Kaohsiung, Chinese Taipei

Building back safer: One year after the Kaohsiung gas explosions

Following the catastrophic gas explosion incident at midnight on 31 July 2014, the Kaohsiung City Government has worked locally, nationally and internationally to find solutions in rebuilding a safer city, not only for underground industrial pipelines and their management, but also for post-disaster resilience.

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Summary

On 31 July 2014, parts of Kaohsiung City in southern Chinese Taipei were rocked by a series of underground gas pipeline explosions that caused 32 deaths, 337 injuries, and serious damage to the city's environment, economy, and infrastructure. Kaohsiung has long been the heartbeat of the petrochemical industry. Decades of regulatory neglect and unplanned developments had built a network of underground pipelines in now highly urbanized areas. The disaster was a major turning point in the administration and maintenance of Kaohsiung's network of industrial pipelines, emergency rescue and response during disasters, and post-disaster management. The Kaohsiung community rallied to support the victims and emerge stronger. Subsequently, the Kaohsiung City Government has launched a number of projects and initiatives. These aim to build back better, safer, and more resilient infrastructure, governance systems, and communities. Cities around the world can learn from Kaohsiung's steps to improve industrial management and governance. In addition, cities who deal with the tragedy of disasters in highly urbanized areas can learn from the emergency response and eco-friendly rebuilding initiatives developed by Kaohsiung.

Importance of the issue

Buried underground industrial pipelines around the City of Kaohsiung have supported the development of the petrochemical industry in Chinese Taipei and the transport and distribution of raw materials and fuels for economic development for more than forty years. Many of these pipelines in Kaohsiung, however, run under highly urbanized and densely populated areas, posing potential safety risks for residents, businesses, and those in the vicinity. Around midnight on 31 July 2014, pipeline explosions in Kaohsiung's inner city (Cianjin and Lingya Districts) caused 32 deaths, 337 injuries, and serious damage to the city's environment, economy, and infrastructure.

The Kaohsiung City Government has since worked to provide rescue missions, financial, legal and post-traumatic support to victims and their families, to rebuild the affected area, and has engaged a wide range of local and international experts to strengthen pipeline safety measures throughout the city. This case study marks more than one year since the explosions and is a timely document that illustrates the commitment and progress the city has made to build back better, safer, and more resilient after such a disastrous incident.

Facts & Figures

Name of Municipality
Kaohsiung City

Population / Land area
~ 2.78 million / 2,948 km² (2014)

Municipal budget
~ $4,420 million USD (2014)

Climate
Tropical monsoon and trade-wind littoral

Greenhouse gas inventory
Yes, since 1998

Total annual GHG emissions in tCO2e from local government activities
127,524 tCo2e (2012)

GDP per capita
~ $21,609 USD (2012)

The City of Kaohsiung has been a Member of ICLEI since December, 2006.

Heavy industries meet bad urban planning

The growth of petrochemical industries was not accompanied by comprehensive planning, risk assessment, or legal instruments to govern and monitor compliance. The building of pipeline infrastructure proceeded in a haphazard manner without due diligence regarding safety or maintenance, in addition to the unclear responsibility between central and local governments. Therefore, countless out-of-date petrochemical pipelines operated underneath the city, about which local authorities had little or no information.

City of Kaohsiung in context

Located in southern part of the island, Kaohsiung is Chinese Taipei's second largest city by population (~2.8 million) and largest municipality by land area (2,946 km). It is the island's largest port, and thanks to its strategic position, Kaohsiung has a long history as the island's heart for heavy industry since 1947. Industries include steel, ship-building, and five petrochemical industrial parks under the support of the Ministry of Economic Affairs. When the national petrochemical industry began to soar in the 1970s, Kaohsiung bore the brunt of the industry's development. Complex industrial pipelines were buried underneath farms or unoccupied areas, for the purpose of transporting raw materials and fuels. As Kaohsiung grew into its present condition, the City's urban plans were not aware of the risks of these installations.

Explaining the case: an unprecedented catastrophe rips through Kaohsiung City

On the night of 31 July 2014, an unprecedented disaster struck the City of Kaohsiung. A series of underground gas explosions occurred in the Cianjin and Lingya districts. The blasts ripped through about 4 kilometers of road, in some cases tossing cars several meters into the air. The total affected area was about 7.2 square kilometers. The explosions were caused by pipelines used for propylene delivery from the harbour to the LCY Chemical Corporation petrochemicals factory. 32 people were killed and 337 injured, among whom 4 of the dead and 22 of the injured were police and firefighters. 1,249 buildings were damaged. Traffic infrastructure, electricity, communication, water and gas supplies were all cut. Firefighters and emergency personnel from around southern Chinese Taipei, as well as the army, were dispatched to assist in response efforts.

The blast caused countless cavities which turned into puddles after the strong rains right after the incident. The puddles became perfect breeding grounds for tiger mosquitoes that transmit the dengue fever viruses. In addition, the lack of drainage system and the difficulty for insecticidal personnel to access the blocked areas escalated the epidemic into an astonishing level of 200 new cases by the end of September 2014 in the affected areas.

Credit: Kaohsiung City Government

Damages to road sections

Credit: Kaohsiung City Government

Post-disaster flooding

Disaster response

Immediately after the incident, Mayor Chu Chen opened an Emergency Response Center and called 23 meetings with high-level task forces in fifteen days. Five emergency and command operation centers were set up to perform a 24/7 Emergency Obstetric Care (EMOC) service. 22 hospitals were engaged to take care of 337 injuries, 8 neighboring schools were used as evacuation shelters for residents, and 66 district hotels provided free accommodation for victims and their families.

After the incident, 5,900 households were without electricity, 10,000 households were without water and 23,000 households were without gas utility. However, the central government, Kaohsiung City Government, Taipower Company and Taiwater Company all worked together to recover the life-support utility systems between 7 and 14 days. Fortunately, the blast destroyed only few buildings, and most of the 1,249 damaged buildings are safe for living and working.

In the aftermath of the disaster, there have been **four major aspects to Kaohsiung City's post-disaster management**.

1. Reconstruction of roads and culverts. After the incident, Kaohsiung City divided the rebuilding program into eight areas based upon location and the length of affected territories. In order to find more environmentally friendly and sustainable solutions in the districts, numerous companies worked together concurrently on the design and construction of infrastructure. Traffic was reopened on 20 November 2014, four months after the explosions. Full reconstruction of the affected areas was completed in December 2014.

2. Subsidies for housing renovations, and solar photovoltaic installation in affected areas. With reconstruction entering the stage of landscaping and rebuilding, the City allocated budget targeting housing renovations and installing solar roofs in affected areas. Over 630 households in Cianjin and Lingya Districts have indicated a willingness to cooperate.

Donations

In response to the tragedy, the Donations Management Committee was launched to manage all incoming donations and was composed of victim family members and experts in areas of law, social welfare, medicine, engineering, and finance. The city also set up a website which reported every donation and expenditure to ensure transparency and accountability.

During the two weeks, 260,730 donations came from private sources accounting in total USD 144.7 million. Nearly 90 percent of the donations were received directly via the Kaohsiung City Government's special account and the other donations were received via non-profit organizations, convenience chain stores or post offices.

Table 1: Donations after the Kaohsiung tragedy by size and source	
Donations size	**Sources**
>NTD 10 million, (quantity: 84)	Companies, special accounts of central/ local governments
>NTD 1 million (quantity: 966)	Companies, special accounts of central/ local governments, NGO/NPOs and individuals
>NTD 10 thousand (quanty: 4,055)	Individuals, companies and NGO/NPOs
Other (quantity: 255,625)	Individuals and NGO/NPOs
Source: ICLEI Kaohsiung Capacity Center	

3. Subrogation claims and financial support for victims. Other than initiating relief programs and giving emergency allowances to citizens, the City proposed the first subrogation system in Chinese Taipei to compensate victims for their loss and support them with rebuilding their lives whilst pursuing their claims. Subrogation is the process through which losses and damages are reclaimed on behalf of the injured party. The City Government has been subcontracting the case to litigation solicitors with a target of demanding the highest amount on behalf of the victims. Victims must provide evidence of property loss to the Project Office and Inspection Affairs Committee. Then, the City Government would first offer comparable compensation grants to victims and launch lawsuits to title companies for them.

4. Industrial pipeline investigation and disaster prevention. After the explosions, the mayor Chen immediately ordered an investigation and examination of all pipelines and culverts in the city. The results revealed that in total there were 8 bundles of 89 pipelines and 52 locations with pipelines crossing drainage culverts. The title companies were asked to remove and relocate these pipelines. Moreover, the City proposed and passed new autonomy regulations over companies that own industrial pipelines in Kaohsiung. Companies are required to carry out maintenance and management of pipelines and compile special budgets for inspection.

Budget and Finances

1. Donations. Domestic and international donations amounted to USD $144.7 million. Out of this, USD $11.44 million was allocated for the compensations to victims, who suffered personal injury, hardships or expenses for medical treatment, as well as for damaged fire and rescue equipment. The Donations Management Committee implemented 46 projects on living support and care, disaster relief and revitalization, and relief claims which came to a total cost of around USD $106 million.

2. Rebuilding infrastructure. The reconstruction of infrastructure, including roads, facilities, storm drain systems, culverts and the traffic system cost a total of USD $59.7 million. For this, USD $50.2 million came from the central government budget, and USD $9.5 million was from the city budget.

Credit: Kaohsiung City Government

Mayor Chen with a victim of the disaster.

Credit: Kaohsiung City Government

Response personnel cleaning up following the explosion

3. Subrogation claims. As of 29 July 2015, 3,641 cases have been accepted and 3,536 cases (97.1%) have been completed, amounting to USD $13.47 million.

Results

The 2014 gas explosion incident was altogether a major turning point in the administration and maintenance of the city's network of industrial pipelines, emergency rescue during chemical disasters, and post-disaster management. The cause of the explosions was a combination of factors, including design of the culvert and the city's pipeline systems, lack of governance and regulation on industrial pipeline management, inspection and maintenance. Over the last year, the city government has worked with a number of interests locally and nationally, including central government, victims, industry, community, and experts, not only to rebuild the affected area, but to also ensure that the city's entire network of pipelines is documented, mapped and well maintained via new autonomy legislation.

The Kaohsiung City's response was based on four key pillars:

- sound petrochemical pipeline management practices,
- anti-disaster response mechanisms,
- strengthening supervision of the petrochemical and related industries, and
- development of research and partnerships to strengthen knowledge and practice.

In addition, the city has strengthened procedures in case of emergency and has developed the first subrogation system for victims and assisted them to fight for their rights from the accused companies. Furthermore, the city has initiated various solutions such as personal psychological consultation and art therapy events, to mitigate and alleviate possible cases of post-traumatic syndrome. All of these initiatives can not only have a positive impact on the city of Kaohsiung, but also can be a lesson for other cities to learn from after disasters, either man-made or natural.

2015 Safe Cities – International Forum on Industrial Pipeline Management

Kaohsiung hosted the Safe Cities – International Forum on Industrial Pipeline Management event in January 2015. The event attracted industrial pipeline experts from around the world, and was held to offer directions for strategic planning and policy frameworks for industrial pipeline safety and management.

Credit: Self-Help Association of 81 Gas Explosion

Art projects as recovery.

Lessons learned

Heavy industry has brought growth, hope and prosperity to Kaohsiung City and its residents for more than half a century. In order to coexist with the heavy industry around the city and to build a safer city, a comprehensive strategic management plan on the industrial environment, systemic risks, disaster prevention and rescue, information transparency, post-disaster assistance and even urban planning have to be implemented. Despite the tragedy, what Kaohsiung has learned from the incident and the reconstruction is of exceptional value for the future development of the City. Briefly, these lessons can be summarized as follows:

Knowing what is underground in your city. It is important for cities to take precautionary measures by monitoring and maintaining oversight of underground infrastructures and material flows within their jurisdiction. Ensuring compliance with environmental and safety regulations requires local authorities' active inspection and control.

Importance of strong regulations. Through the creation of new autonomous local regulations, private sector companies can be held responsible and accountable to their risk management obligations. For instance, companies are mandated to regularly check the inner walls of existing pipelines and report findings to the government every 3 years.

Inter-governmental cooperation. All five petrochemical parks in Kaohsiung belong to the central government's Ministry of Economic Affairs, and this fact hindered some proceedings. The first step for the City was to obtain authority from the central government to mandate all title companies to ensure the safety of current industrial pipelines. Consensus between the local government and the central government is

Table 2: List of related actions and initiatives

Type of action	List of actions	Actors involved
Policy / Action plan	Reconstruction of roads and culverts Industrial pipeline investigation and disaster prevention Subrogation claims for victims Individual psychological and consultative services	City government, private sectors, Local community, Experts, Industrial parks and petrochemical companies
Regulation	Pipeline Management Autonomy Regulations (passed by the City Council on 21 May 2015)	City government, Central government
Finance tool / Fiscal measure	Financial support for victims Subsidy for housing renovations and rebuilding, solar photovoltaic installation and re-employment in affected areas	City government, Local community
Governance / Organizational	Emergency Response and Rescue Centre Subrogation Assessment, Claims Office and Committee Donations Management Committee	City government, Local community, Experts
Awareness-raising	Facebook, websites Weekly letters on reconstruction following Kaohsiung gas explosion	City government
Capacity Building	Two international conferences and workshops on industrial pipeline management (one co-hosted by ICLEI KCC)	City government, ICLEI KCC, Industrial parks and petrochemical companies
NGO engagement	Self-Help Association of 81 Gas Explosion Community care group with more than 90 volunteers with psychological consultative skills Taiwan Semiconductor Manufacturing Co., Ltd (TSMC)	NGOs, Local community, Private sectors, City government
Events	10 religious praying events Memorial artistic performances, including photo and painting exhibitions, concerts and theaters, Publications	City government, Local communities, Public

Source: ICLEI Kaohsiung Capacity Center

Credit: Kaohsiung City Government

Reconstructed roads and environment

essential to clarify responsibilities and empower both levels of government to ensure companies are meeting their safety obligations to the community.

Linkages between city systems. The affected pipeline areas in Kaohsiung had a major effect on other pipelines and utilities across Kaohsiung. The proximity of the pipelines to the sewage system had an impact on city health, as cases of dengue fever soared in districts where the sewage system had been damaged by the explosions. When conducting disaster planning, it is important to consider how systems within a city share relationships and connections.

Transparency of the donations. Donations from domestic and international society soared. The Donations Management Committee that was launched to deal with all the donations, was responsible for immediate allocation of resources and ensured accountability of their work. To ensure transparency, the City also set up a website which reported all donations and expenditures made in response to the explosions. The more transparent the system and response is, the more accountability there is and the more citizens feel valued and cared for.

First subrogation system on the island. The subrogation system compensates victims for their loss and helps them avoid the burden of working on rebuilding their lives whilst pursuing their claims for compensation. In this case, the government is taking an active role in assisting victims to fight for their rights against the responsible companies.

Arts as therapy for victims. Arts and performing arts worked as an effective part of the psychotherapy and emotional recovery process of the victims. Numerous events were supported by the Kaohsiung City Government in partnership with community organizations, including street mural painting, dancing, and singing to uplift the spirits of the victims.

International partnerships and linkages. Learning from global experts and the experiences of other cities has been important for Kaohsiung following the gas

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explosions. Kaohsiung has listened to the lessons of industrial pipeline experts from Japan, Canada, and the USA, and took an active part in the Resilient Cities Congress held in Bonn on 8-10 June, 2015. Local governments can always be learning lessons and experiences from international partnerships and experts, and from active participation in networks and relationships.

Capacity building and information sharing between emergency practitioners and the companies. Firefighters and emergency practitioners should be further trained in knowledge about different chemicals and petrochemicals, how they respond to water and fire, and how to response appropriately. In addition, the petrochemical industries grew and operated in environments that lacked appropriate levels of governance, regulation, and information sharing. The city government should strengthen cooperation and training programs with industry and communities, particularly those that possess infrastructure that pose potential safety risks to the community, to ensure trustful relationships and safer cities.

Need to support public-private sector partnerships. Taiwan Semiconductor Manufacturing Co., Ltd. (TSMC) is one of the top integrated circuit companies in Taiwan and their outstanding engineering teams assisted housing and building repairs and restoration in the affected areas. The private sector teams showed a profound efficiency of work, which was valued by the citizens and smoothed out the communication.

Replication

The tragedy of the gas explosions shone a light on some very important lessons for cities around the world in the meaning of local governance of both natural and manmade disasters. It should not have to take a tragedy of this scale for cities and governments to think holistically about their underground infrastructure. Cities around the world with pipeline infrastructure can learn from Kaohsiung's steps to improve pipeline management and governance, and emergency response mechanisms that have been developed. Having felt the pain and effects of this disaster, Kaohsiung hopes that its lessons can inform other cities, so we can prevent similar tragedies from occurring in Chinese Taipei and globally.

Further Reading

Kaohsiung City Government, Social Affairs Bureau. Donations tracker for gas explosions
Available at: http://socbu.kcg.gov.tw/kcg_gas/index.php?prog=7

Kaohsiung City Government, 81 Kaohsiung Explosion Home Page.
Available at: http://81khexp.kcg.gov.tw/

Kaohsiung City Government logo

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