Amazon Forest Fire

English Report

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CONTENTS

Interview

Cause & Effect

Comparison

Simulation

Conclusion

Interview

- Reporter - Lauran
- Ranger（护林人）- Isaac

Welcome to Panda News[1], I`m Michael Richman, the most famous host of all time.

We feel very sorry to hear that just now, a destructive forest fire took place in the Amazon Forest. Now let`s follow our journalist on the scene of fire in Amazon to figure out what happened.

Michael: Hi Laurent, you there? Expect to your report.

Laurent: (Pause) Yes, Michael, I`m here.

Interview

A ranger and a reporter:

Reporter : Today we invite the **best** ranger in Amazon, **Isaac**.

Ranger : Hello!

Reporter : As we can see, the fire is burning. I heard it's is **not** the first time. Ranger : Yes, the **third** time, though it is just April.

Reporter : That is terrible, because we all know the Amazon forest is the **largest** rainforest.

Ranger : Also called "The lung of the earth".

Reporter : Unfortunately, disasters happened **frequently** these days. **One fifth** of the forest have been destroyed. Can you tell us more details?

Ranger : Yes. Though the Brazilian government and **we rangers** try our best, over **20 percent** of the forest has flattened in the last 40 years. The **most serious** fire happened in 1987, the fire area reached 20 thousand hectares, which is equal to **two** Switzerland.

A ranger and a reporter:

Reporter : I do hope such a tragedy will **never** repeat again. Could you tell us which part is the **most** damaged?

Ranger : That **must be** mato grosso forest, **38** percent of the forest **disappeared** because of the fire and excessive deforestation. **Here** used to be **a whole** forest, but now farmers grow soybeans

Reporter : What a sharp contrast.

Ranger : **And the forest will never come back.**

A ranger and a reporter:

Reporter : It really hurts to think of it. What cause the terrible disaster?

Ranger : It is regrettable that mostly **people** cause the fire.

Reporter : You mean that people set fire deliberately?

Ranger : Yes, in fact, we caught two arson criminals just now. To punish these criminals, the military in Brazil has launched Green Wave Action.

Reporter : I hope things will get better.

Ranger : Actually, we need more government control and scientific research.

Reporter : And everyone's efforts.

Cause & Effect

- Green house effect
- Season
- Natural environment
- Human activity

Cause

What can be the killer of forest?

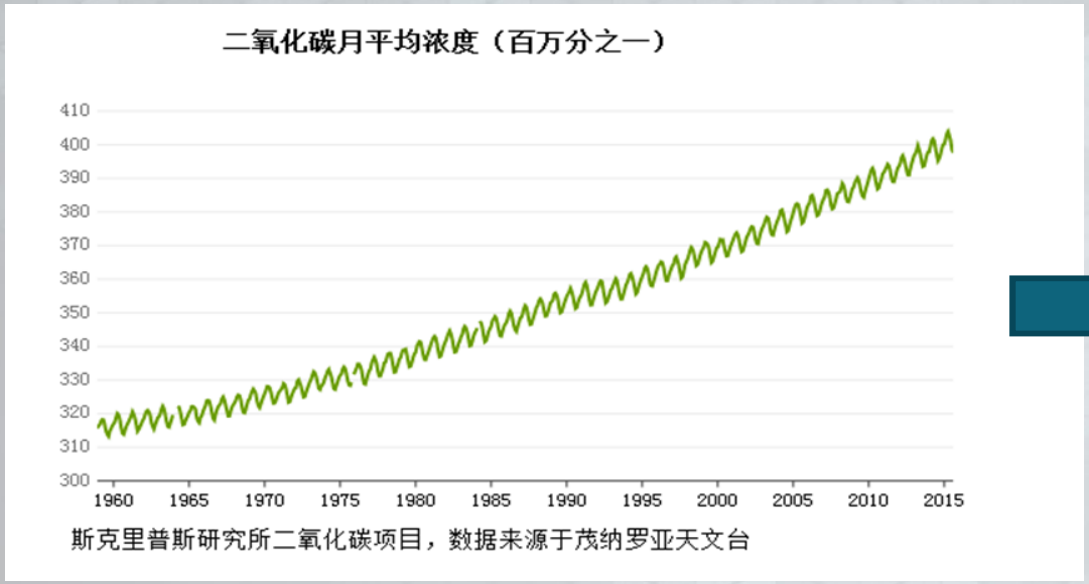
01 Green house effect

02 Season

03 Natural environment

04 Human activity

Green house effect



More strong wind and dry weather days

More easily and frequently

Due to green house effect, the temperature is getting higher. As a result, there are more strong wind weather and dry weather days. Dry deadwood and leaf are easily to be burned, while strong wind will speed up the fire to swallow trees which are not afire.

In this condition, fire may happens more easily and frequently.

During autumn and winter, the environment becomes dry because of the weather and the dead of most plants. The fact is many departments of forest protecting set the special forbidden time in autumn and winter. And it has been proved that the decision is generally correct.

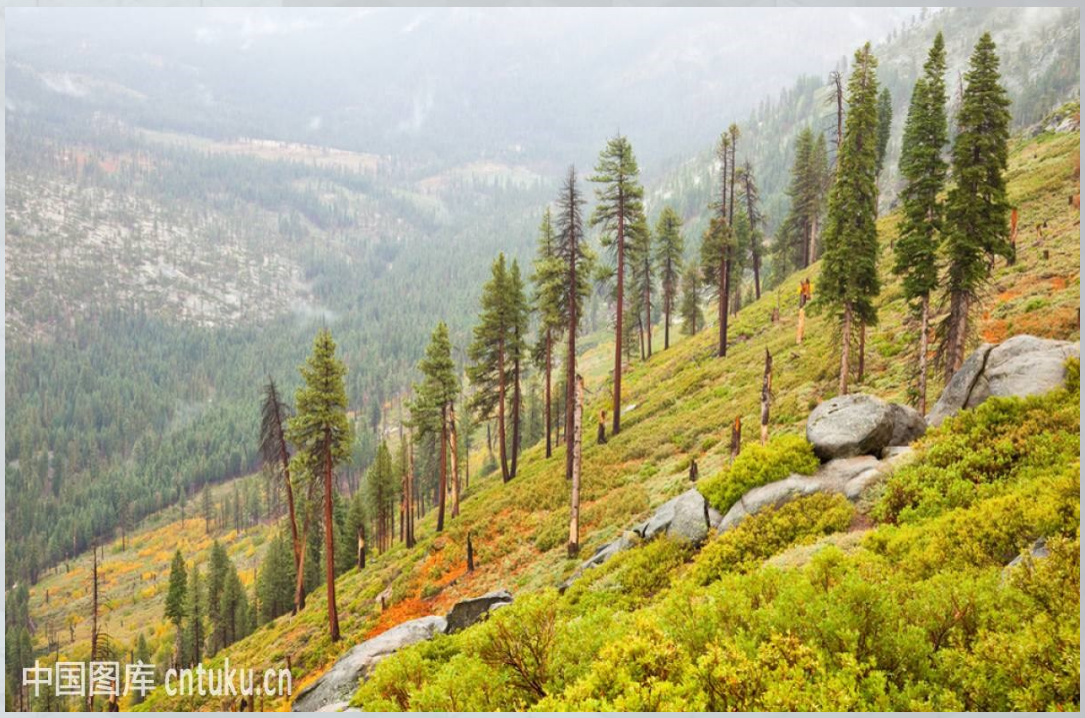
Season

autumn and winter

Serious fires

Natural environment

High density



Low density

Depends on the density and tree variety, there are deadwood which are easily to be lighted especially in autumn and winter. Once fire occurs, it will spread soon.

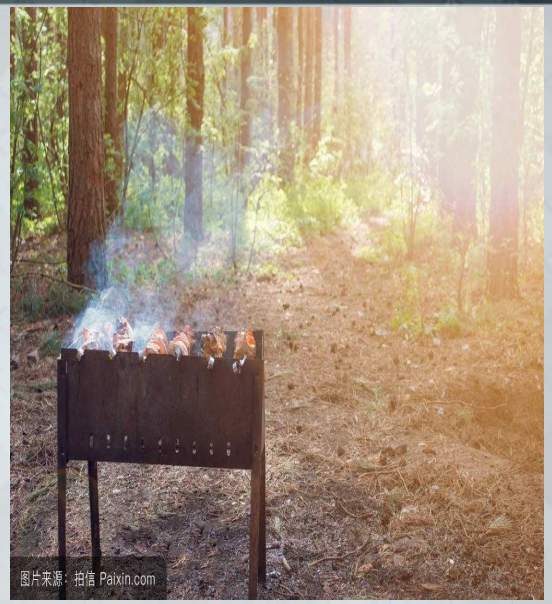
evergreen broad leaved forest(常绿阔叶林)

Larch（落叶松)

What's more, the kind of trees is a cause of fire. For example, Larch(落叶松)、Pinus sylvestris(樟子松)、Pinus koraiensis(红松) contain grease(油脂) which are the helper of fire; evergreen broad leaved forest(常绿阔叶林),which are normal in south of china, have lush leaf which make the fire spread quickly.

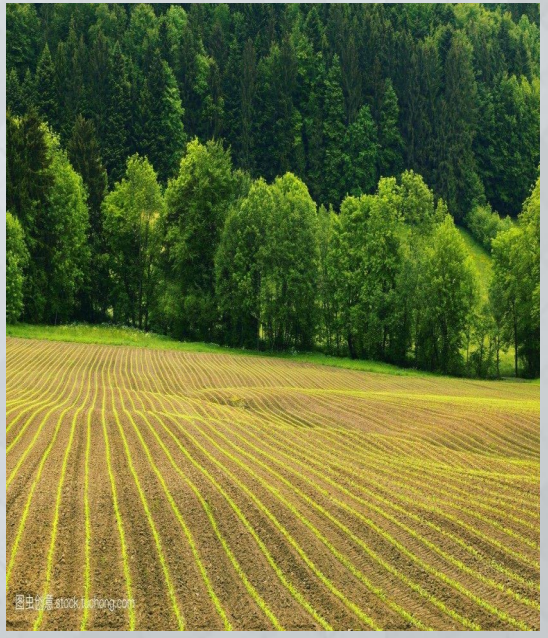
Human activity

travel



entertainment

cutting



algriculture

Human activities, such as lumbering, planting, cultivation, entertainment and so on, may cause fire because of careless action.

For example, due to picnic while travelling, people sometimes set forest fire by accident.

What's more, some people use the method of igniting forest to clear land for planting crops and other agricultures.

Comparison

- By Times & Areas
- By Cause of fire
- By Type of forest

国　家	林火 (起数/年)	受害森林面积 (hm^2/a)	占森林面积 (%)	受害森林面积 (hm^2/次)	统计年代
澳大利亚	1 772	360 073	0.4	203.2	1970~1980
美　国	117 724	1 840 495	0.6	15.6	1970~1980
加拿大	7 162	891 330	0.2	121.6	1970~1980
日　本	6 906	12 867	0.05	1.86	1972~1981
瑞　典	2 359	2 807	0.01	1.1	1970~1980
前苏联	28 000	164 000	0.21	73.6	1970~1988
芬　兰	604	1 119	0.07	1.85	1970~1980
德　国	1 498	2 279	0.06	1.51	1970~1980

American had the most times of fire and the biggest areas of fire. Far-far more than any other countries.

First, let`s have a look at the times and areas of forest fire of different countries. We can see that during 1970s, American had the most times of fire and the biggest areas of fire, far more than any other countries. Maybe that was because American had relatively a larger area of forest.

	1990	1991	1992	1990	1991	1992	1990	1991	1992	1990	1991	1992
	合计			人为放火			跑火			天然火源		
白俄罗斯	2 469	–	–	–	…	…	2 469	…	…	2	…	…
芬　兰	440	221	480	28	17	48	412	204	432	86	42	250
法　国	…	…	…	…	…	…	…	…	…	…	…	…
德　国	688	1 188	…	225	460	…	463	728	…	28	11	…
意大利	7 845	5 267	6 885	5 284	3 751	4 950	2 561	1 516	1 935	82	54	37
土耳其	684	…	501	296	…	70	388	…	431	30	…	100
加拿大	4 900	5 904	…	475	806	…	4 425	5 098	…	4 895	4 151	…
美　国	33 203	…	…	30 634	…	…	52 569	…	…	16 463	…	…

In Europe, it caused by human deliberately set a fire.
In North America, it caused by natural fire (like lightening)

Now here is the interesting part. According to statistics, it seems that in Europe, forest fires were mainly caused by people who deliberately set a fire. While in North American, the fires were caused mainly of natural reasons, like a lightening.

国家	针叶林			阔叶林			萌生林			其它林地		
	1990	1991	1992	1990	1991	1992	1990	1991	1992	1990	1991	1992
白俄罗斯	0.75	0.27	8.2	…	…	…	0.53	0.03	7.8	0.04	0.008	2.6
芬　兰	0.43	0.23	1	°	°	°	–	–	–	–	–	–
法　国	…	…	…	…	…	…	14.6	…	…	12.9	…	…
德　国	0.5	0.9	…	°	°	°	–	–	…	–	–	…
意大利	25.4	5.8	6.8	11.24	3.4	5.3	59.6	15.15	27.6	–	–	–
土耳其	6.1	6.2	6.5	°	°	°	0.8	0.5	1.44	3.33	2.11	2.5
加拿大	122	276.7	…	°	°	°	160	96.8	…	544.5	1 192	…
美　国	…	…	…	…	…	…	…	…	…	…	…	…

It seems that Larch (针叶林) is more likely to catch a fire.

Types of forest also make a difference. It seems that coniferous forest is more likely to catch a fire. Maybe that is because the coniferous forest contains less water than other types of forest, dry enough to be ignited.

Simulation

- Computer
- Cellular Automata(元胞自动机)

Fire

Introduction

In last section, we investigated in different kinds of forest and analyzed how serious a fire disaster can influence the forest respectively. In this section, we try to quantify this influence.

In order to achieve that, we use Cellular Automata(元胞自动机) method to simulate the spread of fire under different conditions.

More specifically, we calculate the **spread rate** as the dependent variable, while setting independent variable as the **original forest density**, the probability a neighbor tree will catch a fire and the ignite point. These four variables are denoted respectively as

$$spread\ rate = \frac{trees\ burned\ out}{Total\ number\ of\ trees}$$

$$pro = the\ probability\ a\ neighbor\ tree\ will\ catch\ a\ fire \in (0,1)$$

$$density = the\ original\ density\ of\ forest \in (0,1)$$

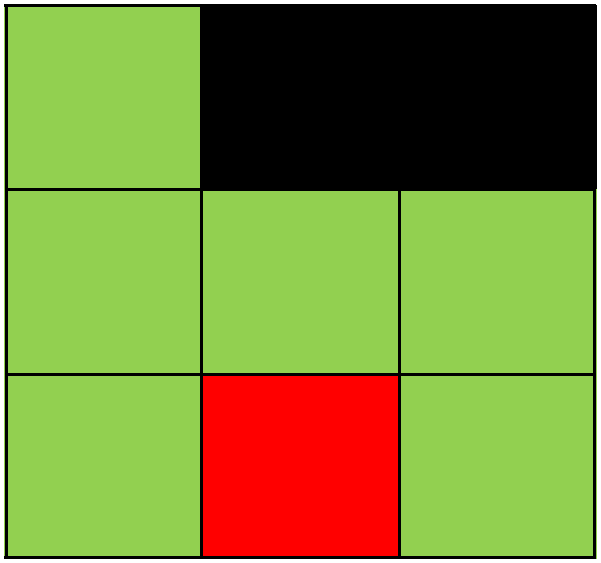
$$fire\ point = the\ ignite\ point \in \{\text{the center, the corner}\}$$

To accomplish computer simulation, typically there are **four steps**:

Fire

Build a forest (The construction of forest environment)

The world of the forest was discretized into small squares of 1m * 1m in size. The size of the world is initially designed as 250 * 250. The following figure shows a 3* 3 grid.



Each small square has three states：

- Tree，Filled with color green.
- Fire，Filled with color red
- Ember，Filled with color black

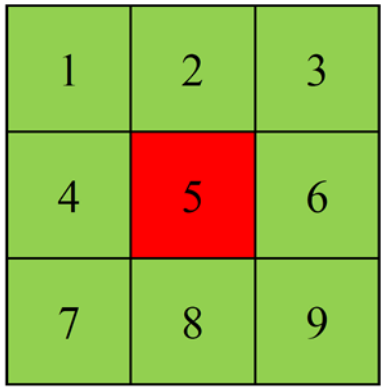
Fire

Design the rules (The laws of fire spreading)

We discretize time into 1s, and each small squares in each time step evolve according to the following rules:

* Tree —> Fire

  The fire area will ignite the nearest 4 trees with a certain probability pro.

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FAKE CODE:
FOR fire ∈ whole forests {
        ask its four neighbors
                if tree?ignite with probability pro
        turn to ember gradually
}
```

For example, in the image above, the No. 5 fire zone (red) will light 2, 4, 6, and 8 trees with probability pro.

* Fire —> Ember

When a tree is on fire, it will gradually become ashes. We use the red to black dimming to demonstrate this process. This process is irreversible, and, after a certain time (here set to 12s), the area becomes ashes.

* Ember —> Tree

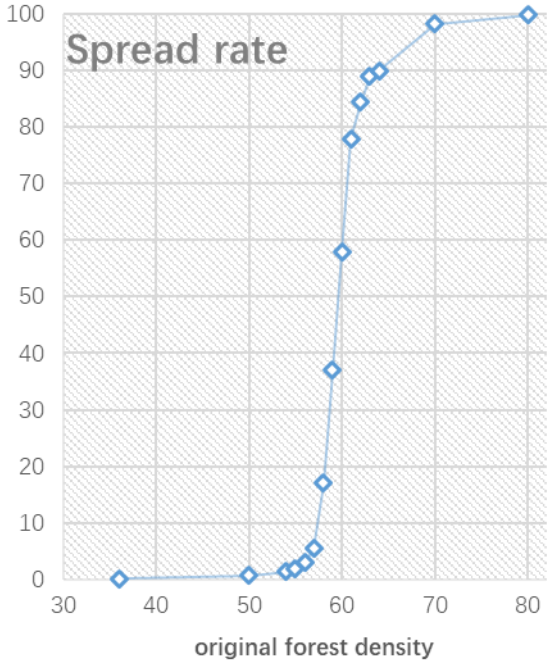
This setting is meaningless and unreasonable when examining whether a fire will spread to the entire forest. Actually, it usually takes a long time for the trees to recover, and in such a long period of time, the fire is long gone.

Fire

Set the variables (Run the model under different parameters)

（1）density

With fixing the probability trees catch fire pro = 1 and the fire point at the exact center, we studied the effect of the original forest density on the fire spread rate.



Density%	Spread rate%
36	0.1
50	0.7
54	1.4
55	1.8
56	3
57	5.5
58	17
59	37
60	58
61	78
62	84.4
63	89
64	90
70	98.3
80	99.8

It can be seen that in the case of a single ignition point, the initial forest coverage density is not linearly related to the fire propagation rate. In fact, when the original forest density is below 40%, the fire situation will end very quickly. The 60% ratio is a **demarcation point** where the curve has abruptly changed. This means that once the original forest density exceeds 60%, the rate of fire spread will increase sharply.

Fire

Set the variables (Run the model under different parameters)

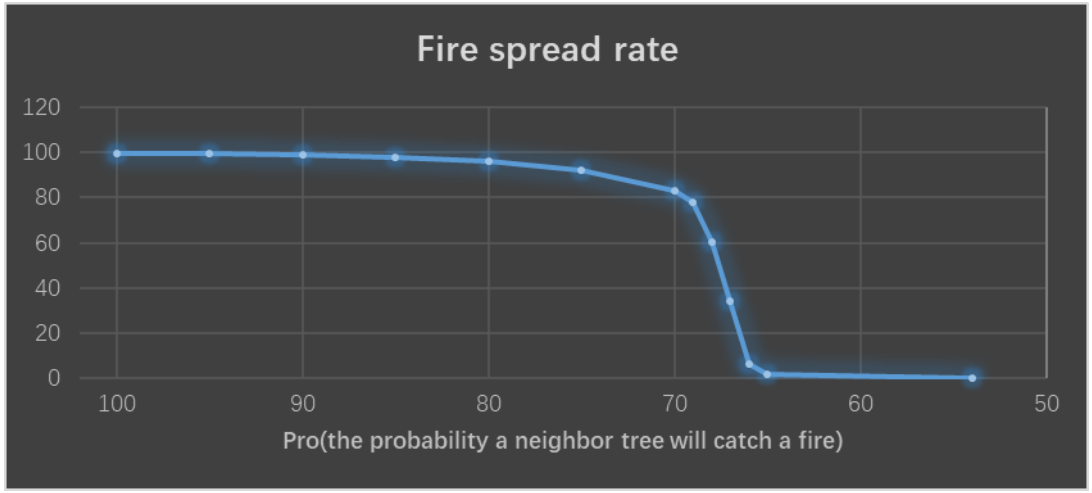
（2）Pro (the probability a neighbor tree will catch a fire)

With a fixed initial forest coverage density of 80% and the ignition point at the exact center, we investigated the impact of fire probability on the fire spread rate.

The reason for selecting density=80% is to eliminate the influence of this factor on the final fire spread rate as much as possible.

It is conceivable that in the case of only one ignition point, the forest can only be burned entirely if the probability of catching a fire is extremely high. In fact, the results of the model simulation also prove this.

pro	100	95	90	85	80	75	70	69	68	67	66	65	54
Spread rate	99.8	99.5	98.9	97.7	96	92.4	82.9	78	60.2	33.9	6.2	1.5	0.1



It can be seen that the probability of catching fire and the fire spread rate have similar tipping point. At density=80%, this mutation point occurs around pro=68%, which means that once the probability of catching a fire is lower than this value, the probability that the forest will be completely burned will be greatly reduced.

Fire

Set the variables (Run the model under different parameters)

（3）Fire point

The location of the fire point is also a factor worth considering. If the fire point happens to be located at the edge of the forest, such as the upper left corner, how will the spread of fire evolve? The rest of the fire points can be approximated as the central area of the forest. Therefore, we only need to compare the above two situations. In order to evaluate the difference between the two, we have a fixed fire probability of 100%

Based on simulation performance and data, there is little difference between the two when the forest cover area density exceeds 65%. However, in the case of density less than 65%, the ignition point in the lower left corner has a negligible contribution to the fire spread rate, compared to the central fire point.

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