Nuclear Weapons in 300 Minutes (or Less!)

William Spaniel

https://williamspaniel.com/classes/nuclearpolitics2019/

Outline

- The Nuclear Club (and Friends)
- Why Proliferate?
- Effects of Proliferation
- Managing the Atom

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United States (1945)

- Manhattan Project
- Hiroshima and Nagasaki bombings
- Would have been a lot worse if the Nazi scientists had won the race
  - …but fortunately the Nazis were Naziing


USA
33
Enrico
Fermi

Soviet Union (1949)

- Manhattan Project spies
- US knew the Soviets were developing a bomb but chose not to launch preventive war
  - Immediately after WWII
  - No intelligence
- Cold War starts in earnest

United Kingdom (1952)

- Tube Alloys
- Agreement with the United States

France (1960)

- France and the United States do not have as intimate a relationship as the U.S. and the U.K.
- France sought strategic independence

China (1964)

- Sino-Soviet split

India (1974)

- India does not like Pakistan very much
- Tested the “Smiling Buddha,” a “peaceful nuclear explosion,” in 1974
- Remained mostly dormant until 1998. (Hold that thought…)

Israel (1979)

- Israel does not have nuclear weapons

South Africa (1979)

- The Vela Incident
  - A US satellite (Vela Hotel) detected a flash in the Atlantic Ocean between South Africa and Antarctica
- Built due to concerns of civil war spillover from Angola
- Dismantled at the end of Apartheid

Soviet Successor States

- Ukraine, Kazakhstan, and Belarus had nuclear weapons on their soil during the Soviet Union's breakup
- Moscow still had command control
- Countries accepted cash to dismantle the weapons and forgo native nuclear development

Pakistan (1998)

- Five weeks after India's nuclear tests in 1998, Pakistan tested six bombs
- Pakistan is now "too nuclear to fail"
- A.Q. Khan network

The 1998 Ig Nobel Prize Winners

The 1998 Ig Nobel Prizes were awarded at the 8th First Annual Ig Nobel Prize Ceremony, at Harvard's Sanders Theatre. The ceremony was webcast live.

SAFETY ENGINEERING: Troy Hurtubise, of North Bay, Ontario, for developing, and personally testing a suit of armor that is impervious to grizzly bears. [REFERENCE: "Project Grizzly", produced by the "National Film Board of Canada. ALSO: *Bear Man: The Troy Hurtubise Saga*, by Troy Hurtubise, Raven House Publishing, Westbrook, ME, USA, 2011.]

BIOLOGY: Peter Fong of Gettysburg College, Gettysburg, Pennsylvania, for contributing to the happiness of clams by giving them Prozac.

[REFERENCE: "Induction and Potentiation of Parturition in Fingernail Clams (Sphaerium striatinum) by Selective Serotonin Re- Uptake Inhibitors (SSRIs)," Peter F. Fong, Peter T. Huminski, and Lynette M. D'urso, "Journal of Experimental Zoology, vol. 280, 1998, pp. 260-64.]

PEACE: Prime Minister Shri Atal Bihari Vajpayee of India and Prime Minister Nawaz Sharif of Pakistan, for their aggressively peaceful explosions of atomic bombs.

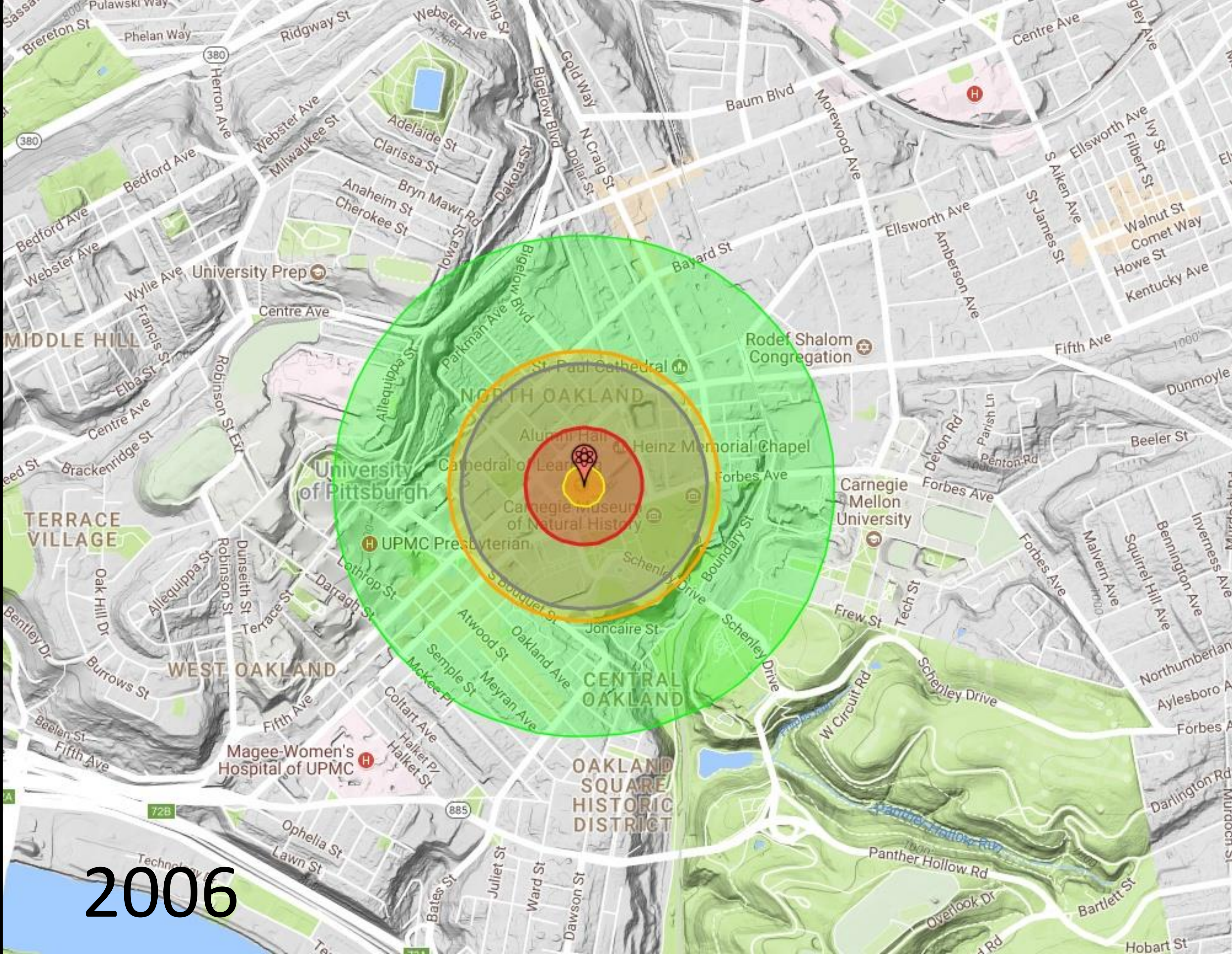
CHEMISTRY: Jacques Benveniste of France, for his homeopathic discovery that not only does water have memory, but that the information can be transmitted over telephone lines and the Internet. [NOTE: Benveniste also won the 1991 Ig Nobel Chemistry Prize.]

[REFERENCE:"Transatlantic Transfer of Digitized Antigen Signal by Telephone Link," J. Benveniste, P. Jurgens, W. Hsueh and J. Aissa, "Journal of Allergy and Clinical Immunology - Program and abstracts of papers to be presented during scientific sessions AAAAI/AAI.CIS Joint Meeting February 21-26, 1997"]

SCIENCE EDUCATION: Dolores Krieger, Professor Emerita, New York University, for demonstrating the merits of therapeutic touch, a method by which nurses manipulate the energy fields of ailing patients by carefully avoiding physical contact with those patients.

North Korea (2006)

- Conducted crummy tests in 2006 (possibly a fizzle), 2009, and 2013
- Scarier tests twice in 2016 and once in 2017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Parkman Ave
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St. Paul Cathedral
Rodef Shalom Congregation
Fifth Ave
Dunmoyle St
NORTH OAKLAND
Alumni Hall
Heinz Memorial Chapel
Devon Rd
Parish Ln
Beeler St
Penton Rd
University of Pittsburgh
Cathedral of Learning
Forbes Ave
Carnegie Mellon University
Forbes Ave
Carnegie Museum of Natural History
TERRACE VILLAGE
UPMC Presbyterian
Boundary St
Schenley Drive
Forbes Ave
Malvern Ave
Squirrel Hill Ave
Bennington Ave
Inverness Ave
Murdoch Rd
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Robinson St
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Frew St
Tech St
Atwood St
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Burrows St
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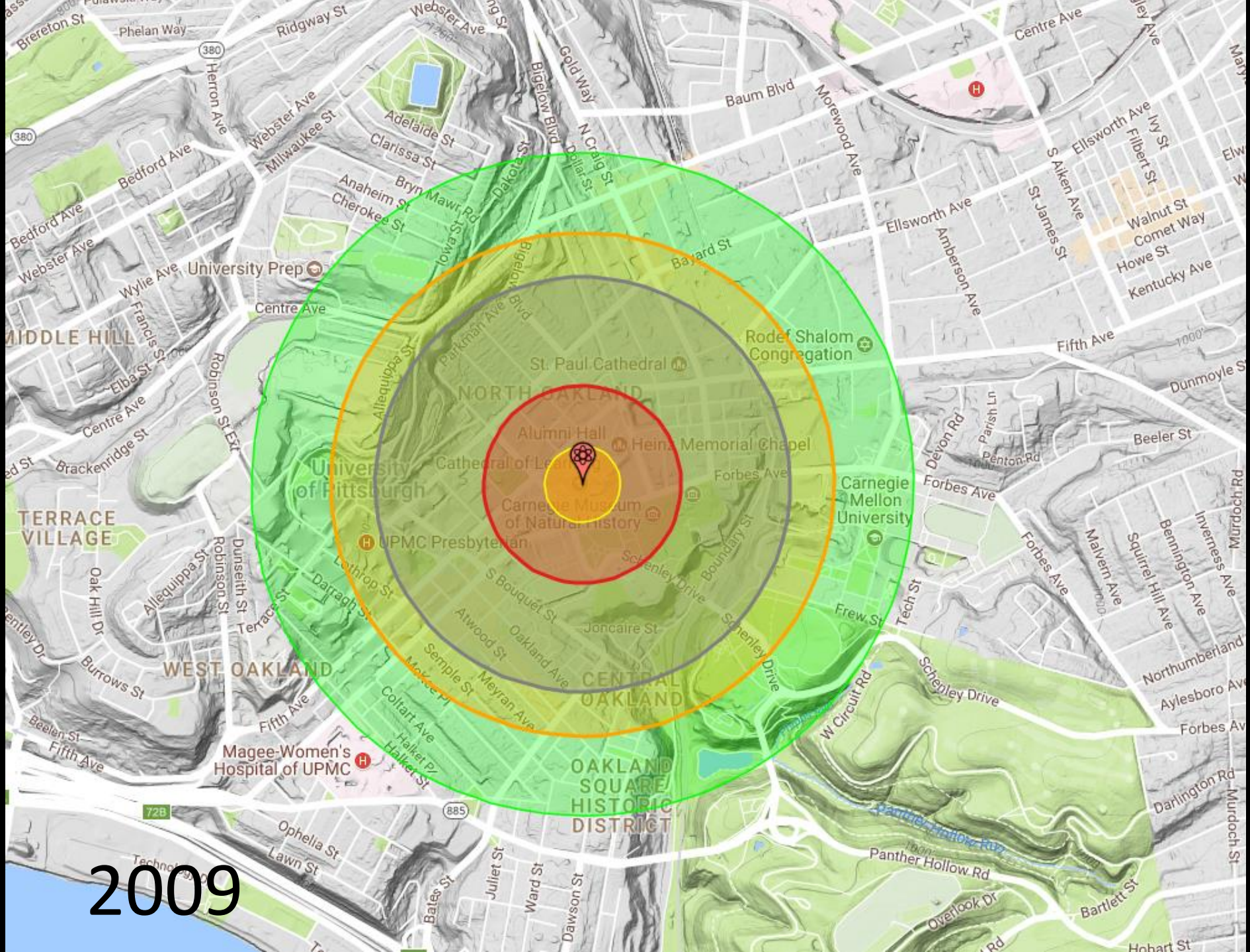
Semple St
Meyran Ave
McKee Pl
CENTRAL OAKLAND
Northumberland
Aylesboro Ave
Schenley Drive
W Circuit Rd
Fifth Ave
Coltart Ave
Halket Pl
Halket St
Forbes Ave
Beelen St
Fifth Ave
Magee-Womens Hospital of UPMC
OAKLAND SQUARE HISTORIC DISTRICT
Darlington Rd
Murdoch St
Ophelia St
Lawn St
Panther Hollow Rd
Panther Hollow Run
Juliet St
Ward St
Dawson St
Bates St
Overlook Dr
Bartlett St
Hobart St

2006


2009
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St James St
Walnut St
Comet Way
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Kentucky Ave
Amberson Ave
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Webster Ave
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Cherokee St
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University Prep
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Bigelow Blvd
St. Paul Cathedral
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Fifth Ave
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Alumni Hall
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WEST OAKLAND
CENTRAL OAKLAND
Burrows St
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W Circuit Rd
Northumberland
Aylesboro Ave
Forbes Ave
Magee-Women's Hospital of UPMC
OAKLAND SQUARE HISTORIC DISTRICT
Darlington Rd
Murdoch St
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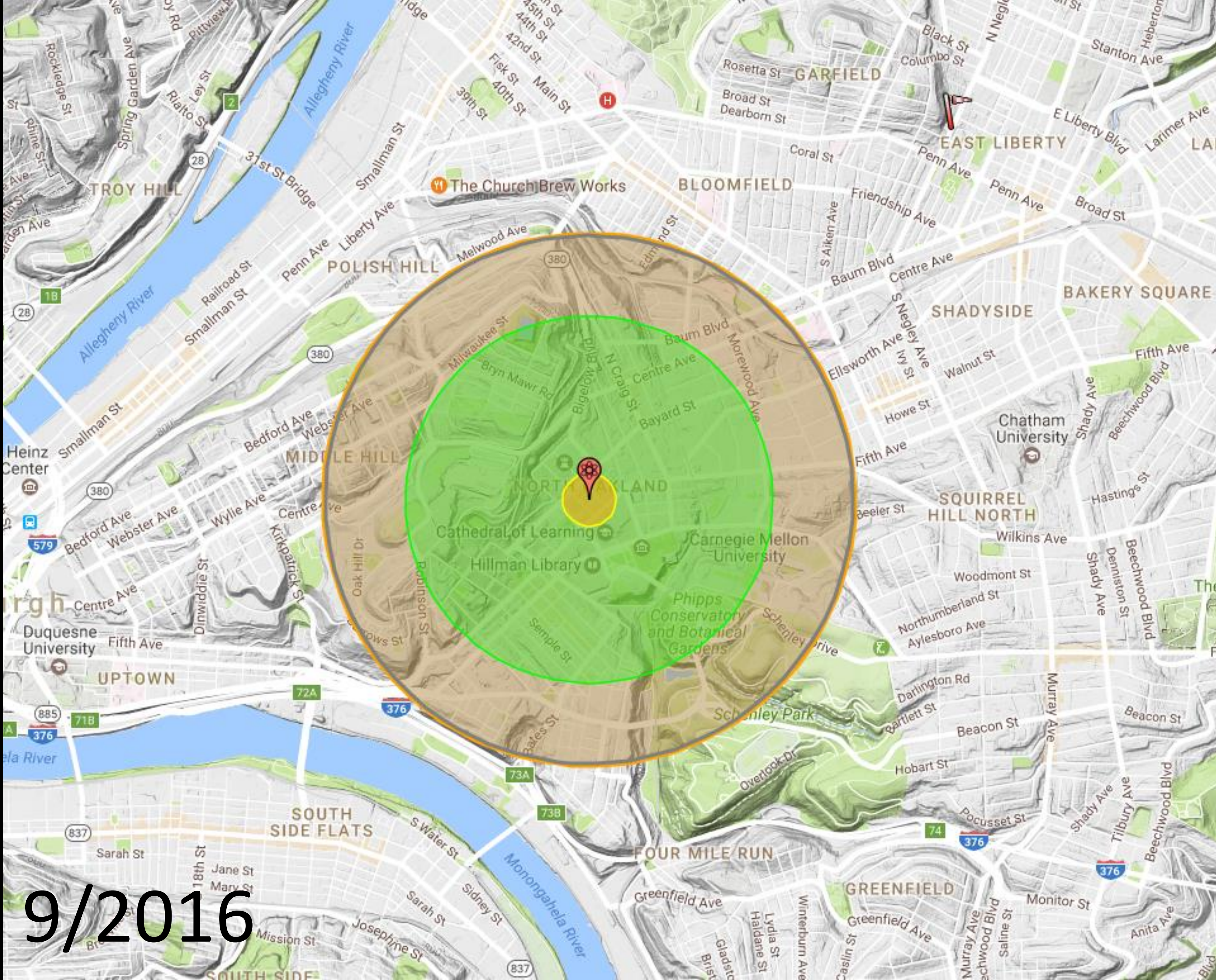
Bates St
Dawson St


GARFIELD
EAST LIBERTY
BLOOMFIELD
The Church Brew Works
TROY HILL
POLISH HILL
BAKERY SQUARE
SHADYSIDE
MIDDLE HILL
NORTH OAKLAND
Cathedral of Learning
Hillman Library
Carnegie Mellon University
Phipps Conservatory and Botanical Gardens
Chatham University
SQUIRREL HILL NORTH
Heinz Center
Duquesne University
UPTOWN
Schenley Park
SOUTH SIDE FLATS
FOUR MILE RUN
GREENFIELD
Allegheny River
Monongahela River
Baum Blvd
Centre Ave
Fifth Ave
Forbes Ave
Penn Ave
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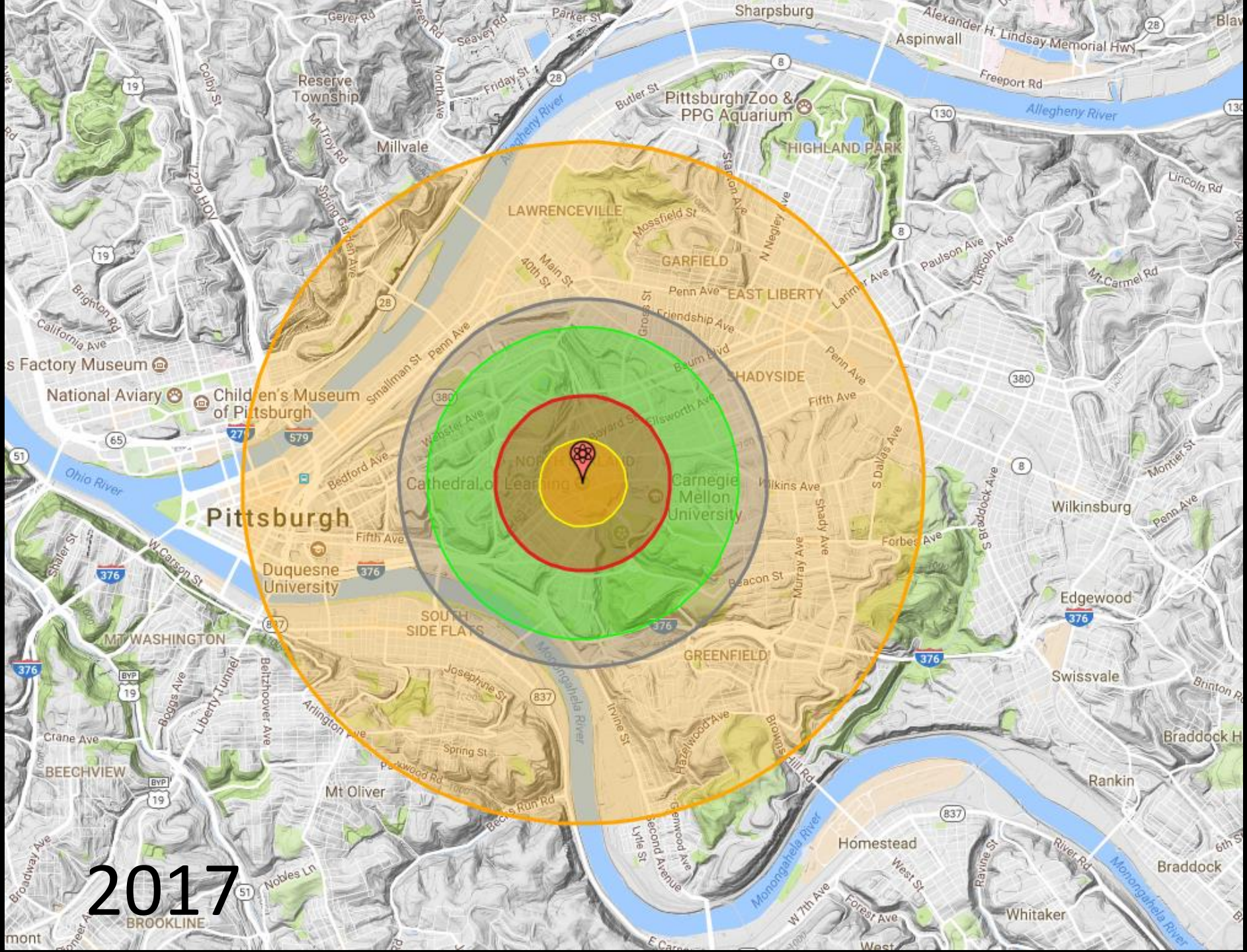
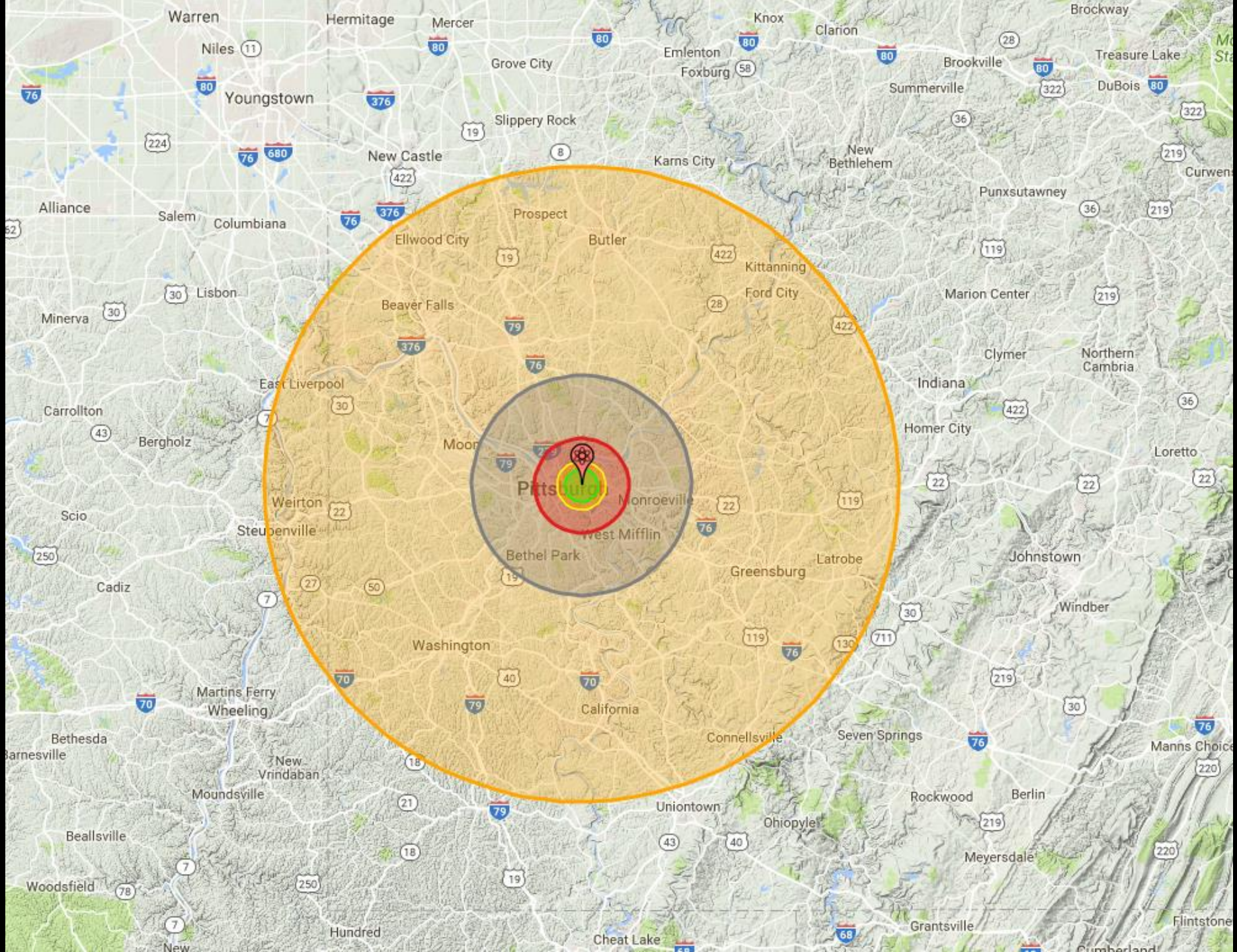
Smallman St
Bigelow Blvd
Morewood Ave
Murray Ave
Shady Ave
Beechwood Blvd
Greenfield Ave

9/2016


2017
Pittsburgh
LAWRENCEVILLE
GARFIELD
EAST LIBERTY
SHADYSIDE
HIGHLAND PARK
Carnegie Mellon University
Duquesne University
SOUTH SIDE FLATS
MT WASHINGTON
BEECHVIEW
Mt Oliver
BROOKLINE
GREENFIELD
Millvale
Reserve Township
Sharpsburg
Aspinwall
Pittsburgh Zoo & PPG Aquarium
Wilkinsburg
Edgewood
Swissvale
Rankin
Homestead
Braddock
Whitaker
Allegheny River
Ohio River
Monongahela River


Warren
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DuBois
Slippery Rock
New Castle
Karns City
New Bethlehem
Alliance
Salem
Columbiana
Prospect
Ellwood City
Butler
Punxsutawney
Kittanning
Ford City
Lisbon
Minerva
Beaver Falls
Marion Center
Clymer
Northern Cambria
East Liverpool
Indiana
Carrollton
Bergholz
Homer City
Loretto
Weirton
Pittsburgh
Monroeville
Scio
Steubenville
West Mifflin
Bethel Park
Latrobe
Johnstown
Cadiz
Greensburg
Windber
Washington
Martins Ferry
Wheeling
California
Connellsville
Seven Springs
Manns Choice
Bethesda
New Vrindaban
Moundsville
Uniontown
Rockwood
Berlin
Ohiopyle
Beallsville
Meyersdale
Woodsfield
Hundred
Cheat Lake
Grantsville
Flintstone

Outline

- The Nuclear Club (and Friends)
- Why Proliferate?
- Effects of Proliferation
- Managing the Atom

Argentina/Brazil

- Had simmering tensions in the 1980s
- Both proficient in nuclear technology but opted against proliferating
- Now have a joint nuclear commission and share technology

Australia

- Site of UK's initial nuclear tests
- Largest uranium reserves in the world
- Had a brief exploration

Belarus, Kazakhstan, and Ukraine

- Soviet nuclear weapons
- Ukraine had 3rd largest stockpile
- No command and control
- Allowed Moscow to recover them in exchange for economic concessions

Egypt

- Slow exploration and pursuit in the 1970s
- Effort went away after the Camp David Accords

Iran

- Long running interest in nuclear weapons
- 2015: Joint Comprehensive Plan of Action

Iraq

- Also had long running interest in nuclear weapons
- Never made real progress
- Operation Scorch Sword
- Operation Opera
- Potential motivation for Iraq War

Japan

- Most nuclear proficient country of the non-nuclear weapons states
- US reaffirmed alliance support when Japan moved toward proliferating
- Now is a staunch supporter of non-nuclear norms

Libya

- One of the longest-running programs
- Ultimately went nowhere
- U.S. traded what little progress they made for some minor economic concessions

South Korea

- Another very nuclear proficient non-nuclear weapons state
- US reaffirmed alliance support when South Korea moved toward proliferating

Saudi Arabia

- Has started showing greater interest in nuclear technology since Iran's push

Sweden

- Neutrality preference
- Limited military budget and chose to build conventional weapons instead

Syria

- Very small progress in nuclear science
- Operation Orchard

Taiwan

- US reaffirmed its alliance benefits when Taiwan moved toward proliferating

(West) Germany

- Another highly proficient non-nuclear weapons states
- Has a nuclear weapons “sharing” agreement with the United States

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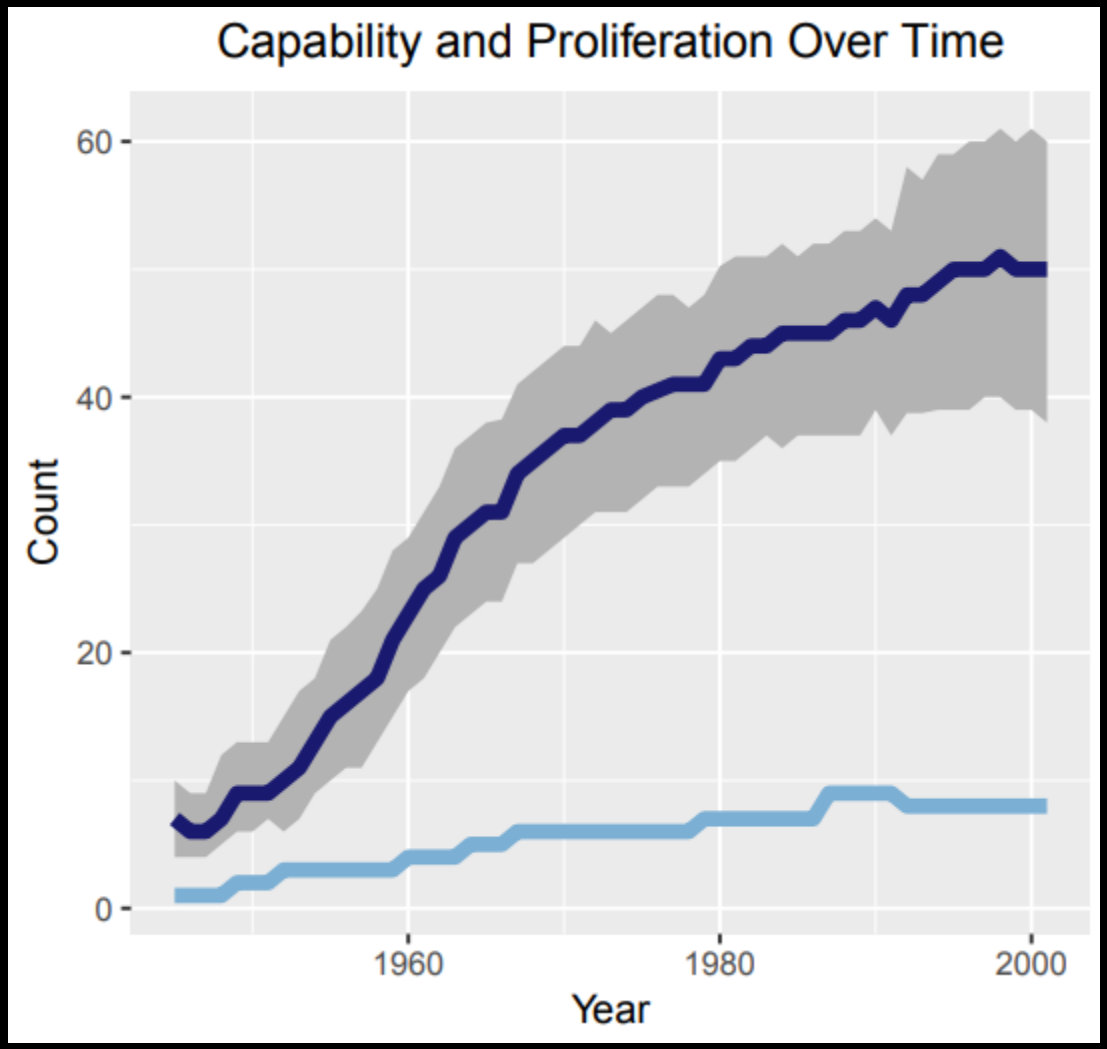
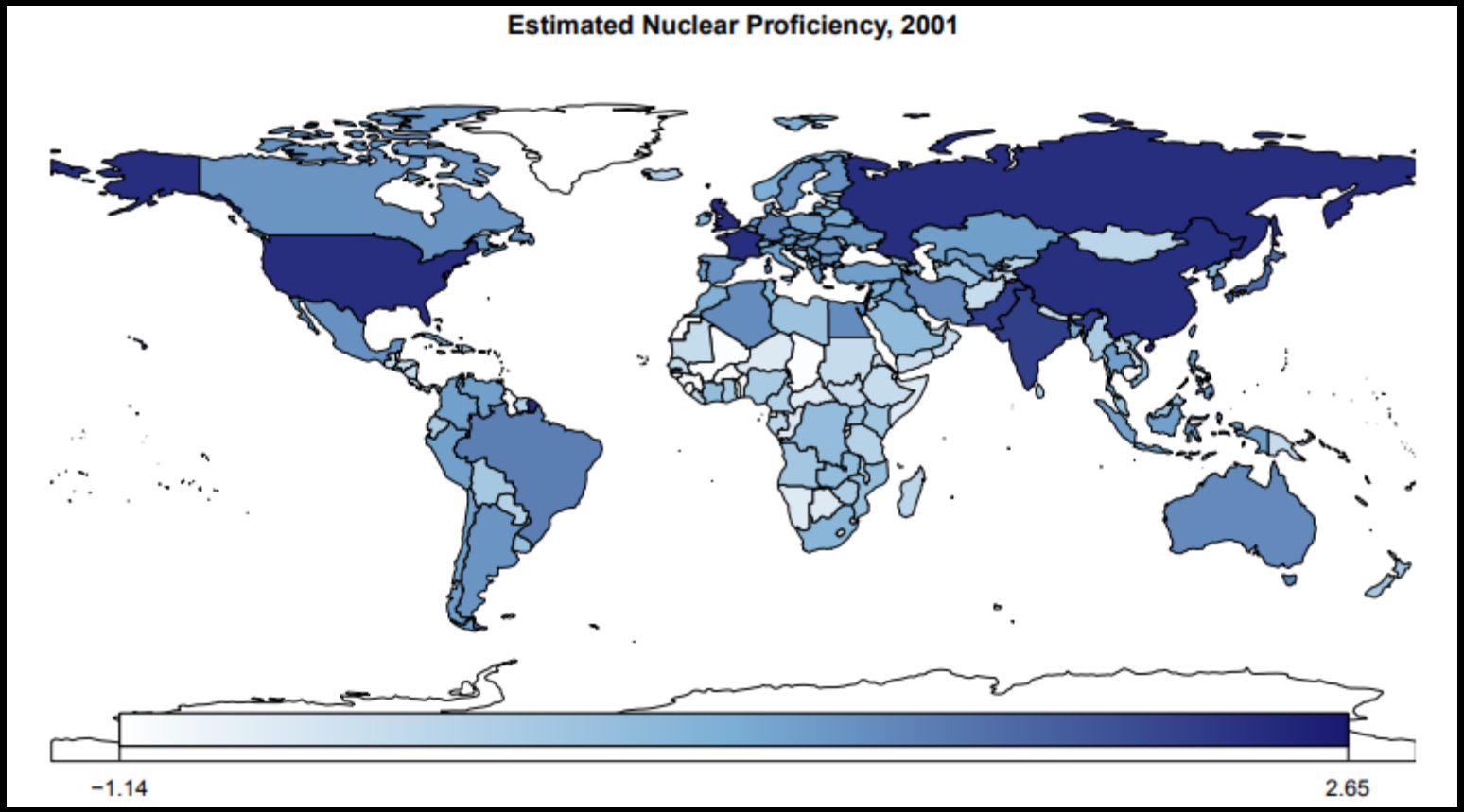
Capacity (Supply Side)

- Can’t build what you don’t understand
- Also need good industrial base (or lots of manpower) to construct weapons
- Explains initial nonproliferation, but does not have much explanatory power anymore


Capability and Proliferation Over Time
60
40
20
0
Count
1960
1980
2000
Year


Estimated Nuclear Proficiency, 2001
−1.14
2.65

Security (Demand Side)

- Main purpose of nuclear weapons is coercive
- Don’t need to build nuclear weapons if you don’t have any disputes

Prestige

- Nuclear weapons possession is an exclusive club
- Makes other countries recognize your importance, allegedly
- Also makes everyone hate you, and there are other things that a state could do with the money

Domestic Politics

- Centralized decision structure makes them useful for insecure autocrats
- But autocrats also take a long time to build weapons

Costs

- Development is expensive, but it’s only one piece
  - Maintenance
  - Delivery
  - Disposal
- There are more costly than actually building a bomb!

Preventive War

- Can’t build nuclear weapons if you don’t have the facilities to do it
- And if you can’t protect your facilities, then you might as well not build them in the first place


TURKEY
IRAN
Mediterranean Sea
SYRIA
LEBANON
Osirak
FUEL TANKS
RELEASED
IRAQ
ISRAEL
JORDAN
EGYPT
SAUDI ARABIA
Erwin P. Released under GFDL through www.en.wikipedia.org


Fordow

Bargaining

- Proliferation causes externalities to others
  - One state's security gain is another's security loss
  - Additional risk of accidental nuclear war
  - Environmental damage from testing
  - Additional risk of black market nuclear technology


KEVIN COSTNER
SERGEY SHNYRYOV
NATALIYA VDOVINA
STANISLAV PETROV
EVERY MOMENT COUNTS
WOODSTOCK FILM FESTIVAL 2014
OFFICIAL SELECTION CPH:DOX 2014
OFFICIAL SELECTION hotDOCS
DENVER FILM FESTIVAL 2014
A PETER ANTHONY AND STATEMENT FILM
THE MAN WHO SAVED THE WORLD
STATEMENT
WWW.THEMANWHOSAVEDTHEWORLDMOVIE.COM

Bargaining

- Why not offer concessions instead?
  - Both win: no costs and no externalities
- Fairly common historically
  - Japan, Taiwan, South Korea, Soviet Successor States, Libya, Iran
- To explain proliferation, we need to first explain why parties couldn't reach a deal instead

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Optimists and Skeptics

- Lots of people think that nuclear weapons are very important
- Lots of other people think they aren’t

Compellence vs. Deterrence

- To compel someone is to convince them to give up something
- To deter someone is to convince someone not to alter the status quo

Compellence vs. Deterrence

- Optimists think that nuclear weapons can compel states to give up concessions
  - Other weapons do that
  - Nuclear weapons are just bigger weapons

Compellence vs. Deterrence

- Pessimists think that nuclear weapons do not work for compellence
  - Is “give me your outlying region or I will nuke you” a credible threat?

Compellence vs. Deterrence

- More people think that nuclear weapons are useful for deterrence
  - Is “if you invade Washington DC, I will nuke you” a credible threat?

Compellence vs. Deterrence

- Some really skeptical people think that nuclear weapons deter only in extreme cases
  - Is “if you invade Hawaii, I will nuke you” a credible threat?
  - Is “if you invade Seoul, I will nuke you” a credible threat?

Compellence vs. Deterrence

- But perhaps this distinction is silly
- Imagine that nuclear weapons are good at deterrence
  - Then they act as an insurance policy in a war
  - That insurance policy raises a state's war payoff
  - If a state has a greater war payoff, then it must receive better negotiated settlements to not fight…
  - …which means it can compel more out of others

Example

- War without nuclear weapons:
  - .1 chance A will win and will get value of 1
  - .3 chance of stalemate and A will get value of .5
  - .6 chance B will win and A will get 0
- A's expected gains are:
  - (.1)(1) + (.3)(.5) + (.6)(0) = .25

Example

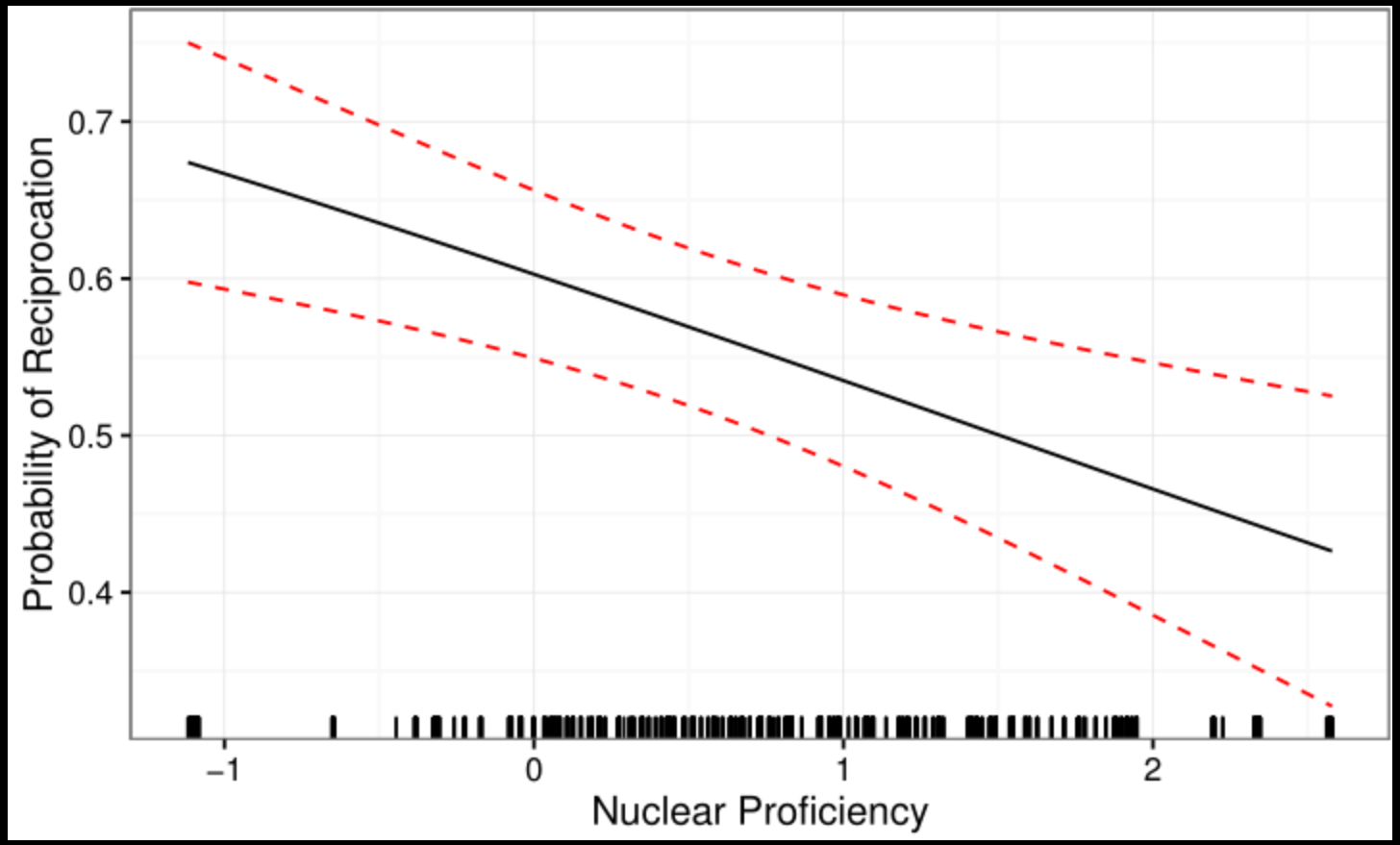
- War with compellent nuclear weapons:
  - .4 chance A will win and will get value of 1
  - .3 chance of stalemate and A will get value of .5
  - .3 chance B will win and A will get 0
- A's expected gains are:
  - (.4)(1) + (.3)(.5) + (.3)(0) = .55

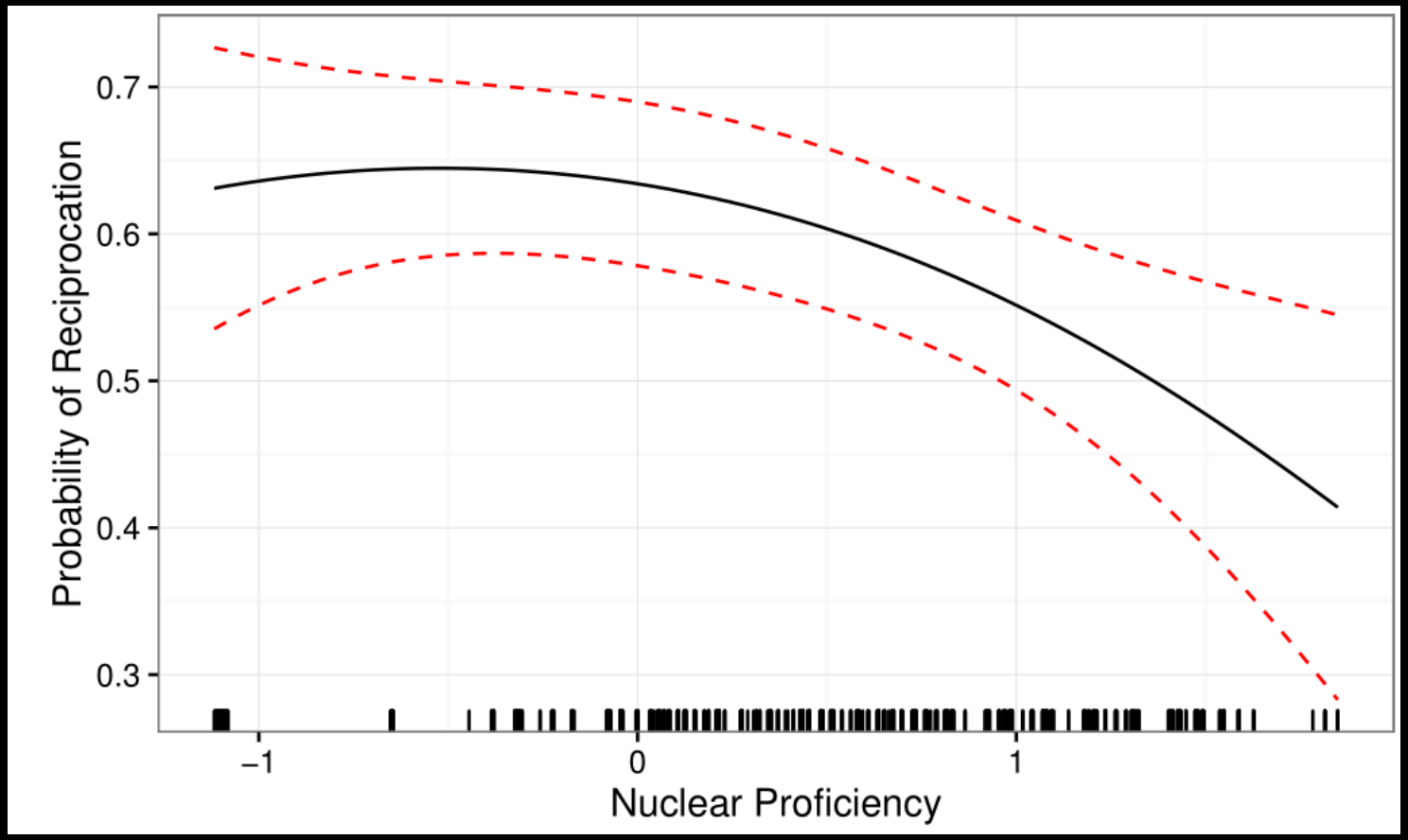
Example

- War with deterrent nuclear weapons:
  - .1 chance A will win and will get value of 1
  - .3 chance of stalemate and A will get value of .5
  - .6 chance B will win but A's nukes deter B from going more than half way, so A earns .5
- A's expected gains are:
  - (.1)(1) + (.3)(.5) + (.6)(.5) = .55

Latent Nuclear Capacity

- Suppose nuclear weapons are useful and states don't want others to develop them
- Then those countries should act with caution when in disputes with countries that could proliferate


Probability of Reciprocation
0.7
0.6
0.5
0.4
−1
0
1
2
Nuclear Proficiency


Probability of Reciprocation
0.7
0.6
0.5
0.4
0.3
−1
0
1
Nuclear Proficiency

Mutually Assured Destruction

- Suppose two nuclear weapons states are self-preserving and possess secured, second-strike capable nuclear weapons
- Is there incentive to fight a war?

Secured Second Strikes

- The United States had three methods of nuclear retaliation
  - Strategic bombers
  - Intercontinental ballistic missiles
  - Submarine-launched ballistic missiles

Secured Second Strikes

- Reason why Soviet Union and United States had way more nuclear weapons than necessary to destroy the entire world
- 68,000 down to 4,100

Instability Paradox

- But if we both have secured second strikes, what stops me from engaging in a conventional war against you?
- You can’t nuke me because I can nuke you right back

Obsolescence

- Some think that major war has been obsolete for a long time
  - Mutually assured destruction did not do much to add to the peace

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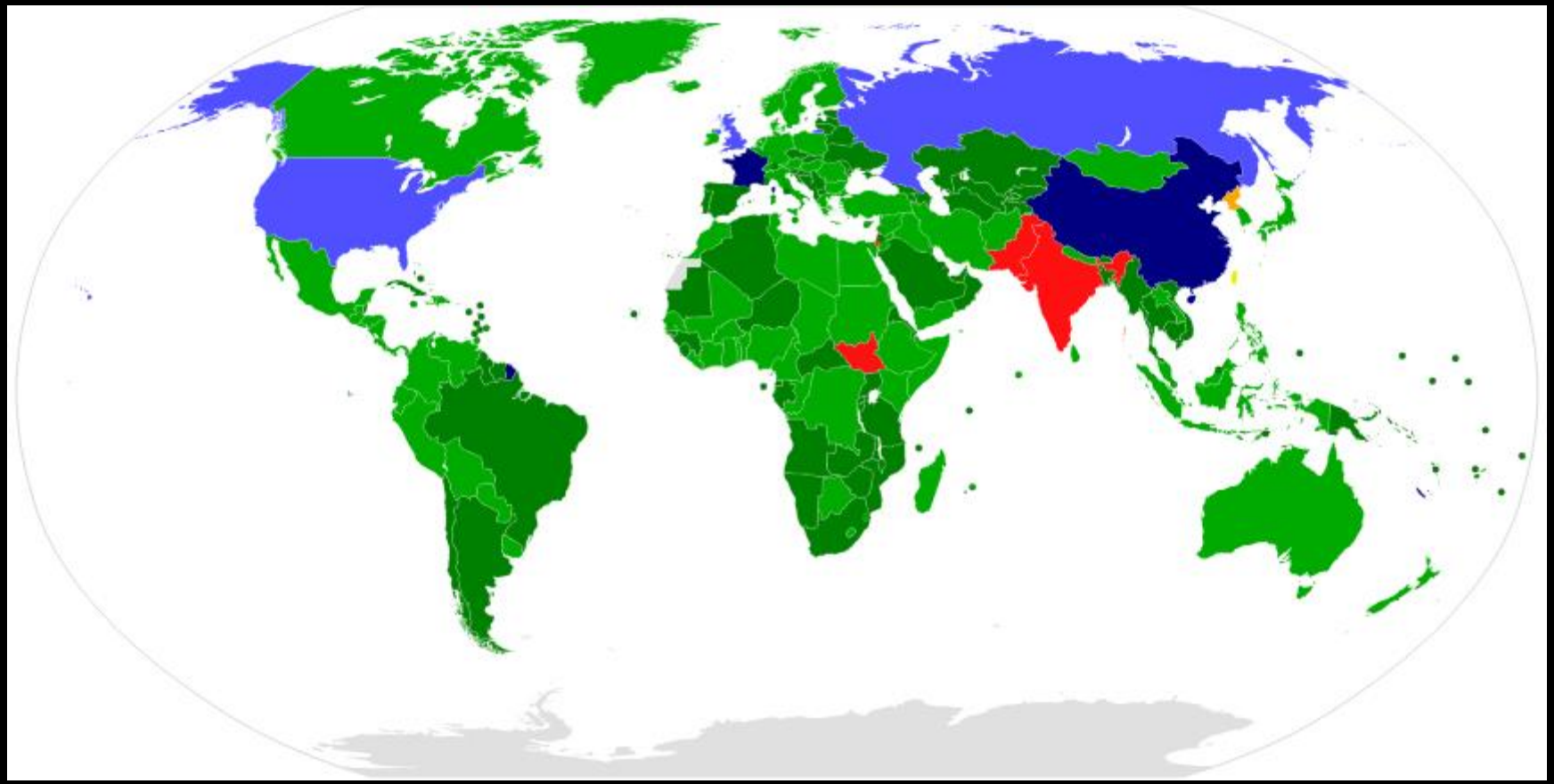
Nuclear Non-Proliferation Treaty

- Developed in 1968
- Obliges recognized nuclear weapons states to work toward eliminating nuclear weapons
- Binds signatories to not develop nuclear weapons



By Some Accounts…

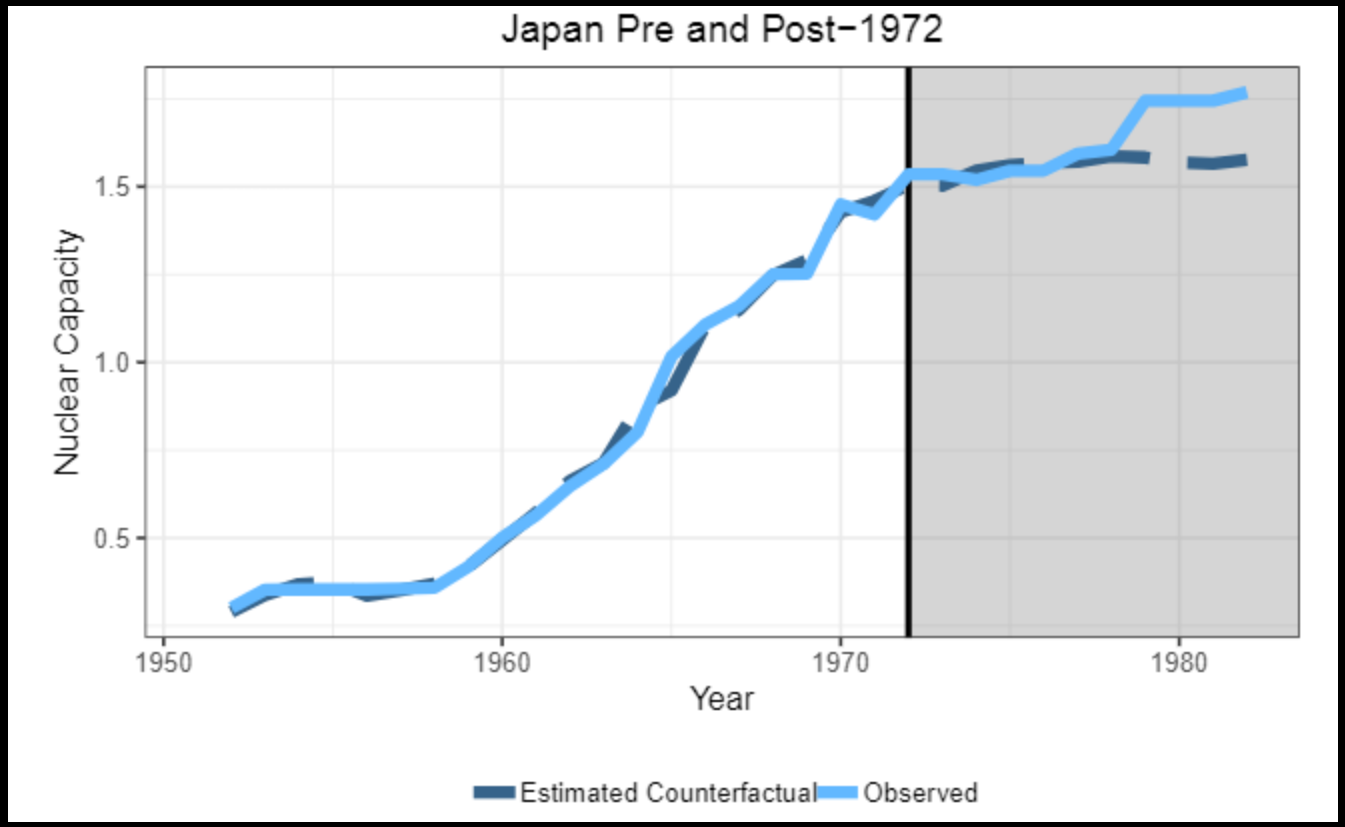
- The best treaty ever
- The worst treaty ever
- A treaty with a marginal but useful effect

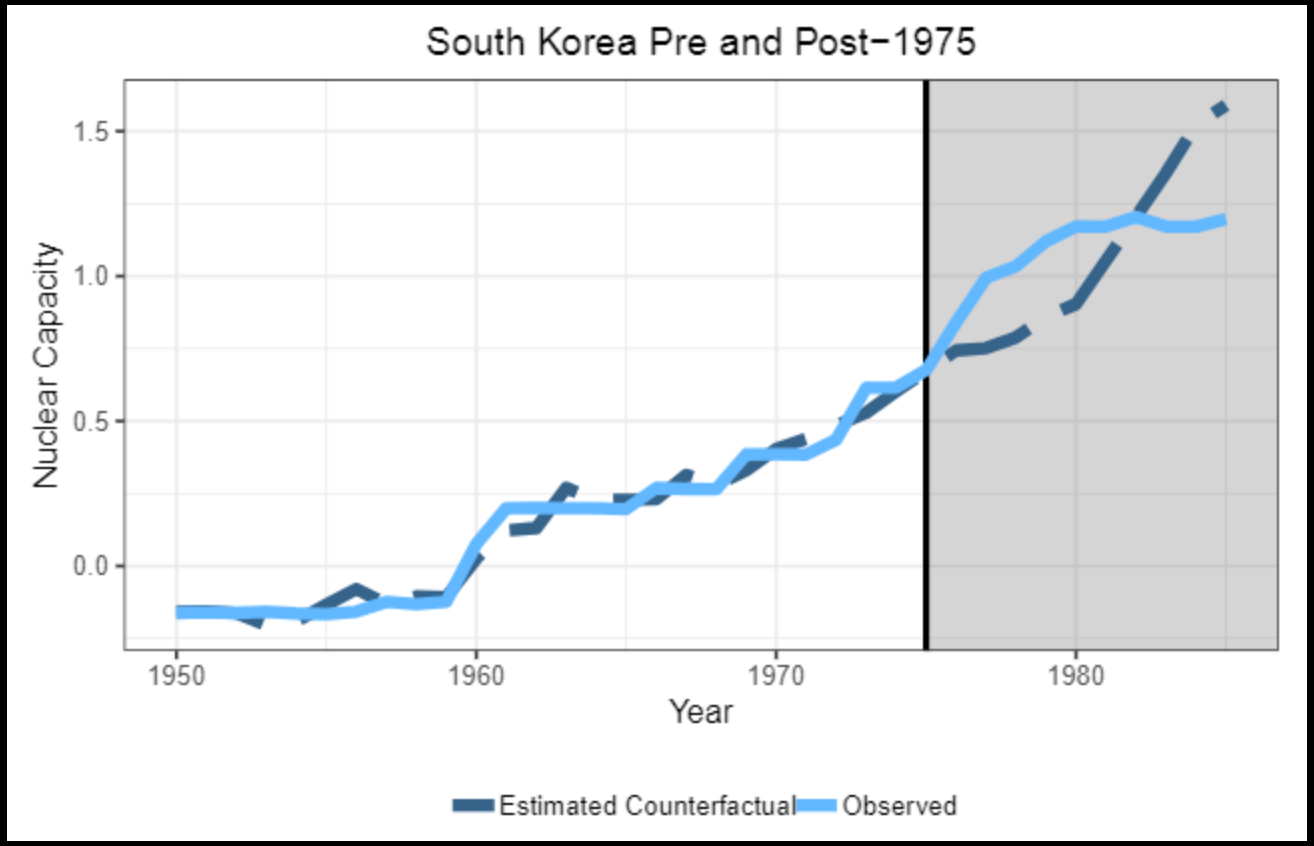
Additional Protocol

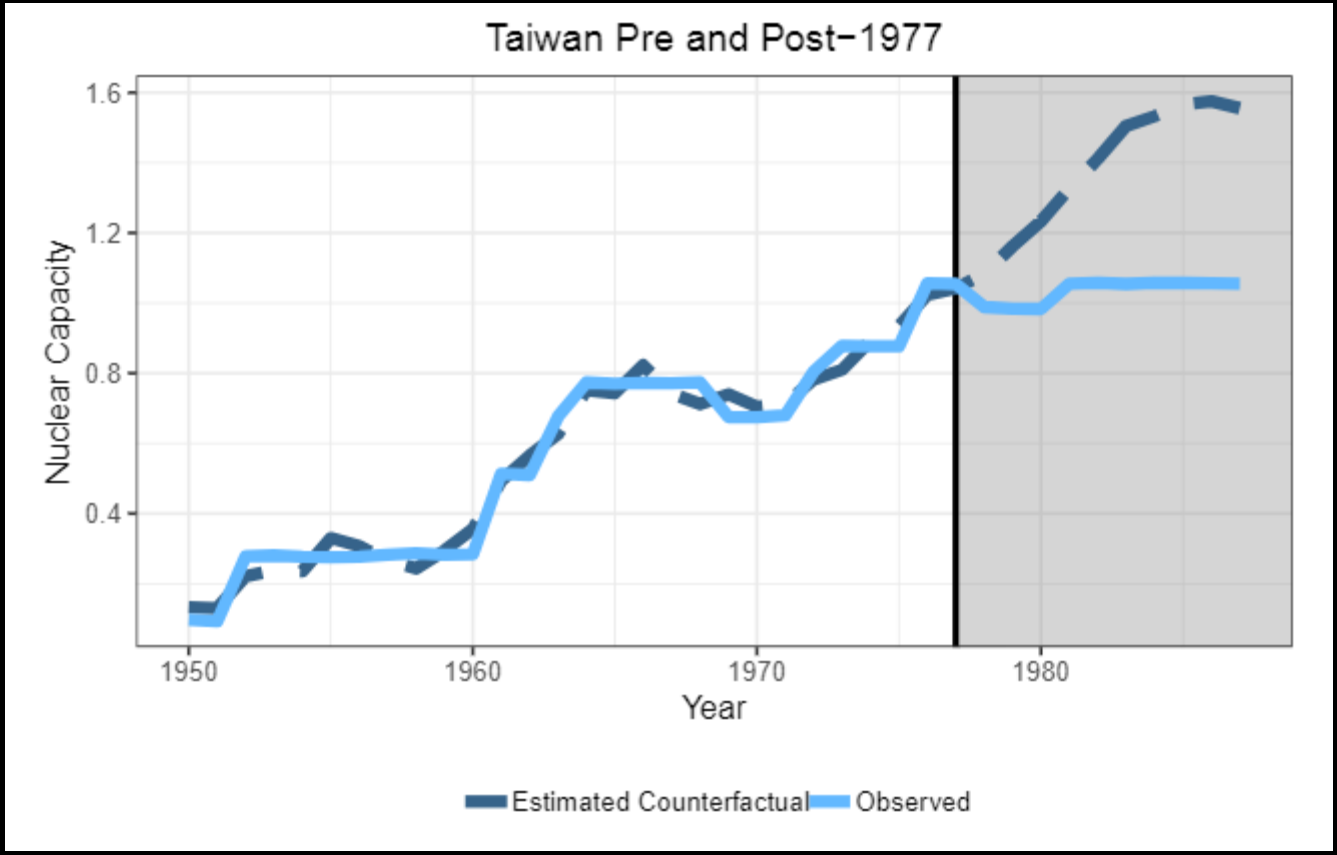
- Developed in 1994 to tighten weapons inspections safeguards
- Was a focal point of the JCPOA

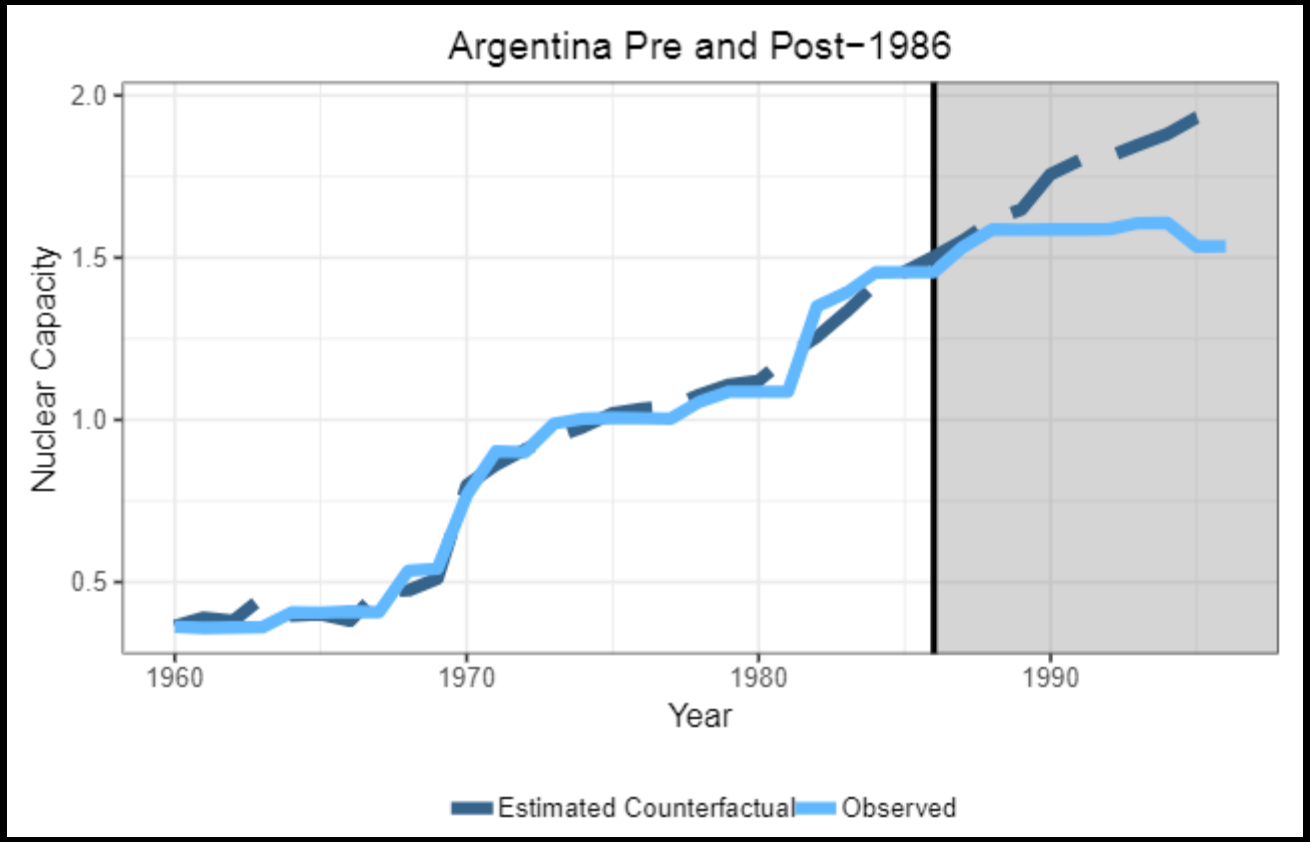
Agreements and Capacity

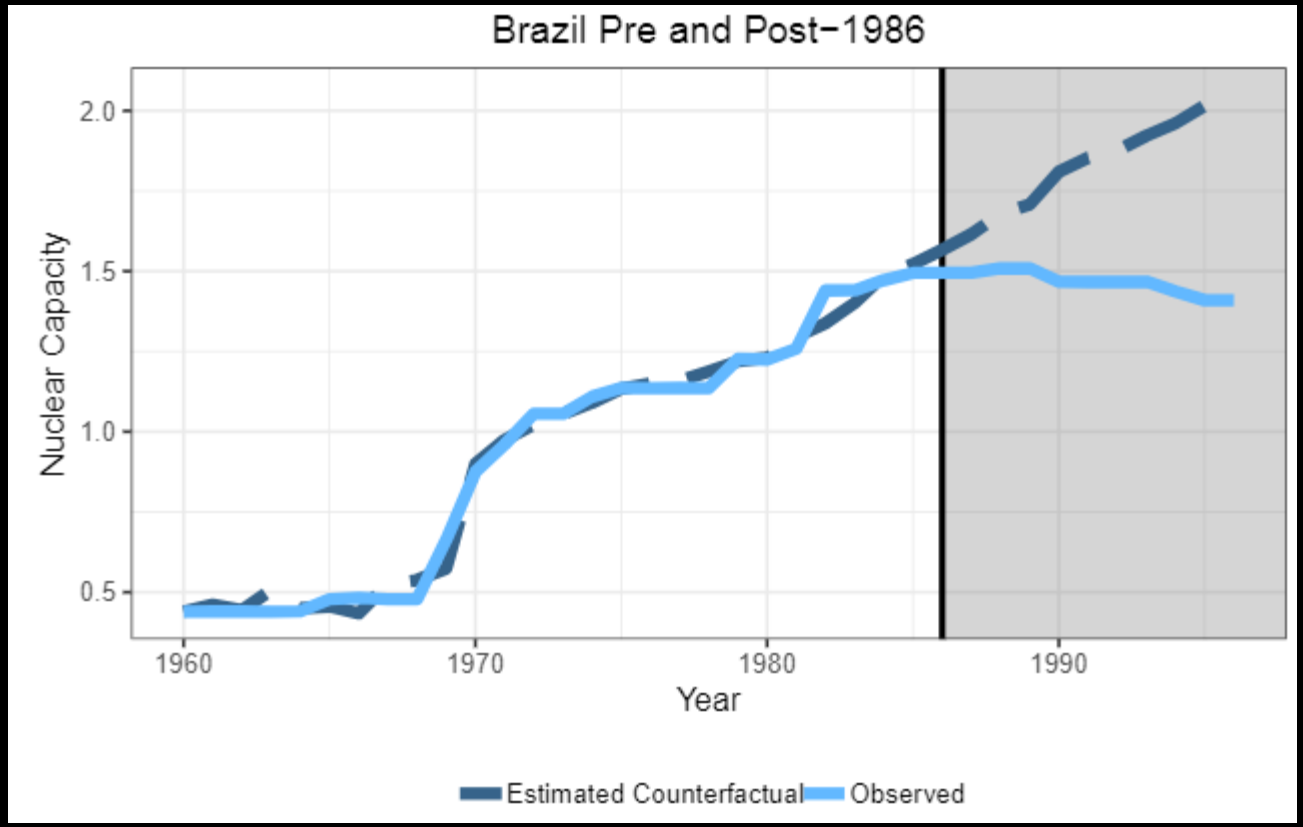
- Reaching agreements does not seem to slow down one's ability to produce nuclear weapons by much


Japan Pre and Post−1972
Nuclear Capacity
1.5
1.0
0.5
1950
1960
1970
1980
Year
Estimated Counterfactual
Observed


South Korea Pre and Post−1975
Nuclear Capacity
1.5
1.0
0.5
0.0
1950
1960
1970
1980
Year
Estimated Counterfactual
Observed


Taiwan Pre and Post−1977
Nuclear Capacity
1.6
1.2
0.8
0.4
1950
1960
1970
1980
Year
Estimated Counterfactual
Observed


Argentina Pre and Post−1986
2.0
1.5
1.0
0.5
Nuclear Capacity
1960
1970
1980
1990
Year
Estimated Counterfactual
Observed


Brazil Pre and Post−1986
Nuclear Capacity
2.0
1.5
1.0
0.5
1960
1970
1980
1990
Year
Estimated Counterfactual
Observed

Atoms for Peace Program

- US-based initiative to begin nuclear science sharing
- Has led to extensive bilateral relations, power assistance, fuel delivery, and research reactor construction

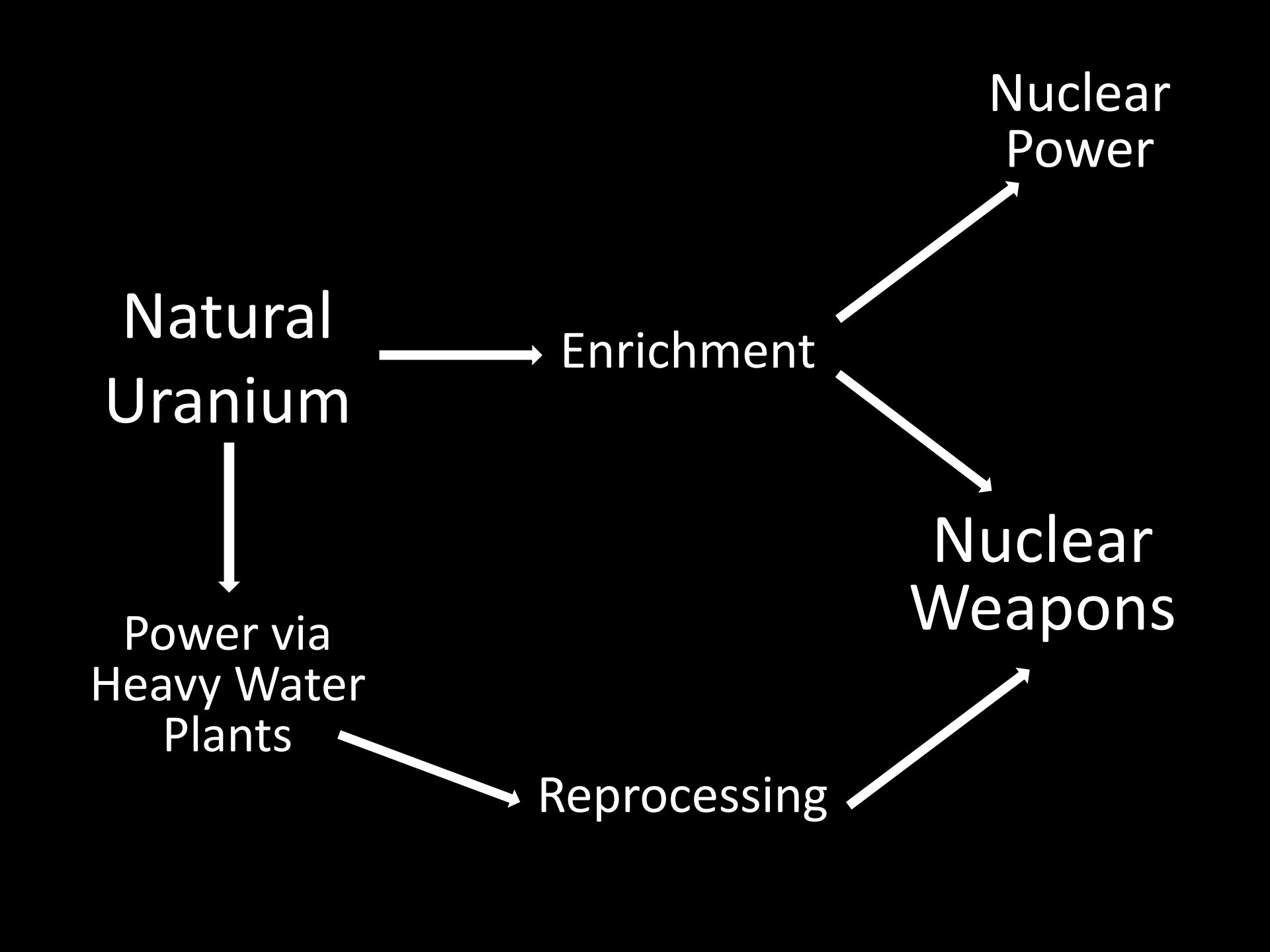
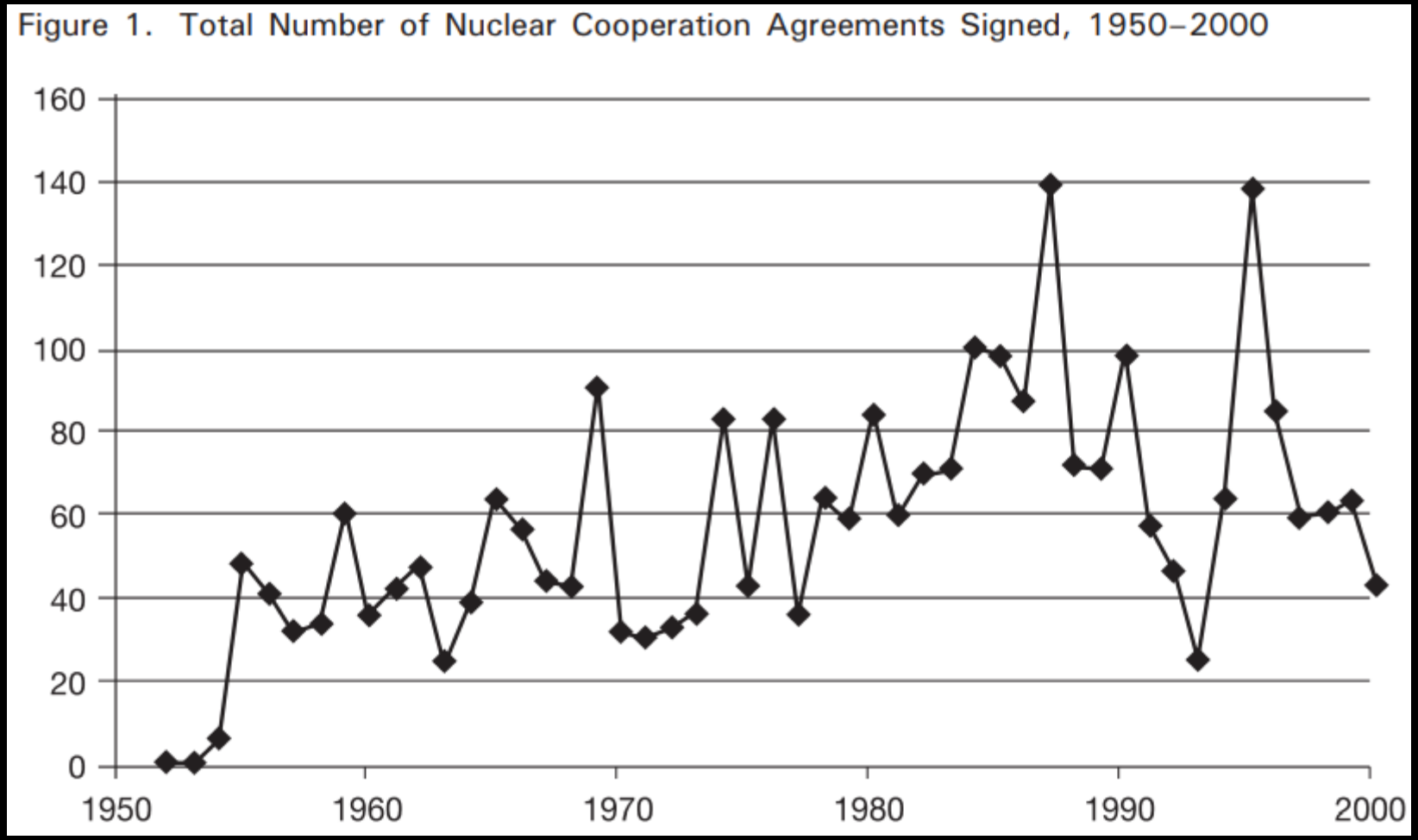
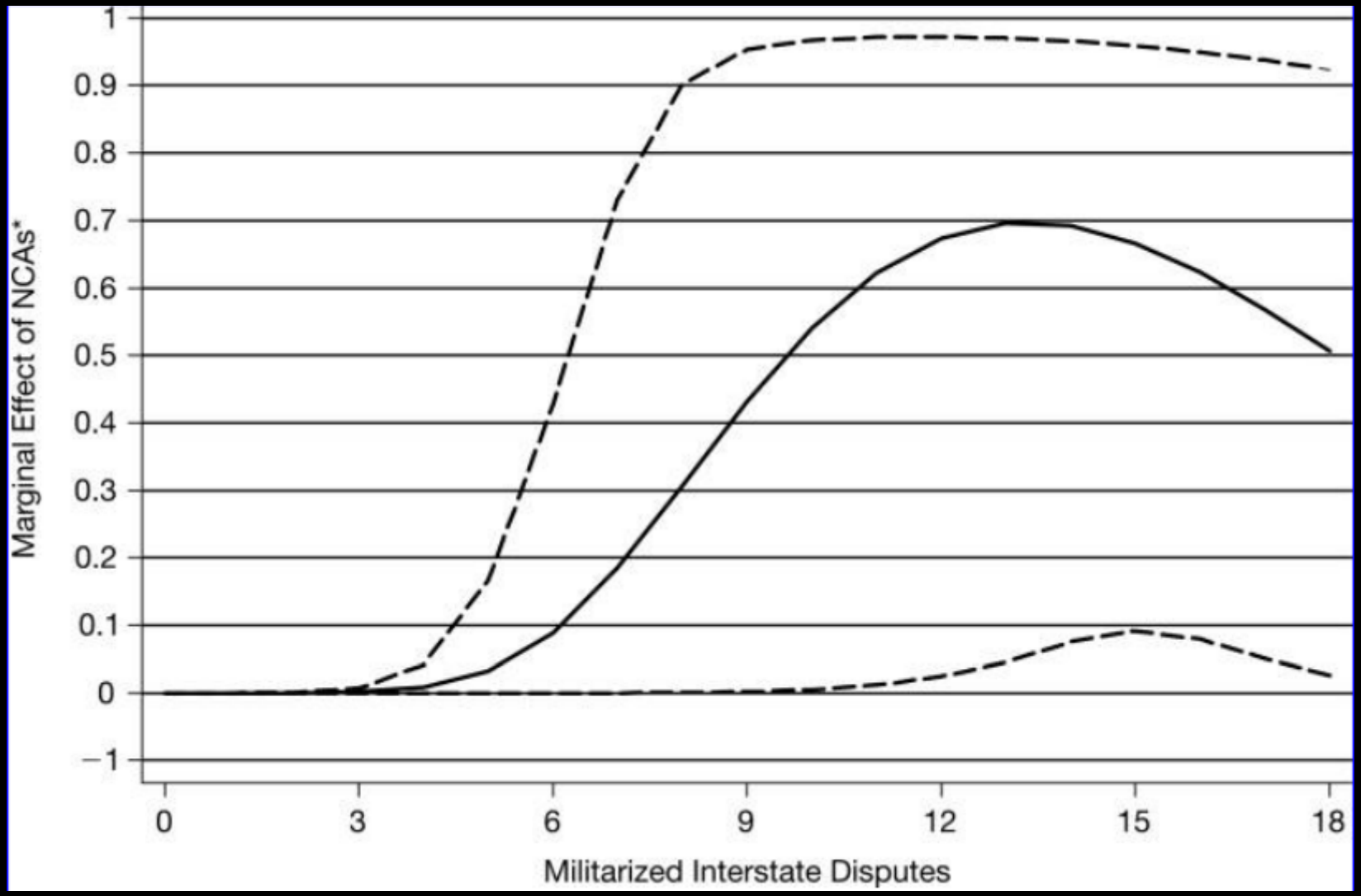

Nuclear Power
Natural Uranium
Enrichment
Nuclear Weapons
Power via Heavy Water Plants
Reprocessing

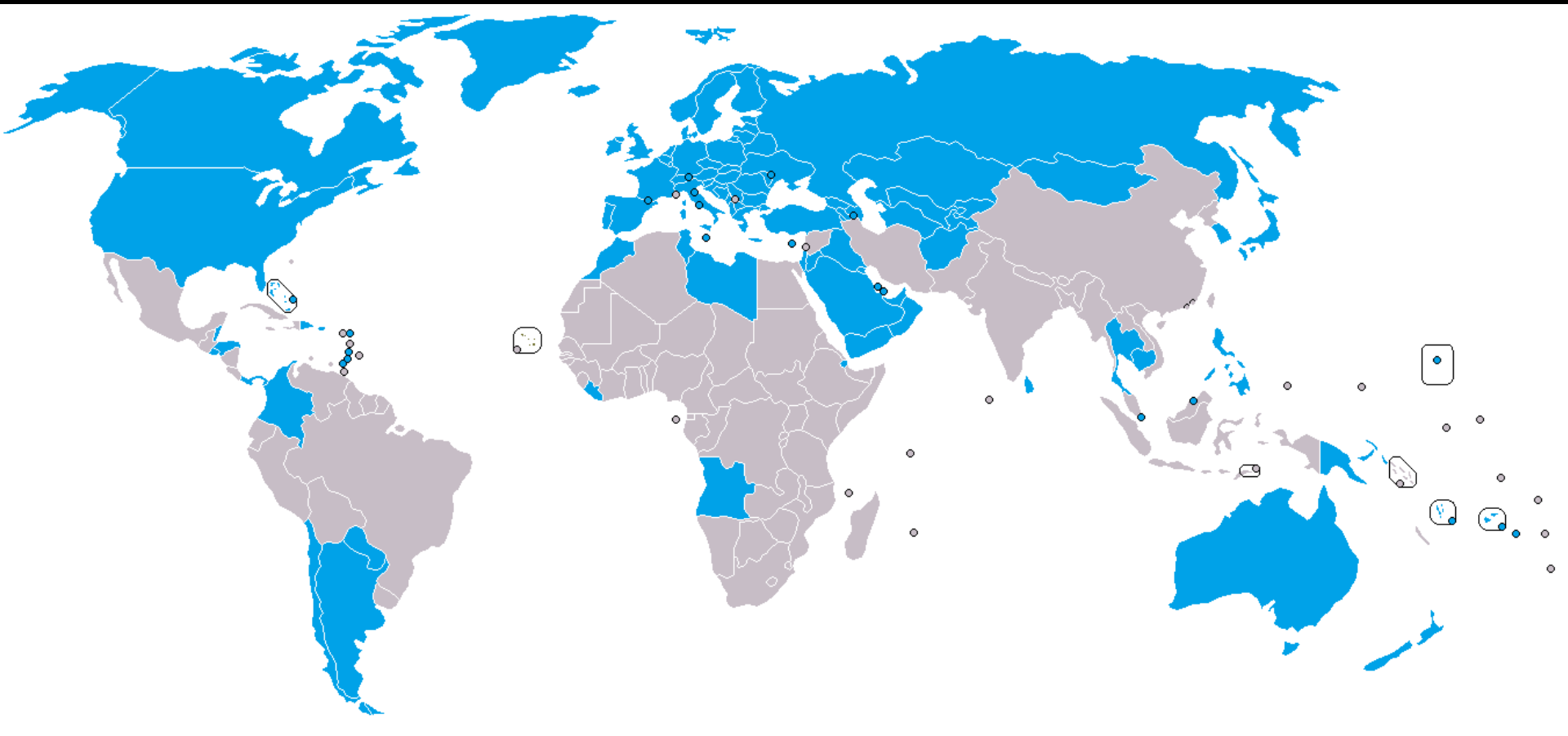
Figure 1. Total Number of Nuclear Cooperation Agreements Signed, 1950–2000




Marginal Effect of NCAs*
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
−1
0
3
6
9
12
15
18
Militarized Interstate Disputes

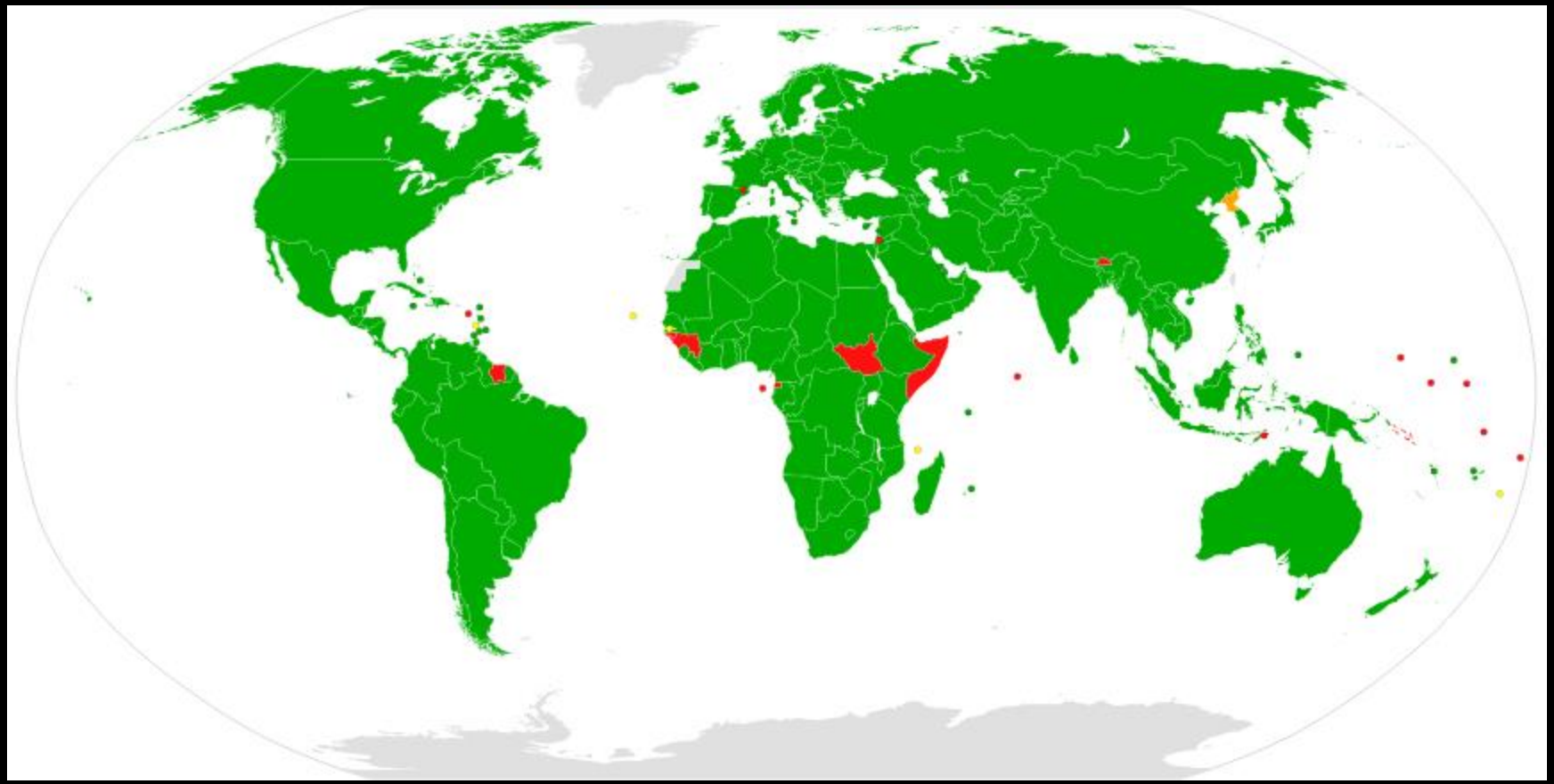
Proliferation Security Initiative

- W. Bush era initiative
- Created by John Bolton
- Designed to create a worldwide anti-trafficking net
- Ships and intelligence



International Atomic Energy Agency

- Two primary functions
  - Weapons inspections
  - Distribution of nuclear technology



Nuclear Weapons Free Zones

- Further legal fortification against development of nuclear weapons
- Also prevents stationing or passing through of other states' nuclear weapons