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DEVELOPMENT OF THE SIMULATION SYSTEM FOR URBAN DISASTER PREVENTION

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SUMMARY

One of the big problems on making seismic disaster prevention plan is the difficulty to know the effect of it beforehand. The disaster prevention plan for storm or flood is judged by real damage year after year. Therefore, the plan can be improved and the plan of next year becomes more practical one. On the other hand, the prevention plan for seismic damage has scarce chance to be judged by real damage because of the long recurrence interval of disastrous earthquake. To solve this problem, we proposed the simulation system to make the effects of seismic disaster prevention measures visible. This system uses the procedure and the database of microzoning study. The analysis procedure is systematized so as to make it possible to execute the calculation on personal computer. Furthermore it is possible to change the building and life-line database corresponding to the future reinforcement or improvement. Therefore, the responsible person for urban disaster mitigation plan or city planning can simulate the damage in many conditions by themselves repeatedly so as to grope for an effective measure.

INTRODUCTION

It is essential to take each step of planning - execution - evaluation cycle, shown in Figure 1, when some measure is taken. Seismic disaster prevention measures are not exceptional of course but it is not easy to adopt this cycle because of the difficulty of evaluation step. The effect of measures for storm and flood damages that occur frequently can be seen easily, for instance year after year. Therefore, measures for storm and flood damage can be revised in every year based on the evaluation of last year experiences. Also, there are many empirical relationships between measures and their effects that can be used as the starting model for planning in the case of storm and flood. On the other hand, it is difficult to judge the effect of measures for earthquake disaster prevention because of the length of disastrous earthquake recurrence interval.

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positioning the fireproof buildings is useful to stop spreading of fire following earthquake. But from a viewpoint of urban disaster prevention, it is not easy to decide where and of which level to perform reinforcement to get the best effect for improvement of earthquake-resisting capacity of the urban area overall. The difficulty to judge the effectiveness of the measure should be one reason. This is likely to be the obstacle to promote the earthquake disaster measure. To solve this problem, we propose to develop the simulation system to make the effects as the whole city of disaster prevention measure visible so as to see it quantitatively.

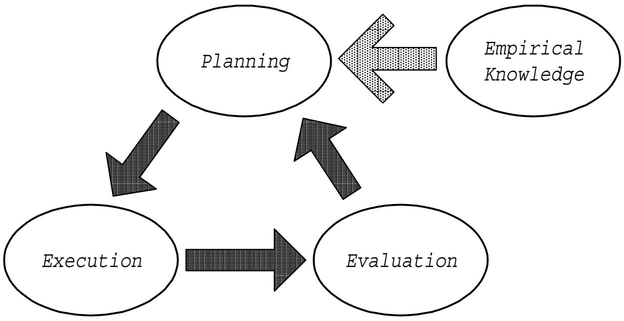

Figure 1: Cycle of disaster prevention measures.

BACK GROUND

There is much way for earthquake safety of urban area. Seismic microzoning is one of the major software techniques to be taken. The usefulness of seismic microzoning is widely recognized in all over the world. Many cities adopted this technique to their policies. In most cases, the results are summarized in a report after several years' study. The results are used to make disaster prevention plan and disaster index map. This type of study requires a huge amount of data to estimate the distribution of seismic intensity, casualties, damage to buildings etc. Therefore, many precise databases about ground condition, inventory of buildings and infrastructures are established through the study. These databases are very precious one and can be used for some systems that are effective for seismic disaster prevention.

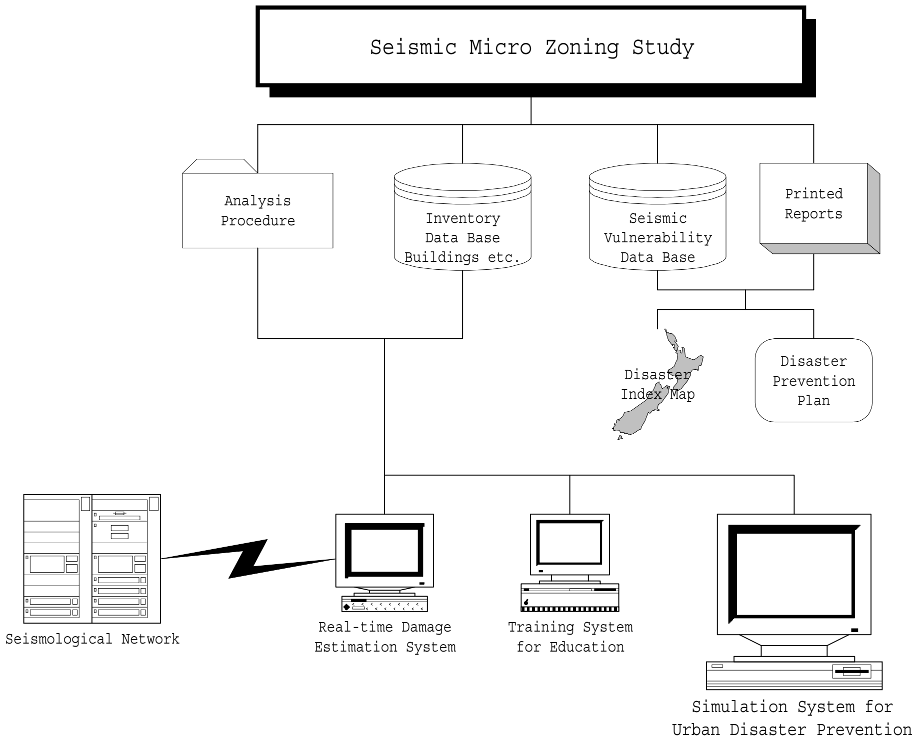

Figure 2: Applications of seismic microzoning study.

Three applications of seismic microzoning are shown in Figure 2. First one is the real-time damage estimation system. This system can be used for quick and effective emergency response activities by estimating the damage distribution right after the earthquake [Segawa and Komaru (1996)]. Several local government and private sector in Japan have already established this type of systems after Kobe earthquake. Second one is the training system for school. Simulation game style educational tool can be made from database. Third one is the simulation system for urban disaster prevention which we propose in this paper.

METHOD

This system is composed making use of the procedure and data of microzoning study. Building stock distribution, life-line distribution and characteristics of them, for example built year, construction type, material etc., were collected and compiled in microzoning study, and the amount and distribution of damage in the case of large earthquake attacked the area are analyzed quantitatively. The analysis programs are systematized so as to make it possible to execute the calculation on computer as a series of procedure. Furthermore it is possible to change the building and life-line database corresponding to the future reinforcement or improvement.

As one example, the analytical flow chart of building damage is shown in Figure 3. The area to be improved should be selected first. Any number of selections is applicable. If the reconstruction of limited part of the city is supposed, one or several area should be selected. To know the effect of city growth, all area should be

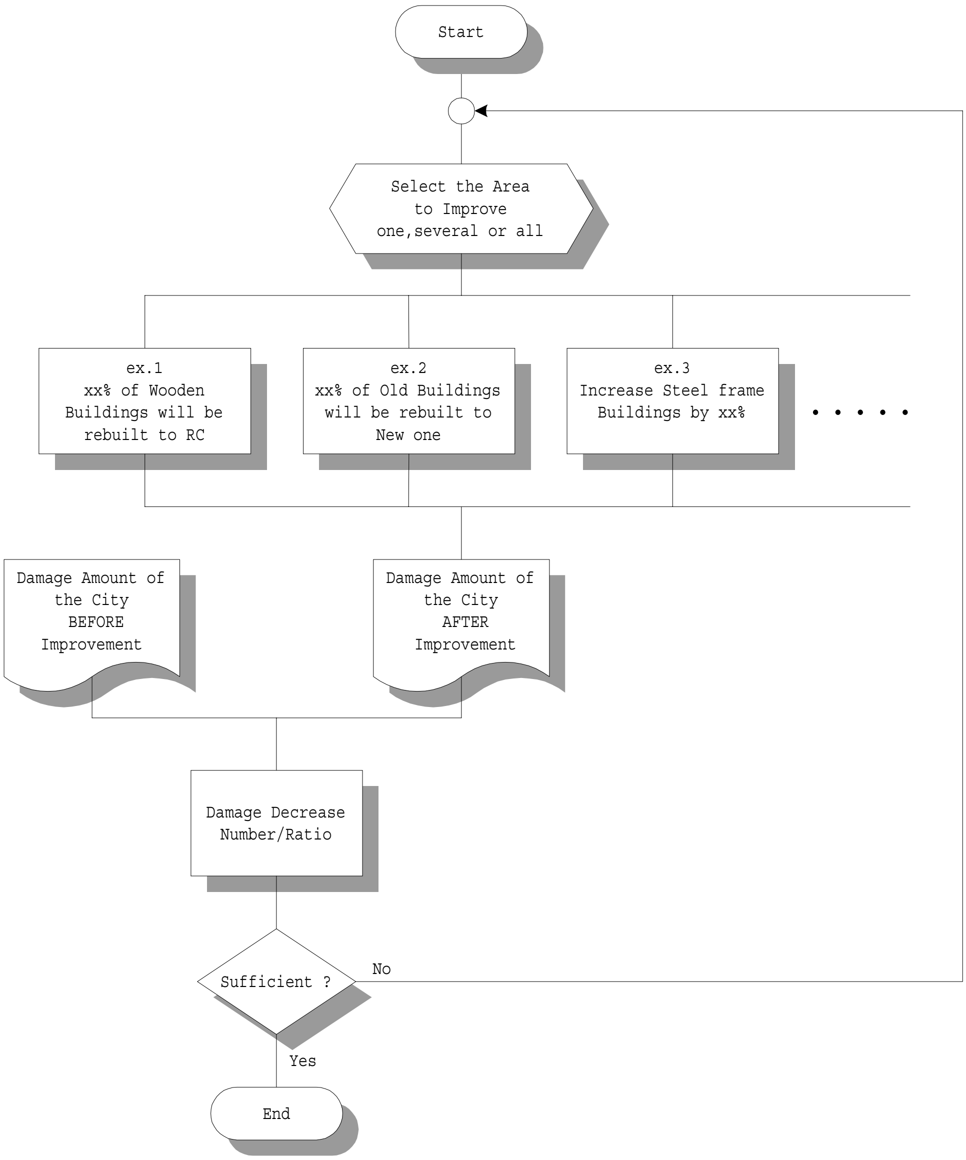

Figure 3: Analytical flow chart of building damage simulation.

selected. Improvement of buildings is designated next, for example 10% rebuilt of wooden buildings to reinforced concrete buildings, 20% increase of steel frame buildings, so on. Under these conditions, the damage distribution and amount can be calculated with the procedure same to the one used in microzoning study. The calculated result will be compared to the one under present condition and the damage decrease effect will be judged. If the effect is not sufficient, the condition can be modified and calculated again till the result becomes sufficient. The user of this system can simulate the effect of improvement again and again. This is the biggest merit of this system.

EXAMPLES

The analyzed example that has been done to choose the most effective area to improve buildings is shown in Figure 4 a) to d). The damage distribution under present condition if large earthquake attack this city is shown in Figure 4 a). The distribution of damage rate of buildings is shown in the map and the values are listed in the table. The dialog box at the center of this figure is used to indicate the improvement of buildings. In this example, total reconstruction of old wooden buildings of all area are selected. If the improvement will be realized, the damage will decrease as shown in Figure 4 b) when the same earthquake attacks. Figure 4 c) shows the damage decrease ratio by the comparison of Figure 4 a) and b). The effect of improvement of buildings in each area are different based on the difference of building inventory. Finally, the effective areas are selected as shown in Figure 4 d).

Another example for fire following earthquake is shown in Figure 5 a) to d). The situation of fire spreading with the lapse of time is shown in Figure 5 a). In this example, fire break at the center of north block and spread to south word by the north wind. The narrow road between north block and south block isn't effective for firebreak zone. Fire spreads north block to south block across the road around two to three hours after outbreak of fire. The effect of road expansion plan, indicated in Figure 5 b), was simulated first. If the road will be expanded to 20m wide, fire will not expand across the road as shown in Figure 5 c). Another measure was simulated in Figure 5 d). This figure shows the fire spreading area if half of wooden buildings in north block have been reconstructed to fireproof buildings. It can be understood through this example that both measures are effective to protect fire spreading from north block to south block.

CONCLUSIONS

We proposed the simulation system for urban disaster prevention based on the seismic microzoning study.
The features of this system are summarized as follows.

- This system is one application of seismic microzoning study.
- This system uses the analysis procedure and database of seismic microzoning study.
- This system can simulate the effect of infrastructure improvement for seismic disaster reduction.
- This system is valid for cost effective measure planning.

This system can be designed workable on a personal computer easily. Therefore, the responsible person for urban disaster mitigation plan or city planning can simulate the damage in many conditions by themselves repeatedly so as to grope for an effective measure.

REFERENCE

Segawa S. and Y. Komaru(1996), "Prediction of Earthquake Damage and Simplified Instantaneous Earthquake Damage Prediction System using Personal Computer", *Proceedings 11th. World Conference on Earthquake Engineering.*

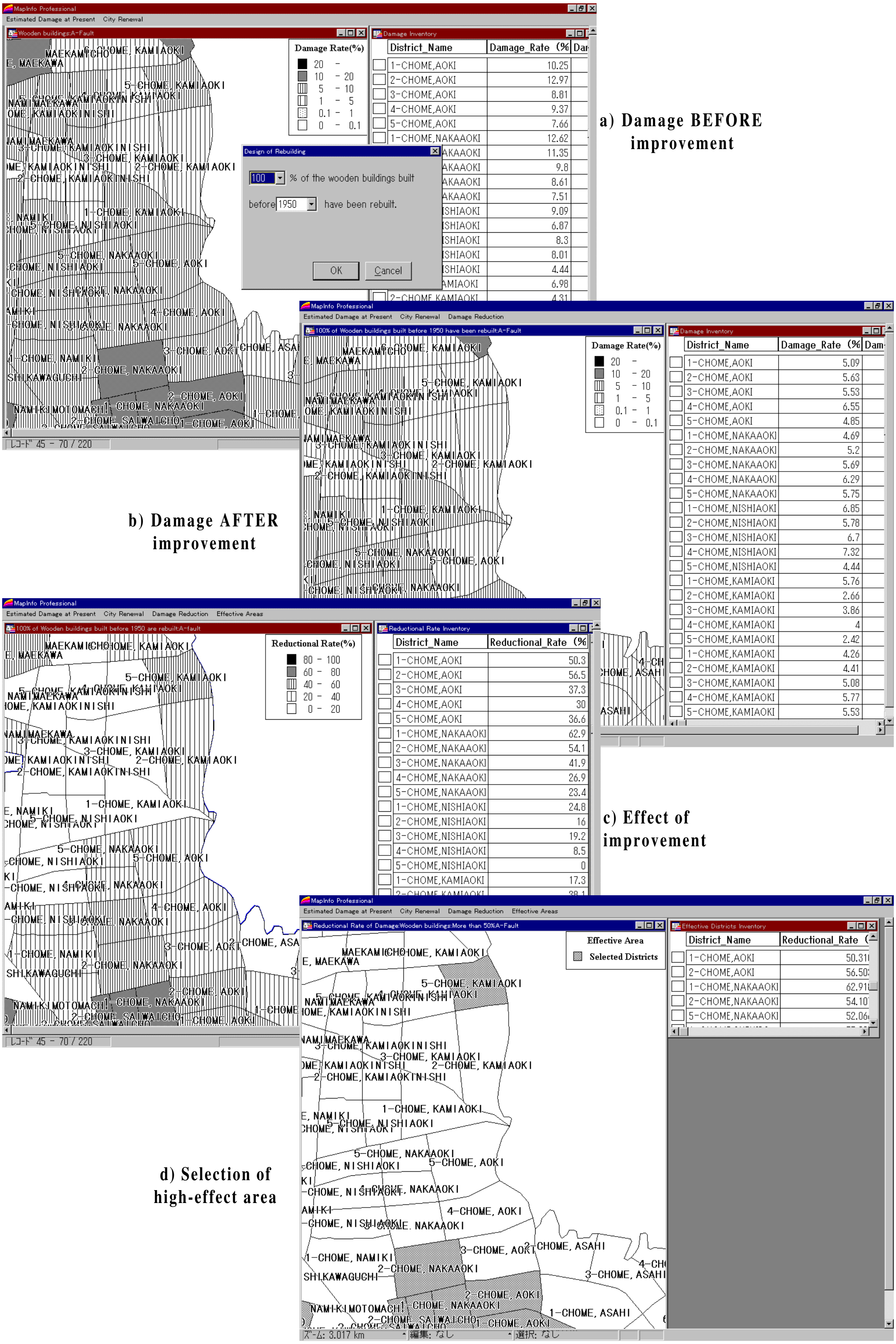

Figure 4: Example of building damage simulation.

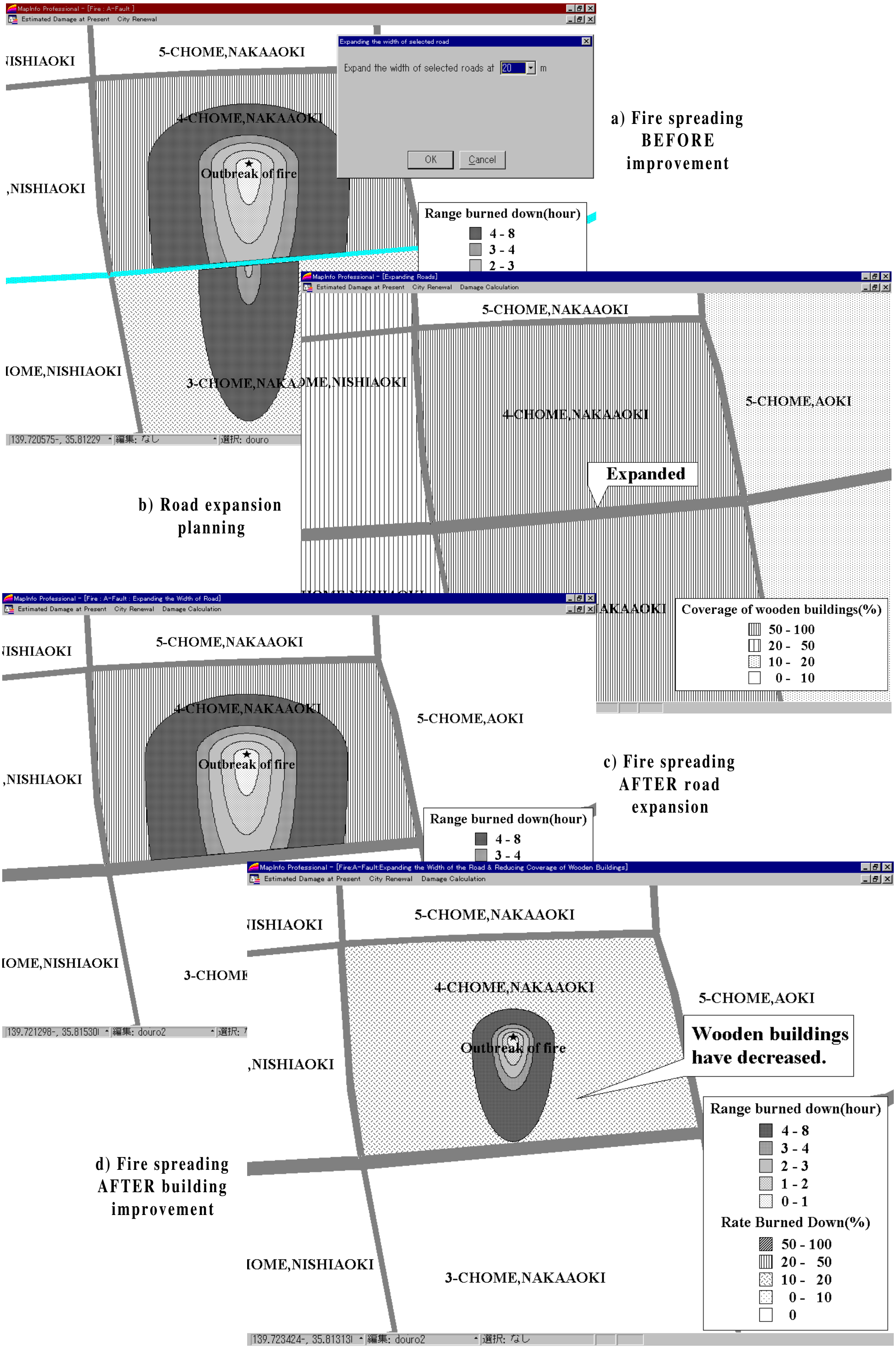

Figure 5: Example of fire spreading simulation.