REGENERATIVE TOXICITY

Research and Proposals for Alleviating Soil Degradation, Reconstructing Local Infrastructure and Re-visioning future of Bien Hoa Air Base, Viet Nam.

Si Zheng

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Committee:

Jeffery Hou

Daniel Winterbottom

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ABSTRACT

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Chair of the Supervisory Committee:
Jeffery Hou, PhD
Landscape Architecture

This thesis is focusing on understanding the facts of the historical expenditure and effects of chemical weapons meanwhile exploring the methods to restore the ecological situation of former military facilities, and to re-vision the future development of this region. These research methods including exploring appropriate ways to remediate the degraded soil, exploiting the existing situation and problems by talking to local researchers and interviewing the residents. And a phasing plan which consist of multiple probable solutions and means to connect the future development and remediation processes.

ACKNOWLEDGEMENTS

I would like to thank Maura Patterson, the environmental remediation advisor at USAID for providing significant information and data which constitutes the spine of my research.

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In addition, I genuinely appreciate following organizations for their paramount efforts on uncovering the disastrous effects of chemical weapons and exploiting resorts to rehabilitate the contaminated lands. The United States Agency for International Development (USAID) Vietnam; Hatfield Consultants Contaminant Monitoring program; Vietnam Veterans of America; Agent Orange Record

A huge thanks to my thesis committee members Jeff Hou and Daniel Winterbottom, for their patience for my slow-motion progress, and their invaluable guidance and support from the beginning to the end.

Thanks to my family for funding me a trip to Vietnam, not to mention their unending care and support when I was under unprecedented pressure.

I am also grateful to many UW faculty who helped me along the way, including Ken Yocom, Lynne Manzo and Ben spencer. Many thanks to Vanessa and JoAnne for their endless help and information in last 2 years.

Thanks to my friends and classmates in University of Washington for offering precious and honest critique for my project. Thanks especially to Kasia K, Andrew P and Rich F.

Girls walk through mangrove forest devastated by Agent Orange (photo courtesy Vietnam Association of Victims of Agent Orange)

PROLOGUE: WARFARE AND LANDSCAPE ARCHITECTURE

Today, modern warfare, including civil war, crusade and terrorism, make this world shattered; not only the painful casualties, but also the great damage upon local ecosystems. The terrorist attacks induced by extremists such as ISIS, Al-Qaeda and Hezbollah have brought painful casualties around world. On the other hand, the damage caused by the anti-terrorism wars initiated by Western countries, drone attacks, highly explosive munitions and regular armed forces, are not inferior in any aspect on Middle East territory. Local feeble dictatorship, close threat from terrorism and direct intervening from western countries makes Middle east people extremely miserable. Warfare has been greatly impacting our world until even now.

Retracing our predecessors' footprints, warfare breaks out in every significant juncture in the long history of human world, inducing the extinction and rebirth of human civilization, disintegration and reunification of human societies. Along with the high-speed developing technologies, after the Industrial Revolution, warfare had become unprecedented lethal and destructive upon civic and natural environment. World War II, Korean War, Vietnam War and many other wars inflamed globally in post industrial revolution period left indelible scars on local civics.

CONTENTS

CHAPTER 1:

RECLAIM POSTWAR SITE LANDSCAPE

ATTRIBUTES OF POSTWAR SITE LANDSCAPE DESIGN

War ruins (former battle field/military base) are such interesting sites and have inextricable connection to local historical remnants, social impacts, cultural heritage and ecological evolutions.

From the perspective of history, war ruins and ex-military facilities usually have strategic location which attracted the flames of wars, the leftovers remain on the site show paramount value to archaeological studies and have revealing meanings to the recovery, redesign and renovation processes. From the perspective of ecology, the ecological impacts brought by warfare or military operations are tremendous, it is meaningful for practitioners in the field to re-balance local ecosystems broken in the wartime and reconstruct local habitats destroyed by military missions.

Landscape architects utilize abundant methods like cartography and analysis to excavate historical facts and data, including the location of frontlines, pillboxes and mine craters. Landscape architects and planners overlay those maps and information to decide their design strategies and proposals.

Postwar landscape projects also focus on land recovering and therapeutic features. A postwar project usually accompanied by badly-damaged land condition with several types of remnants such as mine craters, unexploded mines and bullet cartridges. One characteristic of postwar landscape projects usually includes a process of clearing up and securing the site to make sure the site is in a proper condition and ready to be designed.

In the ecological aspect, other than those ordinary post-industrial projects with a good-shape site or a comparably good-condition soil, the weapon attacks on the land usually change the attributes of the land where post war landscape projects are located. The chemicals left in the soil are hard to eliminate and keep impacting the land in various ways including polluting underground water, changing the pH of the soil and making the soil barren and dead. Several methods of soil remediation have been utilized in the field for a long time: thermal desorption, excavation or dredging, solidification and stabilization and bioremediation.

OPPORTUNITIES AND LIMITATIONS

One of prominent potential opportunities for post war site landscape projects is that, through a redesign of war ruins or ex-military facilities, the pain of warfare is recalled and the pursuit of peace is invoked among the civics. Those symbolic meanings are core values to maintain a potential more stable society.

Another potential opportunity for postwar landscape architecture projects are potential therapeutic functions. Heyde[1] noticed the special format of landscape may contribute an effective way to postwar recovery concerns. “Landscape, far from being an inert background to military operations, can teach us valuable lessons about wartime reality. One of the main reasons why landscape is so prominent in the writings about the war, would be because the war and its seeming opposite, the pastoral landscape, went into a dialectical relationship with each other. In other words, the experience of landscape was significantly altered by the presence of its opposite: the wartime reality.

From the perspective of a soldier who was continuously living in the claustrophobic and monotonous world of the trenches, something simple like a singing bird or a flower would notably gain in significance.” It is very important for landscape architects to utilize landscape, this special format to convey the high value of peace and quench the pain of war rooted in the heart of soldiers, dependents and the public.

[1] Heyde, Steven. “History as a source for innovation in landscape architecture: the First World War landscapes in Flanders.” Studies in the History of Gardens & Designed Landscapes 35.3 (2015): 183-97. Web.

Warfare ecology is another significant aspect that we should take into consideration. Machlis and Hanson[2] think it is necessary to develop and advance warfare ecology for both scientific and moral reasons.

"Scientific reasons include the widespread ecological consequences of warfare, the complexity of warfare's interactions with coupled natural and social systems, and the distinctive characteristics of war—the deliberateness, destructiveness, and intensity of its ecological impacts. Moral reasons include science's contributions to war-making technologies and the need to counterbalance the excesses of this activity, the contribution warfare ecology can make to reduce ecosystem degradation and human misery, and the potential of warfare ecology to help promote peace and security."

This thesis is focusing on understanding the facts of the historical expenditure and effects of chemical weapons meanwhile exploring the methods to restore the ecological situation of former military facilities, and to re-vision the future development of this region. These research methods including exploring appropriate ways to remediate the degraded soil, exploiting the existing situation and problems by talking to local researchers and interviewing the residents. And a phasing plan which consist of multiple probable solutions and means to connect the future development and remediation processes.

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[2] Machlis, Gary E., and Thor Hanson. "Warfare Ecology." NATO Science for Peace and Security Series C: Environmental Security Warfare Ecology (2011): 33-40. Web.

PRECEDENTS

It is not very easy to find landscape projects purely based on former battlefield. Because first, the age of battle fields varied. It is hard to undergo renovation or restoration design based on an ancient battle field like more than 100 years ago since the leftover of warfare might have already worn away. It is also difficult to apply design efforts on more recent, temporary battlefield because it might be still in military action, insecure and instable for designers to evaluate and investigate the site condition. Another problem is the obstacle from local authorities, they might have different plan other than invite landscape architects to renovate and redesign the battlefield. Like just simply reserving the situation of the war ruins for memorizing which landscape architects don't have much space to utilize their kits.

One precedent landscape architects highly participated in is the Yongsan Park, in Seoul, South Korea, designed and planed by West 8. This is the most recent proposed project has been planned based on a highly contaminated former military facility.

Yongsan Park is a historic place which was a military base belong to United States. This is a place fulfilled with excellent location (located in the central area of the city Seoul) and profound tragedy during the time of warfare. This site is isolated and declined any civic access under the force of politics until recently. Its soil has been greatly contaminated by the military use and its ecosystems have been enormously destroyed and disconnected with surrounding area and no citizen has been stepped into this area for more than one century.

The park design emphasizes three main themes:

1. Integration of existing culturally significant historical structures, destinations and important views;
2. Connecting the park ecosystem both spatially and temporally through the regeneration of the lost ecosystems and regional habitat corridors;
3. High performance design that achieves measurable social, economic and ecological sustainability targets.

Yongsan Park Site Plan ©West 8 urban design &
landscape architecture

PRECEDENTS

Yongsan Park ©West 8 urban design & landscape arch

What I have learned from this project can be concluded into 3 main aspects. First, I really appreciate their respect to the historic facts and develop the main design concept based on traditional cultural element. Second, they have paid great efforts to track the ecological environment back to the time which this area has not been contaminated due to military use by foreign force. Removing toxic dioxins and contaminants meanwhile restoring those “lost ecosystems” is a key sustainability practice in this project. Third, I am deeply impressed that the design team utilize ecosystems services to satisfy the needs of users. Those ecosystem services including increasing surface water quality, capturing rainwater, groundwater recharging, heat Island reduction, CO2 capturing, onsite food production, native land nursery, etc. It is a prophetic and fully-thought move to integrate such abundant services into one design proposal and they will bring great ecological benefit and relieve the damage of contamination if those services function well in the future.

itecture

Yongsan Park ©West 8 urban design & landscape architecture

PRECEDENTS

Another precendent is Hiroshima Peace Memorial Park.

Hiroshima Peace Memorial Park is a memorial park in the center of Hiroshima, Japan. The park was built on an open field that was created by the explosion.

It is dedicated to the legacy of Hiroshima as the first city in the world to suffer a nuclear attack, and to the memories of the bomb's direct and indirect victims (of whom there may have been as many as 140,000).

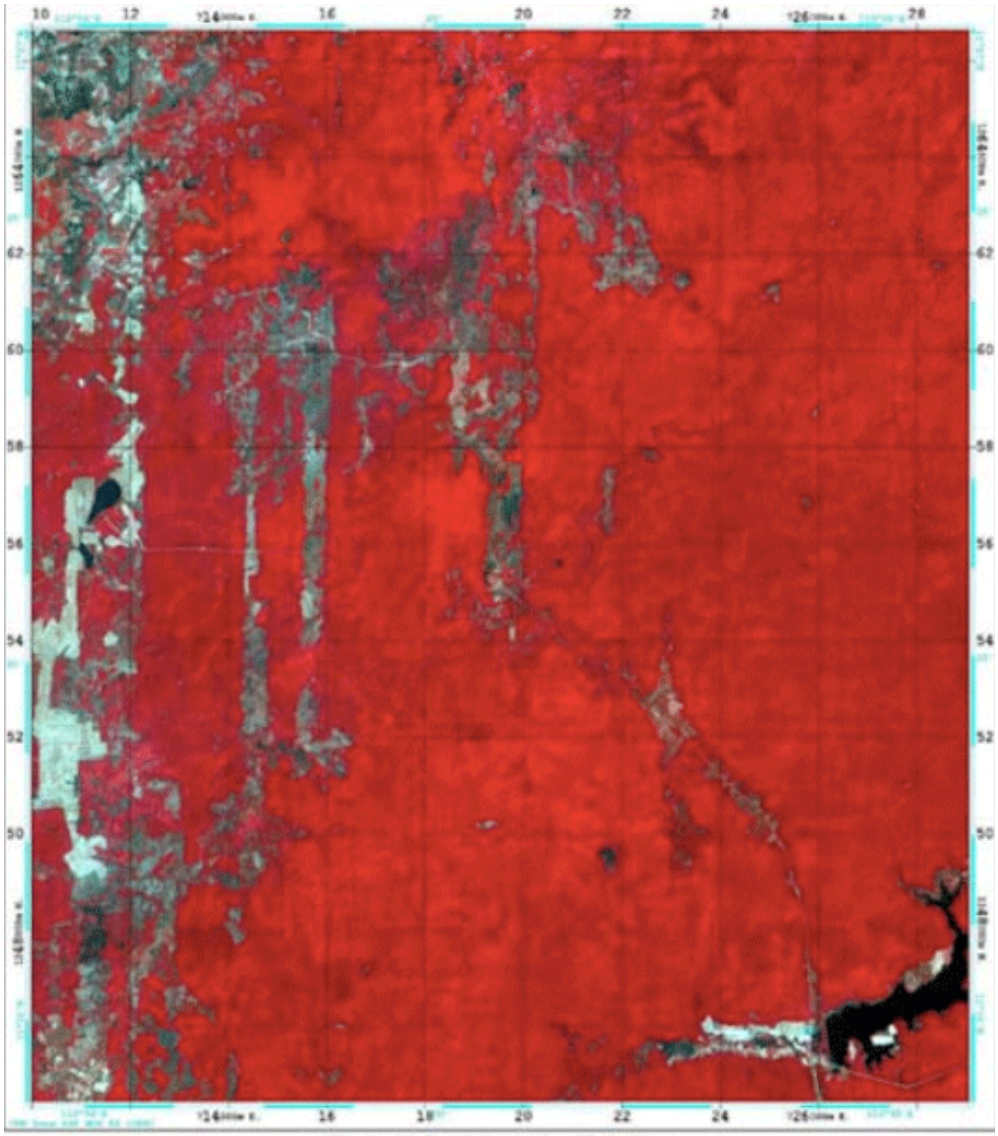
I select Hiroshima Peace Memorial Park as the second case because it presents the other attribute of postwar projects besides regular social and ecological functions, the spiritual power to invoke the remembrance of the past and the hope for a better world in the future. The tragedy happened in Hiroshima is one of the most miserable incident in human history.

Hiroshima Peace Memorial Park - Hiroshima - Touri

sm Media

CHAPTER 2:

AN INHUMAN RESORT: CHEMICAL WARFARE

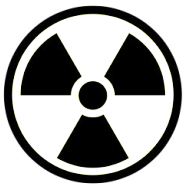


Ma Da Upland Forest, Viet Nam

SPOT XS 3-2-1 False Colour Composite, 05-March-1996

THE DEFINITION OF CHEMICAL WARFARE

Chemical warfare is different from nuclear warfare or other conventional warfare which employs regular armed forces. The destructive effects of chemical weapons do not derive from the explosive forces, or living organisms. Chemical warfare means the wartime use, against an enemy, of agents having a direct (toxic) effect on man, animals or plants.

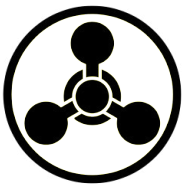


Nuclear Warfare

About 70 different chemicals have been used or stockpiled as chemical warfare agents during the 20th century. Chemical warfare has been considered the most influential type of modern warfare undertaken upon the ecosystems and estimated casualties due to its long-term ecological impacts.

Biological Warfare

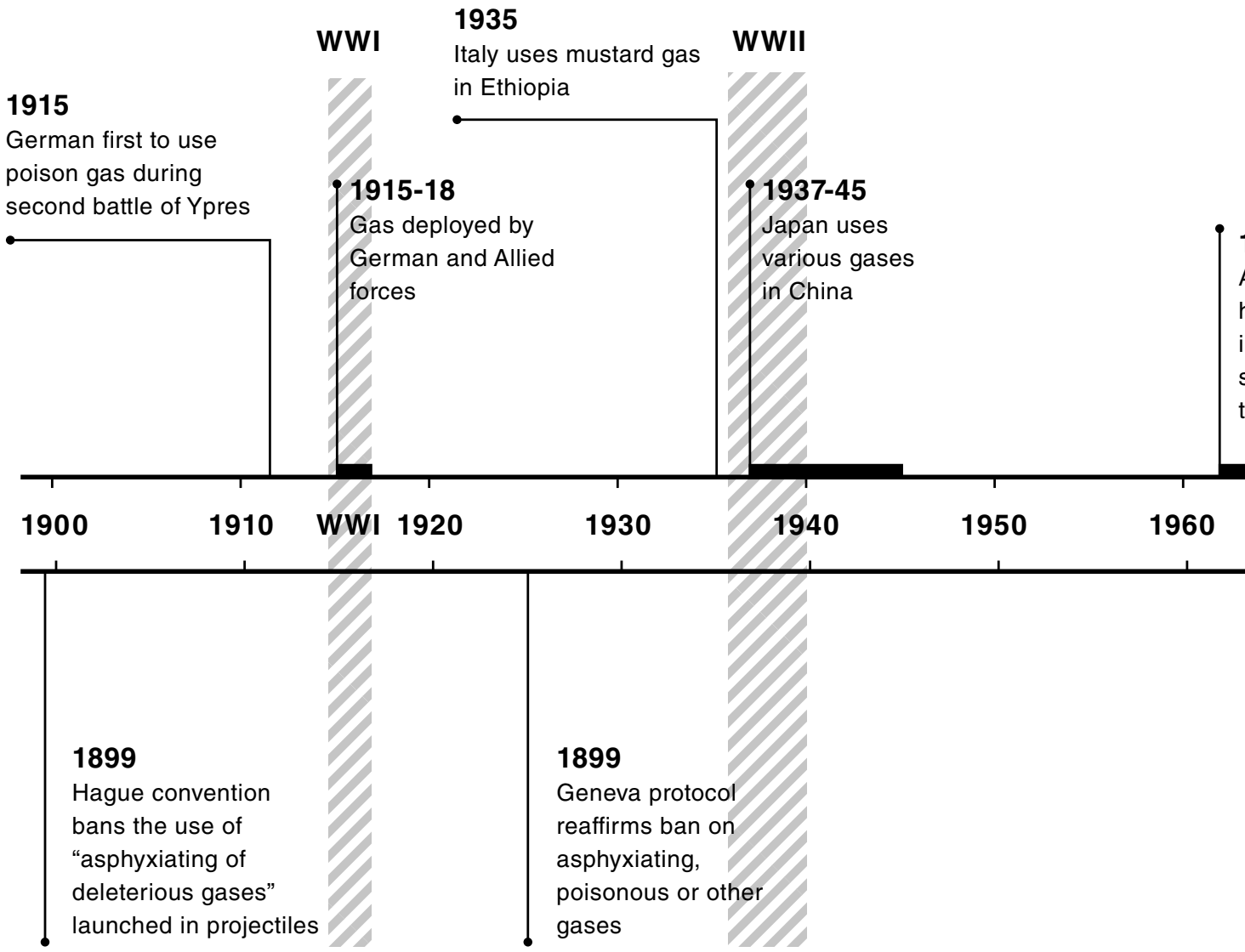
Coleman noted in his book, A History of Chemical Warfare, “When chemical weapons are added to an existing arsenal, the nature of the conflict is changed in two significant ways. First, the number of deaths and injuries are potentially increased. Secondly, if one country has chemical weapons this causes other countries to devote vast resources to develop a matching arsenal.” [3]



Chemical Warfare

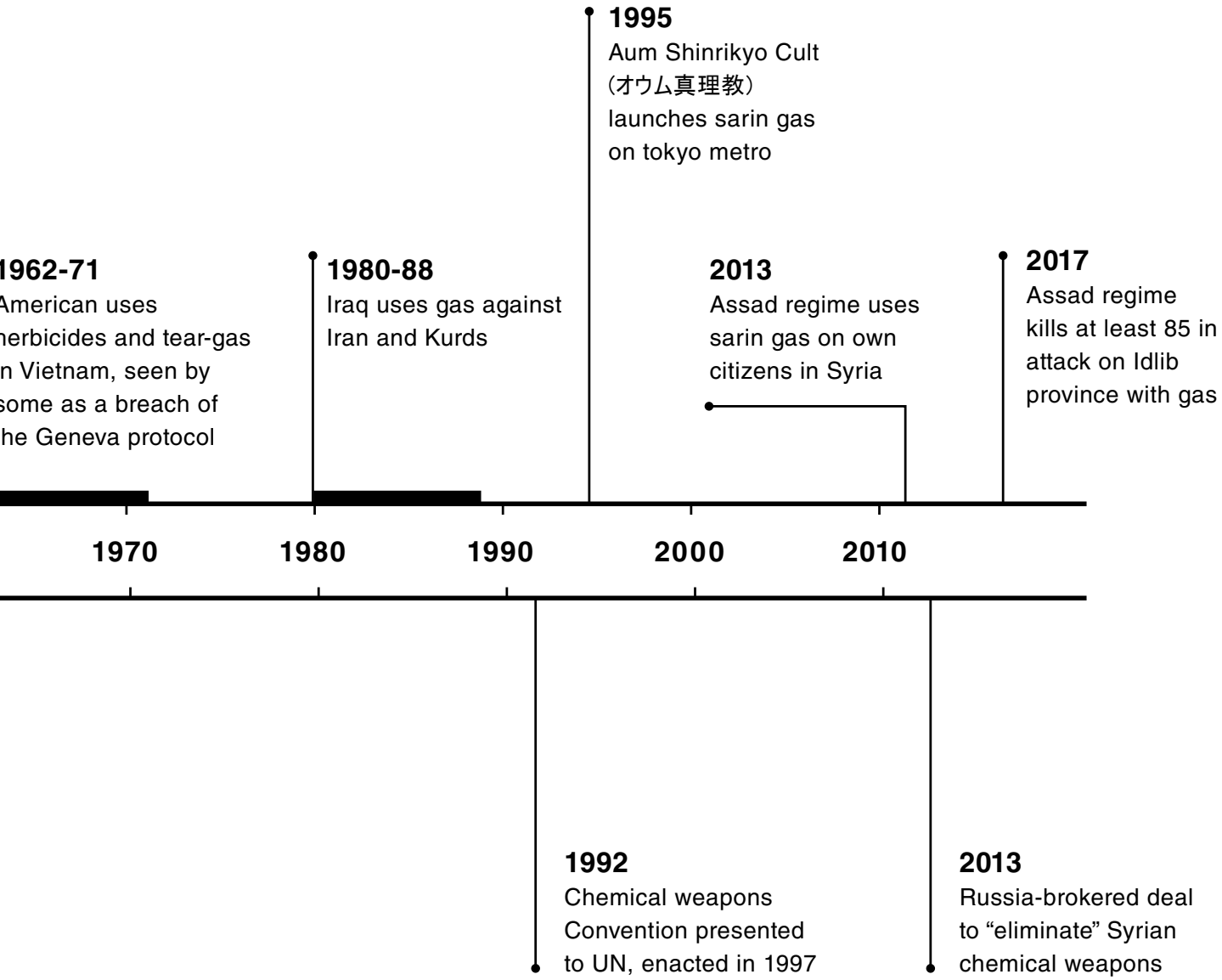
[3] Coleman, Kim. A history of chemical warfare. Basingstoke, Hampshire: Palgrave Macmillan, 2005. Print.

THE HISTORY OF CHEMICAL WARFARE



[4] Data source: The economist

[3] Coleman, Kim. A history of chemical warfare. Basingstoke, Hampshire: Palgrave Macmillan, 2005. Print.


1995
Aum Shinrikyo Cult
(オウム真理教)
launches sarin gas
on tokyo metro
1962-71
American uses
herbicides and tear-gas
in Vietnam, seen by
some as a breach of
the Geneva protocol
1980-88
Iraq uses gas against
Iran and Kurds
2013
Assad regime uses
sarin gas on own
citizens in Syria
2017
Assad regime
kills at least 85 in
attack on Idlib
province with gas
1970
1980
1990
2000
2010
1992
Chemical weapons
Convention presented
to UN, enacted in 1997
2013
Russia-brokered deal
to “eliminate” Syrian
chemical weapons

Ancient times

Chemical weapons were probably first used by the Spartans against the Athenians. They used sulfur and arsenic smoke in 431 B.C. Greek-fire (burning liquid sulfur) was used in the seventh century to set enemy ships on fire. Sulfur with turpentine oil was used against fortresses in the sixteenth century. [5]

World War I

Chemical agents were used on an unprecedented scale during World War I (WWI). It represented the fearful beginning of modern chemical warfare. During WWI, chemical agents have been used in multiple military missions for maiming and killing, it is questionable that if those chemical weapons has been thoroughly investigated and tested since chlorine, phosgene and mustard, these chemical agents were widely used by several countries during WWI and such large scale use of chemical weaponry has not been seen since.

[5] Albright, Richard D. “Chemical Warfare Material.” Cleanup of Chemical and Explosive Munitions (2012): 45-69. Web.

British troops blinded by tear gas during the Battle of Estaires, 1918 Photo credit: Thomas Keith Aitken (Second Lieutenant), from the collections of the Imperial War Museums (collection no. 1900-22)

The inter-war era

The inter-war era (1919-1939) didn't have many instances of chemical warfare except some small scale development and uses and development. During the Russian civil war, the Empire used chemical gas as a supporting weapon in the battles. Chemical means have also been utilized to solidify their local authority for the British in Afghanistan. Japan became involved in heavy research and development of chemical weapons. There are many unconfirmed reports of chemical use against the Chinese during Japanese expansion prior to WWII. [3] The Italians under the direction of Mussolini, employed mustard during fighting in Ethiopia. This use was characterized by a novel delivery system in which mustard was loaded into bombs and dropped from airplanes.

Italian soldiers with a huge mustard gas bomb, 500 tones of mustard gas was used against civilians and the Ethiopian army. (Angelo Del Boca, storico e giornalista, si è occupato in particolare della colonizzazione italiana in Africa. Tra i suoi libri: La guerra d'Abissinia, 1965)

[3] Coleman, Kim. A history of chemical warfare. Basingstoke, Hampshire: Palgrave Macmillan, 2005. Print.

One million Ethiopians were massacred by aerial bombardment using chemical weapons, by execution, by hanging, by firing squads and by cross fiction. 35,000 of the victims died in concentration camps. (Bruce Walker)

World War II

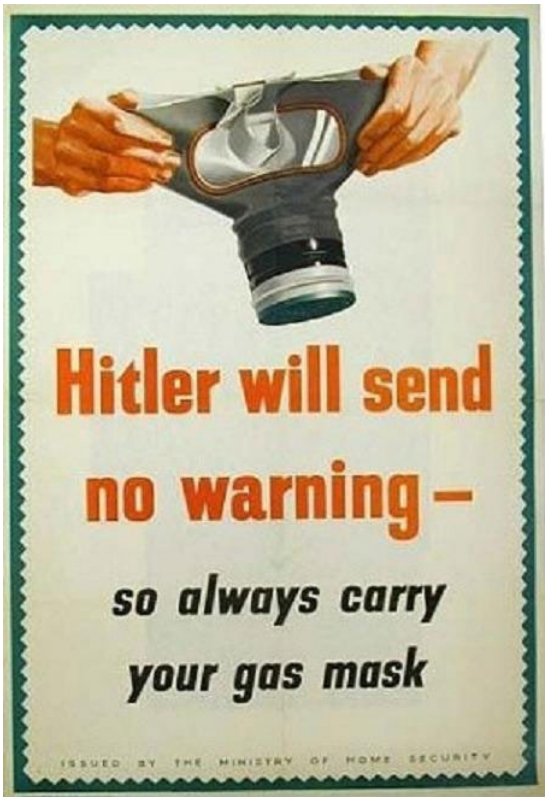
At the beginning of the Second World War, the experience of the First World War gave most of the combatants the expectation that chemical warfare would be used to an even greater extent, despite the Geneva Protocol having been put into place in the inter-war period. [6] During the WWII, a great amount of new weapons has been developed. Among these new weapons, nerve agents were unique. The German war machine mass-produced and weaponized these compounds but then showed uncharacteristic restraint in their utilization.

The Imperial Japanese Army frequently used chemical weapons. Because of fear of retaliation, those weapons were never used against Western countries, but against other Asian countries judged "inferior" by imperial autority.

The Western Allies did not use chemical weapons during the Second World War.

Japanese Special Naval Landing Forces wearing gas masks and rubber gloves during a chemical attack near Chapei in the Battle of Shanghai.
(Brent Jones: Rising Sun in the East 1937)

[6] Ramirez, Jason G., and Douglas R. Bacon. "Modern Chemical Warfare: A History." Bulletin of Anesthesia History 22.2 (2004): 1-15.



UK Ministry of Home Security poster. Hitler will send no warning - so always carry your gas mask.

U.S. troops in Panama participate in a chemical warfare training exercise with smoke during World War II. (Howard R. Wilson/ Courtesy of Gregory A. Wilson)

U.S. Army Huey helicopter spraying Agent Orange over agricultural land during the Vietnam War, U.S. Army Operations in Vietnam R.W. Trewyn, Ph.D. , Huey Defoliation National Archives: 111-CC-59948

Postwar Period

The research and use of chemical weapons quenched during the post world war II period, mostly because of the reinforce of the 1972 Convention, usually referred to the Biological and Toxin Weapons Convention (BTWC). however, further research of chemical weapons by all of the former Allies has been proved.

Although the thermal nuclear weapons and its technology attracted main focus of the United States and the Soviet Union, both the Soviet and Western governments put enormous resources into developing chemical and biological weapons during the Cold War.

From 1962 to 1973, the Department of Defense planned 134 tests under Project 112, a chemical and biological weapons "vulnerability-testing program."[7] The United States also military sprayed nearly 20,000,000 U.S. gallons of various chemicals in Vietnam, eastern Laos, and parts of Cambodia.

There were reports of chemical weapons being used during the Soviet war in Afghanistan, sometimes against civilians.[8]

Chemical weapons employed by Saddam Hussein also killed and injured numerous Iranians and Iraqi Kurds. About 100,000 Iranian soldiers were victims of Iraq's chemical attacks.

Most recently, Sarin, mustard agent and chlorine gas have been used during the civil conflict in Syria. Numerous casualties led to an international reaction.

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[7] Philip Huang, "Sickening strategy", Oregon Daily Emerald, October 17, 2002

[8] Hassan Kakar, "The Soviet Invasion and the Afghan Response", The Story of Genocide in Afghanistan, 1979-1982

Chemical terrorism

Chemical weapons are also used by terrorists to initiate attacks of killing and injuring. Since it is cheap, accessible and its toxic effects are catastrophic, chemical weapon are commonly used in the history of terrorism.

On the morning of March 20, 1995, the Tokyo metro system was hit by chemical attacks on five trains. According to report, members of the Aum Shinrikyo religious cult killed twelve people and injured about 5,000 others. [9]

In August 2013 Syrian government gassed to death more than 1,400 people on the outskirts of Damascus.

On April 4th, 2017, More than 80 people were killed in a suspected chemical attack on the rebel-held town of Khan Sheikhoun in north-western Syria.

Japans Security Forces Run Anti Terrorism Drill, Photo by Junko Kimura.

[9] Kyle B. Olson, “Aum Shinrikyo: Once and Future Threat?”, Research Planning, Inc., Arlington, Virginia

A Syrian child receives treatment at a field hospital after a chemical attack in Syria's Idlib province, on Tuesday. (EPA)

Hague Convention of 1899

(IV,2): Declaration concerning the Prohibition of the Use of Projectiles with the Sole Object to Spread Asphyxiating Poisonous Gases

This declaration states that, in any war between signatory powers, the parties will abstain from using projectiles "the sole object of which is the diffusion of asphyxiating or deleterious gases." [10]

Geneva Protocol

The Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or other Gases, and of Bacteriological Methods of Warfare, is a treaty prohibiting the use of chemical and biological weapons in international armed conflicts.[11]

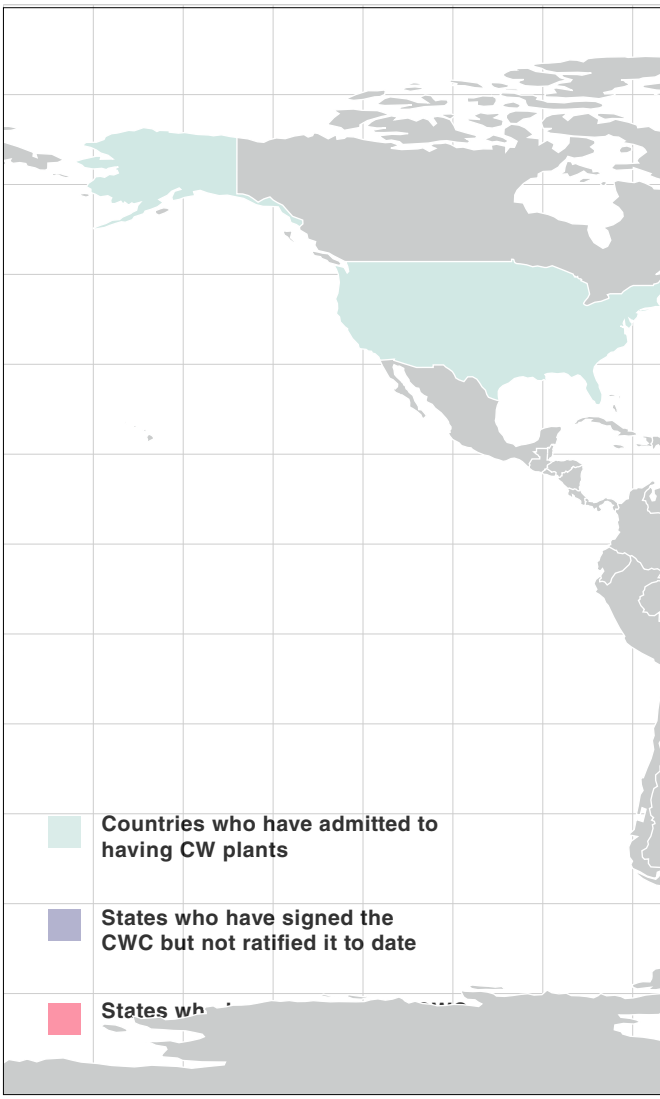
[10] Declaration concerning the prohibition of the use of projectiles with the sole object to spread asphyxiating poisonous gases

[11] "Protocole concernant la prohibition d'emploi à la guerre de gaz asphyxiants, toxiques ou similaires et de moyens bactériologiques, fait à Genève le 17 juin 1925"

The First International Peace Conference, the Hague, May - June 1899, from the collections of the Imperial War Museums.

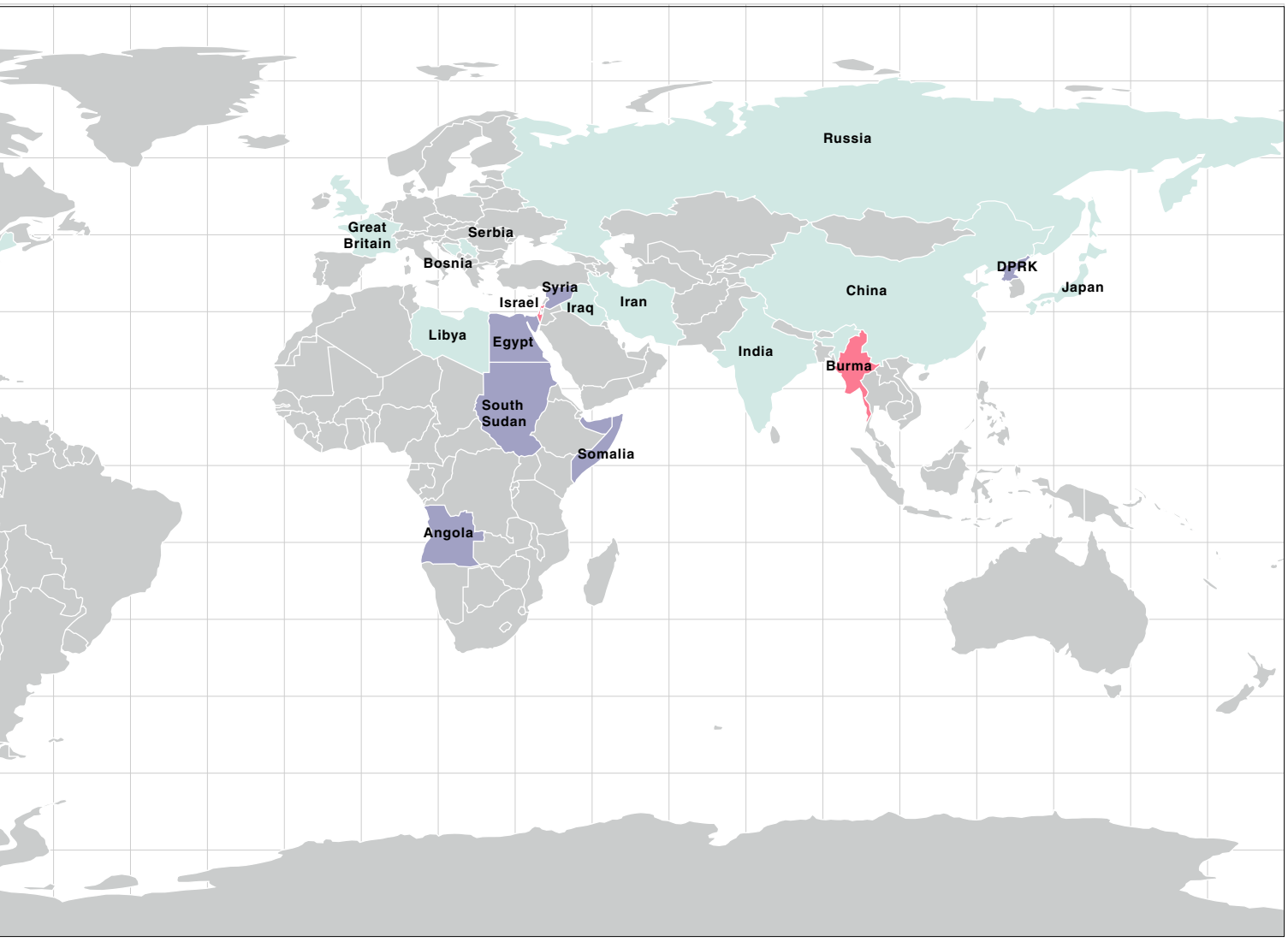
The Chemical Weapons Convention (CWC)

The Chemical Weapons Convention (CWC) aims to eliminate an entire category of weapons of mass destruction by prohibiting the development, production, acquisition, stockpiling, retention, transfer or use of chemical weapons by States Parties. [12]



Data source: Rianovosti

[12] "Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction". United Nations Treaty Collection.


Russia
Great Britain
Serbia
Bosnia
Syria
Israel
Iraq
Iran
China
DPRK
Japan
Libya
Egypt
India
Burma
South Sudan
Somalia
Angola

THE ECOLOGICAL EFFECTS OF CHEMICAL WARFARE

The effects of chemical warfare upon local ecosystems are usually lethal and extremely destructive. Those effects can be separated as two main diversions, intentional manipulation and unintentional manipulation. [13]

The intentional manipulation, obviously, delivered by military authorities during the war against enemies, to cause casualties, destroy enemies' resource and its transportation and gathering, or have a long-term impact on the post-war economy and development on the target. There were several military operations which employed chemical agents directly against human beings during World War I, which generated painful casualties and long-term environmental impacts on local ecosystems. After that, the most disastrous intended manipulation known to the world is the spraying missions initiated by the Department of Defense of United States in Vietnam. Between 1961 and 1976, this mission killed around 3.2 million acres of forest and 247,000 acres of Vietnamese croplands, more information and research about this mission is mentioned in following chapters. [14]

The unintentional manipulation, acts as accidental outcomes of military operations impacting local ecology. One instance of intended manipulation is the use of petroleum as a weapon during the Persian Gulf War, During the Iran-Iraq War of the 1980s and the Persian Gulf War of 1991–92, a large amount of oil tankers and other facilities like offshore production platforms have been targeted and demolished, causing large quantities of petroleum spilled at the sea during the warfare. Another instance for unintended manipulation is the disposal of chemical arsenals, the U.S. Army dumped 16,000 bombs in deep water 5 miles (8.0 km) south of Pearl Harbor after World War II. Each bomb contained 73 pounds (33 kg) of mustard gas. The Army intends to leave the weapons at the site because moving them could pose more of a threat to people and the environment. The military used the ocean as a dumping ground for munitions from 1919 to 1970.[13]

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[13] Arthur H. Westing. "Environmental and Ecological Consequences of War" Conflict Resolution Vol.II

[14] Pfeiffer, E.w. "Defoliation and bombing effects in Vietnam." Biological Conservation 2.2 (1970): 149-51. Web.

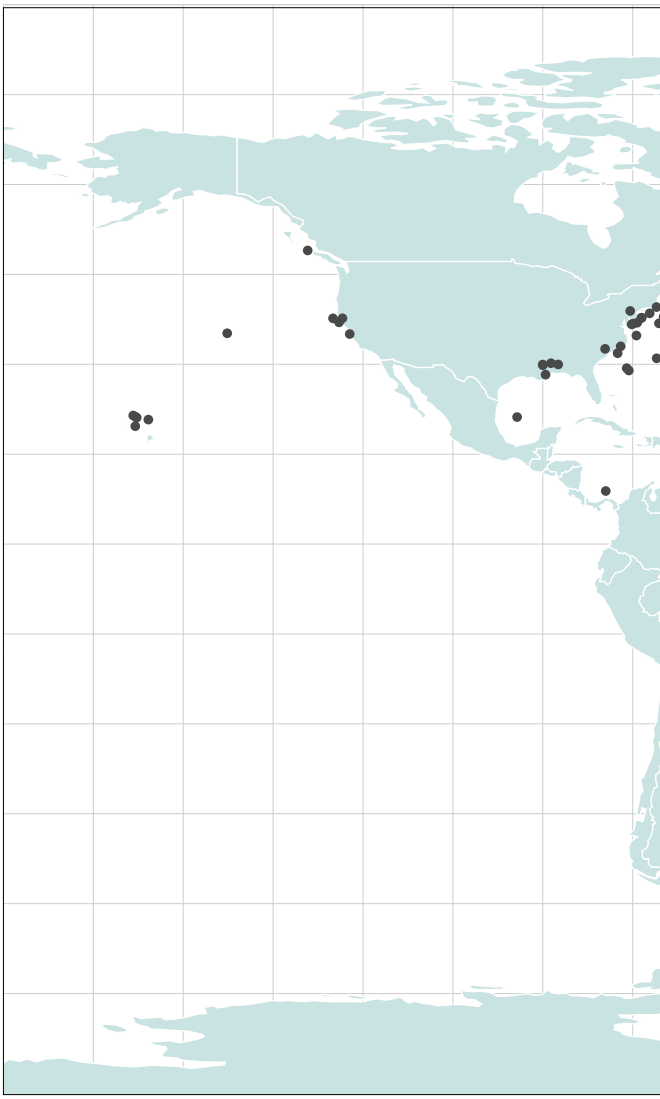
Smoke plumes from a few of the Kuwaiti Oil Fires on April 7, 1991. National Aeronautics & Space Administration

Chemical Weapon Munitions Dumped at Sea

During World War I and World War II, even after World War II, massive quantities of chemical warfare (CW) material were disposed by dumping them in the oceans. According to US Department of Defense reports, the US military alone dumped CW agents in waters worldwide on at least 74 occasions between 1918 and 1970.

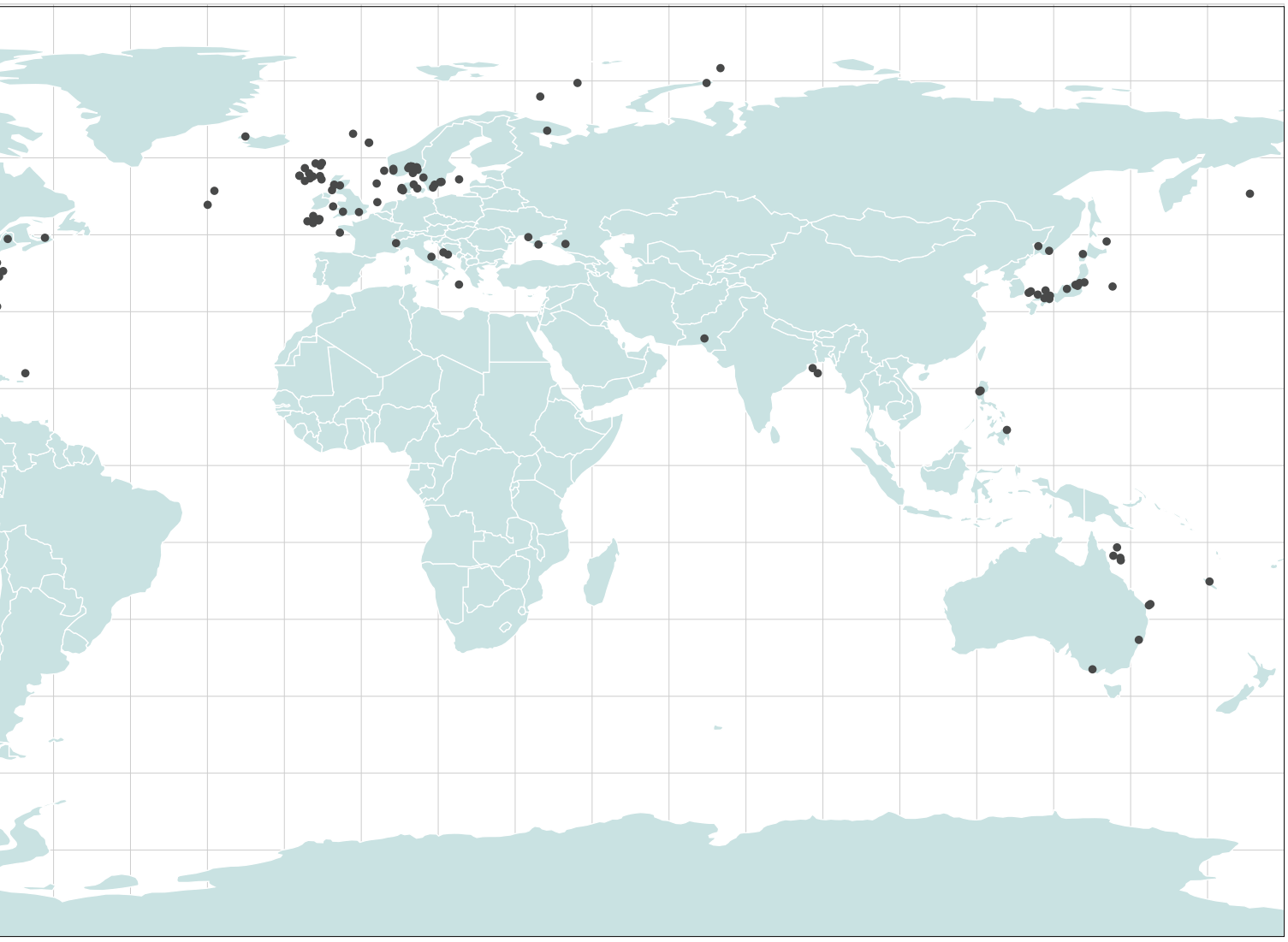
"Some dumping operations were carefully undertaken, including the keeping of records of where the dumping occurred, a listing of the material that was dumped, and the quantities of dumped material. Other dumping was done haphazardly with no or minimal records being written and kept."[15]

Dumping chemical agents at sea is not wise move and may cause further concern of public health and serious enviromental consequenses in the future.



Map Data: CNS experts Caroline Ong, Tamara Chapman, Raymond Zilinskas, Benjamin Brodsky, Anne Marie Steiger, Joshua Newman

[15] National Academy of Sciences, Disposal Hazards of Certain Chemical Warfare Agents and Munitions (Washington, DC: National Academy Press, 1969).



CHAPTER 3:

HERBICIDAL WARFARE PROGRAM INITIATED BY U.S.A. DURING VIETNAM WAR.

THE SPRAYING MISSION

The scale of these military missions initiated by the US D.O.D is unprecedented and massive, these military missions consist of 3 primary categories: chemical spraying, high explosive munition, and land clearing.

During the Vietnam War, between 1962 and 1971, the United States military sprayed nearly 20,000,000 U.S. gallons (75,700,000 L) of various chemicals - the "rainbow herbicides" and defoliants - in Vietnam, eastern Laos, and parts of Cambodia as part of the aerial defoliation program known as Operation Ranch Hand, reaching its peak from 1967 to 1969. The campaign destroyed 5 million acres (20,000 km2) of upland and mangrove forests and millions of acres of crops. Overall, more than 20% of South Vietnam's forests were sprayed at least once over a nine-year period. [16]

Defoliant spray run, part of Operation Ranch Hand, during the Vietnam War by UC-123B Provider aircraft. National Museum of the U.S. Air Force

[16] Pfeiffer, E.w. "Defoliation and bombing effects in Vietnam." Biological Conservation 2.2 (1970): 149-51. Web.

A UH-1D helicopter from the 336th Aviation Company sprays a defoliation agent over farmland in the Mekong Delta. Brian K. Grigsby

THE SPRAYING MISSION

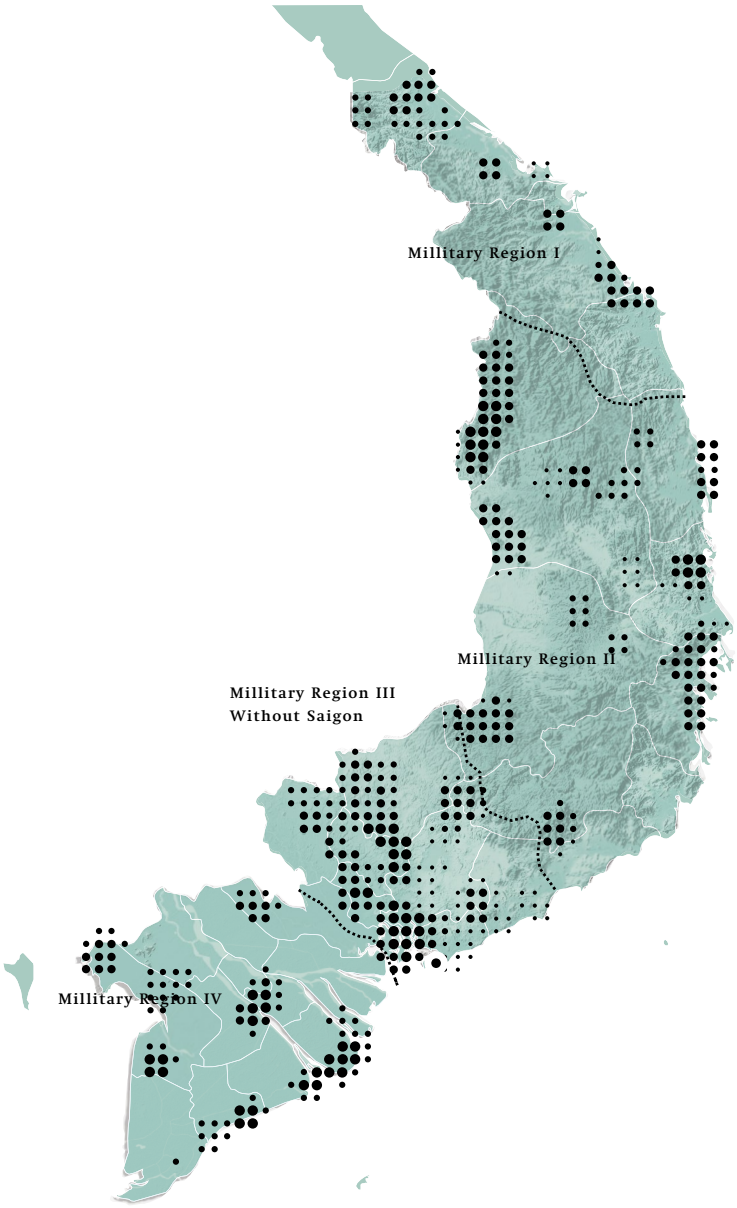
The Vietnam war have resulted in extensive damage to the soils of the region, and thereby to the ecosystems involved. To quantify this damage seems not to be possible. The war-disrupted ecosystems of Vietnam suffered severe, though largely hidden, debilitation via nutrient dumping.

Also, it is safe to assume that various components of the flora throughout Indochina sustained greater or lesser amounts of damage. The fauna of Indochina underwent severe disturbance as a result of the war, the intense bombing of an area might modify local drainage patterns and that bomb craters might exert an influence on the water table. [17]

US Munition/Herbicide expenditure in Vietn
War, Breakdown by area.

[17] Pierre, Andrew J. “Ecological Consequences of the Second Indochina War.” Foreign Affairs 55.2 (1977): 428. Web.

am during the Vietnam



US Spraying mission frequency in the Vietnam War, 1966-1969

Herbicide used

3 selected chemcicals were primarily used during the Vietnam War. The tactical herbicides used in Vietnam were intended to kill a broad spectrum of plants. Agent Orange and Agent White were used against broadleaf plants and woody shrubs and trees, including mangroves. Agent Blue was effective against grasses and grains, such as rice. [18]

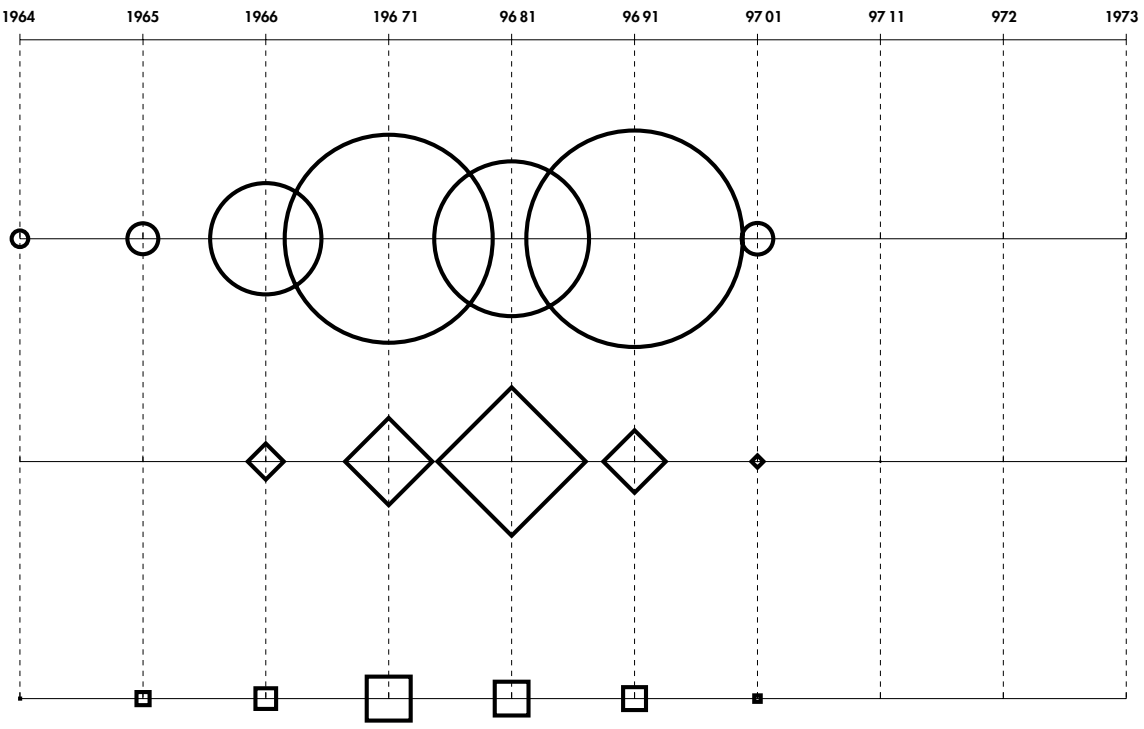
Agent Orange

About 17.8 percent of the total forested area of Vietnam was sprayed during the war, which disrupted the ecological balance.

The government of Vietnam says that 4 million of its citizens were exposed to Agent Orange, and as many as 3 million have suffered illnesses because of it.

Volume of chem
Breakdown by ag

[18] Young, A. L. 2009. The history, use, disposition and environmental fate of Agent Orange: New York, NY: Springer.



NT ORANGE

eral de foliation of f orest,
n, and broad-lea ved crops

NT WHIT E

st de foliation where
er term control is desired

NT BLUE

d short-term de foliation. Good
rass control and use on rice

icals used in Vietnam during the Vietnam War,
gents.

CONTAMINATION HOTSPOTS

Bien Hoa Airbase

Phu Cat Airbase

Da Nang Airbase

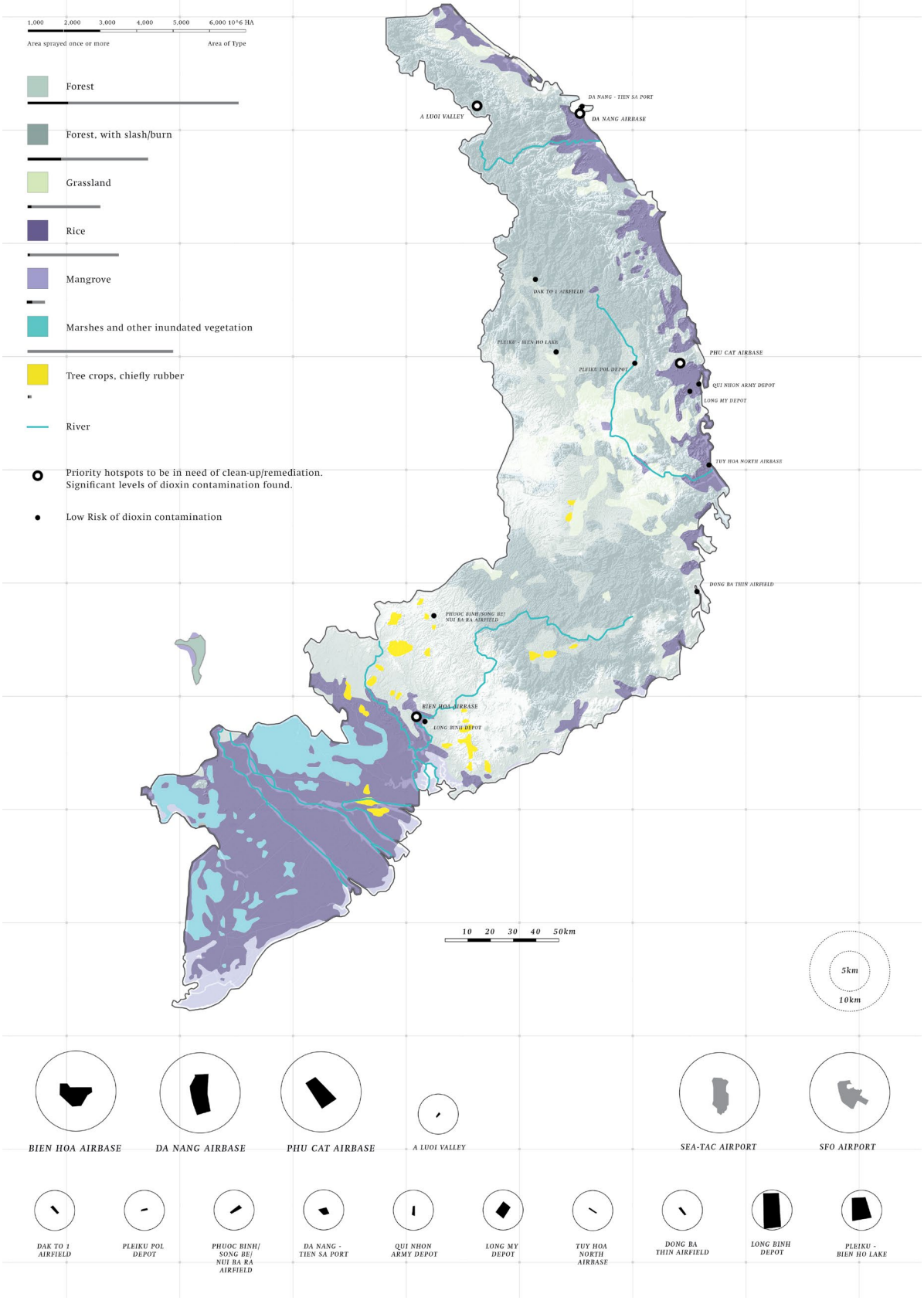
Priority hotspots

This map on the right shows the different vegetation type of South Vietnam. And all the contaminated hotspots in south Vietnam have been marked. Quite a lot hotspots are military airbase and former chemical storage.

There are four priority hotspots which are in urgent need of clean-up/remediation, they are Bien Hoa Airbase, Da Nang Airbase, Phu Cat Airbase and A Luoi Valley. USAID Vietnam (United States Agency for International Development) has been collaberating with local scientific institutions and authorities to work out remediation plans of Da Nang Airbase and Bien Hoa Airbase since 2008.

US HERBICIDE EXPENDITURES IN THE VIETNAM WAR BREAKDOWN BY VEGETATION

KNOWN AND POTENTIAL DIOXIN HOTSPOT IN VIETNAM



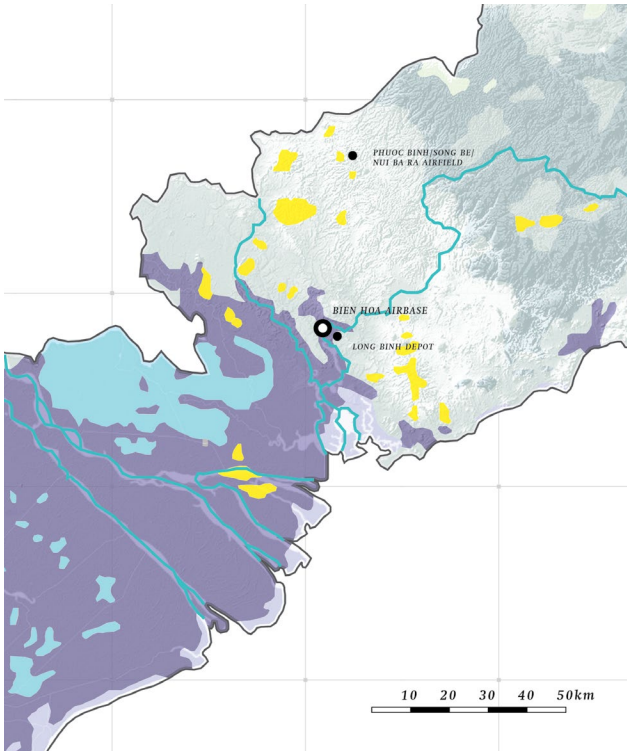
CHAPTER 4:

CONTAMINATION HOTSPOT: BIEN HOA AIR BASE

BIEN HOA AIR BASE

Bien Hoa Air Base

I selected Bien Hoa Air Base as my research and design site since it is one of the most contaminated hotspots other than Da Nang Air Base in South Vietnam. Also, USAID have undergone a thorough soil degradation assessment on this site which means I can retrieve part of essential data from them. Also, Bien Hoa city is near Ho Chi Ming city and the municipality is planning to draw more tourists by developing tourism which contains more possibility of open space design. Furthermore, Bien Hoa Air Base has not started its remediation processes yet (Da Nang Airbase has already begun under the direction and assistance from USAID) which means we still have the time to assess and evaluate different remediation alternatives.



Biên Hòa is a city about 30 kilometres east of Ho Chí Minh City (formerly Saigon). And this airbase is located on flood plain.

During the Vietnam Wars (1955–75), the base was used by the Republic of Vietnam Air Force and United States Air Force. With the influx of USAF tactical air units in the early 1960s, Bien Hoa became a joint operating base for both VNAF and USAF organizations. The USAF forces stationed there were under the command of the Pacific Air Forces (PACAF).

Bien Hoa Airbase, Google Earth

BIEN HOA AIR BASE

1.1 Million
POPULATION, BIEN HOA

26806 HA
CITY AREA, BIEN HOA

1.0 Million
URBAN POPULATION, BIEN HOA

32c**/90**F
DRY SEASON, BIEN HOA

0.1 Million
RURAL POPULATION, BIEN HOA

33c**/91**F
WET SEASON, BIEN HOA

7 DAYS
AVERAGE RAIN DAYS,
DRY SEASON, BIEN HOA

15 mm
AVERAGE RAIN FALL,
DRY SEASON, BIEN HOA

30 DAYS
AVERAGE RAIN DAYS,
WET SEASON, BIEN HOA

223 mm
AVERAGE RAIN FALL,
WET SEASON, BIEN HOA

22 DAYS
AVERAGE SUN DAYS,
DRY SEASON, BIEN HOA

110 hours
AVERAGE SUN HOURS,
DRY SEASON, BIEN HOA

0.7 DAY
AVERAGE SUN DAYS,
WET SEASON, BIEN HOA

112 hours
AVERAGE SUN HOURS,
WET SEASON, BIEN HOA

Bien Hoa Airbase

This map shows the perimeter of the airbase in present. The North is a large area of forest and farmland. On the southeast of the airbase, it's an industrial park. A river flows through this area called Dong nai River.

The Climate of Bien Hoa Airbase

The Airbase has a tropical climate, specifically a tropical wet and dry climate, with an average humidity of 78–82%. The year is divided into two distinct seasons.The rainy season, with an average rainfall of about 1,800 millimetres (71 in) annually (about 150 rainy days per year), usually begins in May and ends in late October.The dry season lasts from December to April. The average temperature is 28 °C (82 °F), with little variation throughout the year.


PERIMETER INFORMATION, BIEN HOA AIR BASE, BIEN HOA, VIET NAM
1261 km
HANOI
223 km
PHNOM PENH
BIEN HOA CITY
BIEN HOA AIRBASE
BUU LONG RESORT
BIEN HUNG PARK
BIEN HOA RAILWAY STATION
DONG NAI RIVER
27 km
TAN SON NHAT AIRPORT
30 km
HO CHI MINH CITY
30 km
SAI GON PORT
44 km
PHU MY PORT
2 km
DONG NAI PORT
BIEN HOA INDUSTRIAL PARK
PLANTATION/FOREST
FARMLAND
RESIDENTIAL/RETAIL
WATER
INDUSTRIAL
HIGHWAY
RAILWAY
DESTINATION
0.2 km
1 km

REMEDIATION

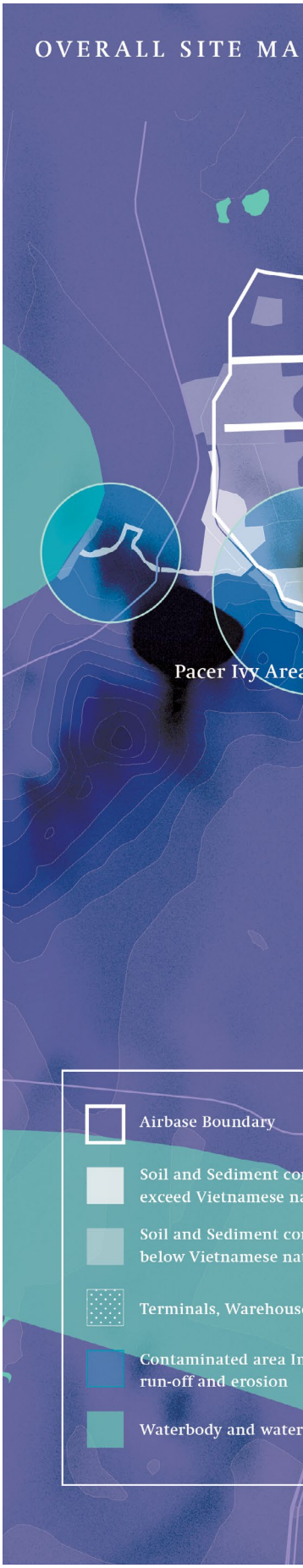
The most important issue of this site is:

Is there any way to remediate this site?

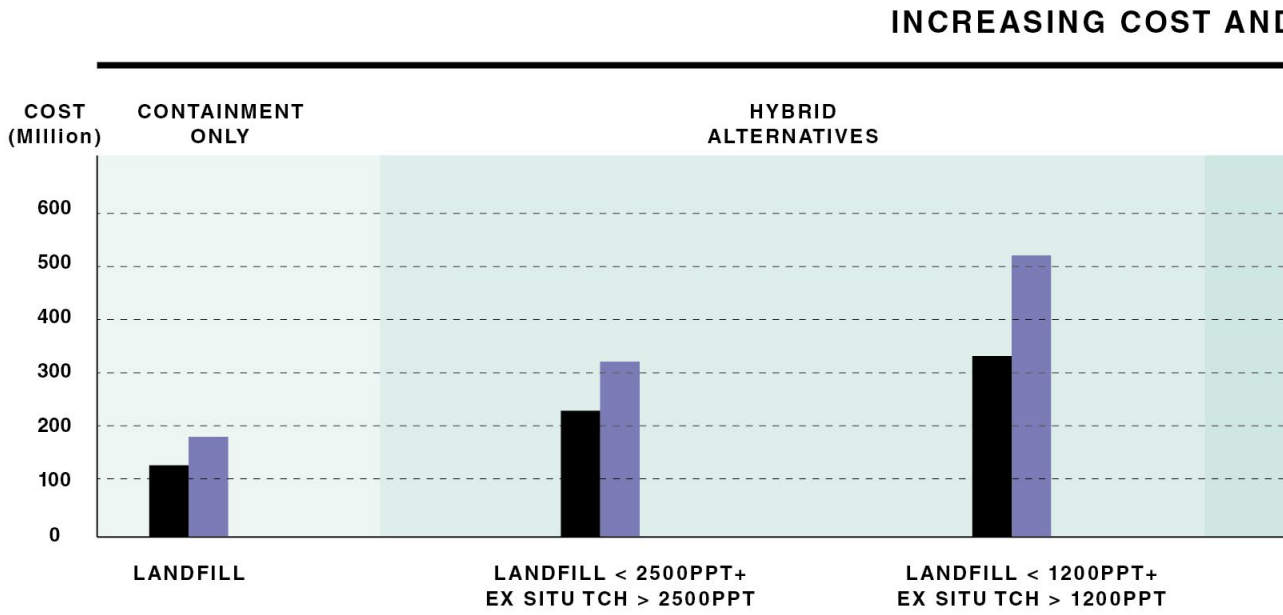
Which alternative methods to remediate the site are prioritized?

How long will it take to remediate?

This map on the right shows the existing situation of site contamination, the deeper white area is highly contaminated, the less deep white blocks are less contaminated and the sampling of these places are under Vietnamese national standard.




P WITH SOIL DIOXIN CONCENTRATION, BIEN HOA AIRBASE, VIETNAM
Z1 Area
Z1 Lake
G2 Lake
Bien Hung Lake
Dong Nai River
ncentrations
ational standard
ncentrations
tional standard
es and Arsenals
npacted by
way
Primary contaminant:
2,3,7,8-tetrachlorodibenzo-p-dioxin
(TCDD)
Cl
O
Cl
Cl
O
Cl
Measurement Unit:
"ppt TEQ"
(parts per trillion
toxicity equvalency)



Remediation alternatives

These remediation alternatives are provided by USAID include:

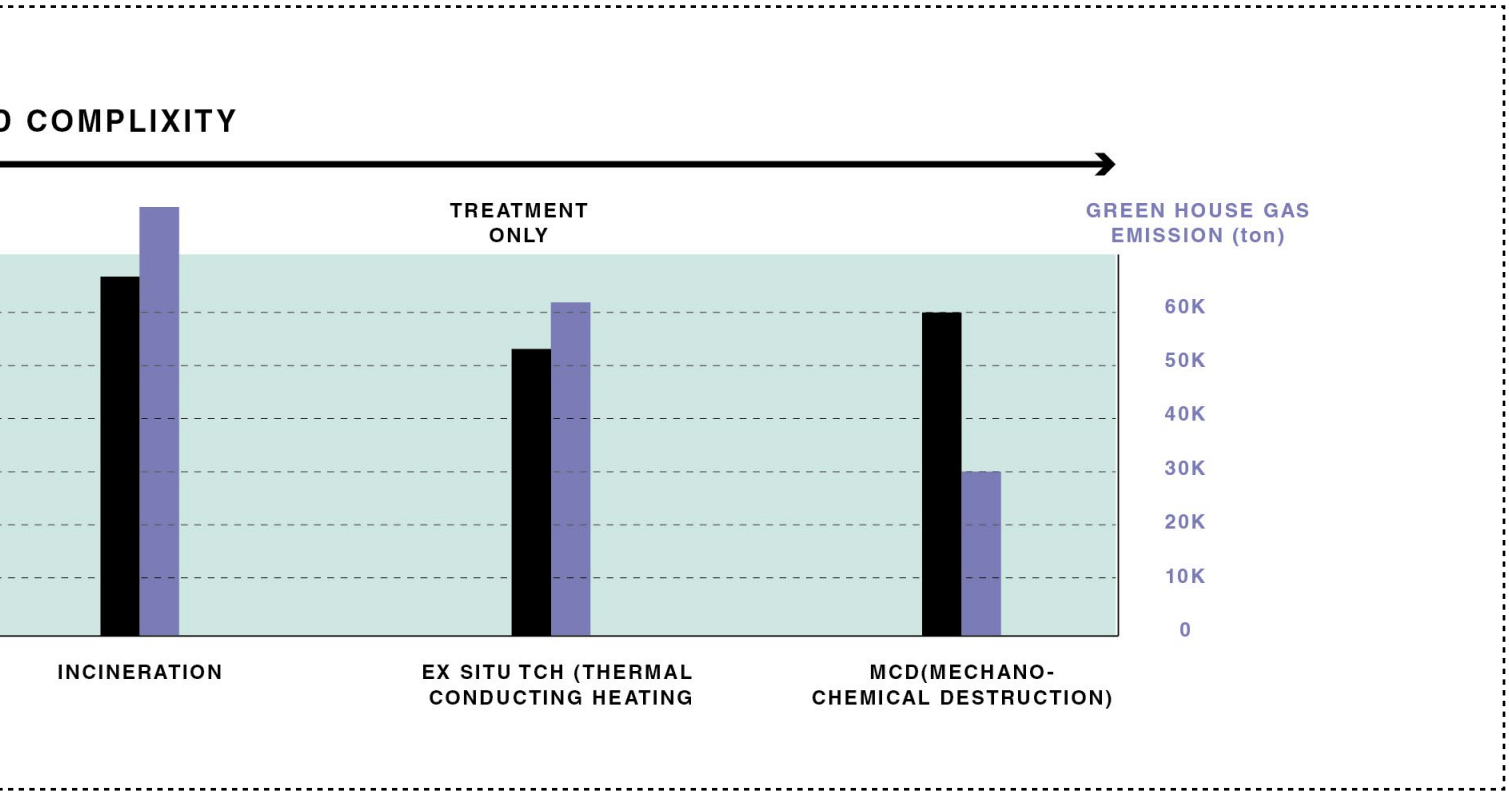
Pure Containment alternative:
Passive Landfill.

Pure treatment alternative:
Incineration
Ex Situ (Offsite) Thermal Treatment.
mechanochemical destruction

2 hybrid alternatives.

hybrid alternative is, using landfill to contain the material below 1200 ppt. and using thermal treatment to treat material above 1200 ppt. This bar chart shows different cost and green house emission of different alyernatives.

After screening, hybrid alternative seems more economic and stable since pure containment is insecure and risky, incineration costs too high and its offgas emission might induce public concern. Mechano chemical destruction, this technology is immature.

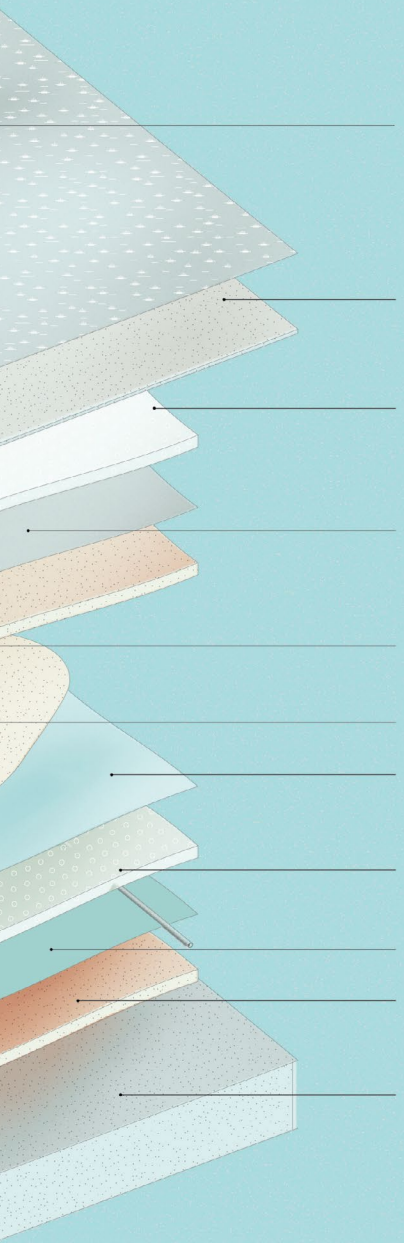

D COMPLIXITY
TREATMENT ONLY
GREEN HOUSE GAS EMISSION (ton)
60K
50K
40K
30K
20K
10K
0
INCINERATION
EX SITU TCH (THERMAL CONDUCTING HEATING
MCD(MECHANO-CHEMICAL DESTRUCTION)

Passive Landfill [19]

This diagram shows how the passive landfill works. First we need to build a landfill construction, and then the contaminated material will be excavated and transported to the landfill construction. The only target of landfill alternative is isolate contaminated soil and sediments. In order to do that, several layers with different material like plastic, sand and clay should be implemented to prevent potential infiltration and exposure.

This chart on the right shows how long to finish a landfill, 4 months for preparation, 4 months for landfill liner construction, 7 months for excavation and placement, 2 months for capping. One thing should be noted is that most of these actions are only available in dry season which is from November to April of next year.

[19] Environmental assessment of dioxin contamination at Bien Hoa Airbase. (USAID)



GRASS
Designed to prevent surface erosion

SOIL
For cover

GEOCOMPOSITE LAYER
To protect the geomembrane and provide drainage of the overlying soil cover

PLASTIC (LLDPE) GEOMEMBRANE
Offers good ultraviolet and chemical resistance

CLAY
To prevent infiltration

CONTAMINANT

PLASTIC (HDPE) GEOMEMBRANE
Forms the primary barrier to leachate migration

GEOCOMPOSITE LAYER
Contain leak collection system

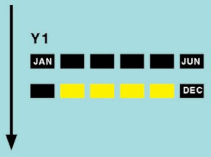
PLASTIC (HDPE) GEOMEMBRANE

CLAY

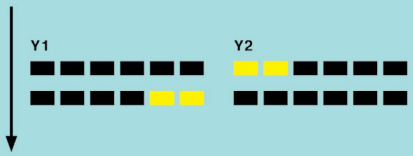
COMPACTED SOIL SUBGRADE

LANDFILL ALTERNATIVE SCHEDULE

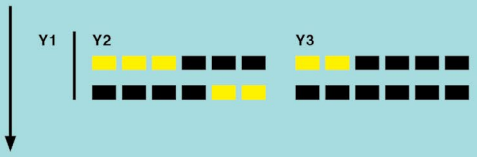
EQUIPMENT, FACILITIES AND PROJECT AREA SET UP



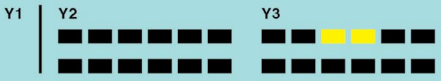
CONSTRUCTON OF LANDFILL LINER AND LEACHATE COLLECTION SYSTEM

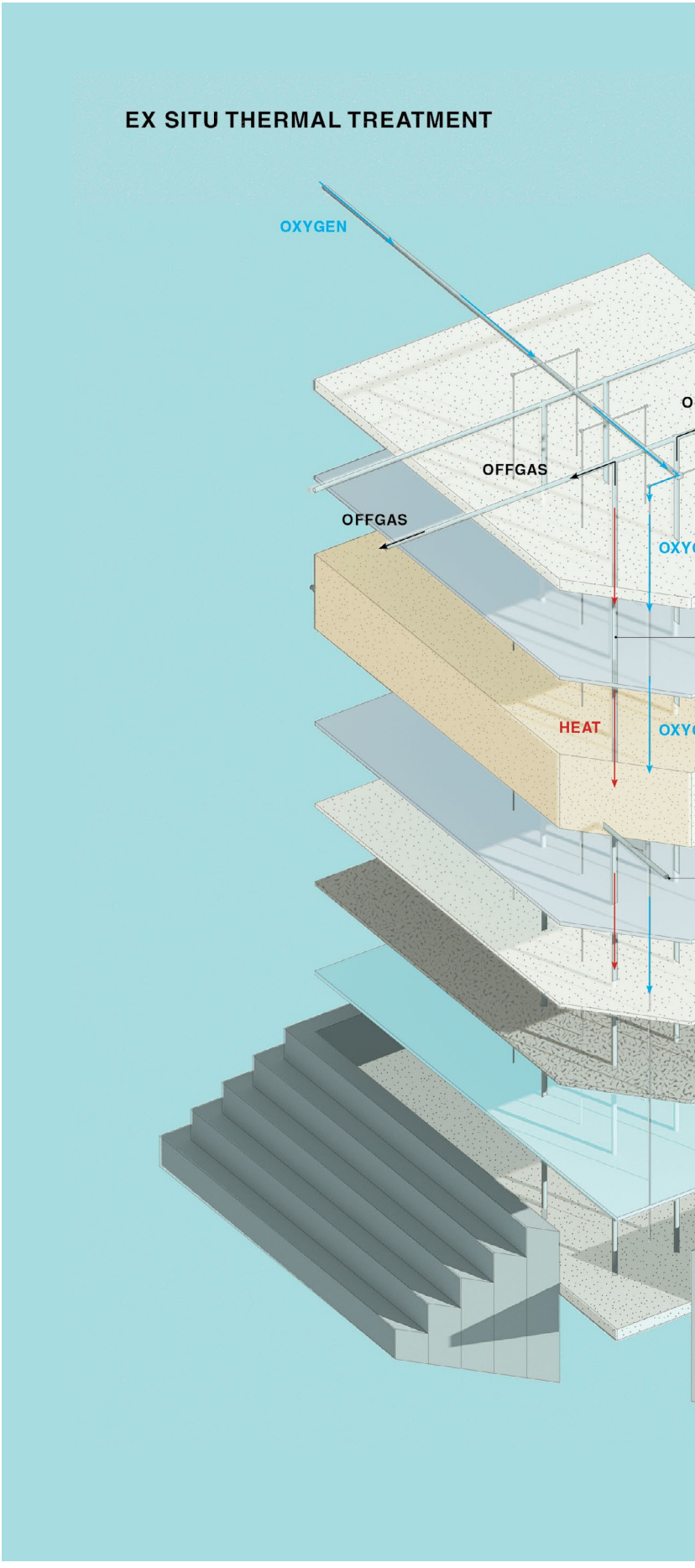


EXCAVATION AND PLACEMENT OF MATERIAL



CONSTRUCTON OF LANDFILL CAP



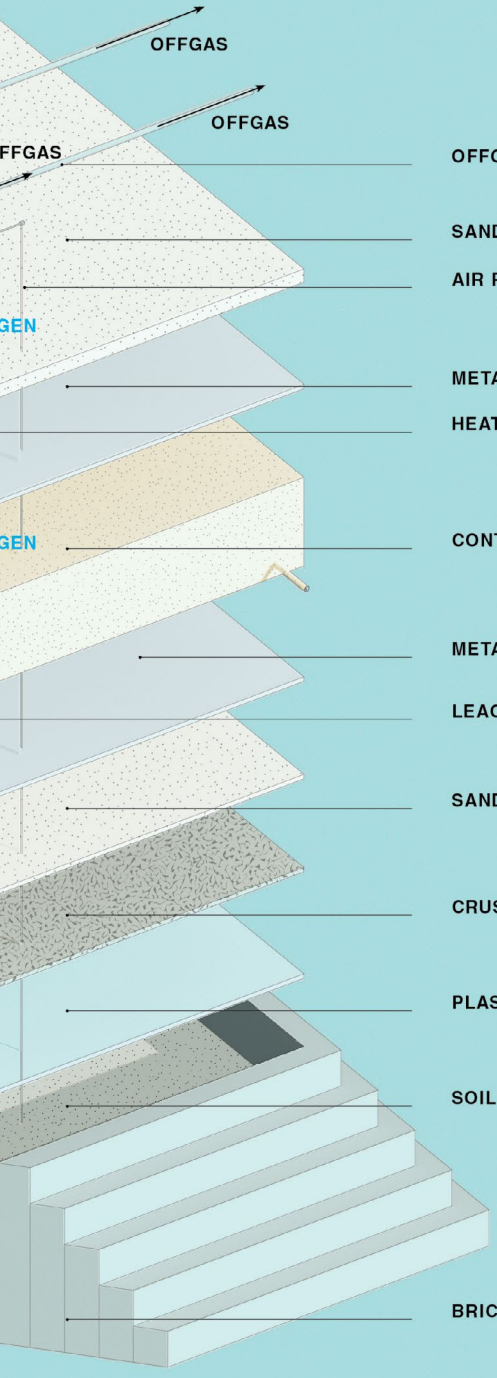


Thermal treatment [19]

This is how Thermal treatment works, it has been used in another contaminated airbase Da nang airbase in Viet Nam. The thermal treatment strategy involves three major steps: building an enclosed, above ground treatment structure; excavating and placing the dioxin-contaminated soil and sediment into the structure; and heating the contaminated soil and sediment to a high temperature (approximately 335°C) to destroy the dioxin. (USAID)

Thermal treatment is much more complicated, we need to construct that pile first, then excavate and haul the matrial, fill the pile, start treatment process the sample and unload the pile. It will cost, positively, around four years to finish it.

[19] Environmental assessment of dioxin contamination at Bien Hoa Airbase. (USAID)



OFFGAS COLLECTING PIPE

SAND

AIR PIPE

METAL SHEET

HEATER WELL

CONTAMINANT

METAL SHEET AND INSULATING CONCRETE

LEACHATE PIPE

SAND

CRUSHED STONE

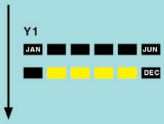
PLASTIC BOTTOM LINER

SOIL

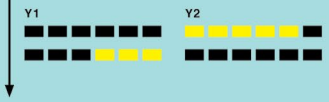
BRICK PILE

EX SITU THERMAL TREATMENT SCHEDULE

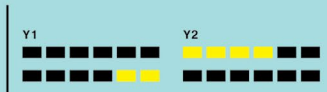
EQUIPMENT, FACILITIES AND PROJECT AREA SET UP



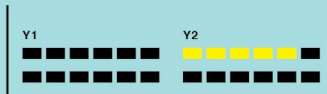
EX SITU TCH SYSTEM CONSTRUCTION



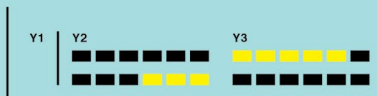
EXCAVATION AND HAULING OF MATERIAL



FILLING THE PILE



CAPPING AND COMPLETING THE PILE

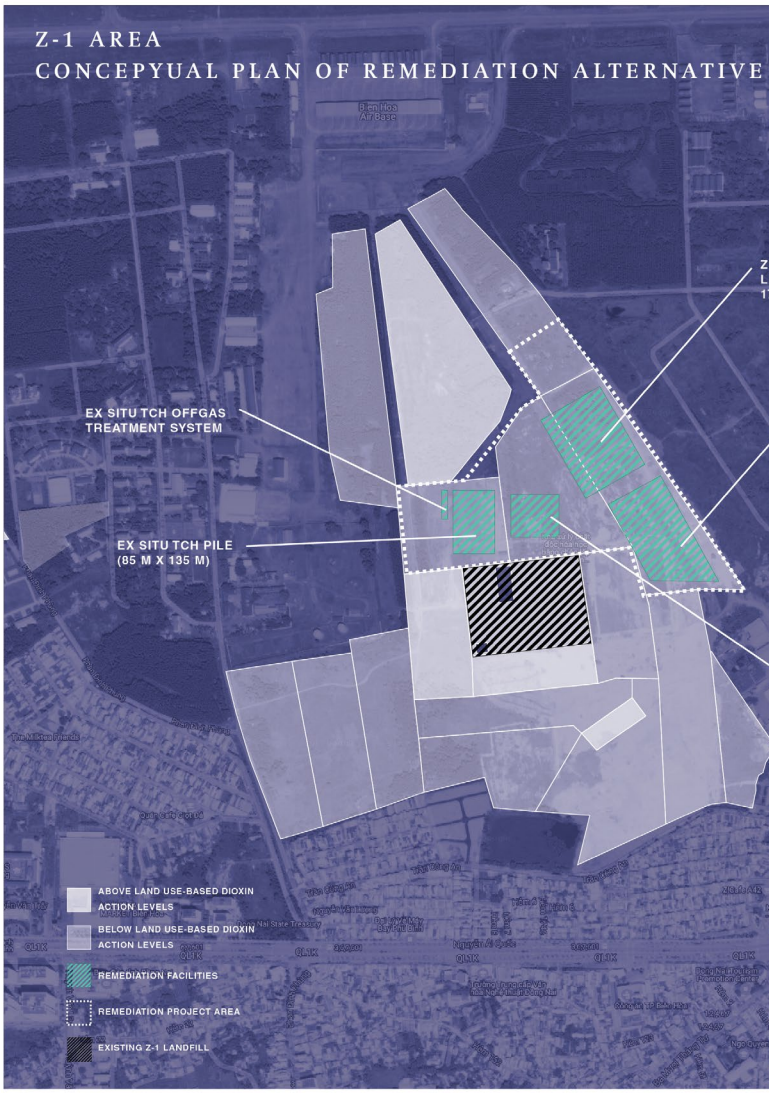


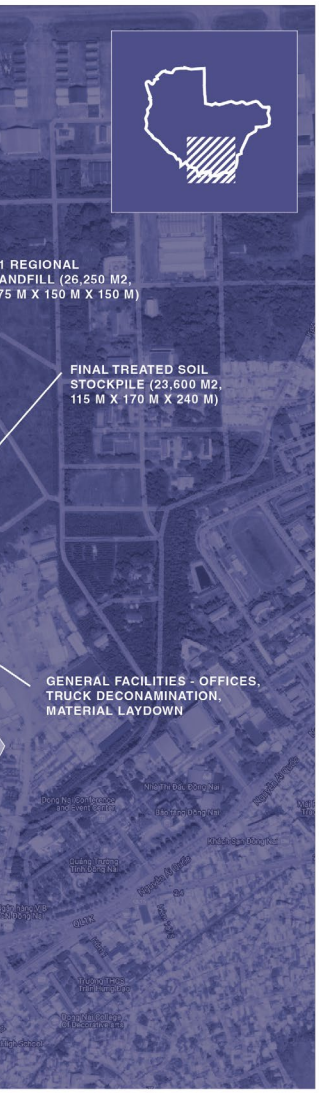
THERMAL TREATMENT

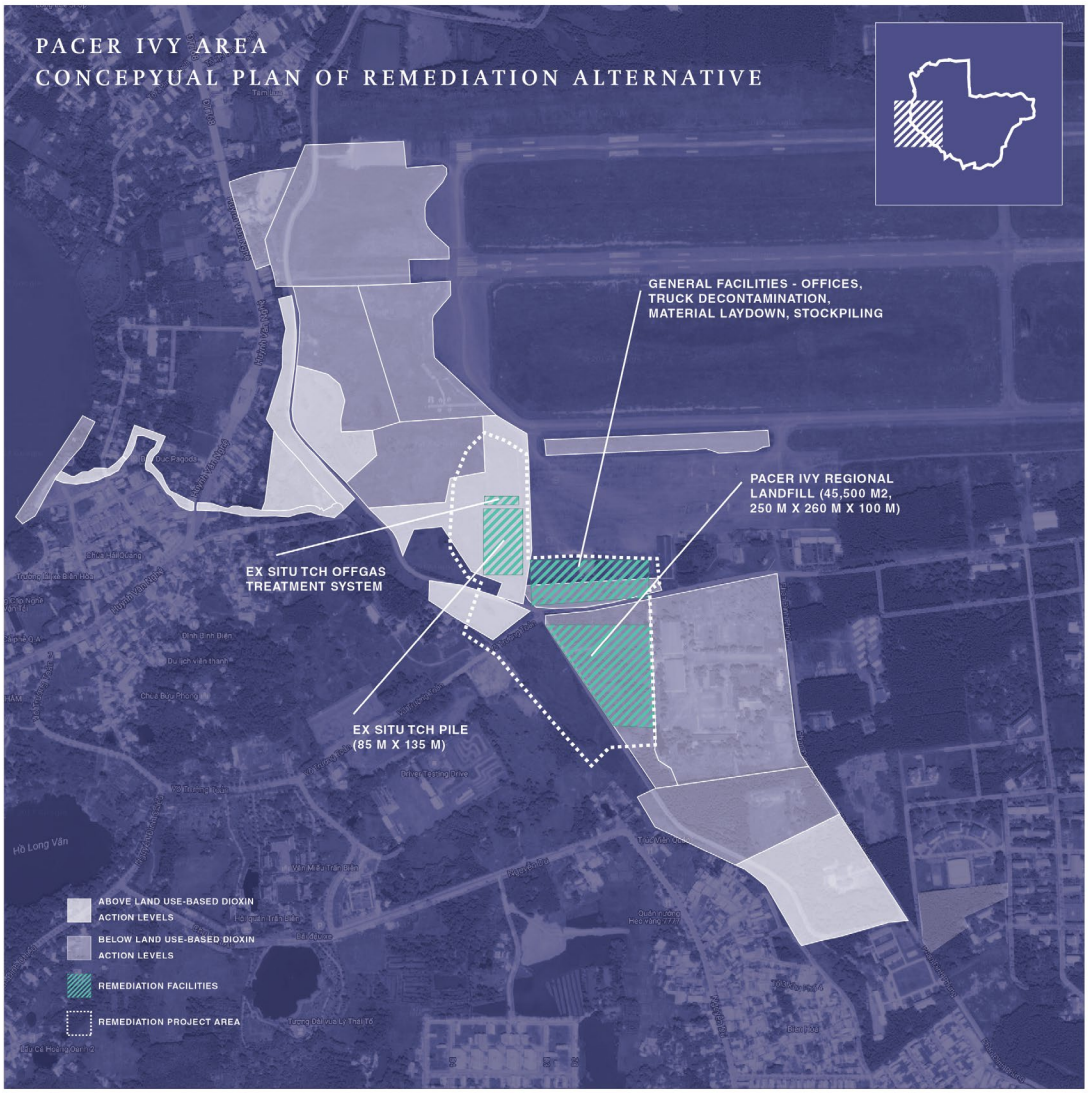
PILE SAMPLING AND UNLOADING

PRIORITY AREA

These two are conceptual plans for two hotspots on the site, the first one called Pacer Ivy area located in the west of the site. By calculating the data provided by USAID, this map shows the possible location for facilities constructions. And this one Z-1 Area which is in the south of the site.




1 REGIONAL
ANDFILL (26,250 M2,
75 M X 150 M X 150 M)
FINAL TREATED SOIL
STOCKPILE (23,600 M2,
115 M X 170 M X 240 M)
GENERAL FACILITIES - OFFICES,
TRUCK DECONAMINATION,
MATERIAL LAYDOWN


PACER IVY AREA
CONCEPYUAL PLAN OF REMEDIATION ALTERNATIVE
GENERAL FACILITIES - OFFICES,
TRUCK DECONTAMINATION,
MATERIAL LAYDOWN, STOCKPILING
PACER IVY REGIONAL
LANDFILL (45,500 M2,
250 M X 260 M X 100 M)
EX SITU TCH OFFGAS
TREATMENT SYSTEM
EX SITU TCH PILE
(85 M X 135 M)
ABOVE LAND USE-BASED DIOXIN
ACTION LEVELS
BELOW LAND USE-BASED DIOXIN
ACTION LEVELS
REMEDIATION FACILITIES
REMEDIATION PROJECT AREA

CHAPTER 5:

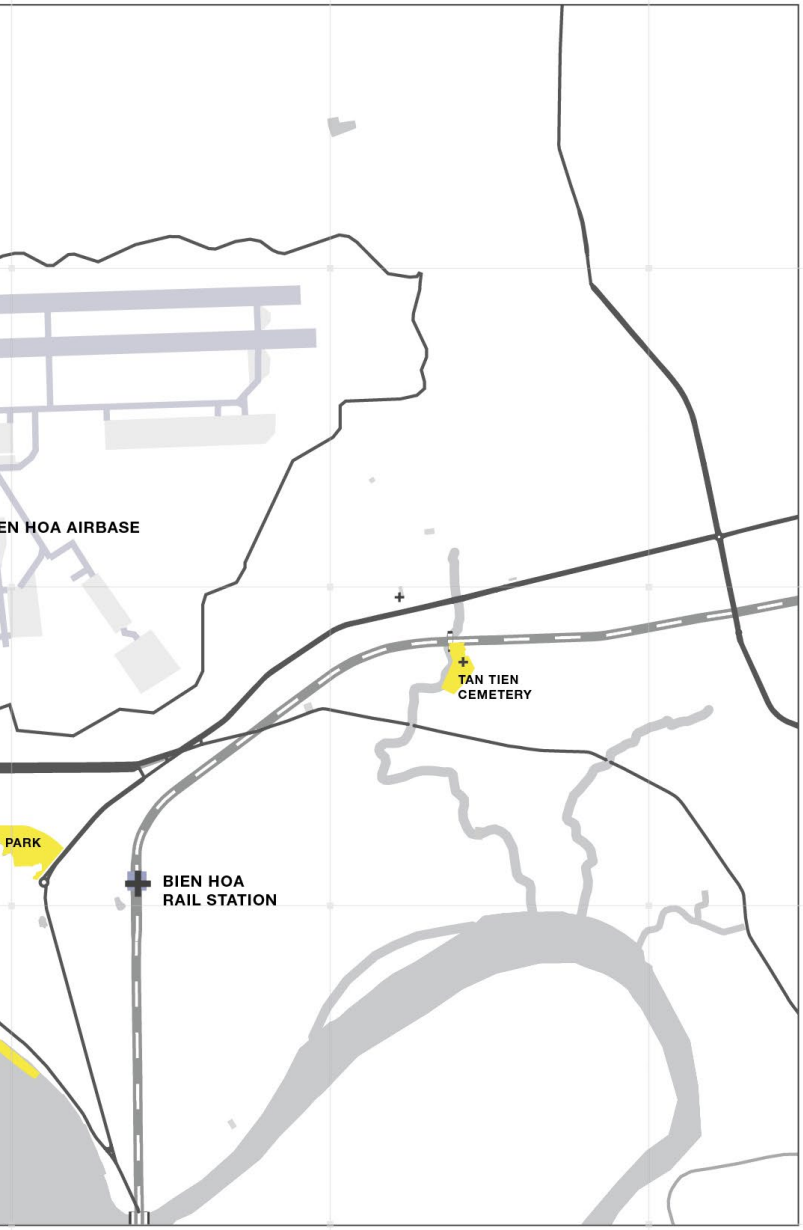
FUTURE PLAN OF THE SITE

EXISTING PROBLEMS

In March of 2017, I have traveled to Bien Hoa and stayed there for 3 days, I have talk to Maura Patterson, an Environmental Remediation Advisor at USAID, requested her opinion about available remediation alternatives, and interviewed several local community members about their opinion on the site by the assistance of Mr. Phuc Nguyen Manh.

By talking to local community, and contact local authority. Some problems which might affect the directions of future planning of this airbase.

First, the municipality want innovate this former military airbase to a civilian/military hybrid airbase. And they also want to develop the tourism industry of Bien Hoa city. This map shows the tourism attractions around site. And we need to try to connect the site to nearby attractions.



TOURISM STASTICS

17
HOTELS,
BIEN HOA

420
HOTEL ROOMS,
BIEN HOA

44 Million USD
TOURISM REVENUE,
2013

235 Million USD
TOURISM REVENUE,
2020 EXPECTATION

3.2 Million
VISITORS,
2013

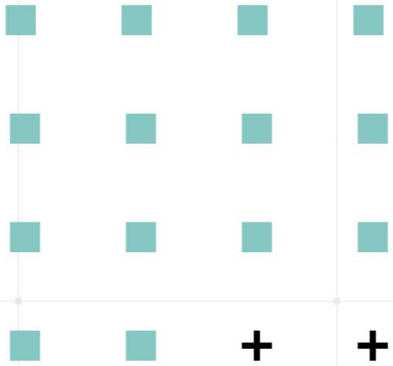
5.8 Million
VISITORS,
2020 EXPECTATION

BIEN HOA CITY ARE PROMOTING ITS TOURISM INDUSTRY FROM 2013, IT DOES HAVE GREAT TOURISM POTENTIAL. DIVERSIFYING TOURISM FORMS AND IMPROVING TOURISM PRODUCT QUALITY IS CONSIDERED ONE OF IMPORTANT TASKS OF THE DONG NAI TOURISM SECTOR. TO IMPROVE THIS SITUATION AND CREATE AN EFFECTIVE RIVERWAY TOURISM ROUTE, THE DEPARTMENT OF CULTURE, SPORTS AND TOURISM WILL COLLABORATE WITH THE DEPARTMENT OF TRANSPORT TO CONDUCT SURVEYS ON WHARVES FOR OPENING WATERWAY TOURISM ROUTES. AS EXPECTED, WHARVES WILL BE BUILT WITH TOURISM STANDARDS: BEAUTIFUL, SAFE AND PROFESSIONAL.

EXISTING PROBLEMS

Another problem is, there are so many schools south of the airbase. Including elementary, high schools and college. However, only one military museum and one university library are available to the citizens, the public education resource is in urgent need.

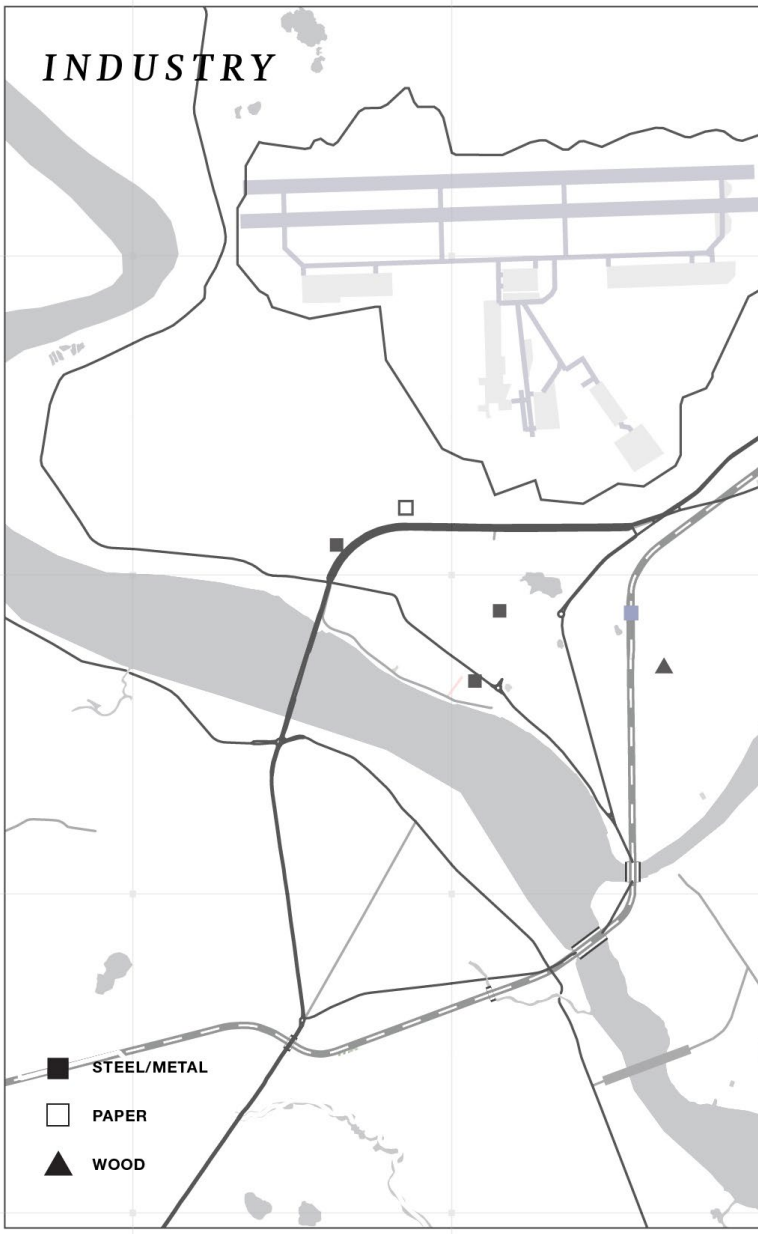
EDUCATION FACILITIES DENSITY COMPARISON



THERE ARE MULTIPLE SCHOOLS DISTRIBUTED AROUND THE SITE INCLUDING ELEMENTARY SCHOOLS, MIDDLE SCHOOLS, TRAINING CENTRES AND COLLEGES. HOWEVER, PUBLIC EDUCATION RESOURCE ARE IN A DEEP NEED. THE ONLY PUBLIC EDUCATION RESOURCE AROUND SITE IS ONE UNIVERSITY LIBRARY AND A MILLITARY MUSEUM.

EXISTING PROBLEMS

This map shows different industries around site, most of heavy industries are located in this industrial park. And the city government is trying to move most heavy industrial facilities which scattered around the Airbase and riverfront into this industrial park which is good for us to include more open space and recreational spots in our plan.



PRIMARY INDUSTRY

WOOD PROCESSING

METAL/STEEL PROCESSING

PAPER PRODUCING

SECONDARY INDUSTRY

BATTERY

MOTORBIKE

REFRIDGRATION EQUIPMENT

REFINED SUGAR

POWDERED MILK

CAUSTIC SODA

PRIOR TO 1975 THE CITY'S INDUSTRIAL PARK DISTRICT HAD INDUSTRIES PRODUCING STEEL, METAL PRODUCTS, REFRIGERATION EQUIPMENT, MOTORBIKES, BATTERIES, PAPER PRODUCTS, CAUSTIC SODA, AND RADIOS. THE INDUSTRIAL PARK UNDERWENT HEAVY DAMAGE DURING THE FIGHTING IN 1975, BUT MANY FACTORIES WERE RESTORED TO OPERATION AND NEW FACTORIES WERE CONSTRUCTED. PAPER PULP, PRESSED WOOD, ROLLED STEEL, REFINED SUGAR AND POWDERED MILK.

EXISTING SITUATION

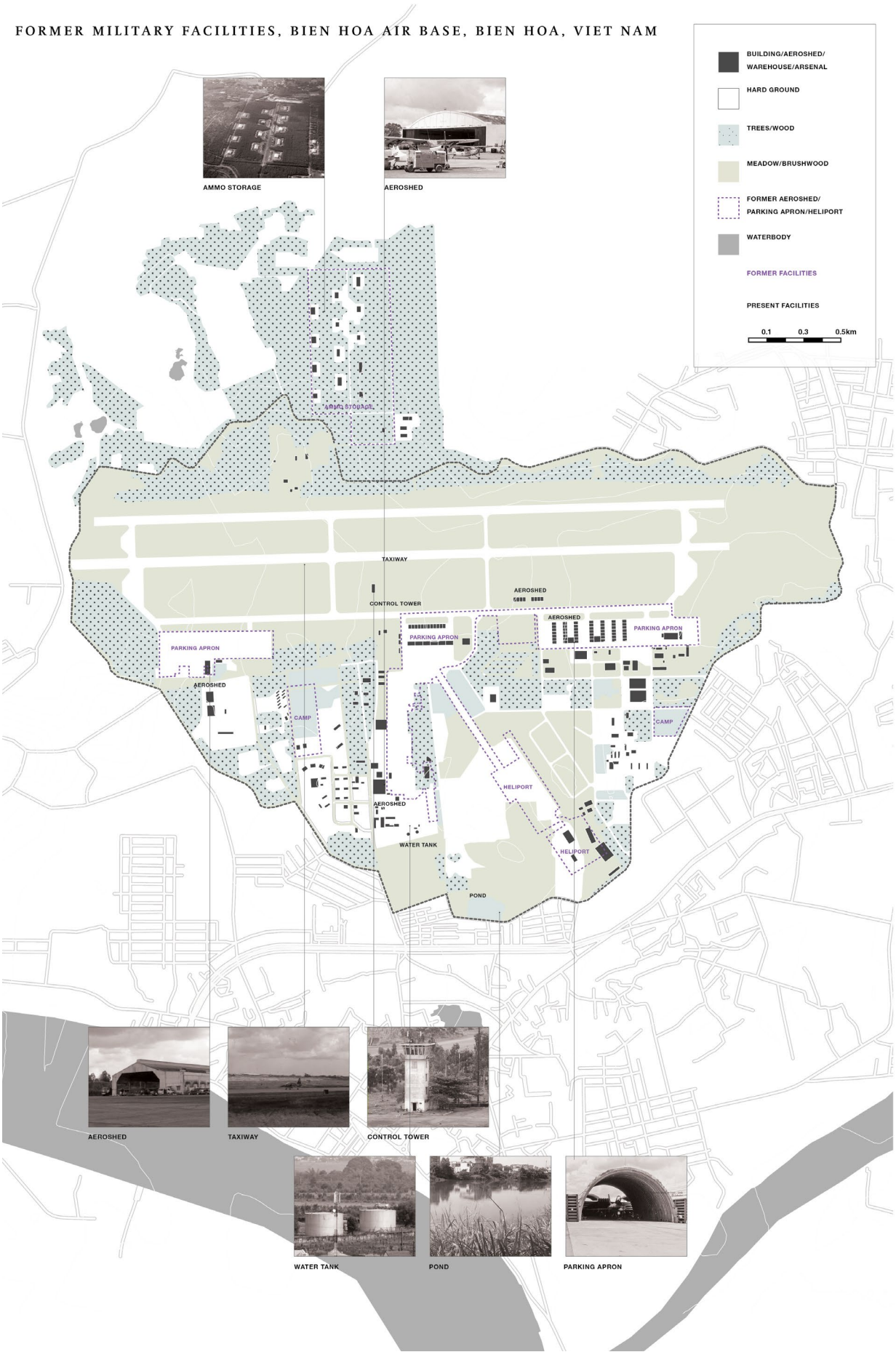
This map shows the land use of the airbase and most of remnant facilities have been marked on this map, aircraft runways, warehouses, control tower, watch tower, water tank, and many more.

It is notable that part of these remnant facilities are in a good shape which means it might be more economic and meaningful to reuse those facilities with new functions rather than simply remove them.






FORMER MILITARY FACILITIES, BIEN HOA AIR BASE, BIEN HOA, VIET NAM



PHASING PLAN

This phasing plan introduce my future vision about this site in ecological and social perspective.

The goal of this phasing plan is to provide a guidance of several future directions for stakeholders. Especially how to connect remediation process to the future development of the airbase.

The 1960-2000 part of diagram shows the historical causes of contamination and the existing situation of the site.

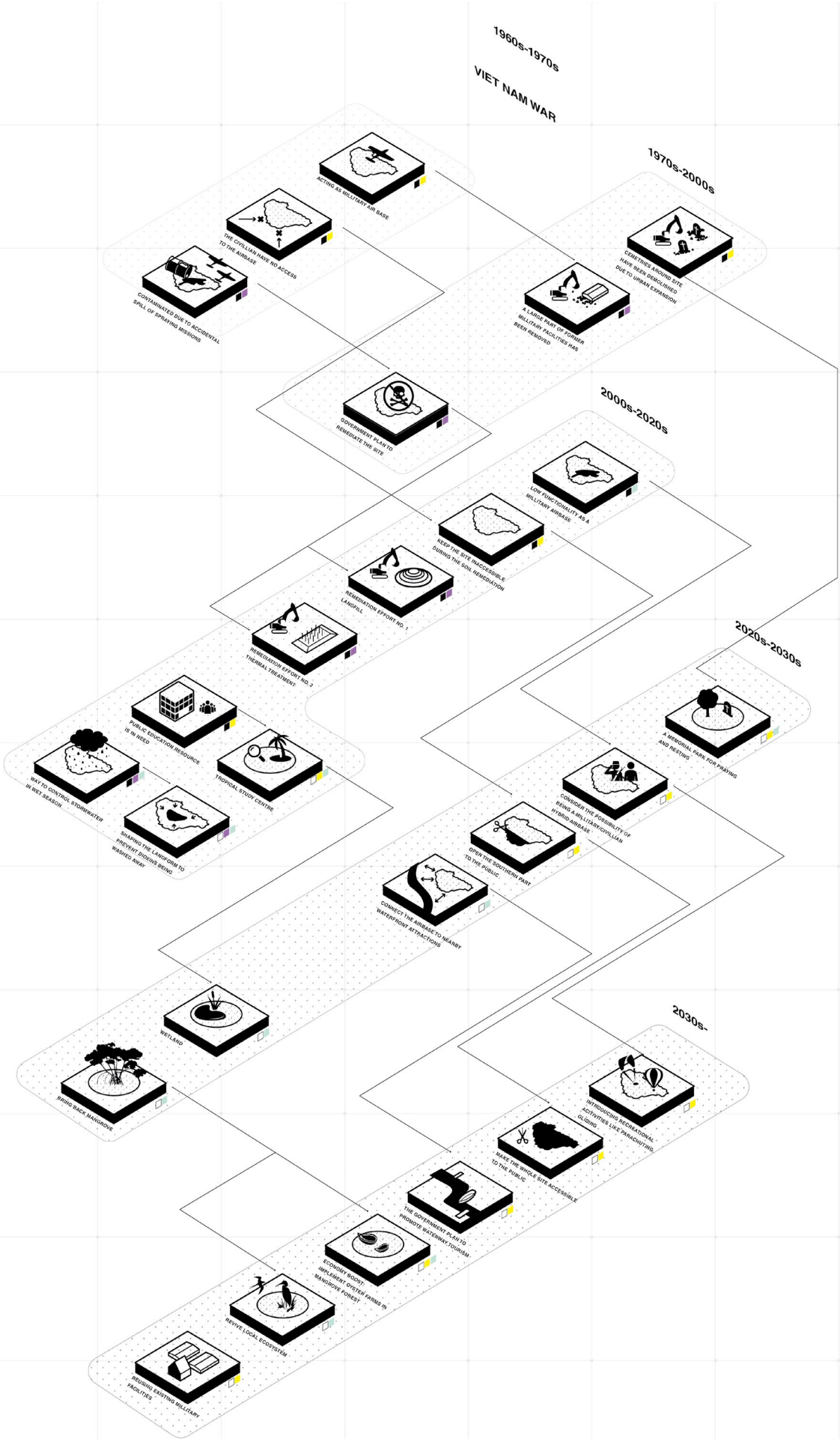
The first planning phase 2000-2020s is the core processes of remediation including possible remediation alternatives and planning of reusing former military facilities.

The second phase 2020-2030s is focusing on the far future development of the airbase including opening the border of the airbase, connecting airbase to the Dong Nai Riverfront area and using ecological efforts to boost local economy like bringing back mangrove forest and implementing oyster farm.

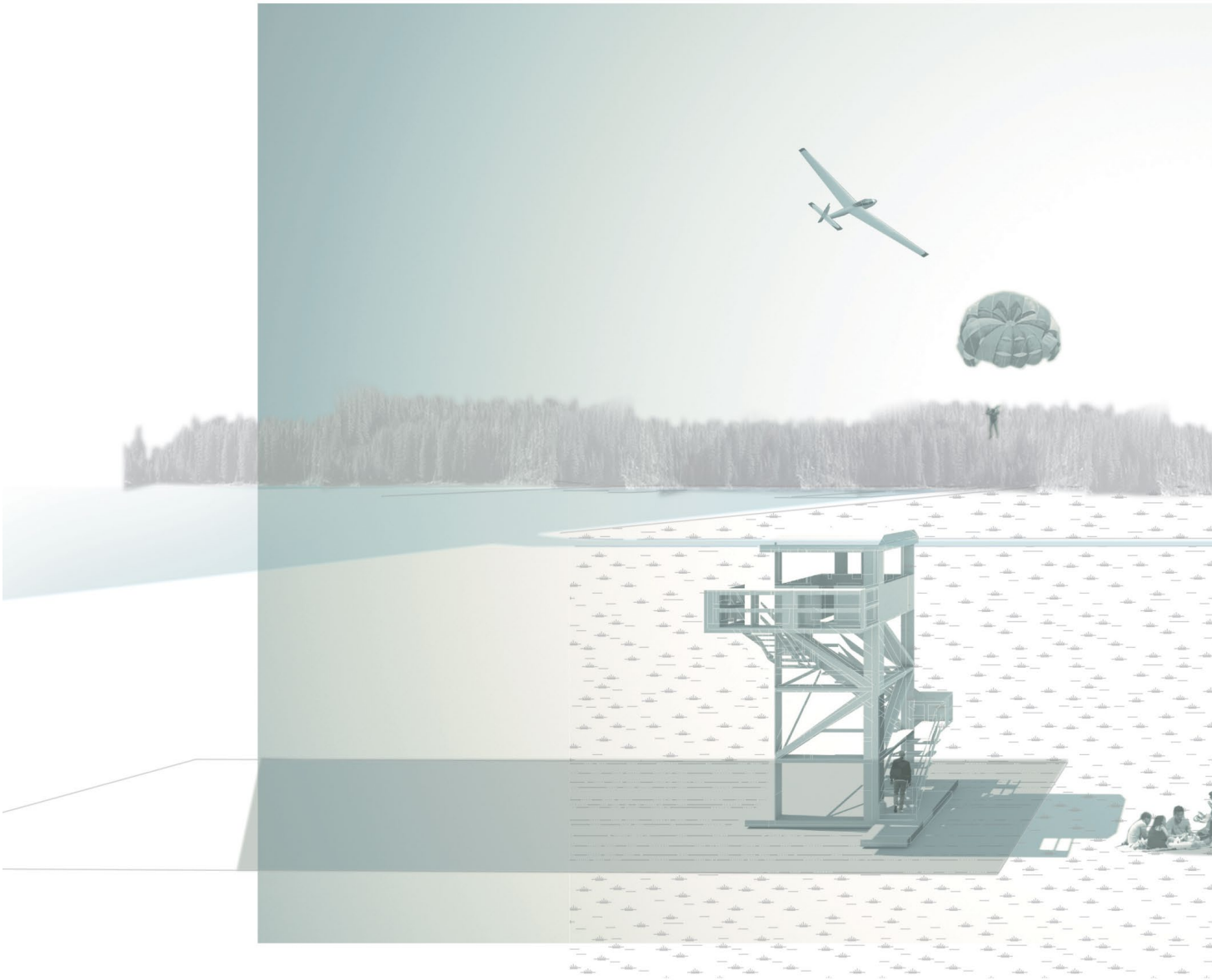
Some specific strategies include,
Using wetland and land form of this site to create a tropical study centre. Altering former aircraft runway as a large open space for recreation, creating activities like parachuting, hot balloons, light airplane flying.

There are a lot of tombs and cemeteries that have been demolished due to government's development expansion, a memorial park located on former helicopter field will be a good place for memorializing and praying, especially for those relatives sacrificed in the warfare.

Bringing back mangrove forest, mangrove is native to this area, and mangrove forest is excellent place to reconstruct local ecosystems. It might also stimulate local economy for creating space for agriculture like oyster farming.


1960s-1970s
VIET NAM WAR
ACTING AS MILITARY AIR BASE
THE CIVILLIAN HAVE NO ACCESS TO THE AIRBASE
CONTAMINATED DUE TO ACCIDENTAL SPILL OF SPRAYING MISSIONS
1970s-2000s
CEMETERIES AROUND SITE HAVE BEEN DEMOLISHED DUE TO URBAN EXPANSION
A LARGE PART OF FORMER MILITARY FACILITIES HAS BEEN REMOVED
GOVERNMENT PLAN TO REMEDIATE THE SITE
2000s-2020s
LOW FUNCTIONALITY AS A MILITARY AIRBASE
KEEP THE SITE INACCESSIBLE DURING THE SOIL REMEDIATION
REMEDIATION EFFORT NO. 1
LANDFILL
REMEDIATION EFFORT NO. 2
THERMAL TREATMENT
2020s-2030s
A MEMORIAL PARK FOR PRAYING AND RESTING
CONSIDER THE POSSIBILITY OF BEING A MILITARY-CIVILLIAN HYBRID AIRBASE
OPEN THE SOUTHERN PART TO THE PUBLIC
CONNECT THE AIRBASE TO NEARBY WATERFRONT ATTRACTIONS
PUBLIC EDUCATION RESOURCE IS IN NEED
WAY TO CONTROL STORMWATER IN WET SEASON
TROPICAL STUDY CENTRE
SHAPING THE LANDFORM TO PREVENT DIOXINS BEING WASHED AWAY
WETLAND
BRING BACK MANGROVE
2030s-
INTRODUCING RECREATIONAL ACTIVITIES LIKE PARACHUTING, GLIDING ...
MAKE THE WHOLE SITE ACCESSIBLE TO THE PUBLIC
THE GOVERNMENT PLAN TO PROMOTE WATERWAY TOURISM
ECONOMY BOOST: IMPLEMENT OYSTER FARMS IN MANGROVE FOREST
REVIVE LOCAL ECOSYSTEM
REUSING EXISTING MILITARY FACILITIES

PHASING PLAN VISUALIZATION



FORMER RUNWAY AS
PARACHUTING FIELD

PHASING PLAN VISUALIZATION

FORMER AIRCRAFT PARKING FIELD AS
VIETNAM WAR MEMORIAL PARK

FORMER TIDAL FLAT AS
MANGROVE FOREST AND OYSTER FARM

EPILOGUE

Chemical Warfare has caused painful casualties on human history and left immeasurable impacts on ecosystems on our planet. It is critical to restrain the regulations or even completely forbid the use of chemical weapons for the brightness of our future.

On the other hand, landscape architects should take more social responsibility. As landscape architects, we need to spare our efforts to recover the land we forfeited in the chemical and to provide long-term greatness of natural world.

The thesis project provides me a valuable opportunity to get a closer look at the relationship between landscape design and former military facilities. More specifically, what is the most powerful impact of warfare? What are these doomed leftovers and how can we deal with that? We usually talk about soil remediation but how does it undergo more specifically?

In the future, following the guidance of my phasing plan, more efforts will be put into eloborating specific design schemes of the Pacer Ivy Area (which is suitable to connect to the Dong Nai River Front for recreational space) and Z-1 Area (the main body of the airbase).