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Research on Intervention Mechanism of Public Opinion of NIMBY in Waste Incineration Based on Cellular Automata

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***Abstract*—With the speed of information dissemination and the strengthening of people's awareness of rights protection, the construction of waste incineration facilities often faces greater obstacles. Among them, the spread of public opinion of NIMBY (Not In My Back Yard) has aggravated people's emotional instability. Cellular Automaton model is used to quantitatively study the transmission of public opinion about waste incineration facilities from three factors: (1) the influence of residents from waste incineration facilities; (2) the confidence of residents; (3) the influence of external environment. And the impact of intervention mechanisms is explored to propose crisis decision-making for different impacts of interventions at different time points.**

Keywords—waste incineration, NIMBY, cellular automaton, public opinion, intervention mechanism

I. INTRODUCTION

As the speed of information dissemination accelerates, once public opinion is disseminated, it may cause serious crises, even mass incidents [1]. In the process of building waste incineration facilities, the surrounding residents often strongly oppose these projects because of public opinion, which puts great pressure on the emergency response of the government and relevant departments.

At present, some studies have used the infectious disease model combined with system dynamics to study the negative externalities amplified by public opinion [2]. Some scholars consider the combination of these factors when studying information dissemination, such as user influence, user intimacy, user similarity, and the importance of Weibo content [3]. However, in the study of the construction of NIMBY (Not In My Back Yard) problems in waste incineration facilities, there are few models that take into account individual characteristics and the influence from surrounding individuals. Therefore, the cellular automaton model is used to model and analyze the problem.

II. MODELING

This article focuses on the spread of public opinion about waste incineration in social networks. Therefore, each resident has two states. Those who have already transmitted information are considered to be infected, and others are considered susceptible. The evolution of resident status depends on the state and interaction rules of the residents at the previous moment.

A. Cellular space and neighbourhood

This paper uses the Moore-type neighbor space model [4]. The gray area is the neighborhood of the central cell, and there are 8 neighbors around each cell. This paper sets a two-dimensional space with a cell space of 100*100.

B. Influencing factors of resident status. This article analyzes from the following three factors:

*Impact from neighbors around the NIMBY facilities:*The residents around the NIMBY facilities are affected by the opinions of their neighbors. When a resident (infected person) spreads the public opinion in the social network, his neighbors (susceptible) will be converted into infected persons in a certain proportion [5]. The ratio is the opinion influence coefficient expressed with α, $\alpha \in [0,1]$,and the greater the value of α, the deeper the residents are affected by neighboring cells.

The confidence of residents: Residents resist their neighbors' influence and maintain their original state by judging new information. This article refers to the threshold of a susceptible person becoming infected under the influence of other infected persons, expressed as η, and supposes that it obeys a normal distribution. Residents' self-confidence can be changed by implementing some interventions or education and training.

The influence of external environment: The environment outside the social network where residents live is considered the external environment [6]. For the waste incineration NIMBY events, the residents' perception of similar events in other areas will affect their own judgment, and we divide it into the influence of the external environment, and use parameters p to indicate the probability that the external environment influences the state of random change.

C. Cellular interaction rules without intervention

In addition to the above three influencing factors, the state of the residents at the previous moment also affects the current state of the residents. Once residents become infected and spread sensations on social networks, this information will persist and affect other susceptible people [7]. Therefore, the current state transition equation for residents is:

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$$s_n(t+1) = f(s_n(t), N_n, \eta_n, p) \tag{1}$$

among them,sn(t+1) is the state of resident n at time t+1, (1 represents the state of infection, 0 represents the state of susceptibility),f is the corresponding law for state transition. sn(t) is the state of resident n at time t. Nn is the influence of resident n's neighbors. □ n is the confidence of resident n. p is the external influences. Therefore, the evolutionary rule of the free dissemination of information is:

$$s_n(t+1) = \begin{cases} 1, \ if \ s_n(t) = 1; \\ 1, \ if \ \sum\limits_{k \in A_n} \alpha_{nk} \times s_k(t) \geq \eta_n; \\ 1, \ if \ s_n(t) = 0 \ and \ p; \\ 0, \ others \end{cases} \tag{2}$$

among them, nk is opinion influence coefficient which represents the extent of influence about neighbor k to resident n. An is the collection of resident n's neighbors. Sk(t) is the state of resident k at time t. The above formula indicates that if the resident is infected before the moment, the next moment is also the infection state. If the influence of surrounding cells exceeds the confidence of the residents, it will be transformed into an infected state. If the resident is in a susceptible state at the previous moment and the external influence reaches the conversion requirement, it is converted into an infected state. In other cases, residents are still susceptible.

D. Interaction rules under public opinion intervention

After the appearance of waste incineration NIMBY crisis, the relevant departments will take interventions to control the dissemination of public opinion. After the intervention is implemented, residents will verify when they contact the public opinion on social network, therefore the value of α will decrease and the value of η_n will improve. The infected person will verify the information that he has transmitted or published, and after confirming that it is a sensation, the probability of deleting the transmitted information is p_d. In addition, *p'* is the random probability that a susceptible person becomes infected under intervention and *p'*<*p*. Therefore, the interaction rules under public opinion intervention are:

$$s_n(t+1) = \begin{cases} 1, \ if \ s_n(t) = 0 \ and \ p'; \\ 1, \ if \ \sum\limits_{k \in A_n} \alpha_{nk} \times s_k(t) \geq \eta_n; \\ 0, \ if \ s_n(t) = 1 \ and \ p_d; \\ 1, \ if \ s_n(t) = 1, others; \\ 0, \ others \end{cases} \tag{3}$$

III. THE SIMULATION EXPERIMENT

A. Experimental scenario construction

Based on the above-mentioned cellular automaton model without intervention and implementation intervention, a simulation experiment is needed, and a scenario needs to be constructed before the experiment. In this paper, we set up a two-dimensional space with a cell space of 100*100 [8]. The cell space has 10,000 cells, and each cell represents an individual in the social network. The number of people infected at a certain time is expressed by N.

B. Parameter setting and experimental simulation

Public opinion dissemination without intervention. In the case of free information dissemination, in order to avoid the excessive value of N at the beginning of the experiment, the setting parameters are shown in Table I.

TABLE I. PUBLIC OPINION DISSEMINATION PARAMETER TABLE WITHOUT INTERVENTION

Parameter	α	η	p
Value	0.6*rand(100,100)	0.04+rand(100,100)	0.0006

The spread of public opinion changes with the number of iterations as shown in the figures (figure 1 to figure 4). As the number of iterations increases, the number of infected nodes increases rapidly, then increases slowly, exponentially increasing, and almost all nodes in the final cell space become infected. Therefore, in the absence of intervention measures, public opinion information will increase with the index, and the scope of public opinion will expand rapidly.

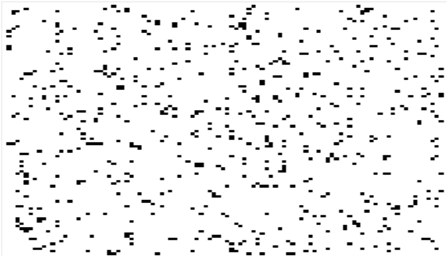

Figure 1. Diffusion map at T=100

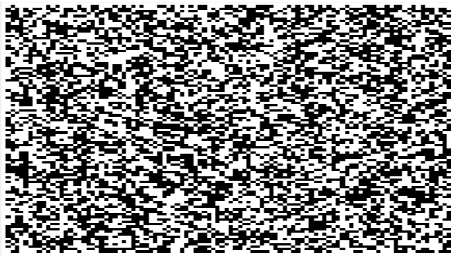

Figure 2. Diffusion map at T=1000

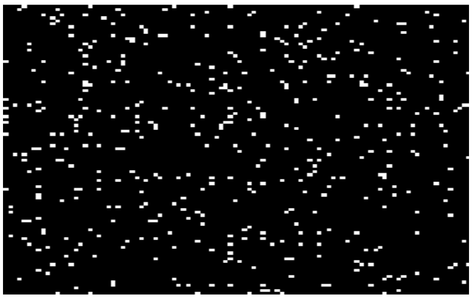

Figure 3. Diffusion map at T=5000

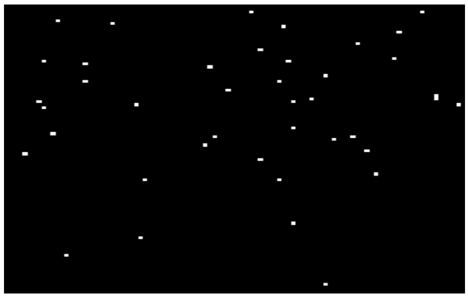

Figure 4. Diffusion map at T=9000

*Public opinion dissemination under intervention:*The time point of public opinion intervention has always been a hot issue of research [9]. This paper studies the effect of intervention at different development stages of lyrics at different time points from a quantitative perspective. In this paper, the time points for intervention implementation are set to the number of iterations of 1000, 2000, 3000, 4000 and 5000 respectively. The parameters of the public opinion dissemination under the intervention are shown in Table II.

TABLE II. PUBLIC OPINION DISSEMINATION PARAMETER TABLE WHEN INTERVENTION

Parameter	α （*intervention*）	η_n （*intervention*）	*p*	*P'*	P_d	Number of iterations
Value	0.4*rand(100,100)	0.04+1.2*rand(100,100)	0.0006	0.0004	0.0008	10000

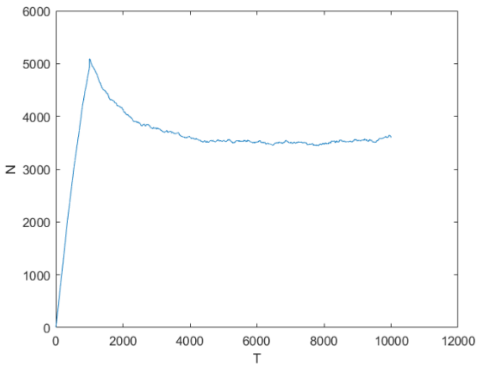

Figure 5. intervention at T=1000

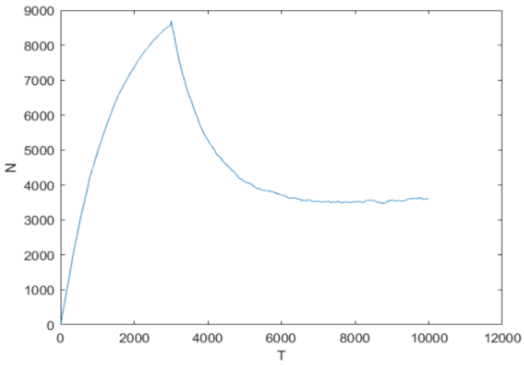

Figure 6. intervention at T=3000

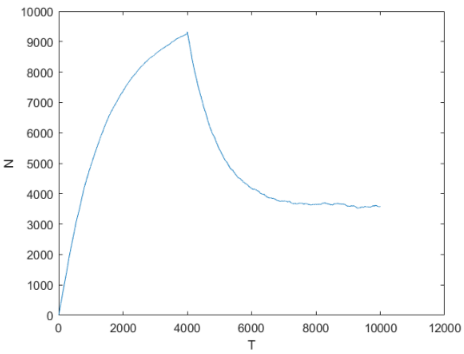

Figure 7. intervention at T=4000

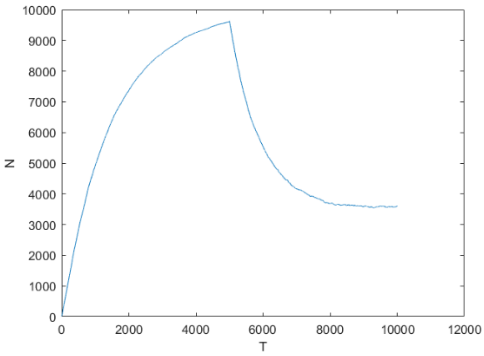

Figure 8. intervention at T=5000

As can be seen from the figures, when the time points for the implementation of the interventions are different, they will eventually enter a relatively balanced state, that is, the scope of the final public opinion information transmission is basically unchanged. When the time points of intervention implementation are different, the maximum impact range is different under different scenarios. When the intervention is implemented later, the maximum impact range is larger, but the time required from the implementation of the intervention to the equilibrium state is not much different.

IV. CONCLUSION

If the scope of the public opinion information is to be kept to a minimum, it is necessary to implement the intervention as soon as possible. It is best to take interventions during the development of the public opinion, which is the best, and can promote the rapid decline of the public opinion. If you miss the sensation in the development period, the intervention measures in the outbreak period and the high tide period of the public opinion, the effect of the intervention measures is not much different, basically does not affect the final state of the spread of public opinion [10]. The earlier the intervention is implemented, the smaller the scope of the public opinion impact. In addition, we can further study the intensity of intervention and explore the impact of intervention intensity on public opinion transmission.

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