fire, plant life comes to an end, the quality of life that we breathe declines, and there is an increase in the greenhouse effect leading to global warming and climate change.

3) Loss of Ecosystem
The most destructive effect of wildfire is the destruction of the habitats of animals and plants. It disrupts the relationship between flora and fauna. Smaller animals, like squirrels, birds, rabbits, snakes, etc., are particularly at high risk of death.

4) Soil Degradation
Due to wildfires, all the nutrients that are present in the soil are destroyed. It also kills the beneficial soils and also leaves the soil bare, and all the nutrients present in the soil are destroyed due to high temperature.

Impact of Wildlife Disasters on Animals
Wildlife disasters can have significant consequences not only on human beings but on animals as well. When there is a disaster, animals go through the same dreadful outcome as people, like, injury, illness, stress, starvation, and displacement from their homes.

For animals who are entrapped in the fire, the impacts are life-threatening. A single fire can destroy millions of animals, and think what thousands of wildfires will do to them. The animals also face the aftereffects like burns, respiratory problems, and blindness in some cases.

Like in 2020, there was a bushfire in New South Wales in which approximately 480 million animals were harmed. These were some of the wildfire facts for kids, which are listed above.

Preventive Measures
We must take measures to put a halt to this disastrous disaster. The most effective strategies are as follows:

- We should avoid doing any outdoor activities if it is dry or windy.
- Make sure to build your campfire in the open and far from flammables and extinguish it by putting out the fire completely before you leave.
- We should never throw lit cigarettes out of our cars.
- Always be informed about any risks of forest fires in your areas.

2. Literature Review

Wildfires are a common type of disaster in some regions, including Siberia (Russia), California (United States), British Columbia (Canada), and Australia. Areas with Mediterranean climates or in the taiga biome are particularly susceptible. Wildfires can severely impact humans and their settlements. Effects include for example the direct health impacts of smoke and fire, as well as destruction of property (especially in wildland–urban interfaces), and economic losses. There is also the potential for contamination of water and soil.

At a global level, human practices have made the impacts of wildfire worse, with a doubling in land area burned by wildfires compared to natural levels.[11]: 247 Humans have impacted wildfire through climate change (e.g. more intense heat waves and droughts), land-use change, and wildfire suppression. The carbon released from wildfires can add to carbon dioxide concentrations in the atmosphere and thus contribute to the greenhouse effect. This creates a climate change feedback.

The potential for wildfires is growing under climate change, with increases in the frequency and intensity of drought and periods of fire-favourable weather driving reductions in vegetation (fuel) moisture and priming landscapes to burn more regularly, severely, and intensely (Matthew W. Jones et al.)

Additionally, human activities and land-use change can contribute to or exacerbate the risk of extremely large, fast-moving or intense fires, especially in tropical forests where people are the primary cause of ignition and forest degradation (Lapola et al., 2023).

The UK Climate Change Risk Assessment (CCRA) 2012 has cited wildfires amongst the top seven risks to the natural environment in England [7]. With climate change, the risk of wildfires is likely to increase and a 30% to 50% increase in wildfires by 2080 is predicted(Sarah Elise Finlay et al.)

Wildfires are often perceived as destructive disturbances, but when integrating evolutionary and socioecological factors, fires in most ecosystems can be understood as natural processes that provide a variety of benefits to humankind. Wildfires generate open habitats that enable the evolution of a diversity of shade-intolerant plants and animals that have long benefited humans(Juli G Pausas et al.). Although learning how to use and control fire is considered to be a key step in the evolution of both humans and human societies (Wrangham 2009; Burton 2011), and being a pyrophilic (fire-dependent) species radically changed the ecological niche of humans, most people today have a negative perception of wildfires.

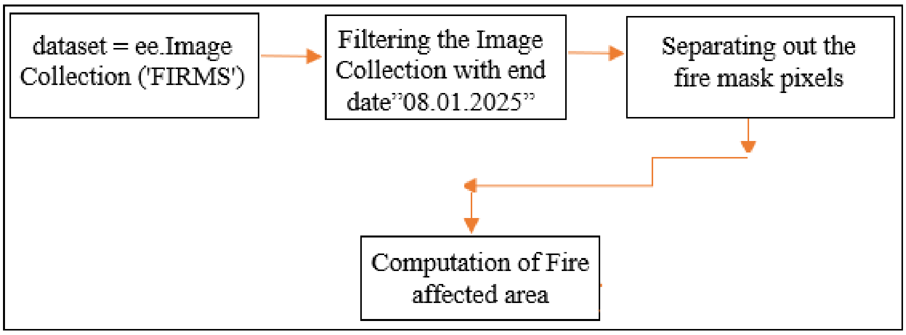
land-use and land management practices are also important, both Gillett et al. (2004) and Westerling et al. (2006) conclude that climate change is the most important factor in explaining changes in fire frequency and intensity over recent decades

Westerling *et al.* found that, in the 34 years studied, years with early snowmelt (and hence a longer dry summer period) had five times as many wildfires as years with late snowmelt. High-elevation forests between 1680 and 2690 m that previously were protected from wildfire by late snowpacks are becoming increasingly vulnerable. Thus, four critical factors—earlier snowmelt, higher summer temperatures, longer fire season, and expanded vulnerable area of high-elevation forests—are combining to produce the observed increase in wildfire activity.

3. Methodology

Data and Methodology

Google earth Engine platform has been utilized to process the satellite imageries in the following manner.



To achieve a globally consistent approach, used the methodology of Huizinga et al. (2017) to estimate present-day maximum economic damage. Huizinga et al. (2017) found the following root function could be used to link GDP per capita to construction costs for each country: Where: y = construction cost (2010 euros) x = GDP/capita (2010 dollars) a & b = constants (e.g., for residential buildings a = 24.08 and b = 0.385) For this tool, we used the above equation to estimate construction costs per country in 2010, using the national level GDP per capita values. In order to transition from construction costs to maximum damage values, several further adjustments were necessary. We adjusted the construction cost values of the baseline and scenario following the suggested factors by Huizinga et al. (2017) for the diferent occupancy types. Such factors include depreciation, since the use of replacement values would overestimate the damage. Therefore, the construction costs are depreciated by a factor 0.6, the default used by Huizinga et al. (2017). Furthermore, Huizinga et al. (2017) suggest that buildings, particularly ones made of more resistant materials, be constructed of parts that will never be damaged. As all stage-damage curves for Aqueduct Floods are developed up to a 100 percent vulnerability fraction (see Section 3), we adjusted the construction costs for 40 percent of undamageable parts. In addition to these structural damage costs, the amount of content and inventory needed to be added to get the total potential maximum damage value. Reviewing the available literature for the diferent factors, Huizinga et al. (2017) suggest that a global methodology take 50 percent, 100 percent, and 150 percent of the structural costs for residential, commercial, and industrial building content, respectively. The above values refer to a country's average maximum damages per m2 for individual objects, diferentiated per occupancy type. The amount of residential, commercial, or industrial land use varies from country to country and within each country. As a proxy for the spatial distribution of different land classes between countries, we used Corine Land Cover data (EEA 2016) and compared for each European country the share of residential and commercial or industrial areas on the 100 m resolution dataset. For countries with these area types, the distribution between these two categories ranges between 75 percent and 95 percent for residential areas (86 percent average), and between 5 percent and 25 percent for commercial or industrial areas (14 percent average). Similar results can be found in a report by Buildings Performance Institute Europe (BPIE 2011) regarding floor space for various building types in Europe, where threequarters of the building stock is residential, with non-residential accounting for the remaining 25 percent. Since more detailed information is not yet available, both sources can only act as a rough proxy to estimate residential, commercial, and industrial areas in Aqueduct Floods' urban land use categories and are further restricted to Europe. Taking into account that every distribution we choose can only be an approximation for the global scale, the shares of residential, commercial, and industrial areas within the urban cells were set to 75 percent residential, 15 percent commercial, and 10 percent industrial, respectively. As for most large-scale models, Aqueduct Floods' impact model does not include information on building footprints but applies a land use–based approach for which we further estimated the density of buildings between 20 percent (residential) and 30 percent (commercial and industrial), again following the suggestions of Huizinga et al. (2017). The present study is limited to computation of economic losses for residential infrastructure.

4. Results and Discussions

The results indicate that massive wildfire has outbroke in California. The area covered by wildfire in California is 340 Km2 and 292 Km2. On the basis of fire mask pixel >330 deg.K, the affected area has been computed.

Considering the GDP in base year i.e.2010 as 58,000 USD and 55,149 USD respectively for Los Angeles and California. The damaged cost is computed as 805.50 USD per M2.

Keeping in view the above figures, eventually the direct residential infrastructure loss is as below:

Los Angeles: 240 Billion USD

California: 274 Billion USD

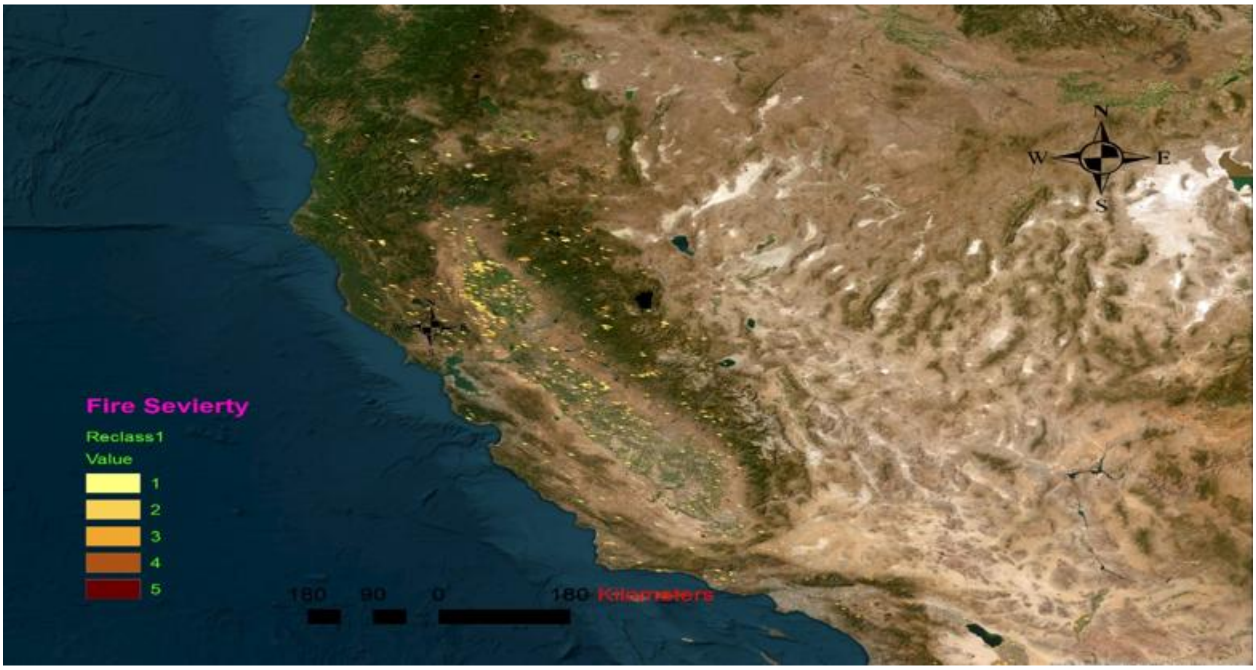


Figure 1: Wildfire of California

Figure 2: Wildfire of Los Angeles

5. Conclusion

In the current study, the direct losses have been computed, however to assess the indirect losses and which particular sector of economy suffers burst hit is of paramount importance. At the same time the recovery cost and recovery time are also very important in order to focus on particular sectors so that speedy recovery can be attained in shorter period of time.

6. Limitations

The study's limitations include its dependence on data and imageries downloaded from Google Earth Engine and constants used in methodology of Huizinga for computing the economic losses. Nevertheless, the high resolution imageries are used, hence results can be relied upon. The validation of the results could not be possible due to unavailability of data.

7. Future Research Direction

Future studies must be computed for Indirect losses which are quite significant in nature .Sometimes these losses surpass even the direct losses. Leontief's Input-Output theory serves as the foundation for several economic impact studies. Wassily Leontief developed this theory, which requires creating a matrix depiction of an economy, illustrating the links between different industries and sectors (Sahani, Sah et al. 2023).

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