

Do Indemnities Make Pollution Victims Happier?: A System Dynamics Perspective

Tsuey-Ping Lee

Department of Political Science
National Chung-Cheng University
Taiwan ROC
E-mail: tsueyping.lee@gmail.com

Abstract

This study examined the reasons for the declining economic quality of life of pollution victims residing in the most severely dioxin-polluted site in Southern Taiwan. At this site, the government has spent enormous amounts of money to compensate victims for their losses and alleviate their anger, and to alleviate the local poverty problem. We constructed a problem-oriented system dynamics model, and identified the reinforcing feedback mechanism in the system that renders the government's expenditures ineffective based on the simulation results. Because the cash compensation program activates a reinforcing feedback mechanism, worsening the economic quality of life among victims, we suggest that both the government and pollution victims be prudent in primarily employing cash compensation programs to solve problems caused by pollution.

Keywords: environmental governance, systems thinking, system dynamics, dioxin pollution, brownfield redevelopment, Taiwan

Introduction

Ubiquitous industrial pollution has partially overshadowed the prosperity created by industrial development in numerous countries. Taiwan commenced industrialization in the 1950s, and the environment has consequently deteriorated since. Serious environmental and social damage caused by industrial pollution inspired the environmental protection movement in the 1970s, which flourished in the 1980s with the establishment of numerous grassroots environmental nonprofit organizations. Among various concerns adopted by the environmental protection movement, demonstrations against industrial pollution in brownfield sites focused the most public attention because of the pollution victims involved and the loss of

property, health, and even lives.

Among numerous famous industrial pollution cases, the 1988 Linyuan incident was the first brownfield case to employ indemnity as a tool to solve conflicts caused by industrial pollution; cash compensation has since become the primary goal in subsequent protests in other pollution cases in Taiwan. Since then, enormous indemnity payments have been paid in various cases, such as NT\$1.3 billion (US\$44 million) for the Linyuan incident (Lin, 2008), NT\$800 million (US\$27 million) for the 1991 Linko Power Plant accident (Shih, 2009), and NT\$1.3 billion (US\$44 million) for the 2005 An-Shun Plant incident (Lee et al., 2009; Lee, 2012). When pollution victims and the media celebrated “delayed justice” after the government agreed to the indemnity policy, a crucial but easily ignored problem remained unsolved. The life quality of pollution victims has not improved after obtaining indemnities.

We constructed a system dynamics model for exploring the disconnect between the enormous amount of money paid to pollution victims and their improvement in quality of life, using the An-Shun Plant incident, the most serious dioxin pollution case to date in Taiwan, as an example. This case is substantial because the indemnity payments are ongoing. The aforementioned US\$44 million in indemnities in the An-Shun Plant incident was used up in June 2010, after which the government agreed to set aside another US\$26 million for the ensuing four-year period, which will be due in June 2014. The polluted community has requested that the government renew the payment program this year. However, a sizable survey conducted in 2008, two years after the cash payment was issued, showed that residents in the polluted community continued to suffer from a poor economic condition. The system dynamics model facilitates in pinpointing the major feedback effect causing this problem.

Section 1 of this article provides the background of the An-Shun Plant incident. Section 2 presents the major feedback relationship causing the disconnect between indemnity and life quality improvement. Section 3 introduces the modeling process, including data collection and reference mode formation, and elucidates key features of the model. Section 4 presents the simulation results and discusses the feedback mechanism that causes the unique system behavior. Finally, Section 6 concludes and offers suggestions for the government to reexamine the cash indemnity policy.

Background of the An-Shun Plant Incident

The An-Shun plant, located northwest of Tainan City in Southern Taiwan, was established by the Japanese company Kanegafuchi Soda in 1942 to produce various chemical products, including hydrochloric acid, caustic soda, liquid chlorine, and

poison gas for the Japanese navy. At the end of World War II in 1945, the Taiwanese government took over this plant, turned it into a state-owned company named Taiwan Alkali Industrial Corporation (TAIC), and started to produce PCP-related products, including pesticides, herbicides, antifungal agents, bactericides, and wood preservatives. The production process generated severe mercury and dioxin pollution. The government shut down the An-Shun plant in 1982, according to declassified government documents, because certain government officials were aware of the mercury pollution at that time (Lee et al., 2009; Lee, 2012).

The environmental pollution in proximity to the plant site was severe. The mud at the bottom of the nearby Luermen River has the highest dioxin level of all the rivers in Taiwan. The dioxin level in fish caught from the reservoir, which was used by TAIC as a toxic waste dump, was as high as 28.3 pg-TEQ/g, compared with the 4 pg-TEQ/g that the World Health Organization has indicated is a safe level for human consumption. For decades, residents have been economically and nutritionally dependent on catching and selling fish, oysters, shellfish, and crabs from nearby reservoirs, fish farms, and ponds. They were never informed of the danger of eating these water products. Residents in the three nearby townships around the An-Shun plant had an average blood dioxin level of 71.1 pg, compared with the acceptable level of 21.0 pg set by the United Nations. Dioxins are carcinogens that can cause birth defects, diabetes, immune system abnormalities, and numerous other health problems when exposure is excessive. Many residents in this area have suffered from liver and diabetes problems (Lee et al., 2009; Lee, 2012).

Beginning in July 2005, the Ministry of Economic Affairs agreed to set aside approximately US\$44 million for a five-year period to compensate dioxin pollution victims. Those registered as residents in the three townships (Hsien-gong, Lu-er, and Si-tsau) before June 30, 2005, were entitled to receive a monthly cash payment of US\$55, US\$91, or US\$480, depending on their blood dioxin levels and physical illnesses. Approximately 81% of the US\$44 million was used for cash compensation, 14% was used for health care, and 5% was used for local services including, but not limited to, children's lunch programs and afterschool assistance in reviewing homework and preparing for course exams. As previously mentioned, the first five-year US\$44 million compensation program ended in June 2010. The government subsequently extended another four-year US\$26 million to maintain the same level of cash payment, which will soon end in June 2014 (Lee et al., 2009; Lee, 2012).

A sizable survey conducted from March to April 2008 for examining the social welfare needs of residents in the three townships who obtained indemnities showed that poverty remains a serious challenge for residents in the polluted areas. Half of the survey respondents indicated they felt their consumption of food and nondurable

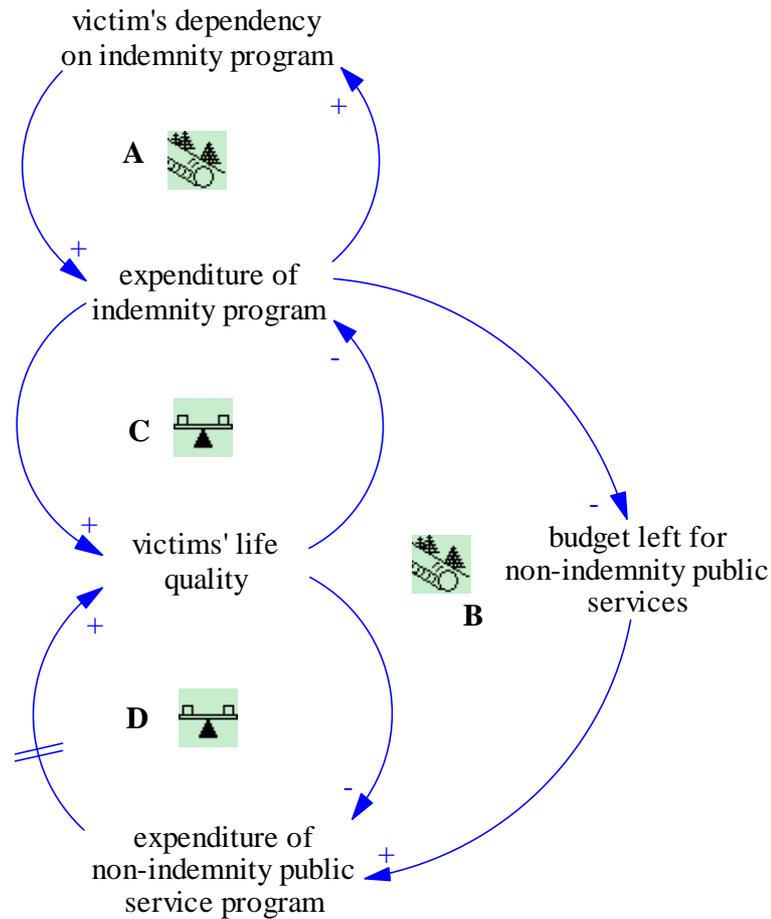
goods was either slightly insufficient or extremely insufficient. The survey results also showed that aging is a serious issue in the polluted communities because of serious unemployment problems. The social welfare needs of residents are multidimensional and are definitely long-term concerns. Following the two-year cash compensation program, the social welfare needs of the pollution victims remain unmet, and the life quality of the victims remains low. Will continuing cash payments improve the life quality of residents in polluted communities? The system dynamics model built in this study attempts to answer this question.

The Major Feedback Mechanism in the An-Shun Plant Incident

When the government decided to calm the anger of pollution victims by distributing cash compensation, several feedback mechanisms formed immediately. The cash compensation program intended to improve the economic quality of life among pollution victims who became unemployed because of reasons related to pollution. However, when the pollution obstacle was transformed into an opportunity for cash distribution, distributive fairness attracted the greatest attention. Various definitions of fairness caused disputes among residents, which evolved into an “everybody gets a piece of the pie” policy. At least two critical feedback loops formed immediately after the cash distribution rule was established: the resident dependency loop and the budget competition loop.

The resident dependency loop, shown as Loop A in Figure 1, shows that pollution victims increasingly rely on monthly payments as they become an expected and stable part of the household income. Although most people received a payment of as little as US\$55 monthly, they were not willing to give it up. The larger the monthly payment a person obtained, the more this person depended on the payment, and therefore, the more unwilling the person was to give it up. After nearly nine years of executing the cash payment program, we can expect another extension this year. In addition, the indemnity program attracted former residents to reregister their residences in the community, which also increased the total expenditure of the cash compensation program.

Figure 1 The main feedback loops formed by indemnity program



The budget competition loop is easy to predict, particularly when the government is undergoing fiscal stress. Although no formal budgetary limit is in place for the An-Shun plant incident, government resources are limited, particularly when numerous other polluted areas in Taiwan are waiting for resolutions. The budget for cash compensation competes with the budget for noncash public services for victims. Loop B in Figure 1 shows that, under budgetary constraints, the resources concentrated on cash indemnity will negatively affect the increase in noncash service expenditures.

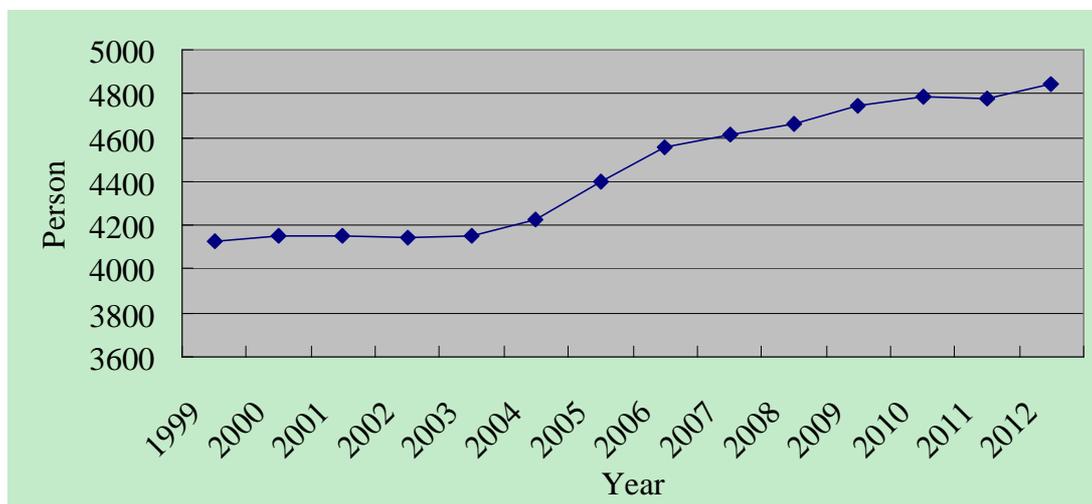
Figure 1 (Loops B, C, and D) presents a “shifting the burden” system archetype. Although cash payments may temporarily alleviate the poverty of residents (shown in Loop C), putting indemnities toward public services such as job training and referral programs, health care, and youth counseling can substantially improve the long-term life quality of residents (shown in Loop D). However, this archetype shows that the monthly cash compensation program has difficulty improving the performance of Loop D.

Modeling

Data and Reference Mode

Quantitative and qualitative data regarding the An-Shun plant incident have been collected since 2007, including face-to-face interviews and a sizable survey conducted in the polluted community. We carefully reviewed newspapers, documentary films, and government documents to ensure that we correctly understood and presented the incident in this article. The model was calibrated to the polluted community around the An-Shun plant. Demographic data such as the number of births, deaths, relocation to, and relocation from 1999 to 2013 were collected from the Household Registration Office of the An-Nan District, Tainan City, where the polluted townships are located. Because the land around the An-Shun plant was proclaimed as the “pollution control site” and the “pollution remediation site” in 2004 and 2005, respectively, and the cash compensation program was implemented from 2005, the demographic data were analyzed from six years prior to the incident, to examine the change in population. In contrast to numerous brownfield cases where the population declined after pollution was formally identified by public officials, the population of these three townships increased. Figure 2 shows the population change.

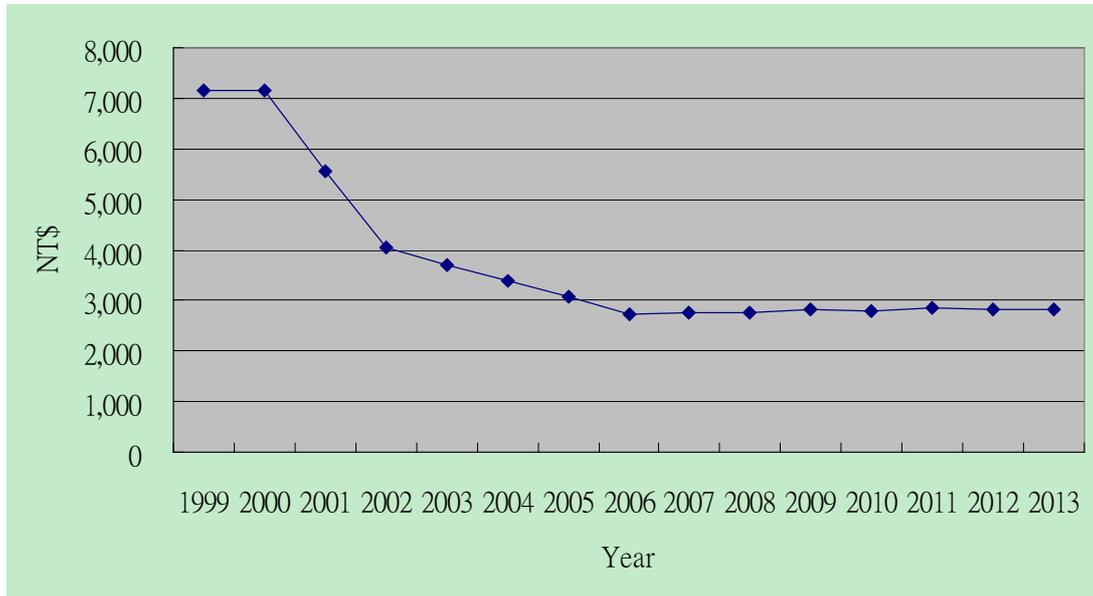
Figure 2 Population of Polluted Area



Data regarding the land price of the three townships from 1999 to 2013 were collected from the Department of Land Administration. Changes in land prices reflect changes in the supply and demand for land. The land price of polluted land typically decreases because potential land users are unwilling to take risks. Land prices are an economic indicator for examining the economic condition of a community. Figure 3 shows the average land price of various land-price sections of the polluted

community.

Figure 3 Land Price of Polluted Area

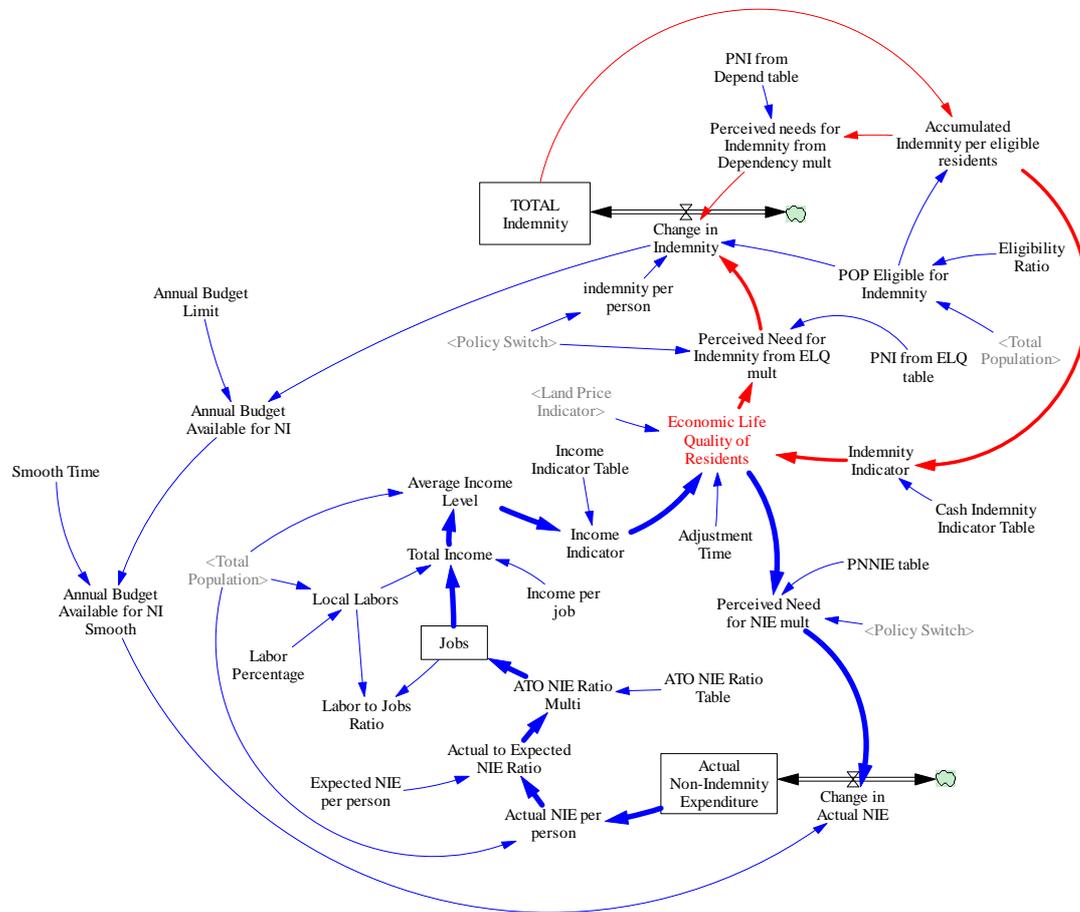


The Model

The model was built using Vensim PLE version 6.2, and was separated into three parts: the main section, population section, and land-price section. The major problem symptom in this study was the stagnant economic quality of life among residents, which was located in the middle of the main section of the model (shown in Figure 4). The main section included all loops illustrated in Figure 1. Loop A, which was victim dependency on the indemnity program, is indicated by the small-red-dot-line loop in the upper-right-hand part of Figure 4. This reinforcing loop demonstrated how victim dependency on monthly cash payments increases the total indemnity. Loop B, which was the budget competition, is the blue-long-dot-line loop at the left-hand side of Figure 4. In this loop, a hypothetical annual budget limit was designed to show that the government budget for assisting this polluted community has a ceiling. The more resources concentrated in cash payments, the fewer resources left for providing public services to victims. In this model, expenditures for pollution remediation were excluded because the cost was paid by the private owner of the now-defunct An-Shun plant. Loop C, which illustrated the symptomatic solution provided by the cash compensation program, is the red-solid-line loop in the upper-right-hand part of Figure 4. This balancing loop shows that the monthly indemnity paid to the victims is expected to alleviate poverty and improve their economic quality of life. Loop D, which was the fundamental solution provided by public services, is the blue-solid-line loop in the central bottom part of Figure 4. This loop showed that public services boost the local economy and consequently improve the economic quality of life

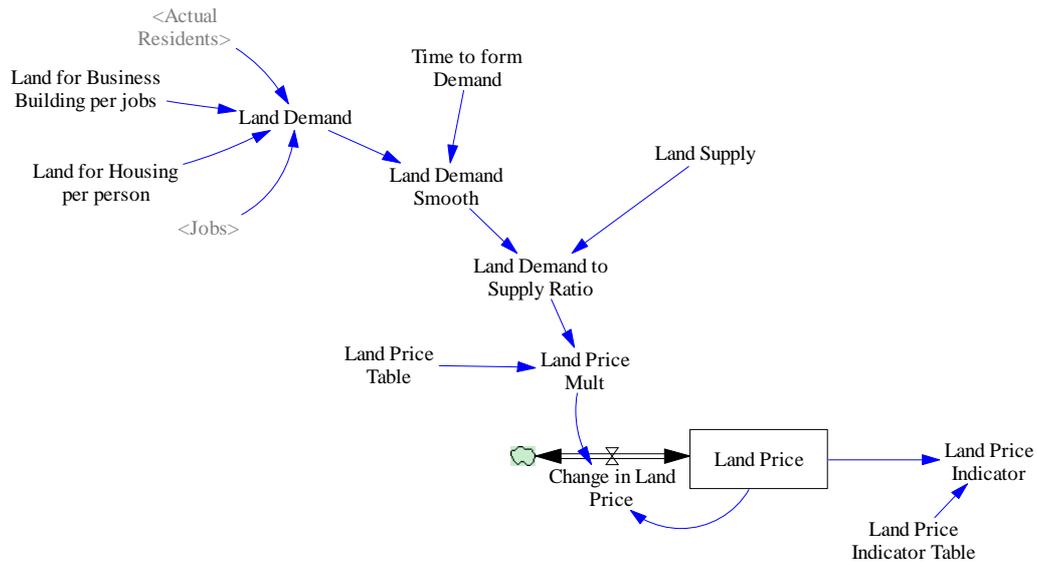
among victims. The effect of this loop was slow and delayed.

Figure 4 The main section of the model



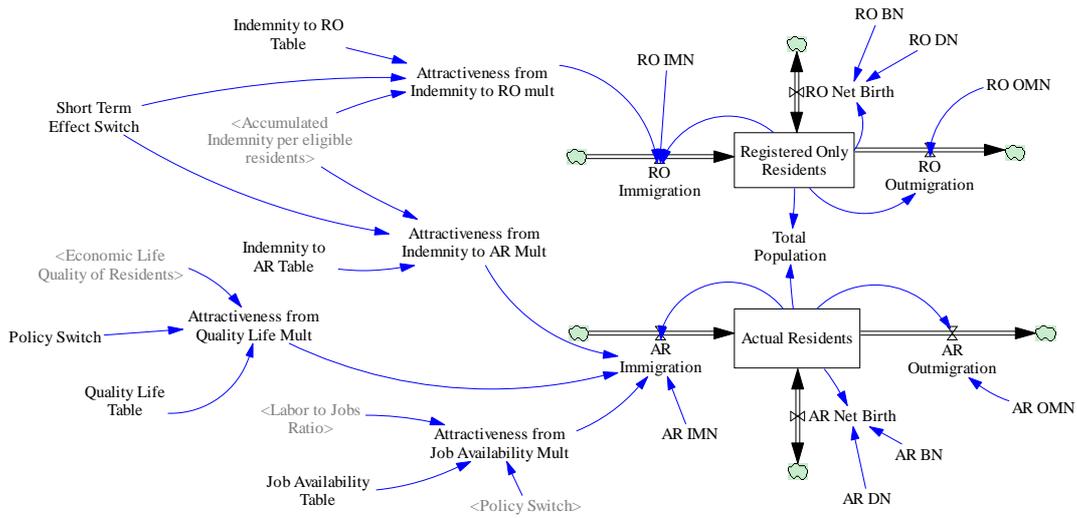
Three factors affect the economic quality of life among victims: land price, income, and indemnity. The highest score for each indicator was two; thus, the economic quality of life among victims ranged between zero and six. The indemnity indicator was affected by cash compensation, whereas the other indicators were affected by nonindemnity expenditures. Land price was formulated as shown in Figure 5. This section shows that both housing and land for business (in this case, it may mean fish ponds) contribute to the demand for land in the land market. When actual residents (who need housing) and local job opportunities (which need land for business) increase, land demand increases, consequently raising land prices.

Figure 5 The land price section



The last section of the model was population (shown in Figure 6). In this model, the population of the polluted community was divided into two parts: residents who actually reside in the community, and residents who registered their residence in the community without actually residing in the community. Examining relocation to and relocation from the polluted community from 1946 to the present, the population rose to a historic high in 1976, which was six years before the plant was shut down by the government in 1982. The population decreased dramatically and subsequently maintained equilibrium. However, Figure 2 shows that the population has grown since 2005. Previous residents began to reregister their residence in the three townships, but did not actually move back to the community. Therefore, separating actual residents from registered-only residents is necessary. The only driving force for registered-only residents to reregister is the cash indemnity policy, whereas the driving force for relocation to the community by actual residents could be the indemnity policy, improved life quality, and enhanced job opportunities.

Figure 6 The population section



Simulation Results

The base run demonstrated the simulation result without the activation of the compensation program. A technical variable, or policy switch, was designed to switch the compensation program on and off. Figures 7 and 8 show the system behavior of population and land price. Figure 7 shows a slightly increased population in the polluted community. By examining the population change in Figure 2 before 2005, the year the compensation program began, the population shows a slight increase. Figure 8 shows that the decline of land price is the exact situation as that occurring in the polluted community. Compared with Figure 3, the land price before 2005 declined dramatically.

Figure 7 Total Population—Base Run

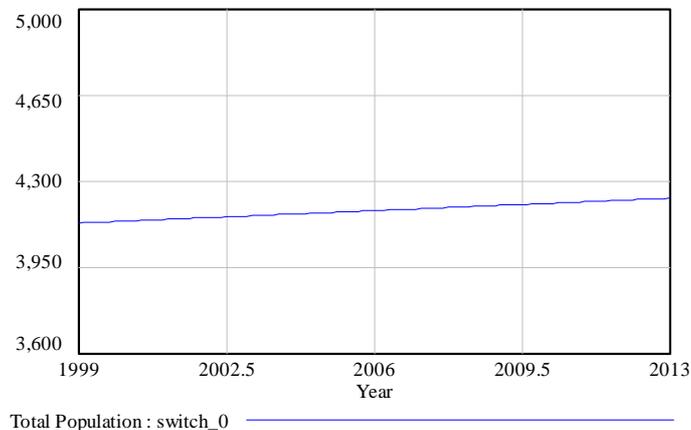
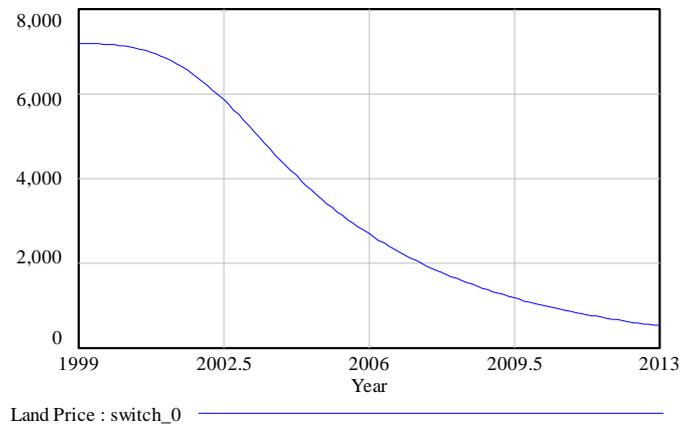


Figure 8 Land Price—Base Run



Figures 9 and 10 show the compensation-policy run results. This simulation activated the compensation policy from 2005. Figure 9 compares the base run (switch_0) and the policy run (switch_1); compared to the base run, the policy run showed a slight jump in the population beginning in 2005. The compensation program attracted previous residents to migrate back to the community. Regardless of whether they actually resided in the community, the number of people registering their residence in the community increased. Figure 10 compares the base run and the policy run in land prices. As shown in this figure, land prices stopped declining in 2005, consistent with the land prices shown in Figure 3.

Figure 9 Total Population--Comparing base run and policy run

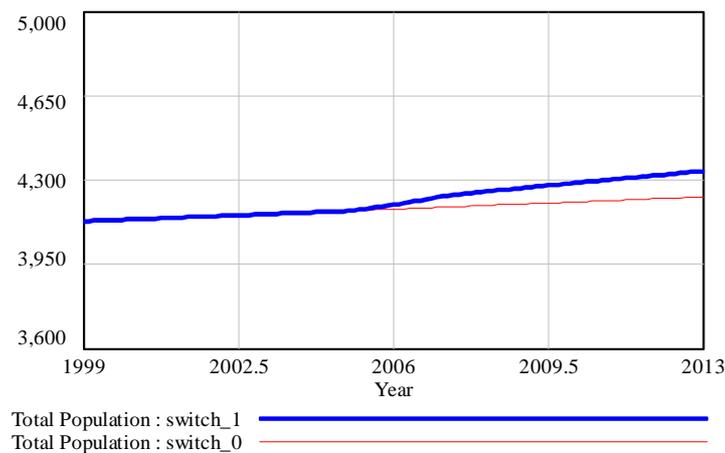
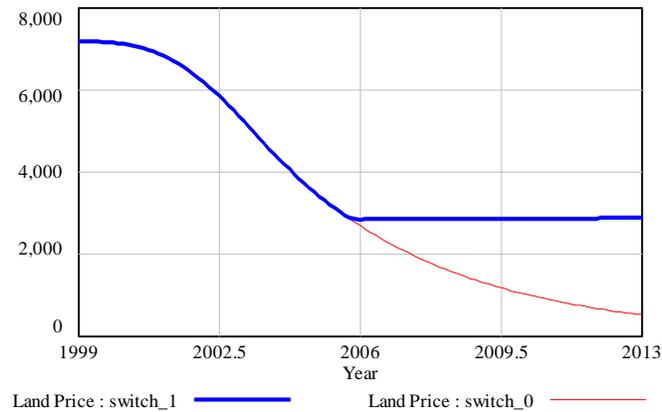


Figure 10 Land Price – Comparing base run and policy run



The major concern of this study was to determine whether the economic quality of life among pollution victims improved following the distribution of an enormous amount of money by the government. Figures 11 and 12 show the total indemnity and nonindemnity expenditures for public services. Both figures show increasing expenditures in various scales. Cash compensation expenditures increased exponentially, whereas nonindemnity public services expenditure increased based on goal seeking. Goal-seeking behavior was substantial when the simulation time was extended, and demonstrated that the budget limit, along with the exponential growth of cash compensation expenditures, will eventually limit the growth of public services expenditures that would actually improve the long-term life quality of the victims.

Figure 11 Expenditure on Cash Compensation

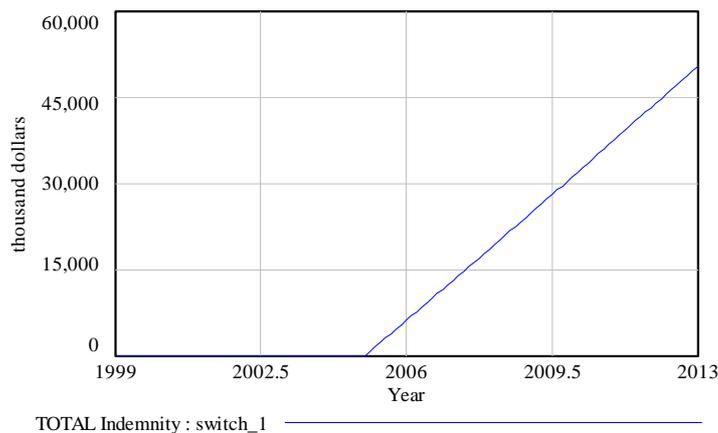


Figure 12 Expenditure on Non-Indemnity Public Services

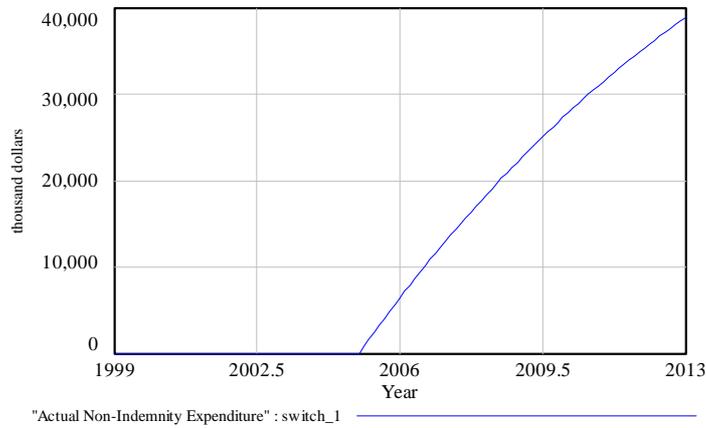
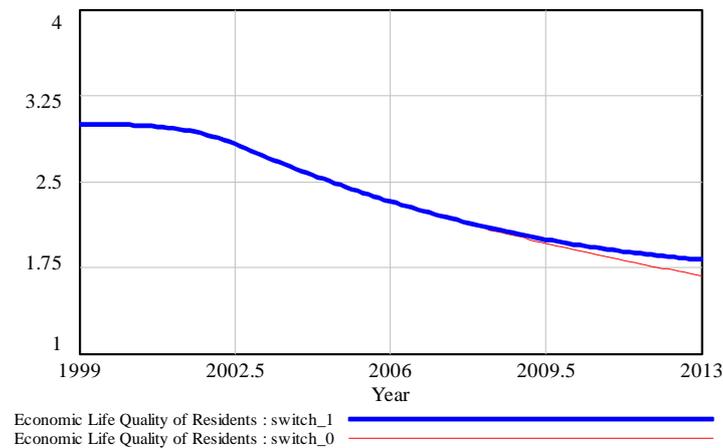


Figure 13 shows the economic quality of life among residents with and without activating the policy. The policy run (switch_1) did not improve economic quality of life, although it helped slightly in alleviating decreases in the economic quality of life.

Figure 13 Economic Life Quality – Comparing base run and policy run



Discussion

The simulation results show that, by spending a huge amount of money on a cash compensation program, the government was unable to improve the economic quality of life among victims. What is wrong with this policy? Is the government unaware that monthly cash payments do not promise an enhanced future for the polluted community? When government officials decided to employ a cash compensation program under tremendous pressure, they probably did not realize that the power of

reinforcing feedback loops created by this decision would pave a difficult path for the government and the community. In this model, two reinforcing loops dominate the system. One is victim dependency on the monthly cash payment. Any economically rational person will not easily surrender a monthly income. The longer residents rely on monthly payments, the greater the difficulty the government will encounter in terminating the cash payment program. The other reinforcing feedback loop that dominates the system is the side effect of increases in cash payments under budgetary limits. The more the government spends on the cash payment program, the less resources the government will have for public services, and the public will not allow the government to overspend on a single pollution incident. Therefore, under resource constraints, the longer the cash payment program is implemented, the fewer opportunities the community will have to revitalize.

The Taiwanese government knows that the easiest way to respond to the complaints of pollution victims is through monetary payments. Because most social problems can be temporarily resolved with money, the government merely calculates the amount of money that is required to ease public anger. In many brownfield revitalization cases in Taiwan, most discussion is focused on compensation calculations and answering questions regarding how much money people will receive. This process does not carefully examine victims' suffering and the costs for redeveloping the polluted area. A monetary value is roughly assigned, and once the compensation is paid, the victims believe that delayed justice has been served. This article is a reminder to the government and the polluted community of the power of the easily ignored reinforcing feedback mechanism. The government and pollution victims should establish mutual trust to enable both sides to wait patiently for time-consuming, long-term redevelopment plans to become effective.

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