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BRIEFING

Uncertainties in the North Korean Nuclear Threat

Bruce W. Bennett

Prepared for the National Defense University

Approved for public release; distribution unlimited

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Preface

North Korea has been very successful in denying the United States and others information about its nuclear weapon program. The result is a high degree of uncertainty about the size and character of the North Korean nuclear weapon threat, how it might be used, and what impact it might have. This briefing examines the various possibilities in these areas and explains the potential implications of the uncertainties.

This documented briefing was developed to serve as a record of a RAND briefing prepared for the Center for the Study of Weapons of Mass Destruction at the U.S. National Defense University (NDU). This briefing was given to NDU students and was viewed as being of sufficient interest to justify publication for broader use within NDU.

This research was sponsored by the National Defense University and conducted within the International Security and Defense Policy Center of the RAND National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense Intelligence Community.

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Summary

North Korea is a master at denying the United States information on its sensitive military capabilities. The resulting lack of information on the North Korean nuclear weapon threat makes that threat highly uncertain. This briefing addresses those uncertainties, including the number and nature of North Korean nuclear weapons, their potential delivery means, how they could be used, and what effects they might cause.

Background

North Korea is a failing state, having serious economic difficulties and unable to feed its population. Starvation is not uncommon. North Korea is experiencing lots of rebellious behavior in the forms of refugee flows into China, major black market activities, graft and corruption by North Korean authorities, and even reported attacks on North Korean leaders. While North Korean propaganda has facilitated survival of the regime, that propaganda appears to be unraveling. And Kim Jong-Il's poor health means that in the next few years a second dynastic succession will likely be attempted; this will apparently be to a son who is very young and not well established.

While the regime is in jeopardy, it has not yet collapsed, and may not in the next few years. It is being sustained in large part by elites who know that regime collapse could doom them to trials and starvation. To moderate external pressure against the regime, North Korea has positioned itself as the ultimate poison pill: The collapse of the regime could be a disaster for China and the Republic of Korea (ROK) in terms of refugees, economic challenges, stabilization, and North Korean revenge. But, at some future time, a group of North Korean elites could decide to act against the regime, forcing it to choose a diversionary war against common external foes to unify North Koreans or risk internal overthrow and regime collapse. And if the regime collapses, a civil war could develop in which weapons of mass destruction (WMD) are used between the factions, likely spilling over into South Korea and China. Regime collapse could also open the gates for WMD proliferation.

The North Korean Nuclear Weapon Threat

North Korea has produced enough plutonium for perhaps 6 to 10 or so nuclear weapons. It may also have received enough plutonium from external sources for another 10 or so nuclear weapons. And it may have enough highly enriched uranium for several nuclear weapons. Thus

North Korea may have as many as 5 to 20 nuclear weapons (after having tested two weapons), though we know for sure only that it has produced the two weapons that it has tested. It may also have obtained external help for designing a nuclear warhead that could be carried on a ballistic missile; for boosting the nuclear weapon yield; and for improving missile/warhead accuracy, reliability, and range. Thus, North Korea may be able to deliver nuclear weapons against ROK, Japanese, Chinese, and Russian cities or other targets.

The characteristics of North Korean nuclear weapons are also highly uncertain. A basic North Korean nuclear weapon might have a yield in the 10 kiloton (Kt) range. The limited North Korean testing and other factors imply that at least some North Korean weapons might have a yield in the 1 Kt range. And if North Korea has had external help with boosting warhead yield, some weapons might have yields in the 30-to-50 Kt range. North Korean nuclear weapon reliability and delivery probability (on a missile) might vary from 30 to 70 percent or so before ROK, Japanese, and U.S. missile defenses are taken into consideration. North Korean missile accuracy might mean that half of the warheads would arrive within 2 to 5 kilometers of the desired target, though that number could be a few hundred meters if North Korea has mastered the terminal guidance that it has apparently tested.

We know little about how North Korean nuclear weapons are controlled or how they might be executed.

North Korean Use of Nuclear Weapons

North Korea actively uses its nuclear weapons for deterrence and coercion in peacetime. The United States and other countries are reluctant to use military force against North Korea because of the escalation that could result. And North Korea has gained substantial leverage in international negotiations because of its nuclear weapons.

North Korea may employ nuclear weapons in a conflict. North Korea has said a little about what it might target with nuclear weapons and when it would do so in a conflict. The available information suggests that North Korea would likely target many of its nuclear weapons on ROK and Japanese cities, hoping to coerce or deter the ROK, Japan, and the United States. For example, North Korea might threaten a nuclear attack on a city like Pusan if ROK/U.S. forces cross the demilitarized zone (DMZ) or approach Pyongyang as part of a counteroffensive, and execute that threat if ROK/U.S. forces still advance. North Korea might try to coerce Japan into withdrawing from a conflict and assuming a neutral position, denying the United States much-needed help. North Korea would likely begin posing such coercion/deterrence early in a conflict, when most of its weapons are still surviving and it has the potential of achieving conflict-winning leverage through nuclear weapon use. It might also use nuclear weapons for signaling, perhaps trying to achieve electromagnetic pulse (EMP) effects.

North Korea might also use its nuclear weapons early in a conflict because it expects early U.S. nuclear weapon use. It might wish to demonstrate its capabilities and resolve, trying to limit the U.S. use of nuclear weapons.

Kim Jong-Il has implied that he would use nuclear weapons for revenge attacks. In response to a request by his father to indicate how North Korea should respond to a war that

North Korea lost to the United States, Kim Jong-Il said, "Great Leader! I will be sure to destroy the Earth! What good is this Earth without North Korea?"[1]

If the North Korean regime collapses, the leaders of various factions may take control of nuclear weapons. Most of those factions would have few nuclear weapons—perhaps only one or two. They may decide to use these weapons against other factions that threaten them, use them against external actors (such as the ROK or Japan), or try to sell them to third parties.

The Damage North Korean Nuclear Weapons Could Cause

Many of the factors mentioned above would affect the damage that North Korean nuclear weapons could cause. At the physical level, a 10 Kt nuclear weapon could have a "lethal radius" of about 1,100 meters and a "serious casualty radius" of almost 1,500 meters if ground burst. A ground burst could cause some fatalities out to perhaps 1,800 meters or so, and casualties out further. Fallout casualties would occur at much longer distances in the direction that the winds would blow the fallout.

Affecting Different Targets

North Korea is likely to focus on threatening and attacking cities with nuclear weapons to give it major leverage in a conflict. If North Korea targets ground forces, three nominal weapons would cause only about 19 percent casualties to a single ground force division—not much of an impact, since the ROK would have more than 30 divisions prepared to advance into North Korea. Damage to airfields would be higher: Three nominal weapons would cause about 70 percent casualties at a single airfield. But would North Korea have enough nuclear weapons to cause substantial damage to the ROK/U.S. air forces across many locations? In contrast, three nuclear weapons targeted against Seoul could cause an expected half-million casualties (after accounting for delivery probability and reliability). That is a huge amount of damage that would have tremendous physical impact and political ramifications.

Casualties

If a 10 Kt nuclear weapon were ground burst in Seoul (delivered and reliable), it could cause 125,000 to more than 200,000 fatalities and 290,000 to more than 400,000 fatalities and casualties combined. Only about 20 percent of the fatalities would die promptly. The majority of those receiving lethal effects would likely seek medical care along with the injured who would otherwise survive, suggesting that 300,000 or so people could seek medical care for apparent serious injury. In addition, perhaps 200,000 people would seek medical care for lesser injuries, and many hundreds of thousands could seek care as "worried well," afraid they had been injured (especially by radiation) but in reality not having been physically injured. This total demand for medical care is highly uncertain but could easily overwhelm the doctors and beds in Korean hospitals and clinics throughout the country.

If North Korea attacked a major Japanese or ROK city other than Seoul, the casualty numbers would tend to be 5 to 40 percent less than estimated for Seoul. But the numbers used for the population of Seoul reflect a residential population distribution (nighttime). If North Korea were to attack in the middle of the day, the casualties would be much less (maybe 30 per-

[1] Kim, H., 2008.

cent) if an attack occurred in the residential part of a city, and much more if an attack occurred in the downtown office area (perhaps 50 percent higher or more).

If North Korean nuclear weapons had a yield as small as 1 Kt, the casualties might be 25 to 30 percent of the casualties from a 10 Kt weapon, depending on the city targeted. If North Korea had a 50 Kt warhead, the casualties could be 2 to 2.5 times higher.

Other Effects

Nuclear weapons can have a wide variety of effects beyond just casualties. They can damage buildings, housing, and other elements of infrastructure, causing serious economic impacts and humanitarian disaster. The fallout residual could deny the use of facilities and other areas, further disrupting the economy. And psychological reactions could affect many people such that their productivity would be lost or reduced. Outside of the attack area, the threat of radioactive contamination and other factors may stigmatize Korean goods, further complicating problems for the Korean economy. And economic disruption can ripple through an economy in devastating ways: While the United States lost less than 0.002 percent of its population to the September 11, 2001, attacks, it lost 1 to 5 percent of its gross domestic product (GDP) that year.

Even a single nuclear weapon hitting Seoul might have devastating economic consequences. Considering only primary and secondary effects, the Korean GDP might be reduced by at least 10 percent for ten years or more, amounting to a cost of roughly $1.2 trillion. The ROK wealth might be reduced by perhaps 4 percent, or $120 billion. And the population loss might cost the ROK economy $220 billion in lost productivity. Together, these costs amount to a nearly $1.5 trillion (1.5 quadrillion won) loss to the ROK economy. The serious magnitude of such effects would justify significant expenditures on defenses to prevent a successful North Korean attack, even if the likelihood of such an attack were low.

The North Korean nuclear weapon threat could also induce the ROK and/or Japan to develop an independent nuclear weapon capability. Both the ROK and Japan are covered today by a U.S. "nuclear umbrella" guarantee, in which the United States promises to use its nuclear weapons in response to extreme actions by North Korea. But some people in both the ROK and Japan lack confidence in the U.S. commitment; they might eventually push for national nuclear weapon capabilities to deter North Korean attack and redress the regional military balance. If they do so, they could imperil the nuclear Nonproliferation Treaty, start a regional arms race, and raise questions in the United States about the wisdom of its alliance with these countries.

Conclusions

North Korea is a failing state that is increasingly dependent on its nuclear weapons for deterrence of outside intervention, for both internal and external leverage in peacetime, and for overcoming its conventional inferiority in a time of war. North Korea's nuclear weapon capabilities are highly uncertain, but even modest nuclear capabilities could cause immense damage, especially if ROK and/or Japanese cities are attacked as North Korean references suggest. Even if North Korean nuclear weapons fail to provide North Korea with enough military power to win a conflict with the ROK and the United States, they may be sufficient to damage the ROK so seriously that it would not be able to absorb the North without immense foreign assistance.

Will the ROK spend what is needed today to develop military capabilities to minimize or avert nuclear weapon damage, or will it instead accept vulnerability and the potentially huge cost of resolving the damage that North Korean nuclear weapons could do?

Acknowledgments

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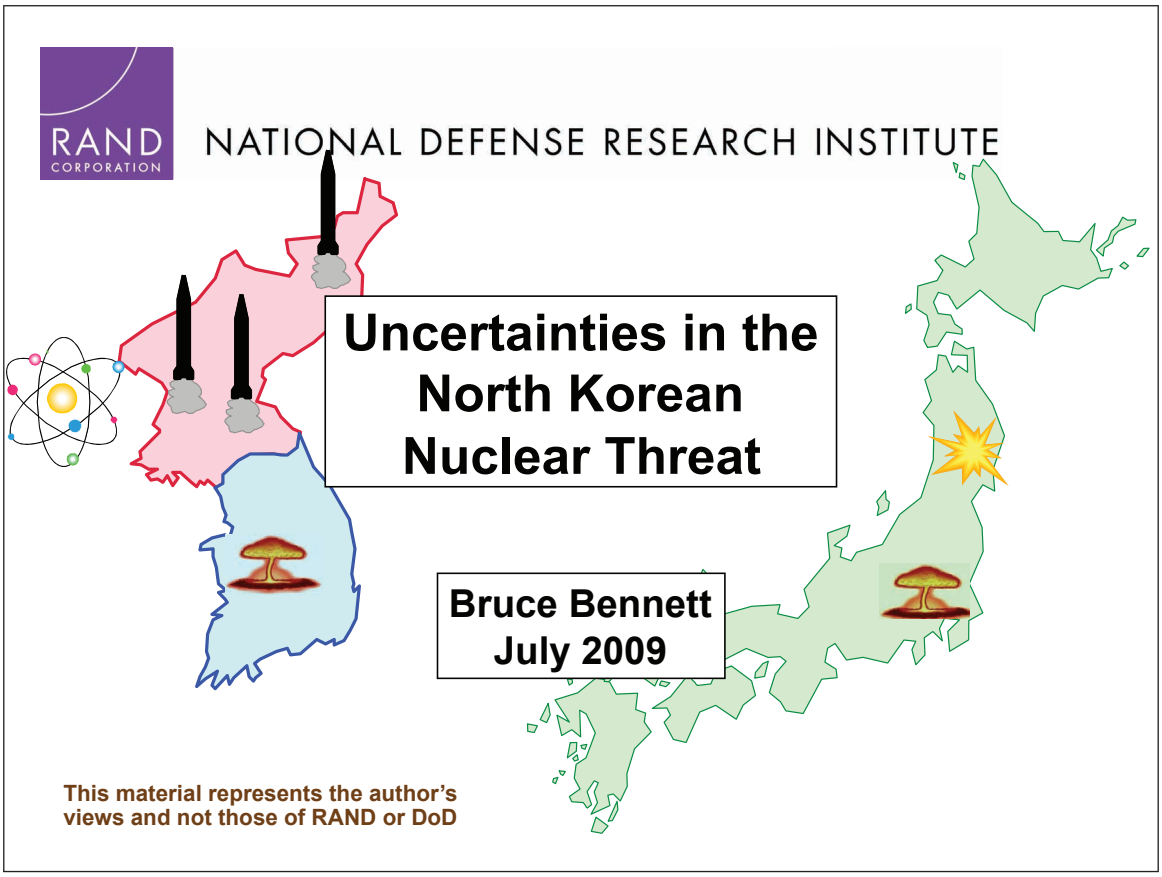
Abbreviations

ABC	atomic, biological, and chemical
B	benefit
BW	biological weapons
C	cost
C4I	command, control, communications, computers, and intelligence
CBW	chemical and biological weapons
CEP	circular error probable
CFC	Combined Forces Command
CIA	Central Intelligence Agency
ConvWar	conventional war
CW	chemical weapons
DMZ	demilitarized zone
DoD	U.S. Department of Defense
DPRK	Democratic People's Republic of Korea [North Korea]
EMP	electromagnetic pulse
FBI	Federal Bureau of Investigation
ft	feet
GDP	gross domestic product
HEU	highly enriched uranium
Init. Rad.	initial radiation
JCS	Joint Chiefs of Staff
KCNA	[North] Korean Central News Agency
kg	kilogram
km	kilometer

Kt	kiloton
LimWar	limited war
LOC	line of communication
m	meter
n mi	nautical mile
NATO	North Atlantic Treaty Organization
NBC	nuclear, biological, and chemical
NDU	National Defense University
NK	North Korea(n)
NucWar	nuclear war
O	outcome
P_B	probability of benefit
P_C	probability of cost
PPP	purchasing power parity
psi	pounds per square inch
rem	Roentgen equivalent man
ROK	Republic of Korea
SLBM	submarine-launched ballistic missile
SOF	special operations forces
WMD	weapons of mass destruction
WR	weapon radius

SECTION 1

Introduction



This documented briefing was developed for the Center for the Study of Weapons of Mass Destruction at the U.S. National Defense University. This briefing characterizes the North Korean nuclear weapon threat, including the vast uncertainties in that threat. North Korean nuclear weapons appear to pose a serious threat to both South Korea and Japan, though China, Russia, and parts of the United States may also be within range of potential North Korean delivery means. This briefing describes the likely technical characteristics of the threat, the damage it could do, and how North Korea would likely use its nuclear weapons.

Originally written in the fall of 2008, this briefing has been updated to include references to the second North Korean nuclear weapon test in May 2009.

This briefing was developed to use custom animations to allow the presenter to focus on specific points as the briefing proceeds. Thus, many of the slides have multiple overlays. While these are not shown separately in the hard copy of the briefing, the beginning of the text for each overlay is indicated by a "»" symbol. The Microsoft PowerPoint version of the briefing is available from the author.

SECTION 2

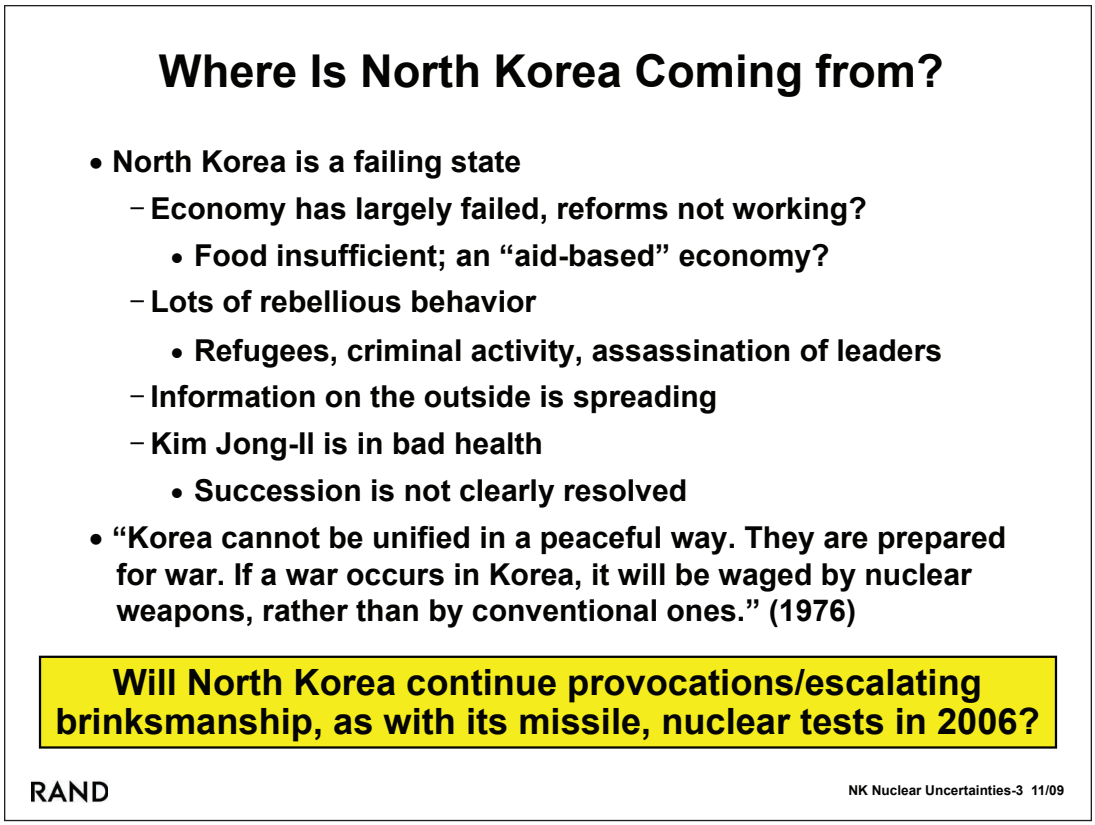
The North Korean Regime Is Failing

To understand the North Korean motivations for having nuclear weapons, it is critical to characterize the security situation that the North Korean regime perceives. And these perceptions fit in the context of the broader Northeast Asian regional security situation.

Any characterization of North Korea is fraught with risks because of the opacity of the regime. Consider, for example, that we have no adult picture of Kim Jong-Eun, the heir apparent to Kim Jong-Il, and in fact his name was apparently misspelled until a few months ago.[1] North Korea purposefully denies information on all aspects of its society to the outside, but is particularly limiting on information about the leadership and the military. Often, we are reduced to one or two dated anecdotal descriptions of North Korea in any given area, and thus cannot be certain that those are accurate. In other cases, we must impute North Korean choices from secondary or tertiary actions, trying to establish logical connections. This opacity forces us to recognize the limitations in what we know and the uncertainties in many aspects of North Korea.

Still, there are some aspects of North Korean society that can be well documented. The failure of its economy is observable from the shutdown of many industries, poor agricultural production, limited consumption of goods internally, and limited outgoing trade to other countries. North Korea is very clear that it follows an "Army First" policy, giving priority to the military with food and other resources. And the regime is also very clear on its siege mentality relative to the outside world.

[1] "N. Korean Poster Seems to Confirm Succession," 2009.



North Korea appears to be a failing state, with a largely failed economy, and agricultural production much less than its subsistence requirements. The population survives, to the extent they do, because of substantial foreign aid, mainly from China in recent years.

» Despite the North Korean efforts to control its people's lives, North Korea is seeing a lot of rebellious behavior. This includes refugee flows into China, major black market activities, graft and corruption by North Korean authorities, and even reported assassination attempts on the North Korean leaders.

» The North Korean regime has tried to maintain its control of the country through the heavy use of propaganda (e.g., North Korea is "Paradise on Earth"[2]; the Republic of Korea (ROK) is ". . . a starving U.S. colony, a 'living hell, land of destitution and despair'"[3]). But information on the outside is spreading in North Korea, debunking the North Korean propaganda, and generating the potential for instability.

Meanwhile, North Korea's leader, Kim Jong-Il, is in bad health, may die, and his succession is not clearly resolved.

» Against this background, the quote shown in the slide is from a Hungarian official who talked with a North Korean diplomat/ally in 1976.[4] It reflects an apparent North Korean perception of the U.S. willingness to use nuclear weapons in any conflict with North Korea.

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2 Kim, H., 2008.

3 Lankov, 2008.

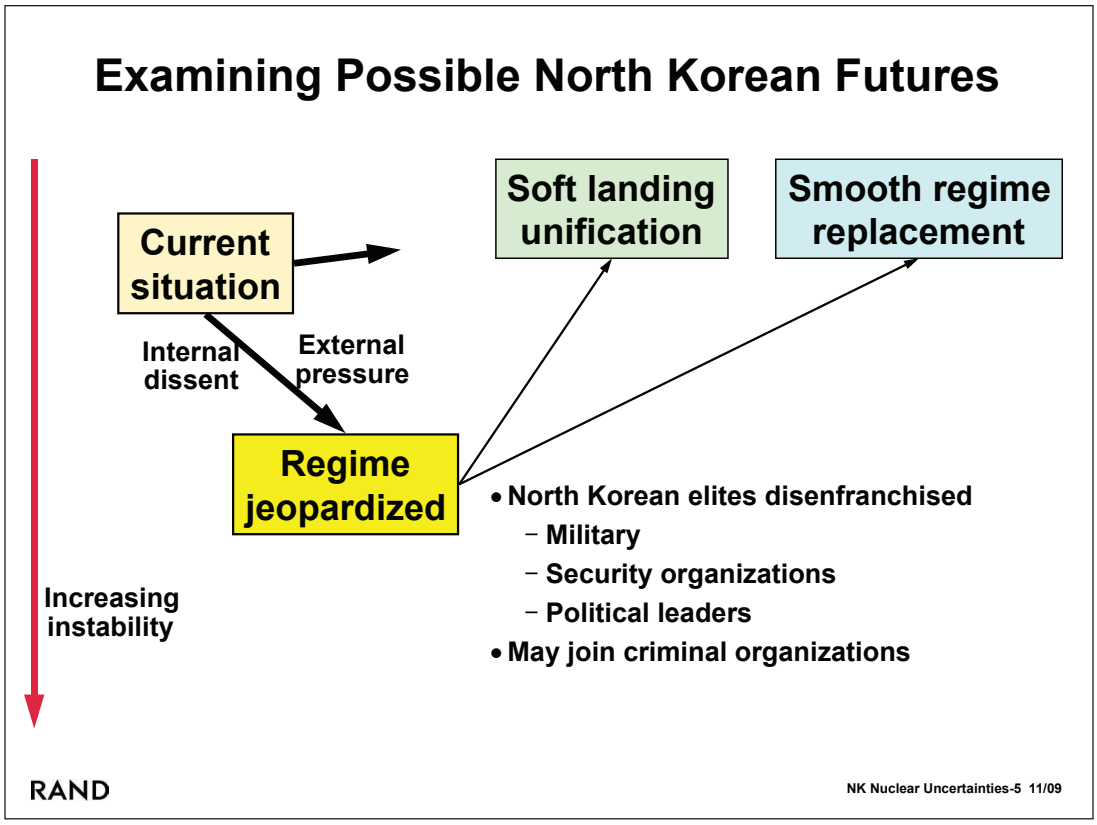
4 Woodrow Wilson International Center, 2005, Document 20. North Korea has made many less direct statements since this one suggesting that it expects war to involve U.S. nuclear weapon use. There appears to be no reason for believing that North Korea has changed this perspective. For example, "North Korea has accused the United States of targeting it with nuclear missiles and warned that nuclear war could break out on the Korean peninsula" (Moore, 2009).

» These instabilities and perceptions suggest that North Korea will continue its pattern of escalating brinksmanship to deal with its decaying situation. Its provocations in 2006 were very successful in resolving North Korea's major challenges at the time; North Korea appeared to follow a similar pattern in 2009.

It is important to understand the extent of North Korean information denial and how it contributes to the uncertainties described herein. But even in this area, we are a bit speculative in trying to describe why the regime is so secretive.

The weaknesses of the North Korean regime make it feel continually "under siege" from both the outside and from potential internal adversaries. By denying information, the regime limits the leverage that its adversaries can exert on the regime: Adversaries often do not know how to exert leverage or what to directly affect. The regime also appears to want to keep its options open. For example, the regime has on many occasions prohibited discussion of succession, allowing Kim Jong-Il to make a decision in the future and preventing the successor from gaining too much power in the short-term. There also appears to be a Korean tendency toward privacy of information, especially information associated with military affairs.

With regard to North Korean nuclear weapon information, North Korean information denial prevents other countries from responding to the North Korean nuclear program or its proliferation activities. Thus, the Syrian nuclear reactor that apparently was being provided by North Korea was fairly far developed before it was discovered, characterized, and subjected to Israeli interdiction. More generally, if the United States and the ROK do not know how many nuclear weapons North Korea has, then North Korea could surrender a few and claim none were remaining, while still retaining a few. Uncertainty about North Korea's nuclear weapon program has tended to strengthen North Korea, leading people to worry about the power North Korea might have. North Korean nuclear weapons could cause such serious damage that they deter North Korea's risk-averse neighbors from taking any serious action against North Korea.



Many experts want to see the current North Korean regime go away and be replaced, without serious costs, by a better government ("smooth regime replacement") or unification with the ROK (a so-called "soft landing").

» The regime is already under some jeopardy, facing external pressure on its nuclear weapons and human rights policies and internal dissent largely due to inadequate food but including the recent currency devaluation, which attacked the merchants and many of the elites. The regime would have to be placed under major jeopardy before either smooth regime replacement or a "soft landing" would be possible. The transition to unification would seriously imperil the future of most North Korean elites, and especially the military, the secret police, and political leaders. Even a new regime could threaten many people in these categories. Thus, major changes, such as unification and regime replacement, will almost certainly be opposed by the existing elites, making the changes difficult to achieve.

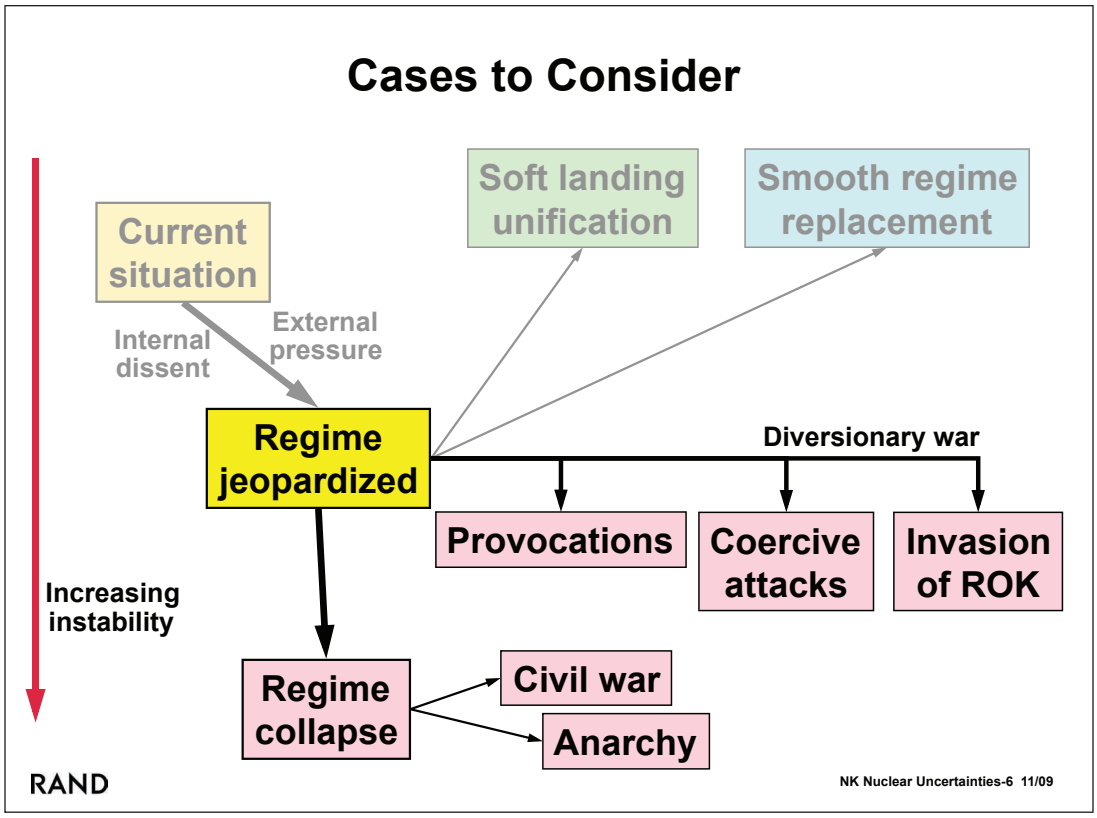
If the changes are achieved, many of the elites will fear for their survival, at least economically. They may well choose to join the existing and pervasive black market and related criminal organizations to survive.[5] These organizations involve members of the elites, and also co-opt members of the security establishment (at least with bribes).

It is reported, for example, that

> German unification completely deprived all East German Communist party and military leaders of their privileges and made them jobless. Kim Jong-il had the plight of former East German leaders photographed and shown to North Korean cadres. And many members of the elite, though they detested Kim Jong-il, thought they had no alternative but to follow him for fear of losing their privileges if the regime collapsed.[6]

[5] "Survival of the Wickedest," 2008.

[6] Kang, 2009.



When jeopardized, the regime could try to unify the elites/population by military action, focusing the attention of the elites and population on external adversaries. An academic theory referred to as "diversionary war" addresses such situations.[7] South Korea has long let North Korea know that the consequences of a failed invasion would be a ROK/U.S. counteroffensive to destroy the North Korean regime and reunify the country;[8] North Korea is thus unlikely to invade the ROK short of being desperate. In trying to survive, the North Korean regime would likely become risk-acceptant[9] and prepared to use military power as a means for unifying the North Korean people against a common external foe (some combination of the ROK, Japan, and the United States).

» If North Korea does not attempt provocations or war in desperate circumstances, the regime could collapse, causing serious conditions that might compel ROK and/or Chinese intervention.

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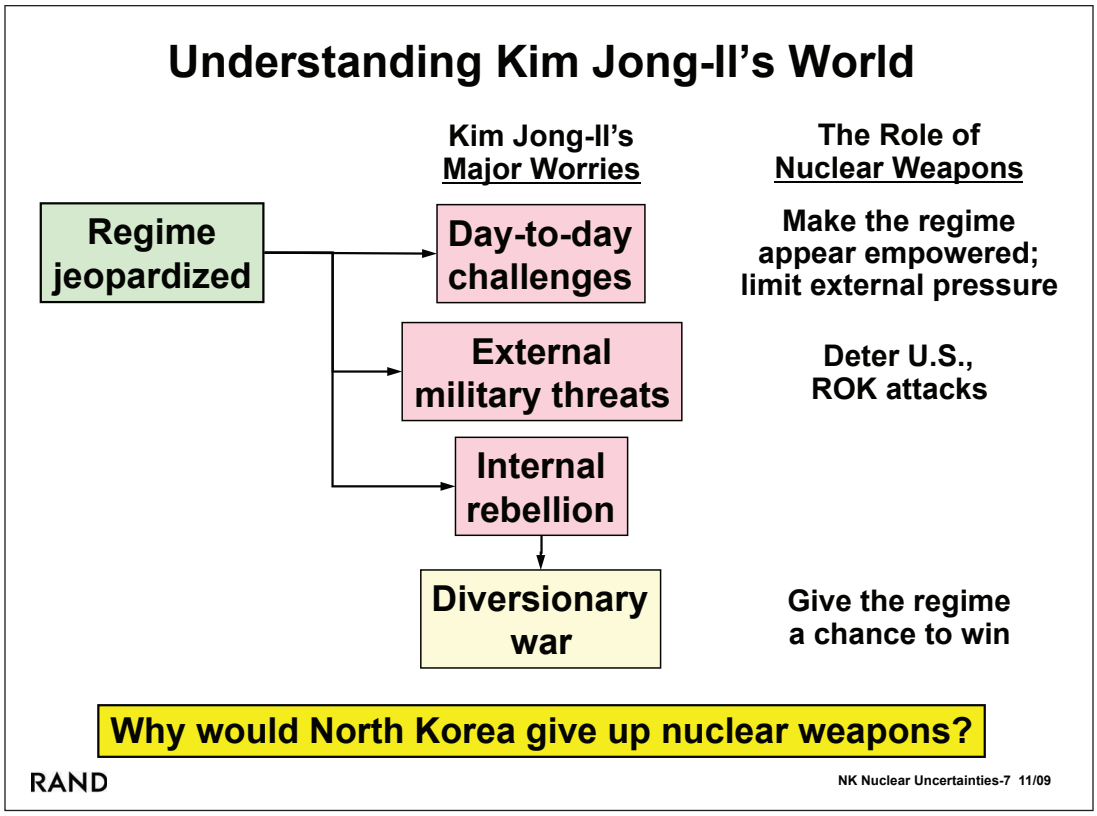
7 See, for example, Levy, 1989.

8 The continuity of ROK and U.S. war planning suggests that little has changed since 1994 statements:

> South Korean state television said yesterday that Seoul and Washington have a plan to topple the North Korean government if the Stalinist state attacks the South. The Korean Broadcasting System said that rather than simply driving back the North's troops, the plan provides for a counteroffensive to seize Pyongyang and try to topple the government of Kim Il-sung. ("KBS reports plan to topple Kim Il Sung," 1994, p. 16).

In addition, the former South Korean president, Kim Young-sam, said: "Once a major military confrontation occurs, North Korea will definitely be annihilated" (Lurie, 1994, p. 11).

9 Berejikian, 2002.



Based on his interviews of North Korean leaders, Joseph Bermudez says, "A primary motivation for the DPRK [Democratic People's Republic of Korea] to develop nuclear, biological, and chemical weapons is to ensure national survival by deterring potential South Korean or American aggression. For DPRK leaders, however, deterring the United States also creates the opportunity to reunify Korea by force and under their terms." Since the Korean War, ". . . the United States has prevented the unification of Korea and threatened the existence of the DPRK with nuclear weapons."[10] The North Korean regime is desperate to survive, and prepared to take very risky action, such as provocations.

» Day-to-day, nuclear weapons make the North Korean regime appear empowered and reduce the external pressure that North Korea's neighbors apply to the North. Thus, North Korea has talked about transforming Seoul and Tokyo into a "sea of fire" if too much pressure is placed on the North, an apt description of a nuclear detonation.[11]

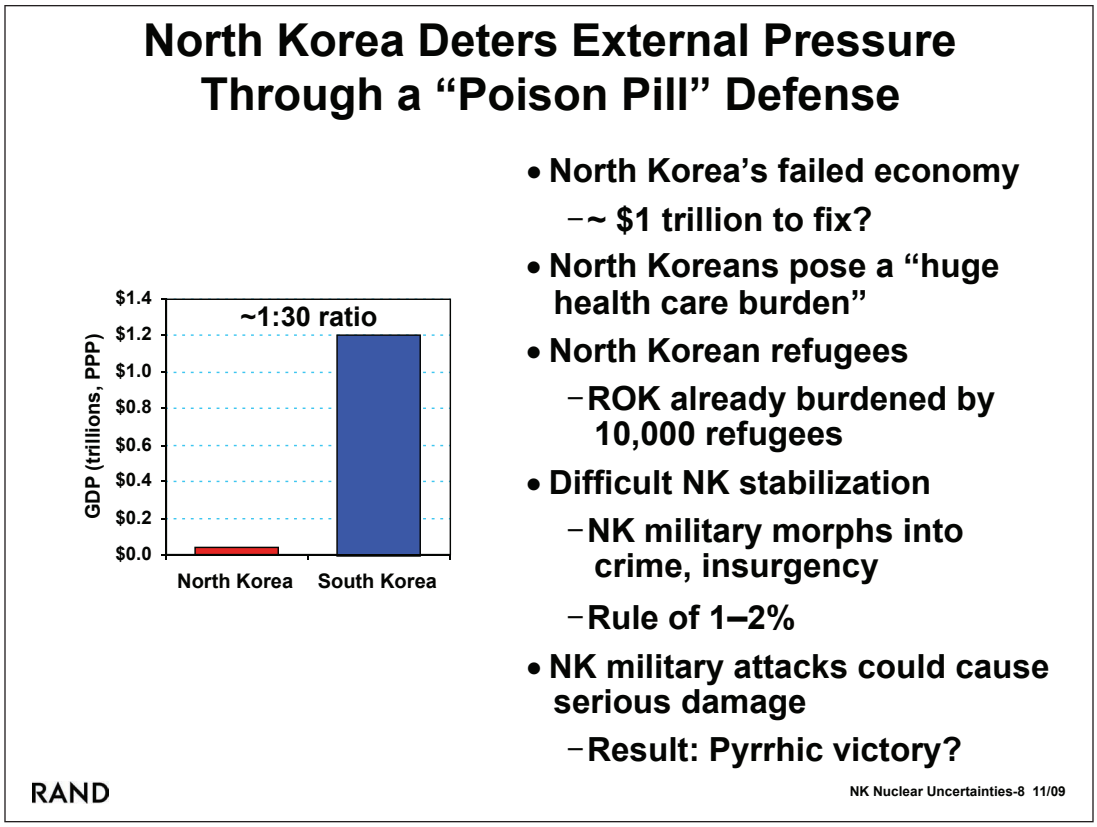
» Against external military threats and those of the United States in particular, nuclear weapons thus provide a basis for deterring attacks (even conventional attacks).

» If the North Korean regime perceives that it is facing serious internal opposition, it could decide to execute a diversionary war. North Korea may well feel that nuclear weapons would be a balancer in such circumstances and may give North Korea a chance to "win," allowing the regime to survive despite the price paid by the country. Still, to survive, the North Korean leaders would have to deter a major U.S. nuclear retaliation.

» With all of these utilities, why would North Korea give up its nuclear weapons?

[10] Bermudez, 2000, p. 183.

[11] "North Korea Warns of 'Sea of Fire' as U.S. Envoy Arrives," 2003; "Yonhap Cites DPRK Warning to Japan on US Cooperation Causing 'Nuclear Sea of Fire,'" 2004.



In peacetime, the North Korean regime has managed to make itself into what is usually referred to in business as a "poison pill"—almost too difficult for another country to absorb. The North Korean government stumbled into this condition, but has used it effectively to deter ROK and Chinese pressure that might cause a North Korean collapse. If a collapse happens, the ROK and China could face the following:

- Repairing the failed North Korean economy, which could cost perhaps $1 trillion (roughly the ROK annual GDP) or more in terms of infrastructure repairs, capital investments, interim humanitarian aid, and other costs.[12]
- » A recent U.S. National Intelligence Council report said that, "If reunification occurs, South Korea will face costs not only of incorporating an economic void, but also those of a huge health-care burden."[13]
- » Dealing with North Korean refugees. In early 2007, the ROK received its 10,000th refugee from North Korea since the end of the Korean War. At the time, the ROK press coverage argued that these refugees were generally a burden, having poor education and a difficulty adjusting to the ROK. The Bank of Korea projects that a collapse could cause roughly 3 million North Koreans to become refugees,[14] a number that would overwhelm the ROK and China.

[12] There are a range of estimates, but the full costs of fixing the North Korean economy have been estimated to be as much as $5 trillion. See "Korean Reunification 'Will Cost $5 Trillion,'" 2010.

[13] National Intelligence Council, 2008.

[14] Na, 2007.

- » Stabilizing North Korea. If the ROK and/or China intervene, many of the North Korean elites, secret police, and military personnel will become involved in the black market/criminal organizations or insurgency. Based on previous stabilization efforts, RAND researchers estimate that successful stabilization requires a military force of 1–2 percent of the population, or up to perhaps 450,000 ground force personnel.[15]
- » North Korea could use its military forces and weapons of mass destruction (WMD) in particular to cause serious damage to the ROK and/or China, making any conquest of North Korea a potential Pyrrhic victory. When asked by his father what he would do if North Korea lost a war with the United States, Kim Jong-Il reportedly said, "Great Leader! I will be sure to destroy the Earth! What good is this Earth without North Korea?"[16]

In short, China in particular is quite deterred from applying any pressure to North Korea because of these various factors. In addition, many in China would not want ROK control of the entire peninsula, especially if there is still a strong ROK-U.S. alliance. But China has also been furious about North Korean behavior, including North Korea's disregard of Chinese diplomacy. For example, China was seriously offended by both the 2006 and the 2009 North Korean nuclear weapon tests. In both cases, ROK reactions included many comments that China was clearly not a regional superpower: North Korea thoroughly ignored and disrespected Chinese influence, and yet suffered no serious consequences for doing so. North Korea appears to have concluded that China is, for now, a "paper tiger," though Chinese distress over North Korean actions is growing.

During the administration of ROK President Roh Moo-hyun, the ROK seriously sought reconciliation with North Korea and was unwilling to pressure North Korea for fear of the implications on reconciliation. The current ROK administration has taken a more assertive role, making reconciliation with North Korea largely dependent on North Korean denuclearization. The ROK has therefore refused to provide major aid to North Korea in the past two years, though that position appears to be softening. North Korea has responded with cycles of antagonism and diplomacy toward the ROK, apparently seeking to break the hard-line ROK position. It has made some progress in doing so, as illustrated by recent ROK offers of humanitarian aid to the North.

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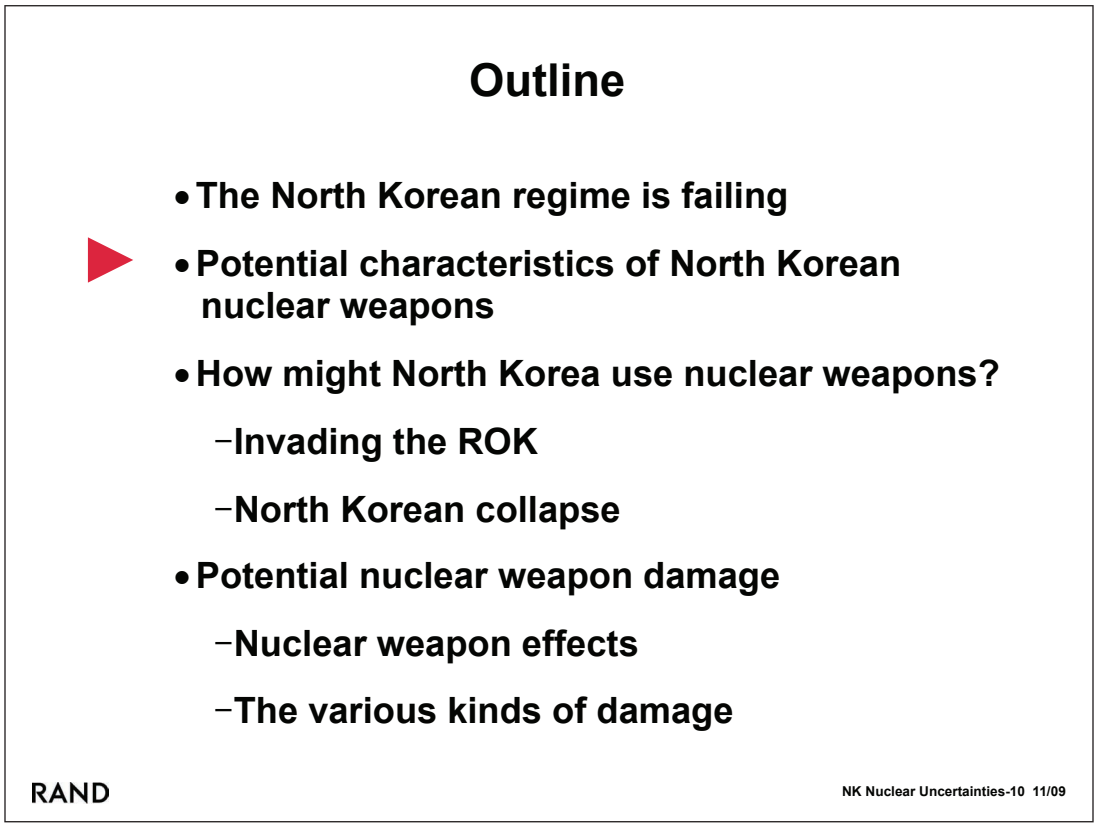
15 Quinlivan, 2003; Dobbins, 2003.

16 Kim, H., 2008.

SECTION 3

Potential Characteristics of North Korean Nuclear Weapons



This section looks at what is known or potentially true about the North Korean nuclear weapon threat.

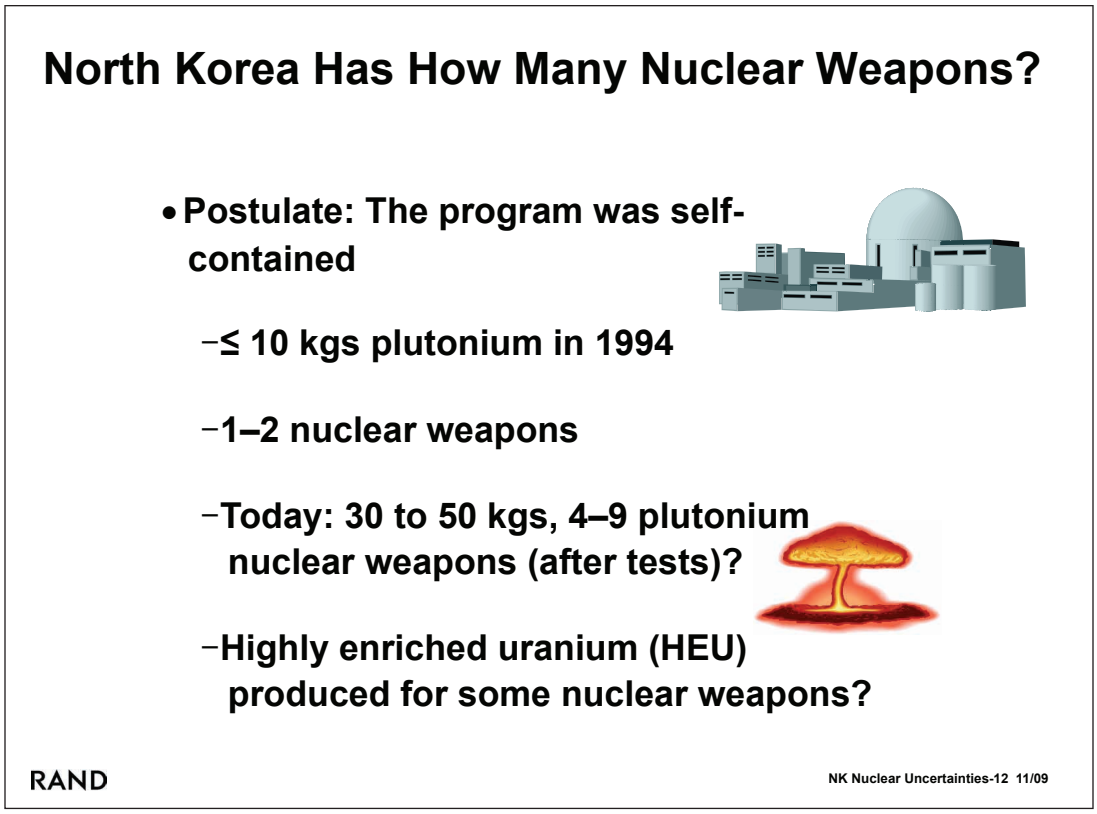
As noted previously, North Korea has been very effective in denying the outside world any significant information on its nuclear weapon program. As a result, the outside world has little direct evidence of the North Korean efforts and mainly indirect inferences, leaving substantial uncertainties.

From observing the operations of the North Korean Yongbyon nuclear plant, experts are able to estimate how much fissile material (the essential ingredient of nuclear weapons) North Korea has made. The Yongbyon plant has been used to make plutonium; highly enriched uranium is the other major kind of fissile material, which North Korea has apparently been making with centrifuges.

North Korea has produced at least two nuclear devices: the one it tested in October 2006 and the one tested in May 2009. It appears that North Korea does have adequate fissile material for at least 5–10 nuclear weapons,[1] but has it made those weapons? And if so, what form have they taken? Are they bombs, missile warheads, or just nuclear devices that might be hidden along a road or some comparable place?

In these issues, the key question is: Has North Korea pursued nuclear weapon development entirely on its own? Or has it gotten external help? And if so, has that help been in terms of expertise provided, key components and materials provided, and/or what? For example, many experts assume that North Korea may not yet have a nuclear weapon capable of fitting on a ballistic missile because making such a weapon requires significant expertise in nuclear weapon design and explosions. But if North Korea has had external help in such designs from experts of other countries, then it may have already completed such nuclear warheads. Not knowing makes the North Korean nuclear weapon threat very uncertain.

[1] Albright and Brannan, 2007. North Korea may have used one weapon worth of plutonium in its two tests thus far, purposefully using a small amount, especially in its first test.



Consider the evidence. Most U.S. estimates of North Korean nuclear capabilities assume that the program has been self-contained. Before the 1994 Agreed Framework, U.S. intelligence concluded that North Korea had produced and processed up to 10 kilograms of plutonium, or enough for 1–2 weapons.[2] Today, it is estimated that North Korea has produced up to 50 kilograms of plutonium,[3] enough for 5–10 nuclear weapons.[4] North Korea claimed that its test device in 2006 used 2 kilograms of plutonium,[5] and the device in 2009 may have used 4–6 kilograms, so North Korea may still have enough plutonium for 4–9 plutonium weapons. North Korea claims it produced a somewhat smaller amount of plutonium and has used less in making nuclear weapons.[6] Of course, the number of weapons could be less than what is possible with the available plutonium; it could even be zero.

[2] "North Korean Nuclear Weapons: CIA Estimate for Congress," 2002.

[3] Nikitin, 2009, p. 4; "Hill Says N.K. Must Hand Over Plutonium," 2007.

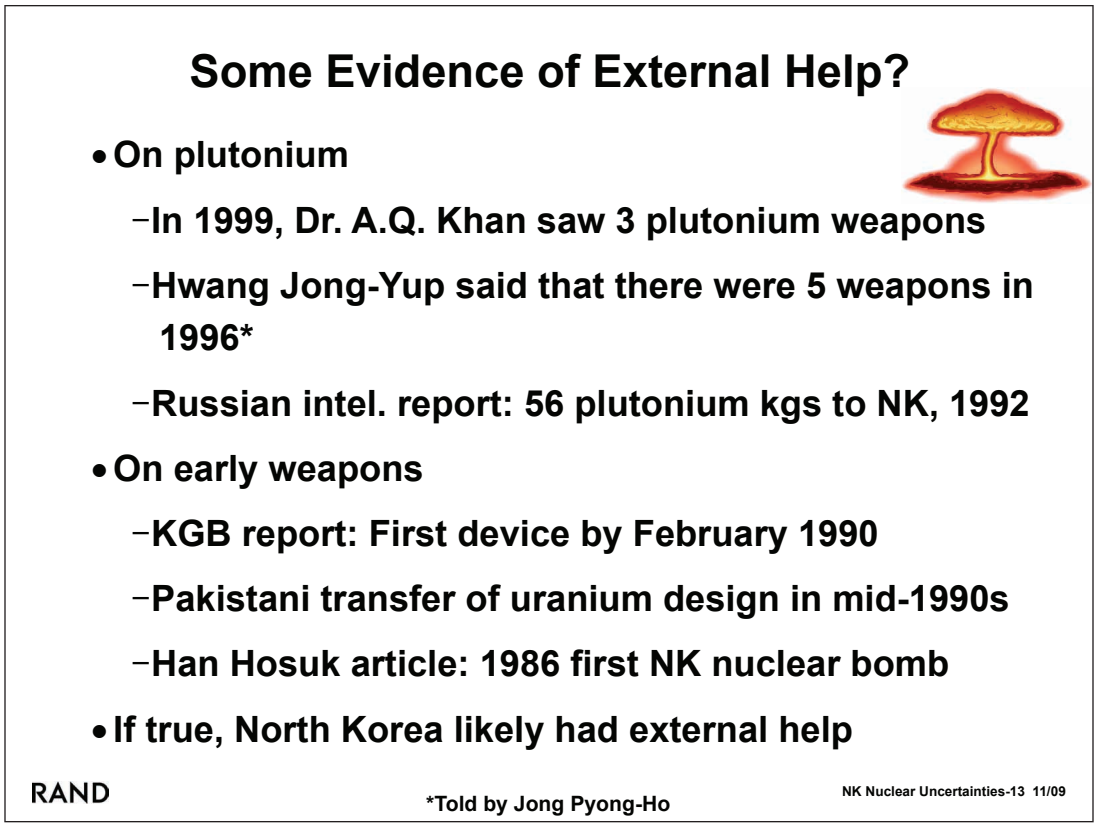
[4] This assumes that each weapon contains about 4 to 5 kilograms of plutonium, though about 6 kilograms would be more appropriate for a ballistic missile warhead. See Albright and Brannan, 2007.

[5] "North Korea Declares 31 Kilograms of Plutonium," 2008.

[6] North Korea apparently claims to have produced "38.5 kilograms of plutonium from which 26 kilograms were used to manufacture nuclear warheads" ("N. Korea Admits to Using 26 Kg of Plutonium for Nuclear Bombs," 2008). More recently, Pyongyang officials told Selig Harrison that "the North has already weaponized the 30.8 kilograms (67.8 pounds) of plutonium listed in its formal declaration" ("Researcher: North Korea Has 'Weaponized' Plutonium," 2009).

In December 2009, Pakistani nuclear scientist A. Q. Khan said that North Korea was doing uranium enrichment with 3,000 or more centrifuges as early as 2002 (with Pakistani help),[7] which, if true, could mean that North Korea has even more nuclear weapons.

[7] Smith and Warrick, 2009.



There is also evidence that the North Korean program was not self-contained, potentially affecting the uncertainty range of North Korean nuclear capabilities and the likelihood of the possibilities in that range. For example, A. Q. Khan said that in 1999 he saw 3 North Korean nuclear weapons that could be assembled on a ballistic missile in an hour,[8] more than the U.S. estimate of 1–2. North Korea was unlikely to put its entire inventory in one place at one time and show them to a foreigner, as a security failure could have led to U.S. preemption. North Korea may thus have had at least 5–6 then, consistent with what the defector Hwang Jong-Yup said he was told in 1996.[9] If this is true, where did North Korea get the fissile material for these weapons? One possibility comes from a Russian intelligence report in 1993 that North Korea had received 56 kilograms of plutonium from the former Soviet Union.[10] If so, North Korea could have enough fissile material today for perhaps 20 nuclear weapons. If the weapons Khan saw were missile warheads, then North Korea almost certainly had help in developing them.

In addition, the earliest reports of North Korean nuclear weapons were before plutonium from Yongbyon would have been available.[11]

Are these reports accurate, and, if so, where did North Korea get this material, and was it plutonium or highly enriched uranium? What other help has North Korea obtained from outside? For example, if some organizations risked giving North Korea fissile material, they may have also provided the technical expertise necessary to make ballistic missile warheads.

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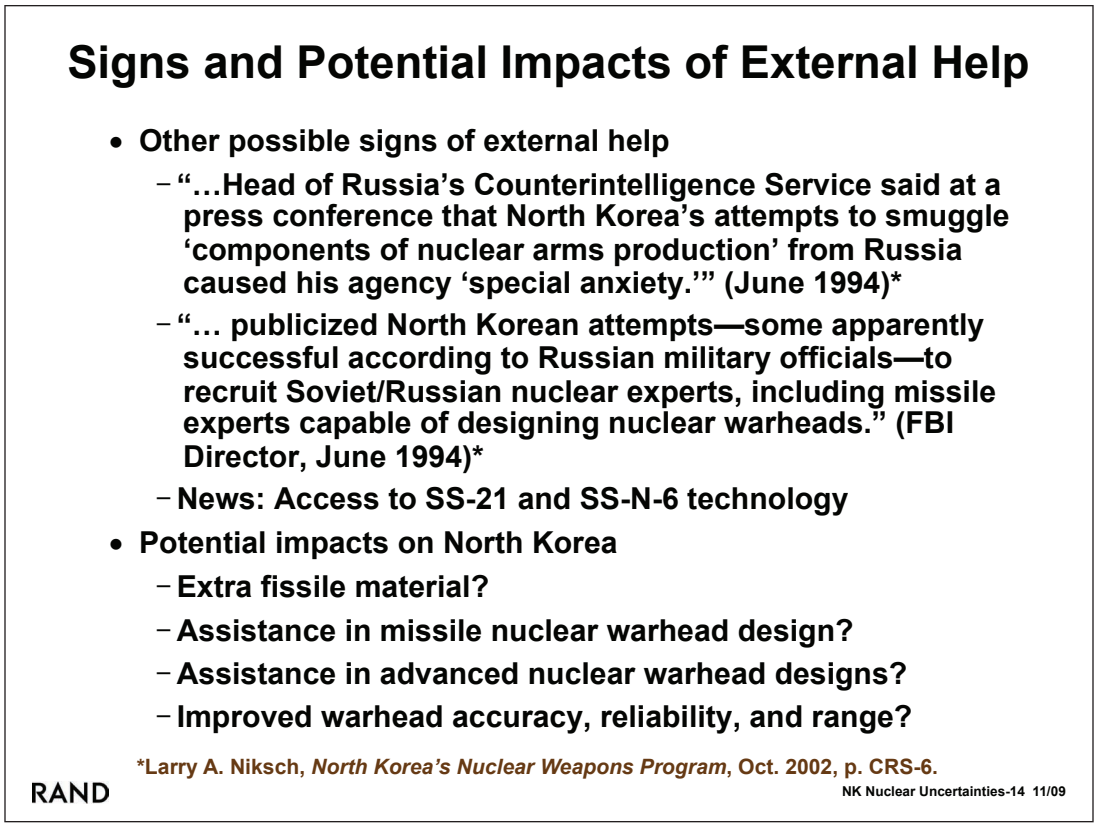
8 Smith and Warrick, 2009; "A. Q. Khan's Network," no date.

9 "[Hwang Jong-Yup] . . . said that Jong Pyong-Ho, a senior party official in charge of military matters, had told Hwang in 1996 that North Korea had five plutonium-based nuclear weapons" (International Institute of Strategic Studies, 2004).

10 Niksch, 2003, p. 9.

11 Shapiro, 1994, p. 17, and Han, 2000; see also Hersh, 2003.



There has been other evidence of external help for the North Korean nuclear weapon program. This slide offers two quotes, from a Congressional Research Service report, indicating that North Korea may have sought nuclear materials and/or expertise from Russia. The report also states that there is evidence of "the close connections that North Korean intelligence and military organs have had with the former KGB and elements of the network of agents North Korea is known to have inside Russia," and the report quotes a former director of the FBI as saying that Russian criminal organizations "may already have the capability to steal nuclear weapons, nuclear weapons components or weapons-grade material."[12]

North Korea has obtained a variety of ballistic missile technology from external sources. It is reported to have obtained solid-fueled SS-21 missiles from Syria, including the SS-21's terminal guidance technology. It has reportedly used the terminal guidance technology in its design of upgraded Scud missiles.[13] And North Korea has imported the Soviet SS-N-6 missile technology and upgraded it to the North Korean Musudan missile. The SS-N-6 was designed to carry nuclear warheads, raising the question of whether North Korea acquired the warhead technology along with the missile.

» If, indeed, North Korea has acquired help from external (e.g., Russian) experts, its nuclear weapon program could be much further along than typically assessed. It could have (1) more fissile material than reported, (2) nuclear weapon designs for ballistic missiles, and

[12] Niksch, 2002, p. CRS-6.

[13] See "'SCUD C' Variant (Hwasong 6) and 'SCUD D' Variant (Hwasong 7)," 2006, and "Syria 'Boosts Accuracy' of Scud D," 2006.

(3) advanced warhead designs (e.g., boosted yields).[14] With the transfer of SS-N-6 and SS-21 technology, it has already gotten missiles that should be more accurate and reliable, the former with a longer range.

[14] We cannot dismiss the possibility that Russian or Chinese or other nuclear weapon experts provided assistance to North Korea in fielding an advanced design, such as one with a boosted yield. We lack evidence that such a thing happened, but we also lack evidence that it has not happened.

Potential Delivery Means and Locations

Delivery Means	Nuc.Wpn. Possible?	Timing Of Use	Likely Location*
Artillery	Very Low	D+0 to 30?	Ammo storage
Cruise missile	Low	D+0 to 50?	Missile bases
SOF	Low	D+0 to 90?	SOF bases
Aircraft	High	D+0 to 1?	Air bases
Ballistic missile	High	D+0 to 10?	Missile bases
Surface ship	High	D+0	Naval port
Submarine	High	D+0 to 5?	Naval port
"Land mine"	Very High	D+25 on?	Along LOCs

*Locations could include the vicinity of production facilities or in separate high security facilities.

"Land mine": Old nuclear weapon, won't fit on a missile; placed in a building along the avenue of advance?

RAND

NK Nuclear Uncertainties-15 11/09

Any nuclear weapon threat is strongly influenced by the means it has available for delivery, as listed in the first column. Among possible delivery means, it seems unlikely that North Korea has already developed a nuclear weapon small enough for use by artillery, cruise missiles, or special operations forces. But it could potentially deliver nuclear weapons by the other means identified here.

During a conflict, each of these means has a timeframe in which delivery is relatively possible. For example, a North Korean aircraft trying to deliver a nuclear weapon after the first day or so of conflict would almost certainly be shot down, while a surface ship carrying a nuclear weapon after that same period would likely be sunk well before penetrating into ROK territorial waters. North Korean ballistic missiles might survive longer than the 10 days indicated in the slide, but North Korean leaders would likely have little confidence in such survival, and thus might consider using nuclear weapons on ballistic missiles relatively early in the campaign.

In contrast, a nuclear "land mine" could not meaningfully be used until ROK/U.S. forces had advanced into North Korean territory.

The final column of this chart suggests where the nuclear weapons might be stored to support each of these delivery means. These locations become potential targets for ROK/U.S. counterforce attacks seeking to disarm the North Korean nuclear weapon force.

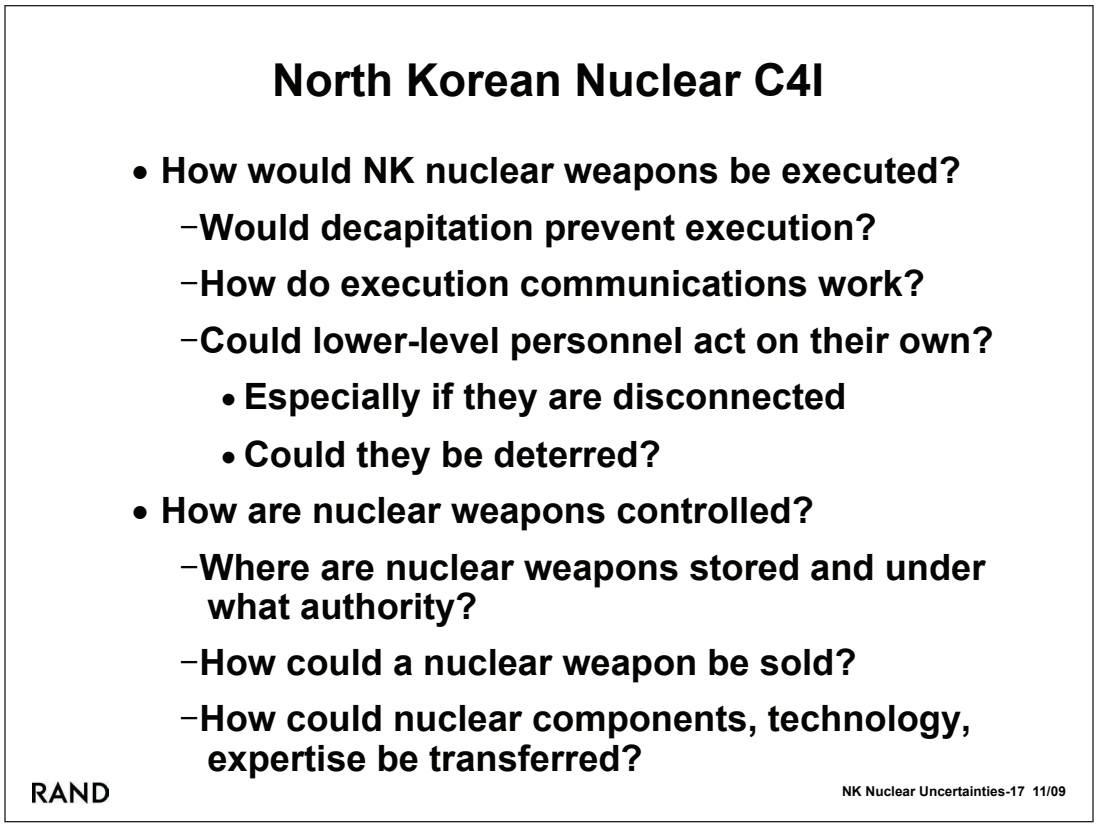
The lack of knowledge of North Korean nuclear weapons extends to their physical characteristics. In terms of weapon yields (the explosive power of a weapon), the October 2006 North Korean nuclear weapon test had a likely yield of less than 1 kiloton (Kt, equivalent to 1,000 tons of TNT). North Korea claimed that was achieved with 2 kilograms of plutonium,[15] a smaller amount of fissile material than normally used in a nuclear weapon. The 2009 test had a much larger yield, consistent with normal designs that have a yield of 10 Kt. And if North Korea is boosting warheads (using elements to create some fusion), they could have an even larger yield.

Other key characteristics of nuclear weapons are their reliability and delivery probability. Because there appear to have been only two tests of a North Korean nuclear weapon, the reliability of such weapons is likely fairly low. Moreover, even the ballistic missiles that would likely be used for delivery have had few tests and could also have a low delivery probability.

North Korean NoDong missiles, a likely delivery means, are usually considered very inaccurate, having perhaps a 2–5 km CEP (circular error probable; the radius around the target within which half the missiles would be expected to arrive). But if North Korea has terminal guidance on these missiles, they could be far more accurate, with CEPs potentially measured in tenths of a kilometer, significantly increasing the probability of damaging a planned target.

The North Korean Musudan missile, which may carry nuclear weapons, may have a range as long as 4,000 kilometers.

[15] "North Korea Declares 31 Kilograms of Plutonium," 2008.

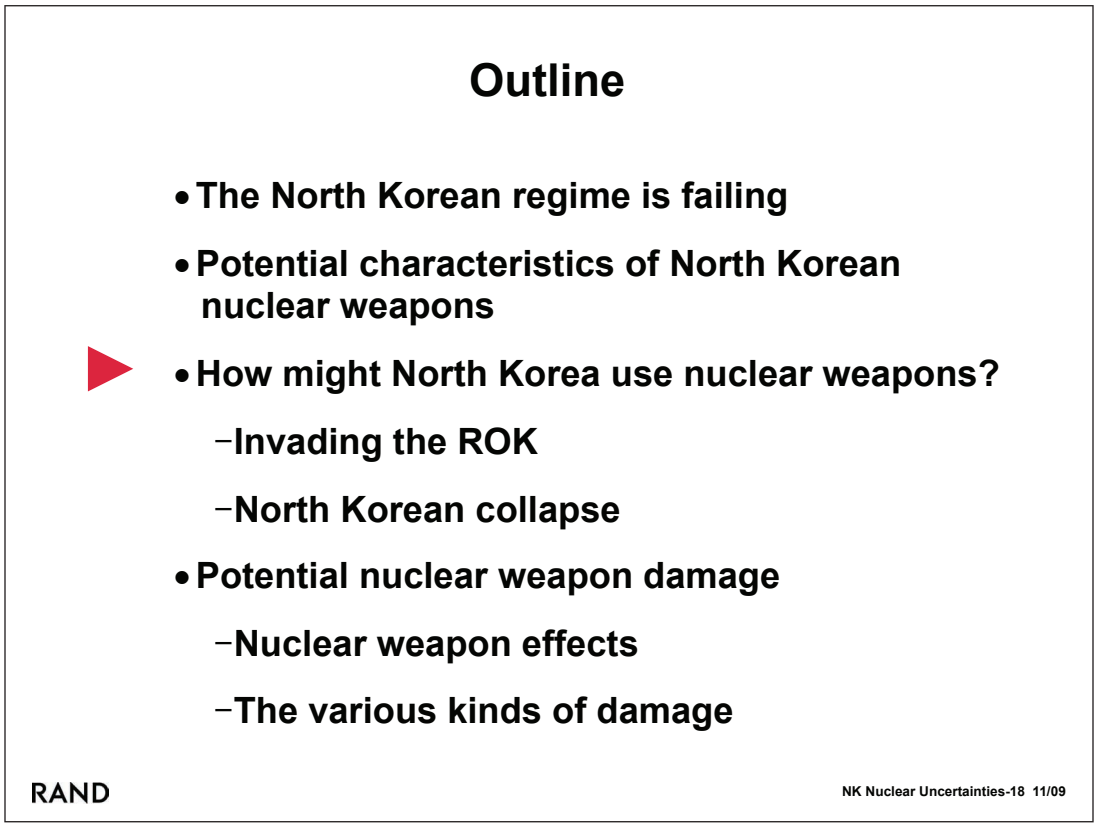


We do not know much about how North Korean nuclear weapons would be launched. While it seems logical that Kim Jong-Il would insist on approving any nuclear launches, he might also delegate launch authority as a "fail-safe" against decapitation or other losses of control. We also do not know how a launch order would be communicated. These information gaps leave us with little confidence that efforts to decapitate the leadership or interdict its communications would stop a launch. Alternatively, if personnel below Kim Jong-Il would have a role in "turning the key" to launch a nuclear missile, it may be possible to deter them from taking such action.

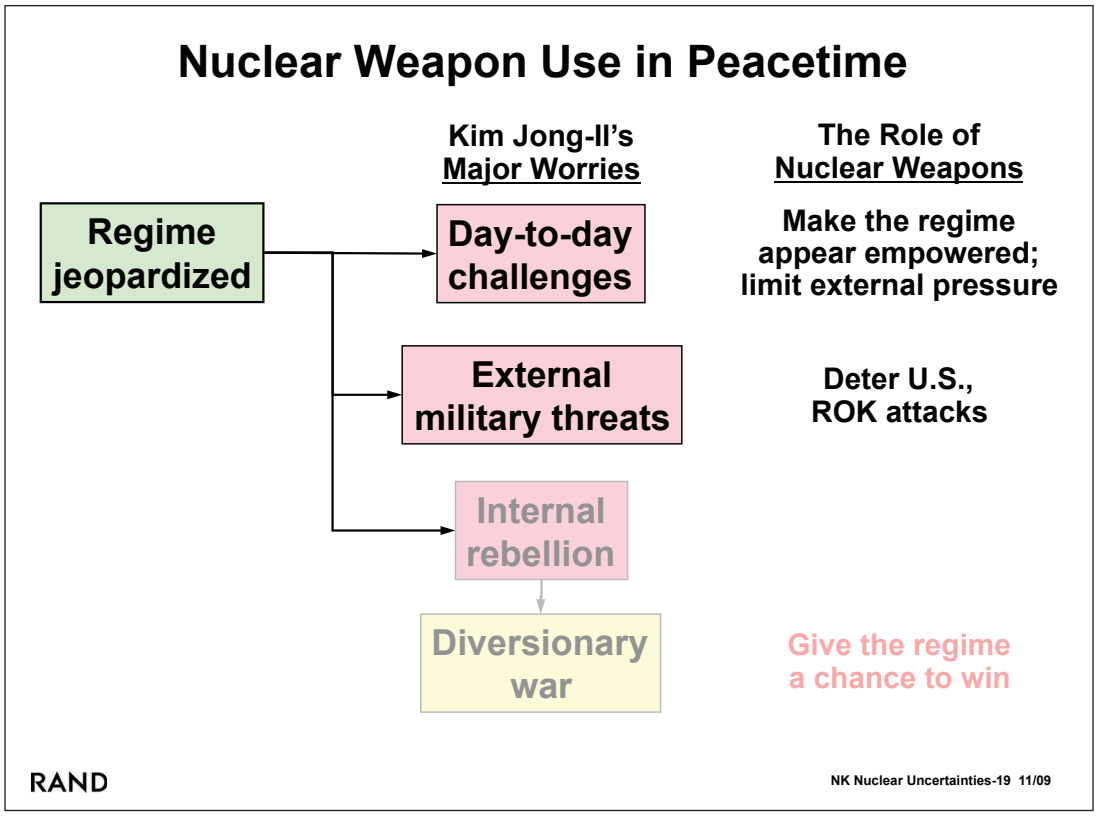
» More generally, we also do not know how North Korea handles nuclear weapon custody. This includes where nuclear weapons are stored and under what authority. These issues are important in considering counterforce action against the North Korean nuclear weapons. These issues are also significant in thinking about the control of nuclear weapons if there is a collapse of the North Korean government or if North Korean security arrangements begin to break down. The result could be the unauthorized use or sale of entire nuclear weapons, or the sale of nuclear components or expertise—not unlike what may have happened with A. Q. Khan of Pakistan.

SECTION 4

How Might North Korea Use Nuclear Weapons?



Nuclear weapons can be used in a variety of ways. We consider here three contexts: peacetime, a North Korean invasion of the ROK, and a North Korean government collapse.



Going back to a previous chart, it is important to note first that North Korea uses nuclear weapons every day to achieve influence and the appearance of empowerment with both internal and external audiences.

A former State Department official, Mitchell B. Reiss, is reported to have said:

> Perhaps the least noted and most astonishing aspect of the entire diplomatic process involving North Korea during the past few years has been the almost complete inability of four of the world's strongest military and economic powers, including three nuclear-weapons states and three members of the UN Security Council—the United States, China, and Russia—and Japan to shape the strategic environment in Northeast Asia. They have [proved] thoroughly incapable of preventing an impoverished, dysfunctional country of only 23 million people from consistently endangering the peace and stability of the world's most economically dynamic region. This has been nothing less than a collective failure.[1]

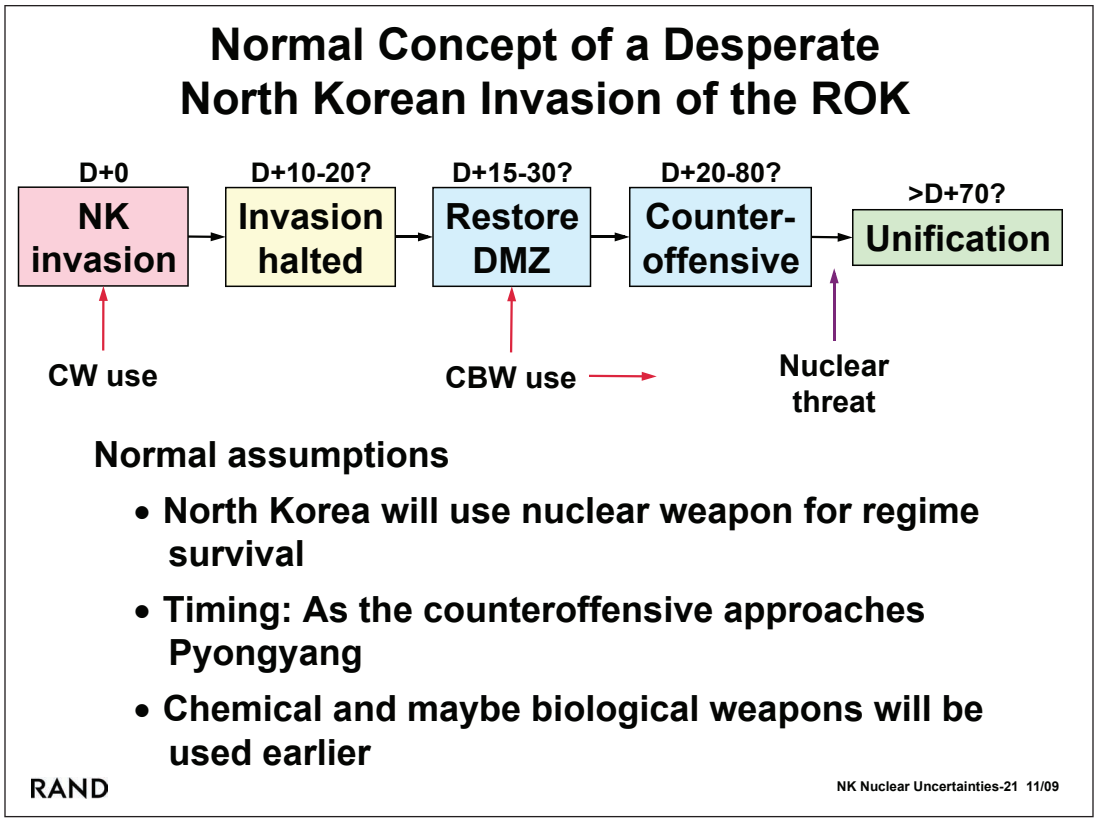
North Korea also uses its nuclear weapons to deter action against it by the United States or other countries. According to the North Korean news agency KCNA: "'The reality testifies to the fact that the D.P.R.K.'s nuclear weapons serve as a powerful deterrent to keep the equilibrium of forces in the region, avert a new war and ensure peace.'"[2]

[1] Kim, M., 2007.

[2] "North Korea Warns of Improved Nuclear Deterrent," 2005.

A North Korean Invasion

If North Korea invades the ROK, the key alternative views of North Korean nuclear weapon use are in terms of what North Korea would target and when.

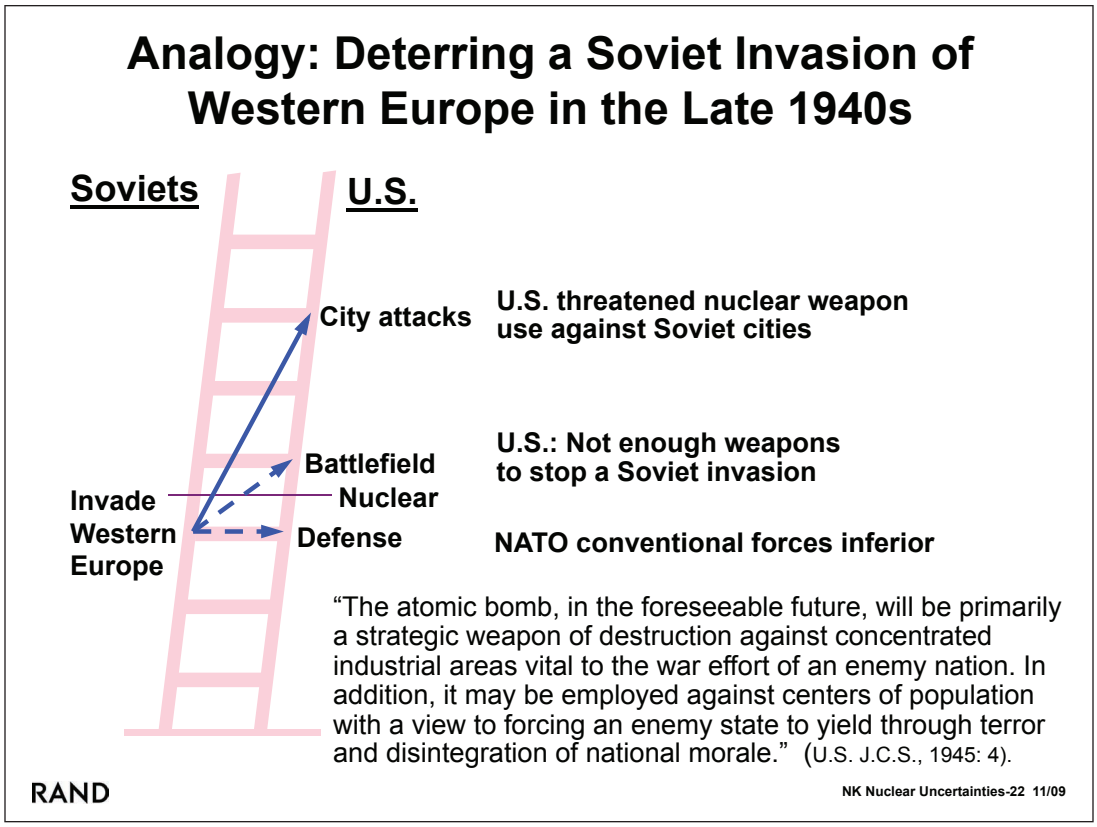


Most discussions of actual North Korean nuclear weapon employment come in the context of a North Korean invasion of the ROK. This is largely because many feel that North Korean use of nuclear weapons would constitute a very high risk, one the North Koreans would not take short of desperate conditions in which regime survival is jeopardized and an invasion is launched as a diversionary war (as argued previously). To succeed in such an invasion, North Korea would likely employ chemical weapons from the beginning of the conflict, in part because it does not characterize them as WMD.[3]

If the North Korean offensive fails, ROK/U.S. forces would launch a counteroffensive to defeat the North Korean Army, capture North Korea, and depose the North Korean regime. At that point, the North Korean regime would be even more desperate and prepared to take extreme measures against the counteroffensive, including the heavy use of chemical and perhaps biological weapons.

Even in this context, many postulate that North Korea would wait until the ROK/U.S. counteroffensive is advancing on Pyongyang before using nuclear weapons. They argue that the advance on Pyongyang would be a final, serious threat to the regime, one that Pyongyang would need to stop. North Korea would feel driven to nuclear weapon use if it had failed to stop the ROK/U.S. counteroffensive earlier. While any use of nuclear weapons would be risky, at this point North Korea would anticipate close to a 100 percent chance of regime destruction if it did not use nuclear weapons, and thus nuclear weapon use would be a last, desperate attempt at survival.

[3] The former U.S. commander in Korea, General Leon LaPorte, said, "They don't view using chemical weapons as weapons of mass destruction. They see it as part of their normal doctrine" ("Nuclear Nightmare—Understanding North Korea," 2003).



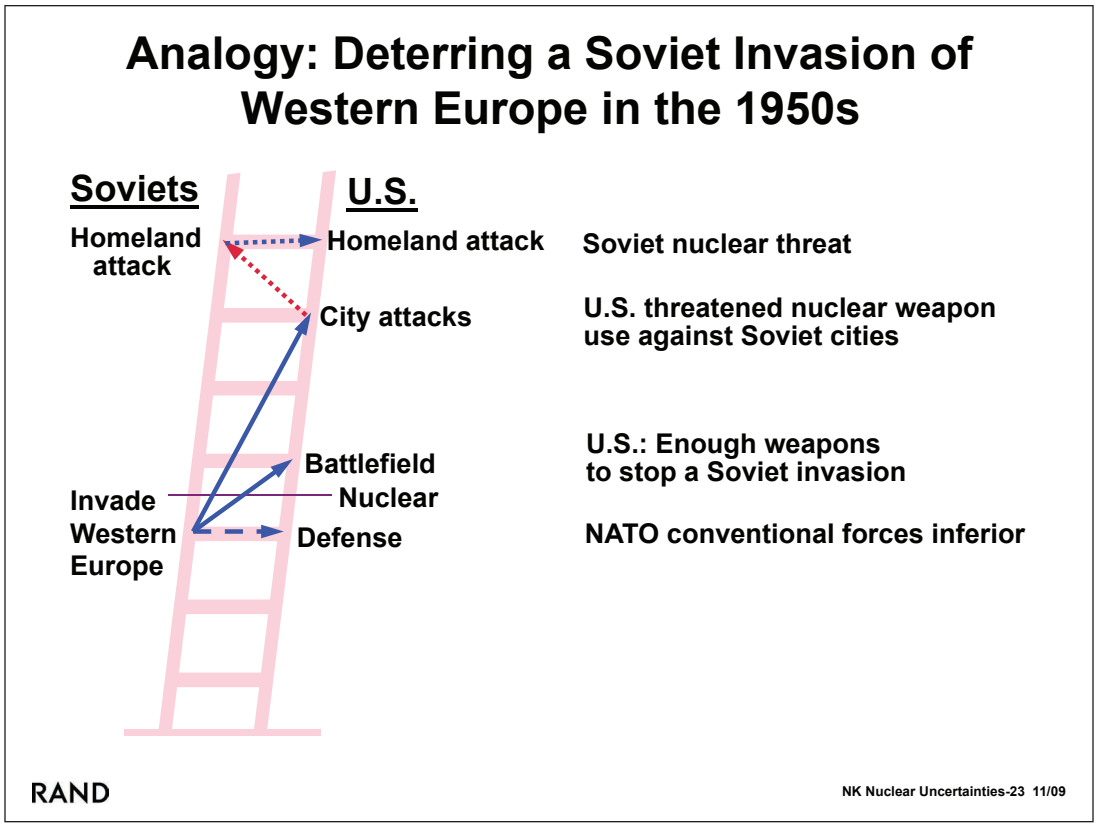
Relative to North Korea stopping the ROK/U.S. counteroffensive, the North Korean situation resembles the U.S./NATO situation in the late 1940s. At that time, the Soviets threatened to invade Western Europe with conventional forces, and the United States perceived that it had several options to defeat/deter this threat, shown in the slide on an escalation ladder.

» The viability of these U.S. options was:

- **Conventional defense.** The U.S./NATO would have lost because the Soviets had clear conventional force superiority.
- **Battlefield nuclear weapon use.** The United States had too few nuclear weapons to apply to European battlefields and stop a Soviet advance into Western Europe.
- **Nuclear attacks on cities.** The only viable (though still poor) option was to threaten Soviet cities with destruction if the Soviets invaded Western Europe, hoping to deter an invasion.

» The quote at the bottom from the U.S. Joint Chiefs of Staff in 1945 shows how serious the United States military was about targeting Soviet cities.[4]

[4] U.S. Joint Chiefs of Staff, 1945, p. 4.

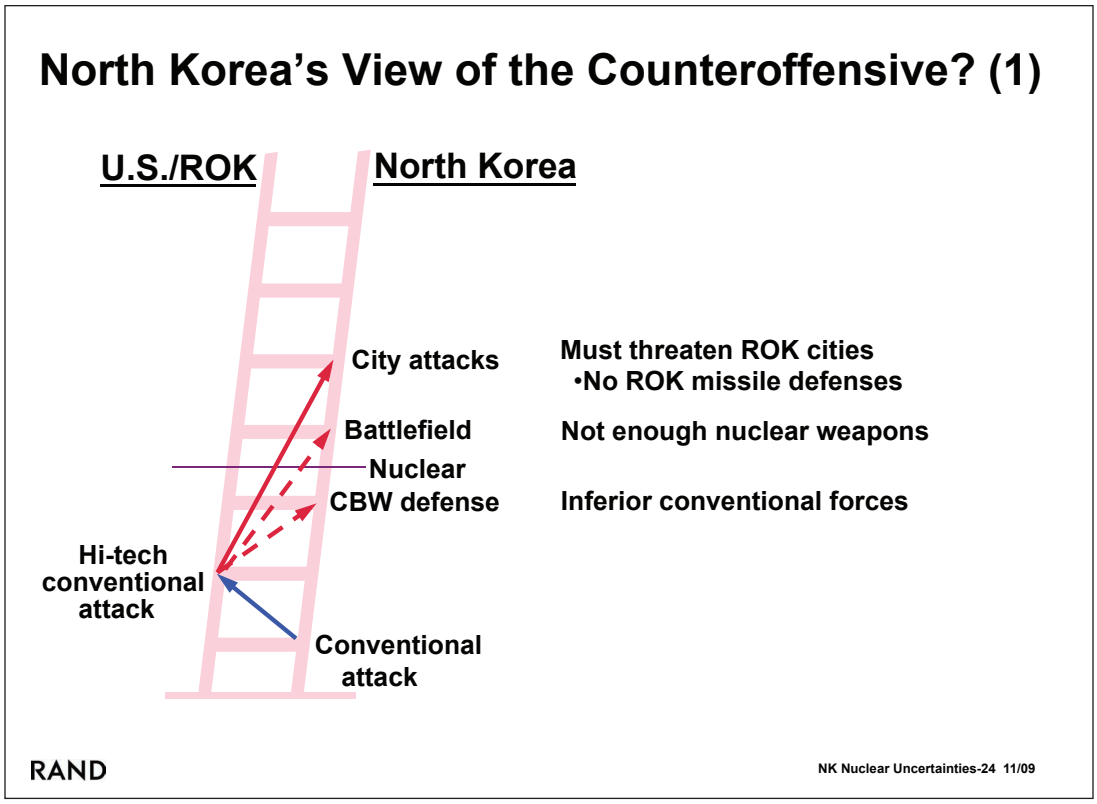


By the 1950s, two major conditions had changed the U.S. and allied thinking about deterring or defeating the Soviet threat of invading Western Europe.

First, the United States fielded enough nuclear weapons (thousands) in the 1950s such that battlefield nuclear weapon use became a viable option. But North Korea does not appear to be in a position to gain such a capability.

» Second, in the 1950s, the Soviets developed capabilities to use nuclear weapons against U.S. allies and the United States. Thus, if the United States used nuclear weapons to stop a Soviet invasion, and especially against Soviet cities, the United States and its allies could have suffered a Soviet retaliation with similar nuclear attacks. This Soviet capability raised questions with several U.S. allies (especially the French) about the U.S. willingness to use nuclear weapons to stop a Soviet invasion, but the United States remained adamant that it was prepared to accept this risk.

The North Koreans face a similar quandary: If they use nuclear weapons, they can expect a U.S. nuclear retaliation. But it appears that they already expect U.S. nuclear weapon use from roughly the beginning of a conflict, and thus may not be deterred from their own nuclear weapon use.



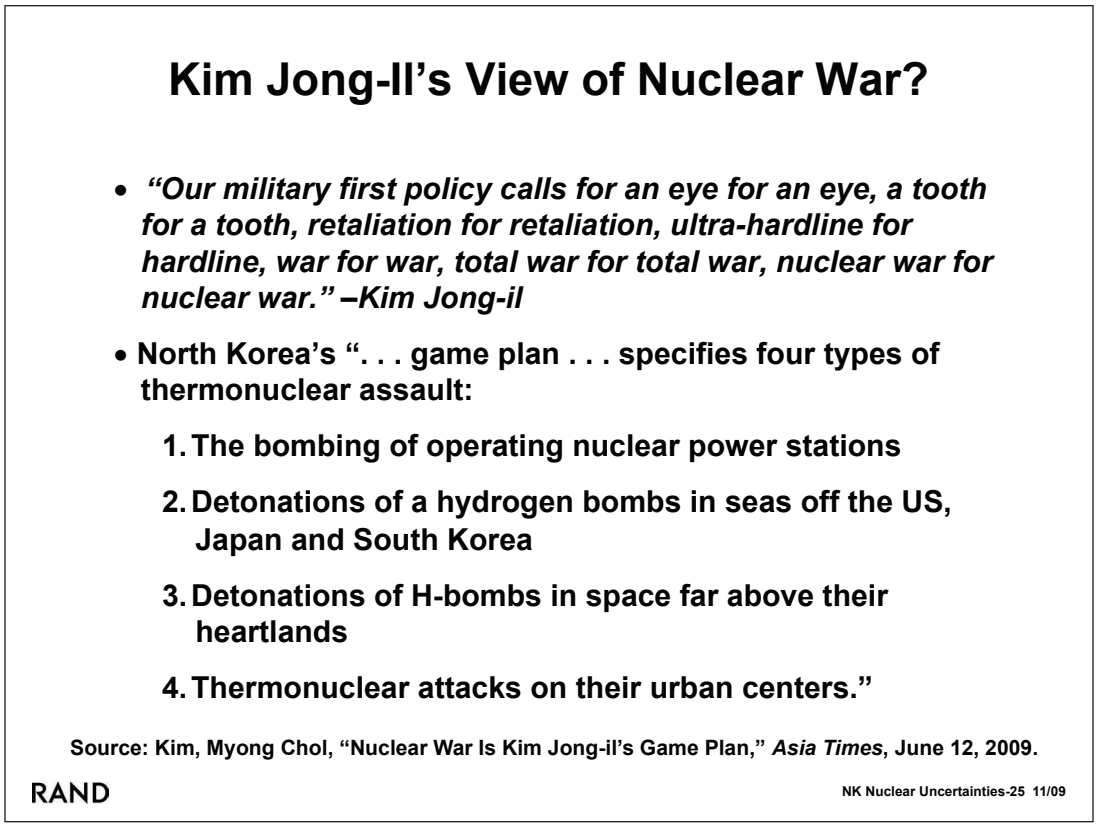
The North Koreans would likely view the ROK/U.S. hi-tech counteroffensive as a major escalation of their conventional attack, one that would lead to North Korean defeat and regime destruction.

» Similar to the U.S./NATO case, they would have three defensive options:

- **Conventional defense.** North Korea could not stop the counteroffensive with just conventional weapons because of ROK/U.S. conventional force superiority.
- **Battlefield nuclear weapon use.** North Korea likely has too few nuclear weapons to stop a ROK/U.S. advance with battlefield nuclear attacks.
- **Nuclear attacks on cities.** The only viable option would be to threaten ROK cities with destruction if the ROK/U.S. advance on Pyongyang is not halted. Indeed, North Korea could proactively threaten the ROK/U.S. forces not to advance above the demilitarized zone (DMZ). As discussed below, city attacks could be devastating.

Even as early as 1976, a North Korean diplomat is reported to have said, "By now the DPRK also has nuclear warheads and carrier missiles, which are targeted on the big cities of South Korea and Japan, such as Seoul, Tokyo, and Nagasaki, as well as on the local military bases, such as Okinawa."[5] While North Korea almost certainly did not have nuclear weapons that early, its leadership has apparently thought about North Korean nuclear weapon use for a considerable period of time. These targeting concepts appear to still prevail in North Korea: North Korea regularly threatens to do great damage to the ROK, Japan, and the United States if the United States or anyone else takes military action against North Korea and its regime.

[5] Woodrow Wilson International Center, 2005, Document 20.



We have little information on how North Korea would envision city attacks. But one of Kim Jong-Il's purported spokesmen has given the perspective shown on this slide. His quote of Kim Jong-Il suggests that Kim Jong-Il would at least retaliate against a U.S. nuclear attack by using nuclear weapons, if not be more proactive.[6]

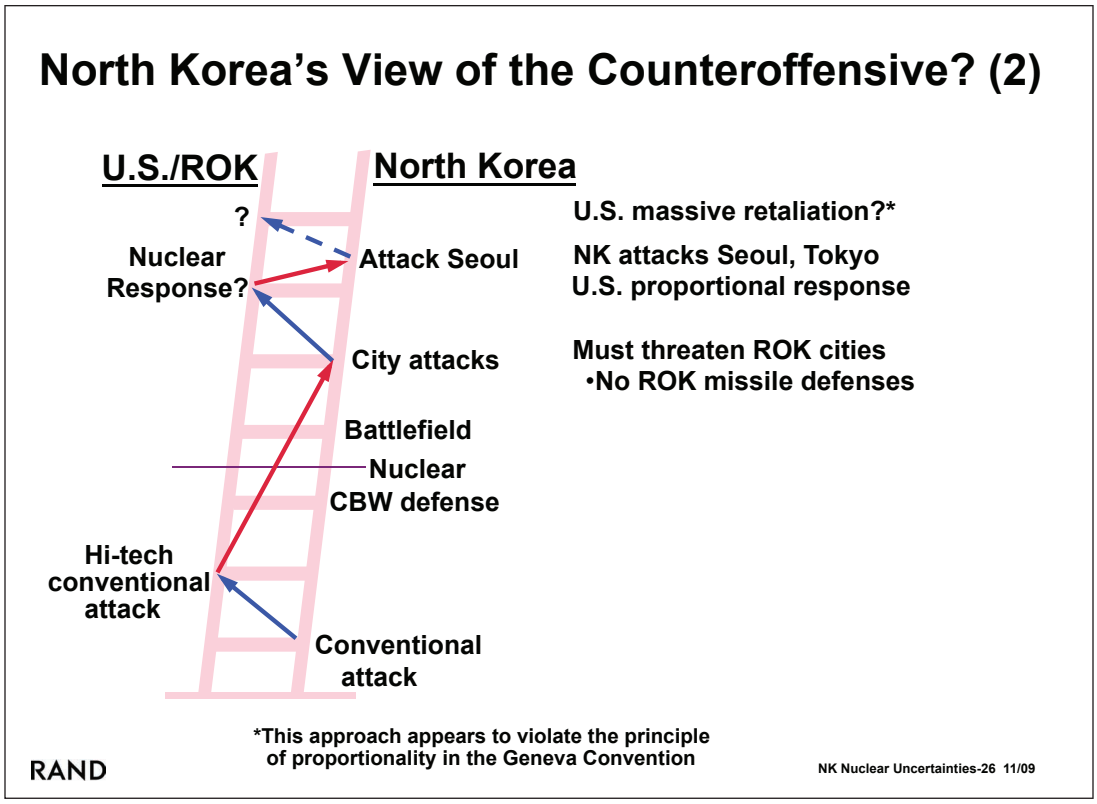
In terms of targeting, this spokesman identifies four options that are actually tied to city attacks:[7]

- The first two options are attacks on nuclear power stations or in the seas next to the coast; the intent of such attacks would be to generate large amounts of fallout that would pollute a country and perhaps make it uninhabitable, at least for some period of time in the areas where fallout is deposited. For attacks on nuclear power stations, the challenge for North Korea would be delivering a nuclear weapon with sufficient accuracy that it could destroy a nuclear power station—a very difficult task.
- Nuclear attacks in space would be intended to generate electromagnetic pulse (EMP). Such attacks could disrupt/destroy electronics and electricity generation and transmission. They could leave cities and the military without functioning electrical systems. An EMP attack is basically a demonstration of nuclear weapon capability, as the detonation would occur at such a height that it would cause no blast or radiation damage directly on the targeted country.
- The final option the spokesman discusses is direct attacks on cities.

[6] Kim, M., 2009.

[7] Kim, M., 2009.

While the author does not discuss attack sequencing, EMP/demonstration attack(s) might occur early in a conflict, whereas attacks to create massive amounts of fallout, especially from nuclear power plants, would likely occur late in a conflict as a revenge or related effort.

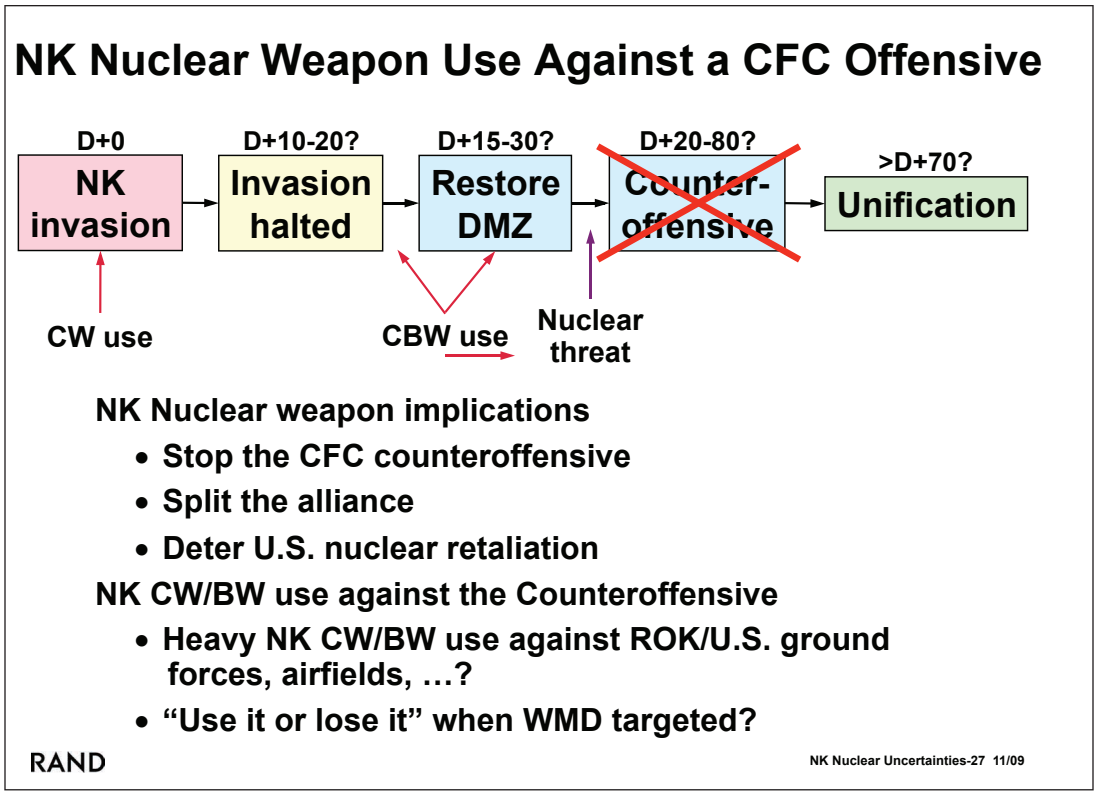


The major difference from the 1940s case is that the United States does have the ability to retaliate with nuclear weapons against North Korean nuclear attacks today. Many U.S. experts expect the United States to use appropriate, proportional retaliation.

» As a result, North Korea likely has a concept for controlling nuclear escalation: It has threatened Seoul and Japanese cities with a "sea of fire"—apparently a nuclear attack—if the United States uses nuclear weapons. Kim Jong-Il also has a history of disappearing during high-end provocations,[8] presumably so that he cannot be targeted.

» The question becomes how the United States would respond to attacks on Seoul or Tokyo. Would it employ massive retaliation, as some think, but in apparent contravention of the Geneva Convention? Would North Korea think that the United States had the will for such an escalation?

[8] "Kim Jong Il Vanishes From Public Eye," 2006; "North Korea Mum on Kim's Location Since Sept. 15," 2006.



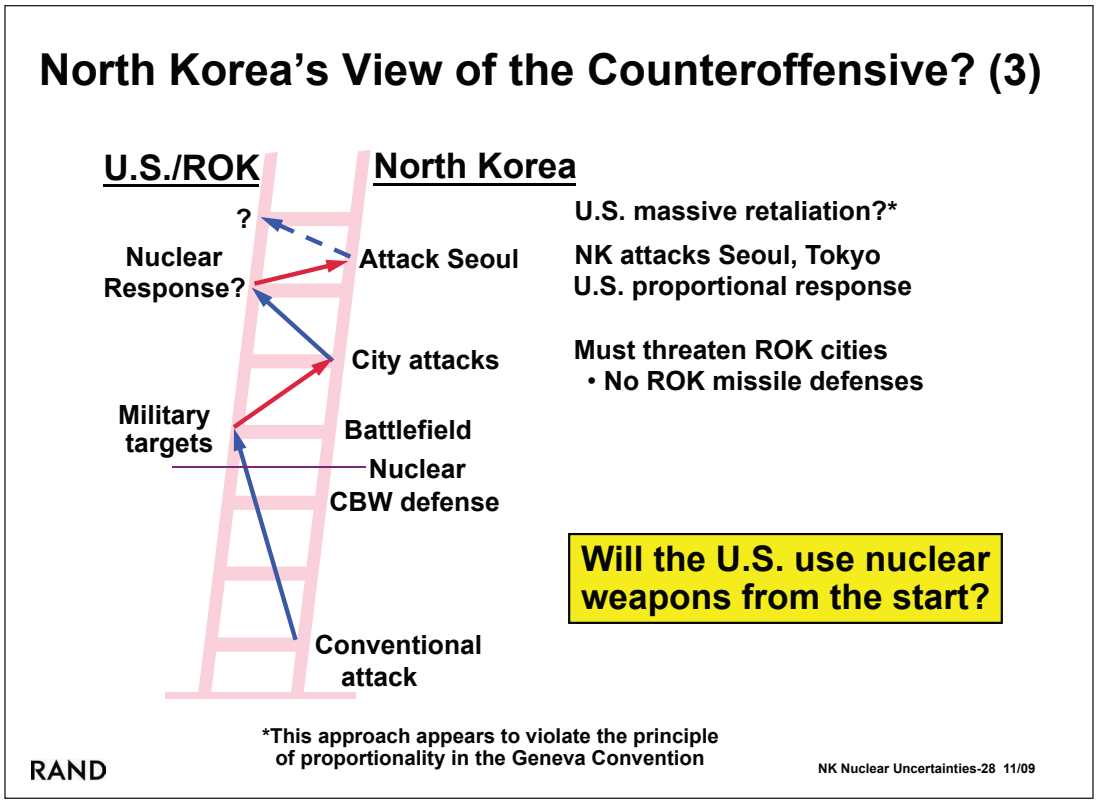
In addition, would North Korea really wait to use nuclear weapons until ROK/U.S. forces were approaching Pyongyang? If so, North Korea would be allowing the ROK and United States to first gain control of almost half of its country, and the area where much of North Korea's food is grown, only exacerbating future starvation.

One alternative that North Korea might consider is to make a nuclear threat against the ROK before ROK/U.S. forces cross the DMZ. North Korea could say, for example, "If ROK and/or U.S. forces enter North Korean territory, a nuclear weapon will be detonated on Pusan." North Korea could make such a threat whether or not it had the capability to deliver on it.

A ROK president facing such a threat would have a difficult decision to make. After North Korean forces had killed perhaps hundreds of thousands of people with conventional forces, it would be difficult to allow the North Korean government to survive. But would the ROK president be willing to risk the lives of potentially several hundred thousands or millions more ROK civilians threatened by North Korea? If not, the counteroffensive might be stopped and the alliance split, as the United States would presumably not want the North Korean regime to survive.

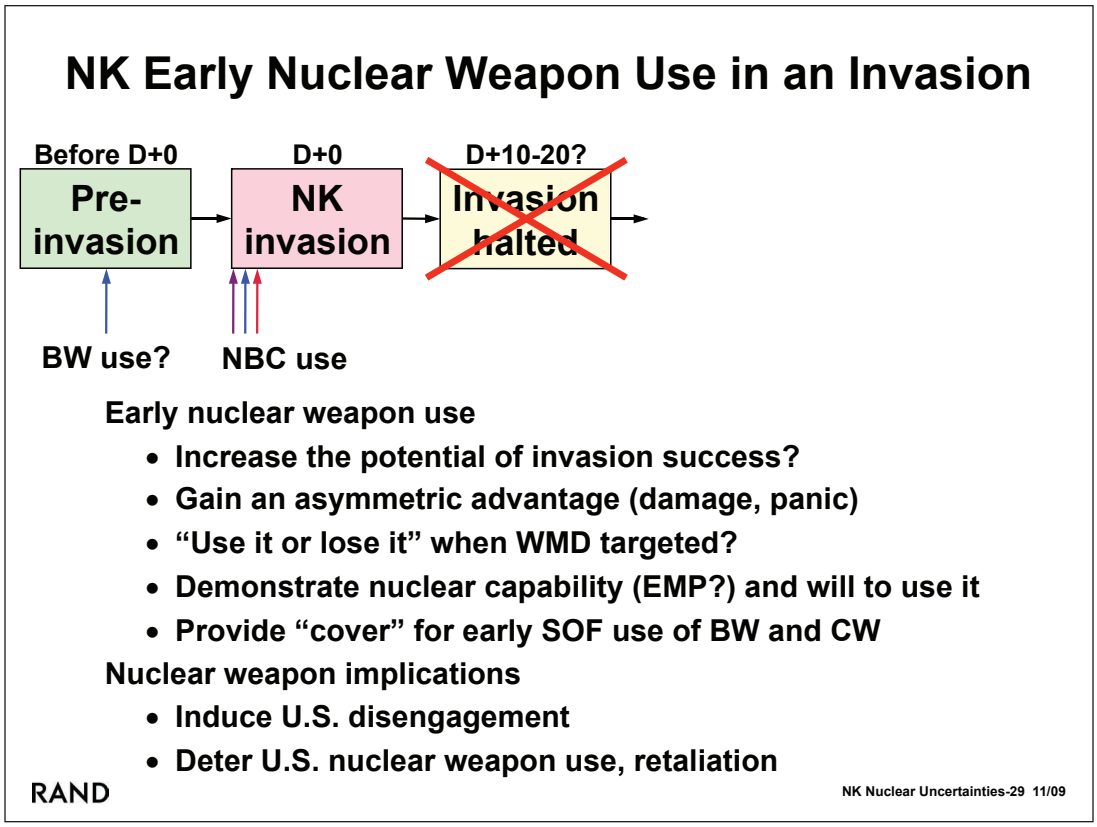
North Korea might also hope that nuclear weapon use would deter or at least restrain U.S. nuclear retaliation, with the United States fearing further North Korean nuclear escalation.

» Note that North Korean nuclear weapons may make North Korea feel far less constrained in the use of chemical and biological weapons (CBW) against the counteroffensive: North Korea may perceive a U.S. reluctance to use nuclear weapons to retaliate against CBW use, because North Korea would likely use nuclear weapons in response. North Korea may also be prepared to use its WMD when the survival of its WMD is threatened—when North Korea fears that it must use its WMD or lose it.



A third alternative for North Korean nuclear weapon use would come potentially much sooner in a conflict. As argued earlier, North Korea appears to believe that the United States would use nuclear weapons against the North from the beginning of any conflict.

» If North Korea believes this, then it would be even more prone to use nuclear weapons early in the conflict, perhaps from the very beginning of the conflict. This would not change the upper part of the escalation ladder, but would potentially move it much earlier in the conflict. Indeed, North Korea may choose to preempt U.S. nuclear weapon use when it starts the conflict, anticipating that early use of nuclear weapons would be most likely to succeed.

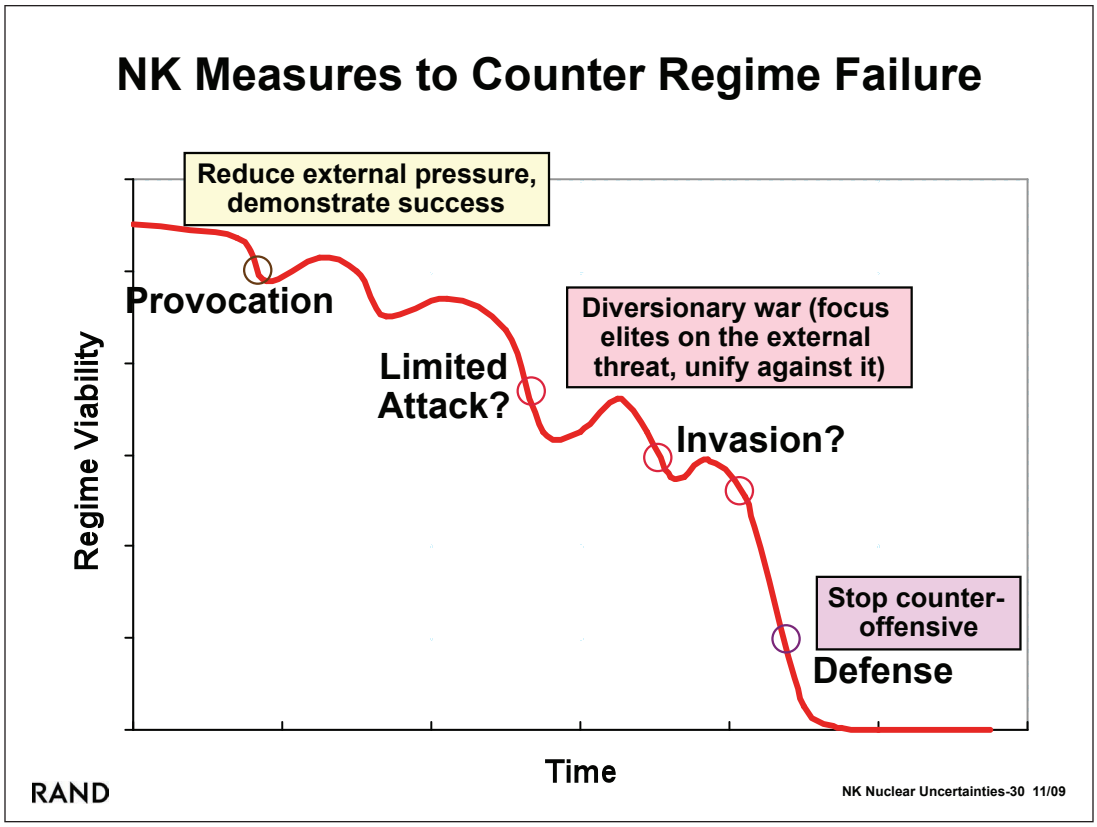


North Korea may choose to use nuclear weapons from the very beginning of the conflict for several strategic and operational reasons:

- The ROK and the United States have anticipated being able to halt a North Korean invasion fairly quickly. North Korea might hope that early nuclear weapon and CBW use would actually allow an invasion to succeed.
- Nuclear weapon use may have its greatest impact at the beginning of an invasion, causing unexpected damage and panic in the ROK from which recovery might be difficult, at least in the short term. North Korea might particularly target ROK/U.S. command and control to disrupt early ROK and U.S. responses to the invasion.
- North Korea may be concerned about the potential survivability of its nuclear weapons—the "use it or lose it" quandary—as noted earlier.
- North Korea might use nuclear weapons early to establish the credibility of its nuclear deterrence: North Korea would demonstrate both nuclear capability and the will to use it. North Korea might do so with a "demonstration" attack, such as an EMP burst that would cause few casualties and thus not compel a U.S. nuclear weapon response, though possibly impairing many ROK and U.S. advanced weapons.
- Moreover, early use of nuclear weapons might establish escalation control, with which North Korea would feel freer to use CBW.

» North Korea might hope that the United States would back away from a nuclear war, fearing its consequences, and perhaps even disengage from the conflict. At the very least, it might hope that its demonstrated nuclear capability and escalatory threats would moderate

U.S. nuclear weapon use. While this may appear to many Americans as North Korean wishful thinking, there are no precedents or "rules" for such a conflict. And the United States has shown significant timidity in enforcing its lower-level red lines, potentially leading North Korea to expect U.S. timidity in war, as well.



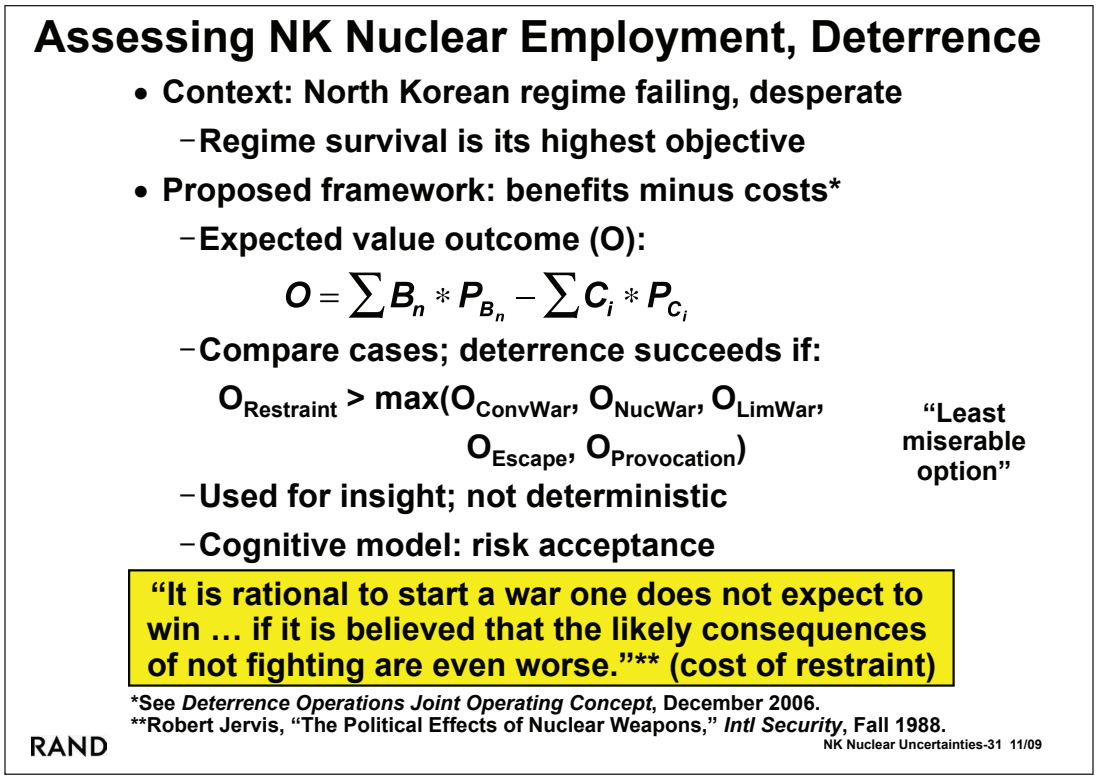
In practice, the problem Kim Jong-Il faces is a country whose viability is decreasing along a path that neither he nor the United States can precisely know. While North Korean nuclear weapon attacks near the bottom of that path, to stop a counteroffensive or to help an invasion of the ROK, seem quite possible, we must also consider potential North Korean nuclear weapon use earlier in the regime-failure process. Indeed, the October 2006 North Korean nuclear weapon test was a nuclear weapon "use" for coercive purposes. North Korea has already conducted a second nuclear weapon test and could do more, all of which would be very escalatory. North Korea might even mount a nuclear warhead on a ballistic missile and fire it out over the Sea of Japan.

Given the history of North Korean actions, such as the Rangoon attack that failed to create a true "diversion" (in large part because the ROK made no retaliation), limited attacks would likely need to be very serious to force a serious U.S. retaliation, and such limited attacks could include using nuclear weapons from the beginning. For example, a North Korean "atmospheric nuclear test" over Japan or near its coastline could potentially cause serious electronic and economic damage to Japan. But because few people would be killed, there might be tremendous international pressure on the United States to minimize the response and thus the cost to North Korea. Retaliating against North Korea, especially with a combined Japanese/U.S. attack, might galvanize the North Korean elites against common external foes, a benefit to the regime that might easily surpass its estimated cost. Deciding how the United States

should respond to such an attack might also lead to frictions in the Japan-U.S. alliance and/or in the ROK-U.S. alliance,[9] a further benefit to Kim Jong-Il.

The bottom line is that early North Korean use of nuclear weapons in a limited conflict or an invasion of the ROK appears possible. The United States should seek to deter that possibility and be prepared to appropriately defend against it.

[9] This might be especially true if the United States allowed Japan to participate in a retaliation against North Korea (given Korean concerns about Japan's historical militarism).



The Department of Defense has published a Deterrence Operations Joint Operating Concept[10] that provides a framework for evaluating North Korean decisions about nuclear weapon use. But the North Korean context considered here, with North Korea desperately seeking regime survival, colors the framework. The framework has North Korea estimate the outcome of its various potential courses of action, comparing the costs and benefits of each action, including the probabilities of each benefit and cost.

» The author believes that North Korea will choose the best outcome, recognizing that even restraint (not using nuclear weapons) could have a highly negative value when the regime faces serious internal threats. It thus selects a "least miserable option."

» This framework is intended to provide insights on potential North Korean actions rather than to directly predict North Korean behavior. Kim Jong-Il's decision calculus and values in this framework would be very uncertain, though he is likely to act as a risk-taker when the regime is seriously jeopardized (consistent with cognitive deterrence, also referred to as *prospect theory*[11]).

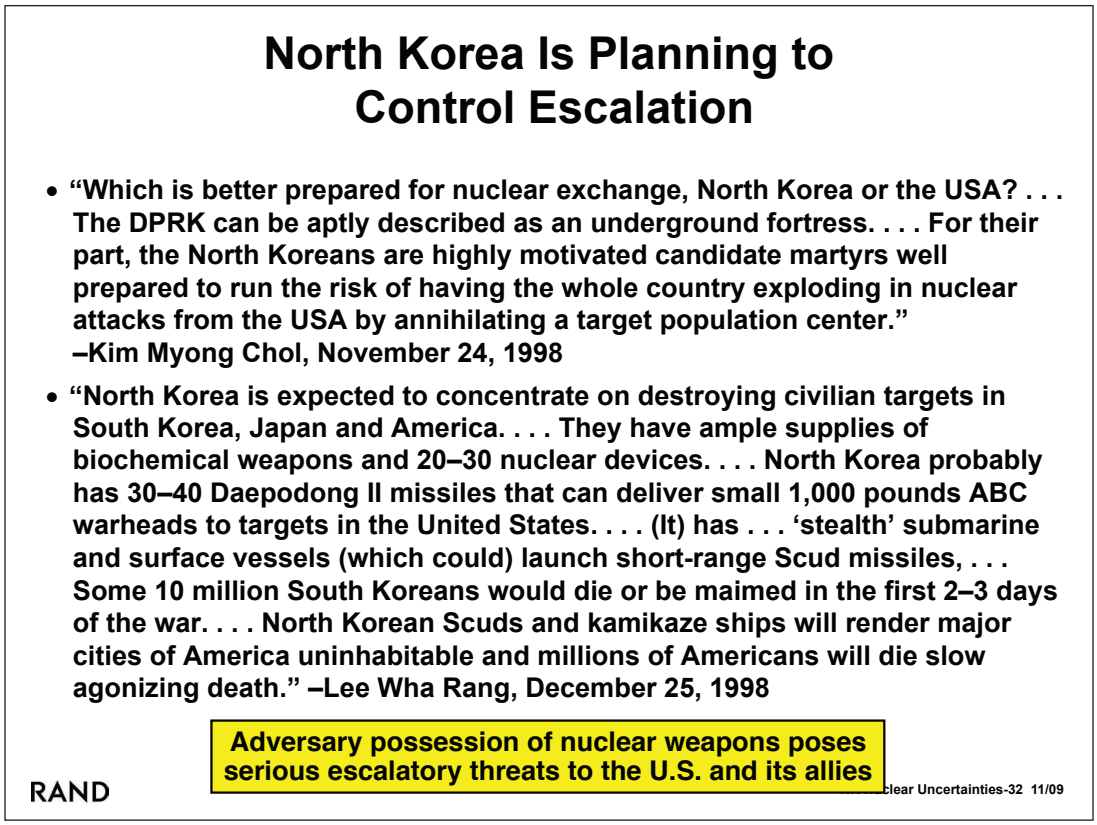
» The logic of the "least miserable option" is different from what is normally assumed in decisionmaking. The quote in the slide from Robert Jervis,[12] an expert on deterrence, clarifies that Kim Jong-Il could potentially use nuclear weapons even though he expects that such use will lead to dire consequences, as long as the outcome from using nuclear weapons appears better than the outcome of doing nothing and potentially being overthrown.[13] The United States needs to use such a framework to evaluate its deterrence options.

[10] Department of Defense, 2006, p. 5. Deterrence is one of the four components of U.S. national defense strategy (Department of Defense, 2005, p. iv).

[11] Levy, 1992; Berejikian, 2002.

[12] Jervis, 1988, p. 81.

[13] See a related analysis in Ochmanek and Schwartz, 2008, pp. 31–45.



These two statements by North Korean defectors suggest the degree to which some North Koreans have thought about the entire escalation-control process.[14]

The first highlights the fact that superior nuclear weapon capabilities alone do not convey escalation control. If one side is more prepared to accept nuclear damage, that side may have an advantage in trying to control escalation. This North Korean defector believes that such is the case with North Korea.

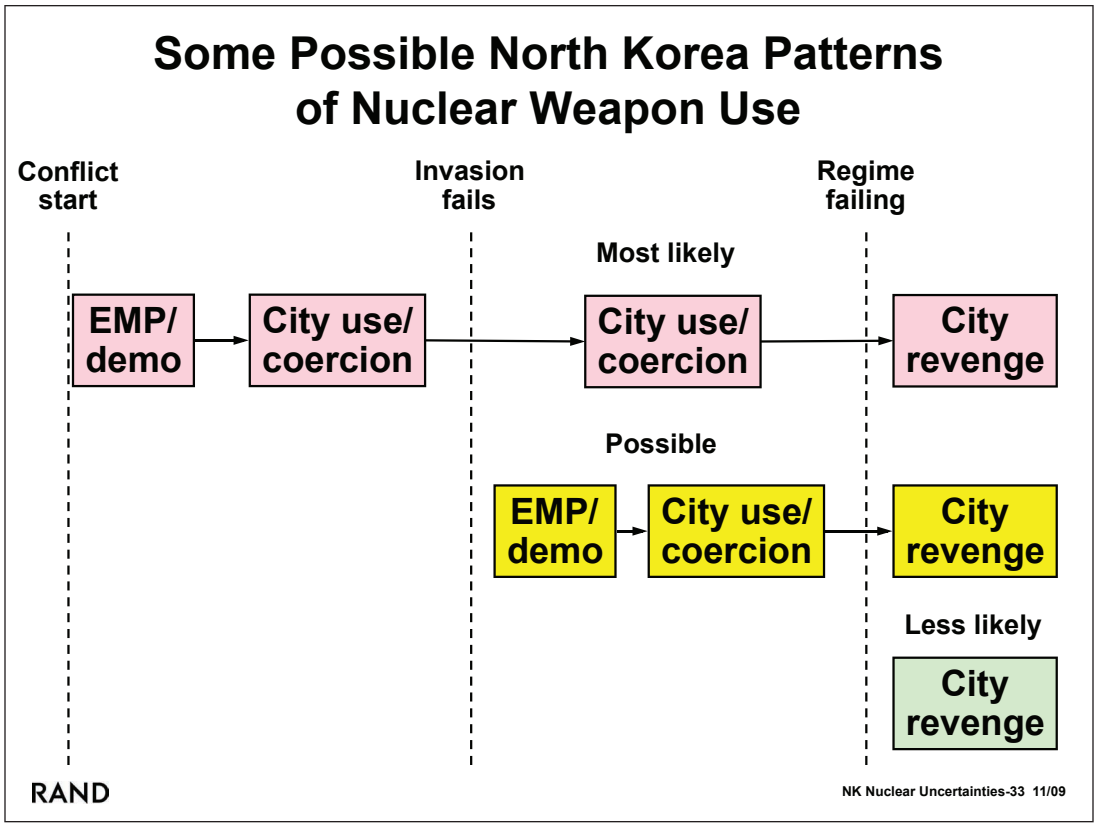
The second statement appears extreme in terms of North Korean nuclear capabilities in 1998 (e.g., 20–30 nuclear devices and 30–40 Daepodong II missiles would be at the high end of the North Korean threat even in 2009). Still, the concept of launching Scud missiles from merchant ships or submarines against the United States is an interesting possibility that the United States needs to hedge against. A 2009 press report suggests that North Korea may now have developed such capabilities.[15]

» Indeed, even a single adversary demonstration of such a capability could significantly affect U.S. security interests, encouraging other states to pose similar threats.

[14] The first quote in the slide is from Kim, 1998; the second is from Lee, 1998.

[15] Recently, North Korea's ability to pose such a threat was clarified:

> North Korea reportedly purchased 12 decommissioned Russian Foxtrot and Golf-II class submarines for scrap metal from a Japanese company. "The Golf-IIs, which are capable of carrying three SS-N-5 SLBMs [submarine-launched ballistic missiles], did not have their missiles or electronic firing systems when they were sold to the North Koreans, but they did allegedly retain significant launch sub-systems including launch tubes and stabilization systems." . . . Some experts believe that "this technology, in conjunction with the R-27's well-understood design, gives North Korea the capability to develop either a submarine or ship-mounted ballistic missile," the report said. "It is also possible, according to some observers, that North Korea might attempt to incorporate this launch technology into a merchant ship." ("N. Korea May Have Sea-Based Missile System: Report," 2009; Hildreth, 2009, p. 5).



North Korean nuclear weapon use as part on an invasion could vary in terms of both timing and targeting. Across three broad options, I believe that early North Korea weapon use is most likely (70 percent?), though delayed use is possible (20 percent?), and late use is less likely (10 percent?).

As argued earlier, North Korea is likely to view the survivability of its nuclear forces as limited, pushing it to use them relatively early in a conflict. This attitude would be strengthened by a belief that the United States will use nuclear weapons early, and that nuclear weapons would provide greater, potentially conflict-winning leverage early on. For example, North Korea might hope that appropriate nuclear weapon use would convince Japan to not become involved in the conflict, and thereby deny the United States the use of Japan to support U.S. deployments and operations. Most North Korean nuclear coercion would likely be focused on cities, potentially leading to city attacks. North Korea could also attack military facilities, such as airfields and ports, in the rear, but nuclear damage to one or a few of these facilities would likely not affect U.S. capabilities that much (there is no simple bottleneck).

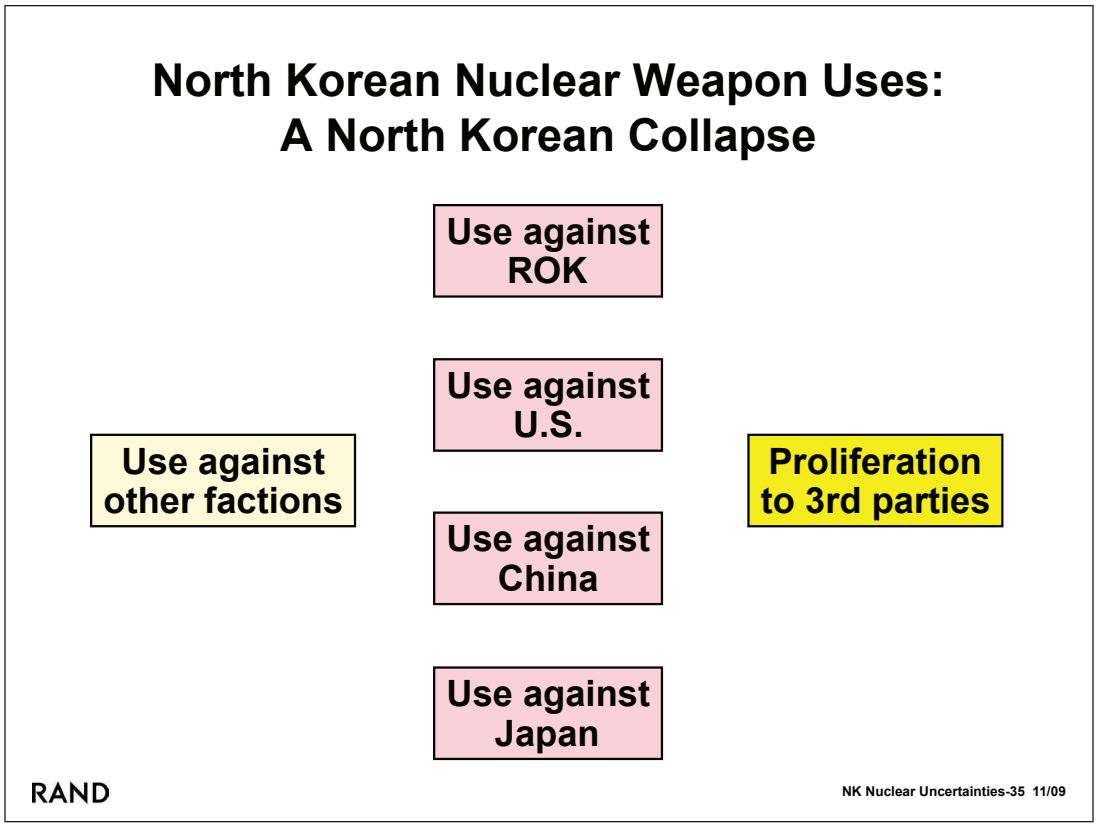
The main alternative option would be for North Korea to wait until its invasion fails and the ROK and United States start a counteroffensive. The North Korea regime would know that it had to stop the counteroffensive or not survive, and so would be prepared to take very risky actions to survive, including nuclear attacks on cities.

The less likely option would be for North Korea to withhold its nuclear weapons for some kind of revenge attack as the regime is failing.

North Korea has invested a lot in its nuclear weapons; it would have largely wasted that investment if they give the regime little leverage in a conflict.

A North Korean Collapse

We next examine potential North Korean use of nuclear weapons after a government collapse.



In terms of nuclear weapon use, a North Korean collapse would be somewhat different from a North Korean invasion of the ROK. In a collapse, central government authority would be lost, and nuclear weapons might be held by a number of military commanders in various regions. As these commanders try to establish control in North Korea, they may threaten other North Korean factions with nuclear weapon use to coerce/defeat them or to deter the action of stronger factions.

These commanders might still threaten the ROK and the United States with nuclear attack if ROK/U.S. forces advance into North Korea, hoping to deter such an advance. But they might also wait until their specific area is threatened. And some commanders without nuclear weapons may still threaten nuclear weapon use, hoping to deter ROK/U.S. action. Commanders might also use nuclear weapons to extort aid from the ROK and United Sates, since many of them will not likely have sufficient food and other resources for everyone in their area of control.

China would also likely intervene into North Korea in the aftermath of a North Korean collapse. Some North Korean commanders might thus threaten China to deter its action against them or to extort aid.

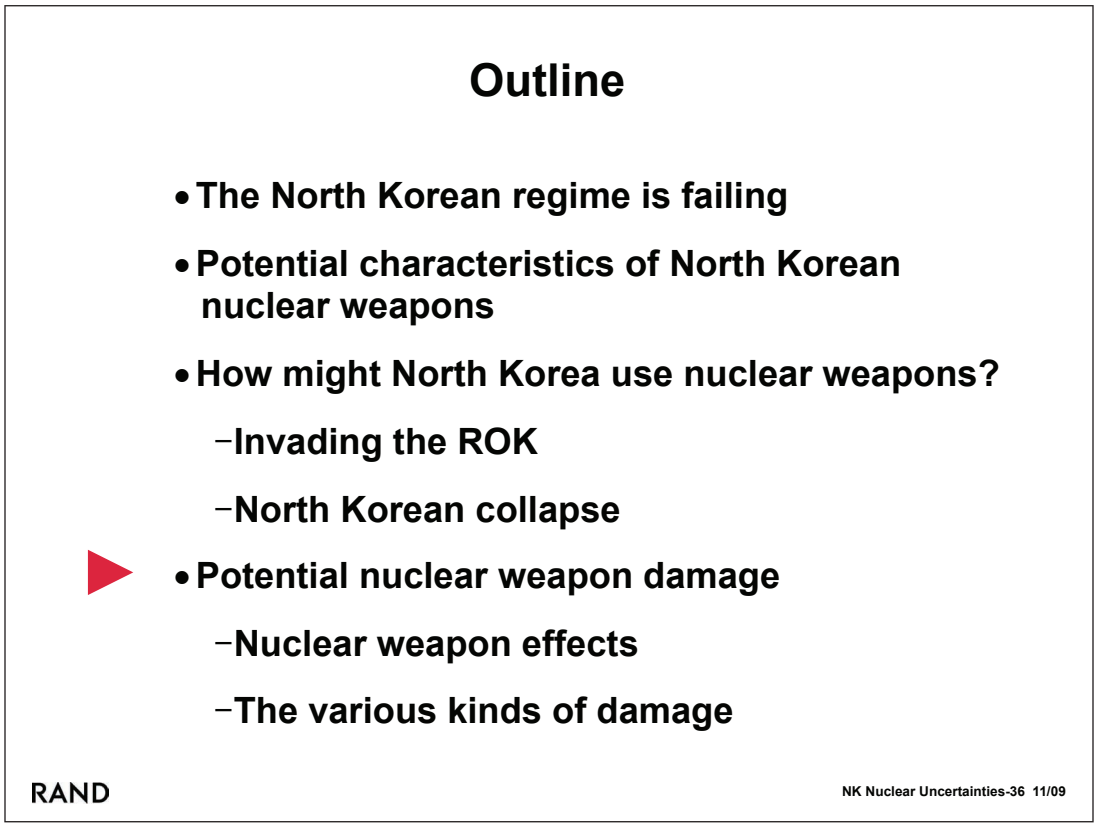
Some commanders might use nuclear weapons for revenge attacks, especially against Japan, remembering the hatred for the historical Japanese occupation of Korea.

Because North Korean commanders would have few nuclear weapons, they would be more inclined to coercion and deterrence. But if they employed nuclear weapons, urban targets would still appear to be a major focus.

North Korean commanders might also proliferate nuclear weapons or, more likely, nuclear expertise and materials, seeking hard currencies for food and other resources.

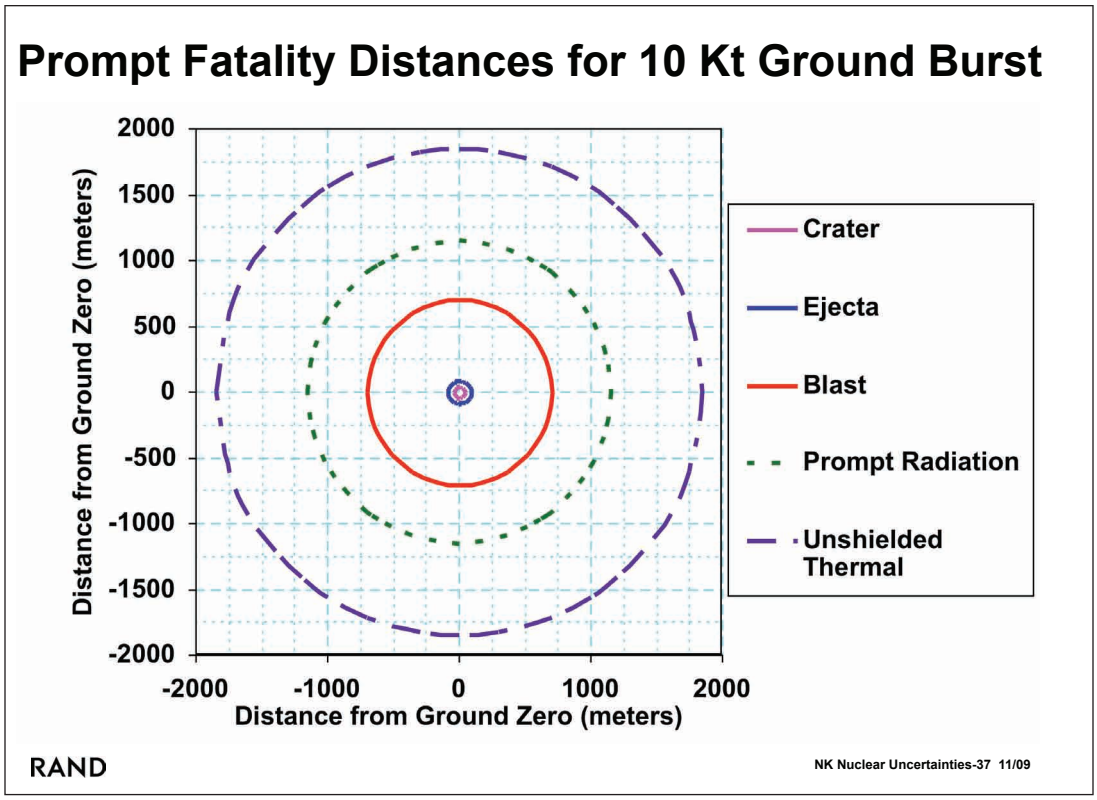
SECTION 5

Potential Nuclear Weapon Damage



The damage that a nuclear weapon could cause to a city is large but also somewhat uncertain. Many factors would affect the damage, including the actual yield of the weapon; the height above the ground at which it is detonated; the atmospheric conditions; the terrain, buildings, and other shielding near the explosion; the physical characteristics of the people; and the medical care and other emergency response available in the aftermath of the nuclear detonation.

Recognizing the variations that can occur in these various factors, this section seeks to provide *approximate* information on the damage that North Korea could cause with a nuclear weapon targeted on the ROK or Japan.



Nuclear Weapon Effects

This graph shows the approximate distances at which a 10 Kt nuclear *ground burst* would likely cause fatalities. These distances assume an ideal, flat earth surface, with the effects going out to specified "lethal radii" in a circular pattern. In practice, terrain variations, the slope of the ground, and other factors could change this depiction.

The crater and ejecta distances reflect small areas of severe devastation.[1]

The weapon radii for blast and prompt radiation effects are calculated using the Physical Vulnerability System developed in the 1970s.[2] These radii reflect potential fatalities to people in buildings, normally the significant majority of the population. For a 10 Kt ground burst, the dominant kill mechanism is prompt radiation, with a lethal radius of a little more than 1,100 meters.

For people in the open, the dominant lethal mechanism is thermal radiation, with a lethal radius of about 1,800 meters.[3] Typically, 5–20 percent of the population will be outdoors and potentially vulnerable to thermal radiation (not only in the open, but also unshielded by buildings, trees, or other items from a direct view of the nuclear explosion).

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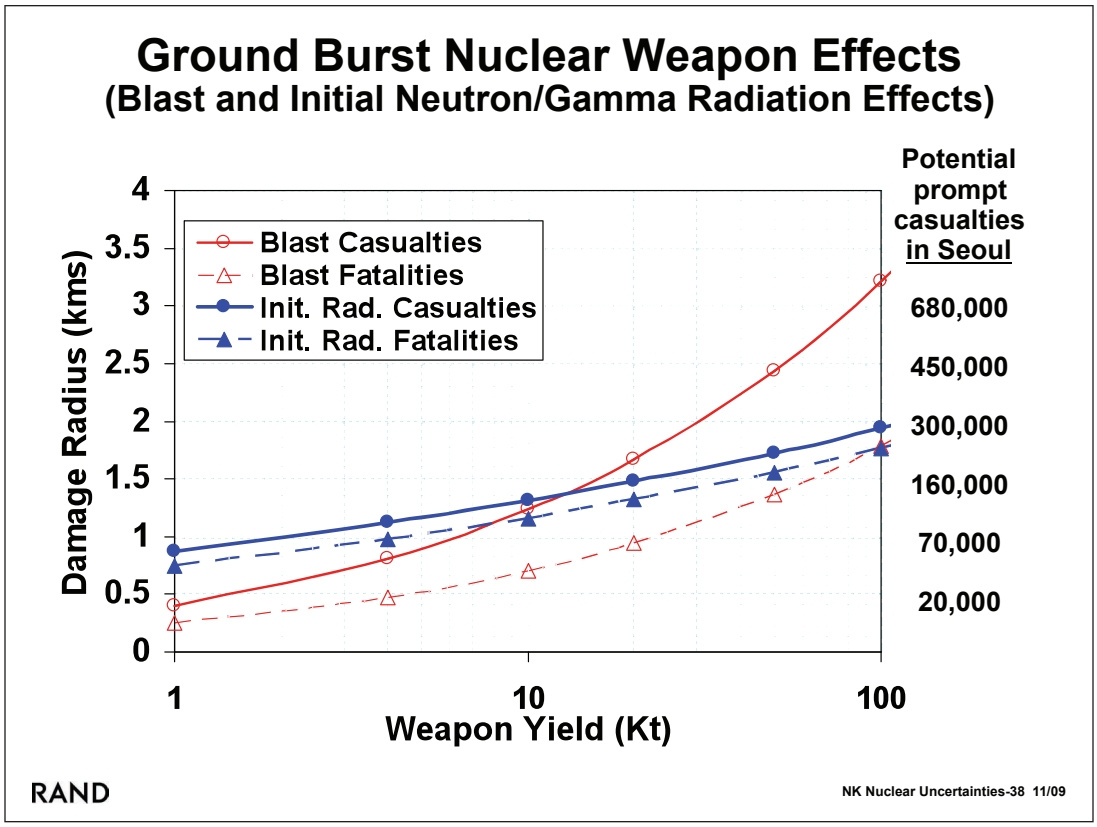
1 Glasstone and Dolan, 1977, pp. 254–256.

2 Defense Intelligence Agency, 1974. The blast vulnerability for people is assumed to be 12P4, with a σ_d=0.3. Initial radiation is assumed to have a 50 percent probability of killing personnel at a dosage of 450 rads. "12P4" is a measure of target vulnerability in the "VNTK" system. For a 20 Kt weapon (the benchmark in that system), it is equivalent to a 10 psi overpressure vulnerability (psi=pounds per square inch), enough to destroy most common buildings. In statistics, sigma (σ) is the standard deviation; σ_d is the damage sigma, a measure of the variation in target vulnerability. As shown on page 48, a σ_d of 0.4 has more variation (a larger spread) than a sigma of 0.2.

3 Glasstone and Dolan, 1977, pp. 291, 564. It is assumed that thermal radiation will cause fatalities at 8–10 cal/cm^2 to personnel in the open for a 10 Kt weapon.

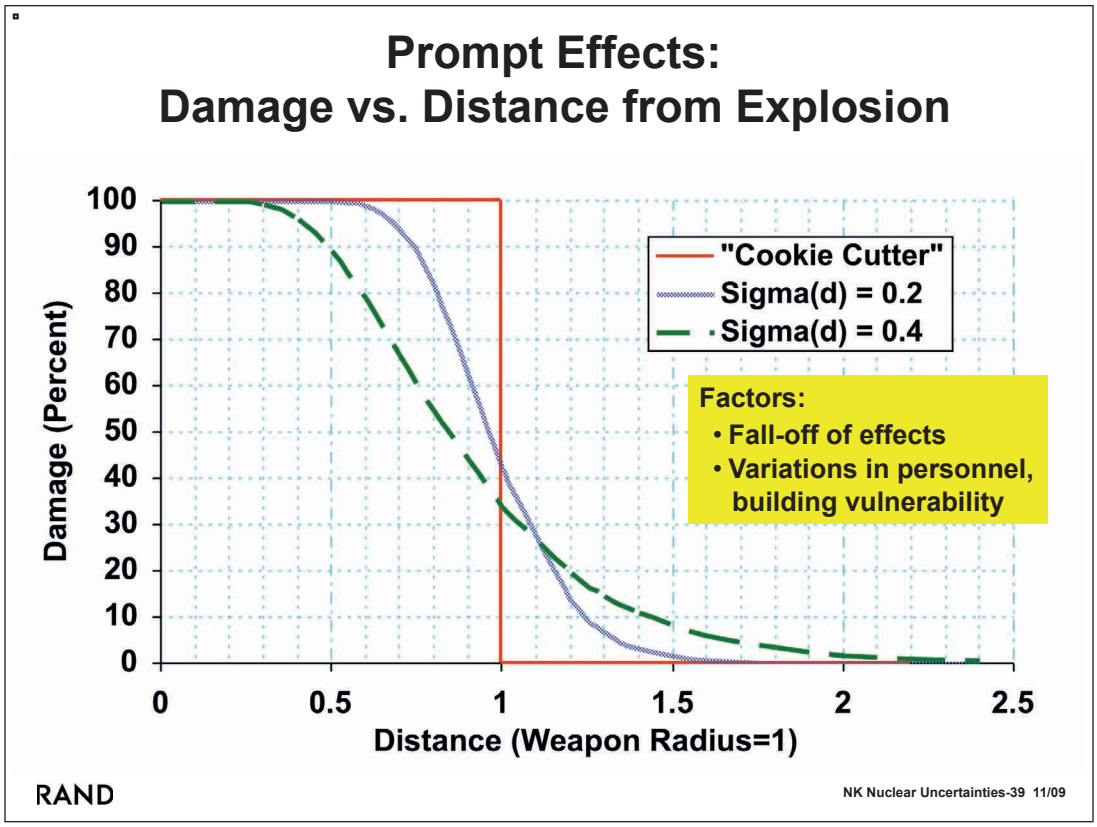


This chart shows the relative sizes of the lethal radii for initial radiation and blast effects across a range of ground burst weapon yields from 1 Kt up to 100 Kt. At any given yield, the initial radiation effects decrease significantly over short distances, making the radii for fatalities and the radii for casualties not very different. But blast effects have big differences in the distances at which there would be fatal and casualty effects.

With regard to fatalities, initial radiation effects dominate up until yields of almost 100 Kt. But with casualties, blast effects begin to dominate around 10 Kt.

In a city such as Seoul, a 10 Kt ground burst could cause blast fatalities out to about 700 meters from the nuclear explosion, potentially killing about 40,000 people if the city were not evacuated. But the lethal radii for initial radiation goes out further, to over 1.1 kilometers. At this radius, about 100,000 people in Seoul could be exposed to fatal radiation doses, including those who would suffer fatal blast effects.

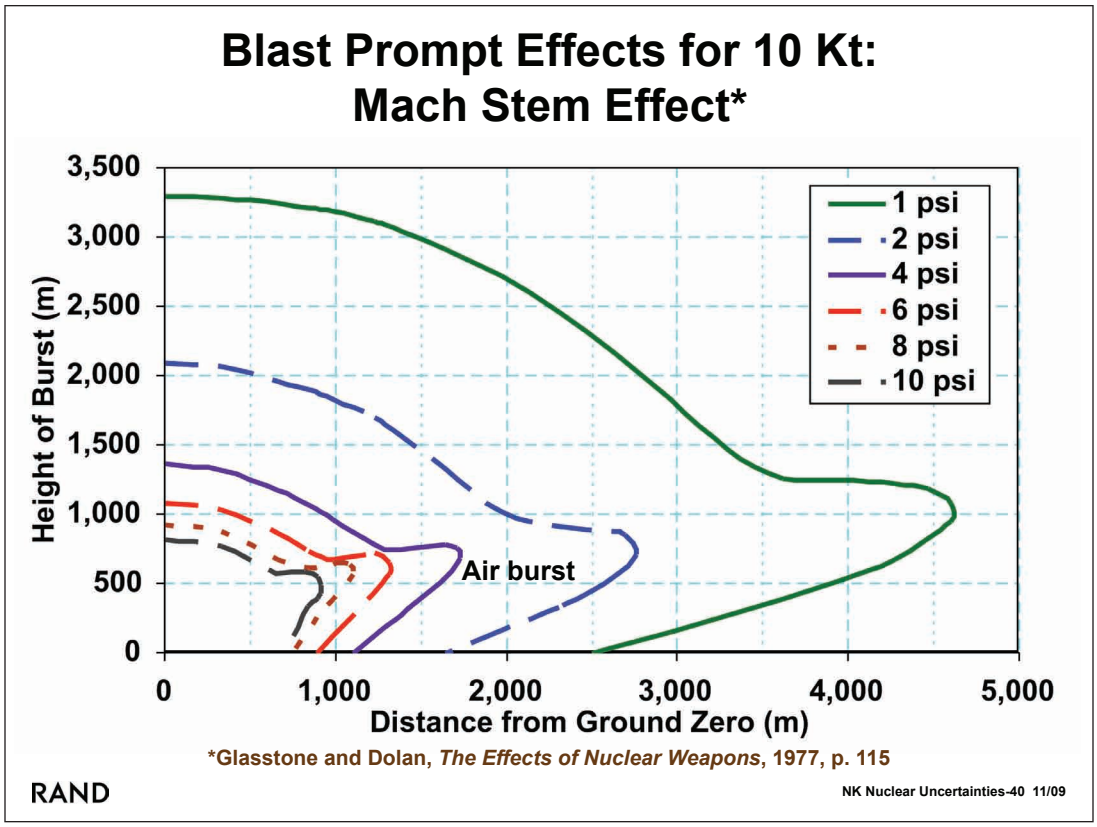
While many argued that the North Korean nuclear weapon test of 2006 was very small (less than 1 Kt), this graph shows that a 1 Kt explosion could still cause significant fatalities. Initial radiation would have a lethal radius out to about 750 meters, causing close to 45,000 fatalities total (blast fatalities would be a subset of this). This is over 10 times the magnitude of the deaths in the U.S. 9/11 terrorist incidents.



The distance at which nuclear effects occur (for example, casualties or fatalities) is usually referred to as the weapon radius (WR). Some analyses of nuclear weapons effects treat the weapon radius as a "cookie cutter," causing 100 percent damage within this distance and no damage outside of it.

» In reality, buildings and other aspects of the environment vary in their characteristics, as do people vary in their susceptibility to nuclear weapon effects. To reflect these variations, the Physical Vulnerability System employs a factor referred to as the *damage sigma* (or the sigma_d), which is effectively a normalized standard deviation on the effects. This graph illustrates the effect of the relative values of sigma_d, including some amount of damage occurring potentially well beyond the weapon radius. With regard to the weapon radii, values of sigma_d (σ_d) typically range from 0.2 to 0.4.

Thus, in interpreting the weapon radius numbers discussed on the two previous slides, it is important to note that being just outside that distance is not safe, and that some people inside the weapon radius will still survive.



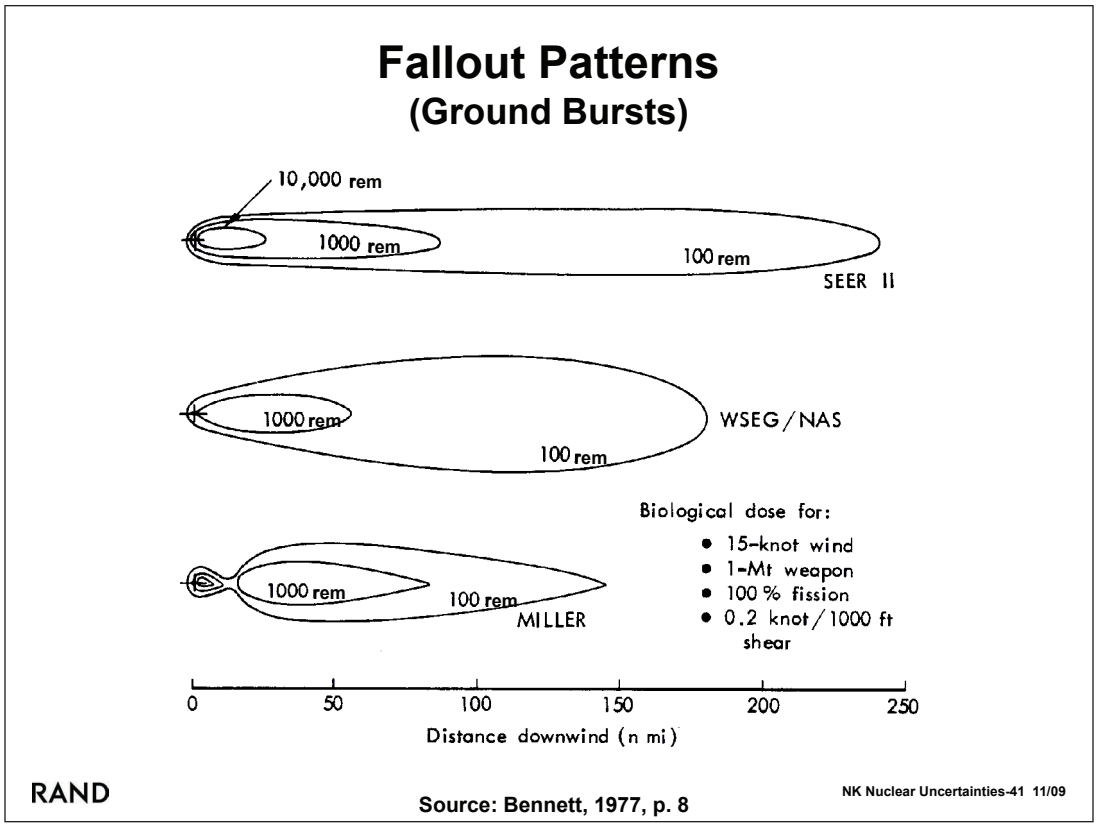
This chart, derived from data in *The Effects of Nuclear Weapons*, shows that up to some height above ground, an air burst increases the radius over which any given level of blast damage is caused.[4]

For example, consider a level of 4 psi of overpressure, which should be enough to seriously damage many buildings. That level of overpressure is created out to about 1,100 meters for a 10 Kt ground burst (height of burst equals zero); thus, an area of about 3.8 square kilometers would be covered by 4 psi or higher levels of overpressure. But if the 10 Kt nuclear weapon is delivered by a missile and is detonated at a 500-meter height, the 4 psi level of effects will occur out to about 1,600 meters, covering an area of roughly 8 square kilometers with 4 psi overpressure or higher. Thus, raising the height of detonation can more than double the area affected at this overpressure.

Raising the height of detonation also significantly reduces fallout. For a 10 Kt nuclear explosion, burst heights over about 150 meters will lead to relatively little fallout.[5] Thus, an air burst increases blast damage while reducing fallout, a desirable outcome if the attacker wishes to avoid casualties at large distances from the detonation (as will be discussed below).

[4] Glasstone and Dolan, 1977, pp. 114–115. I have changed the original distances and heights from feet to meters and adjusted these distances from a 1 Kt explosion to a 10 Kt explosion.

[5] Glasstone and Dolan, 1977, pp. 71–72.



This chart shows possible fallout radiation patterns for a larger, 1 megaton (1,000 Kt) nuclear weapon, generated by three computer models.[6] Fallout develops from the material evaporated in the crater and other dust particles that are irradiated; these particles become the nuclear cloud of a ground burst or near ground burst. After cloud formation, radioactive particles travel with the wind as they gradually fall to the earth (heavier particles falling faster). For this figure, the wind is assumed to be steady and in the same direction at all altitudes, clearly an oversimplification compared with normal circumstances.

These three patterns show how far downwind significant quantities of fallout can travel from even a single nuclear detonation. Usually, 100 rems will cause some symptoms of radiation illness, 200 rems will cause significant injury in many people, and 450 rems will cause death in about half the population of unshielded people. Of course, with a smaller nuclear weapon, the lethal fallout area would be much smaller, as shown on page 52, but casualty-causing amounts of radiation could still occur downwind. While exposures less than 100 rem will usually not cause short-term illness, they may cause longer-term effects and can therefore be expected to generate at least significant psychological distress.

These three patterns show the differences between the estimated fallout patterns of alternative fallout models for even a simple, constant wind. More complex wind patterns, as have historically happened with atmospheric nuclear tests, make the models relatively poor predictors of actual fallout patterns. It will thus be difficult to identify the areas affected at alternative radiation levels until the exposures are observed.

[6] Bennett, 1977.

Approximate Nuclear Effects on ROK Cities

Weapon Performance	Weapons Launched Per Target	Army Division: Prompt Casualties	Airfield: Prompt Casualties	City: Prompt Casualties
Low (1 Kt)	1	3%	3%	40,000
Medium (10 Kt)	1	7%	33%	200,000
High (50 Kt)	1	12%	70%	840,000
Low (1 Kt)	3	9%	9%	120,000
Medium (10 Kt)	3	19%	70%	530,000
High (50 Kt)	3	33%	97%	1,600,000

*Expected casualties, including reliability/delivery probability. Thus a medium weapon *launched* at a city will cause an expected 200,000 casualties (using the 60% reliability/delivery probability); if it actually *detonates* on a city, it will cause an expected 340,000 casualties.

Legend

Weapon Performance	Delivery Probability	CEP (Accuracy)
Low (1 Kt)	50%	3 km
Medium (10 Kt)	60%	1.5 km
High (50 Kt)	70%	0.5 km

RAND

NK Nuclear Uncertainties-42 11/09

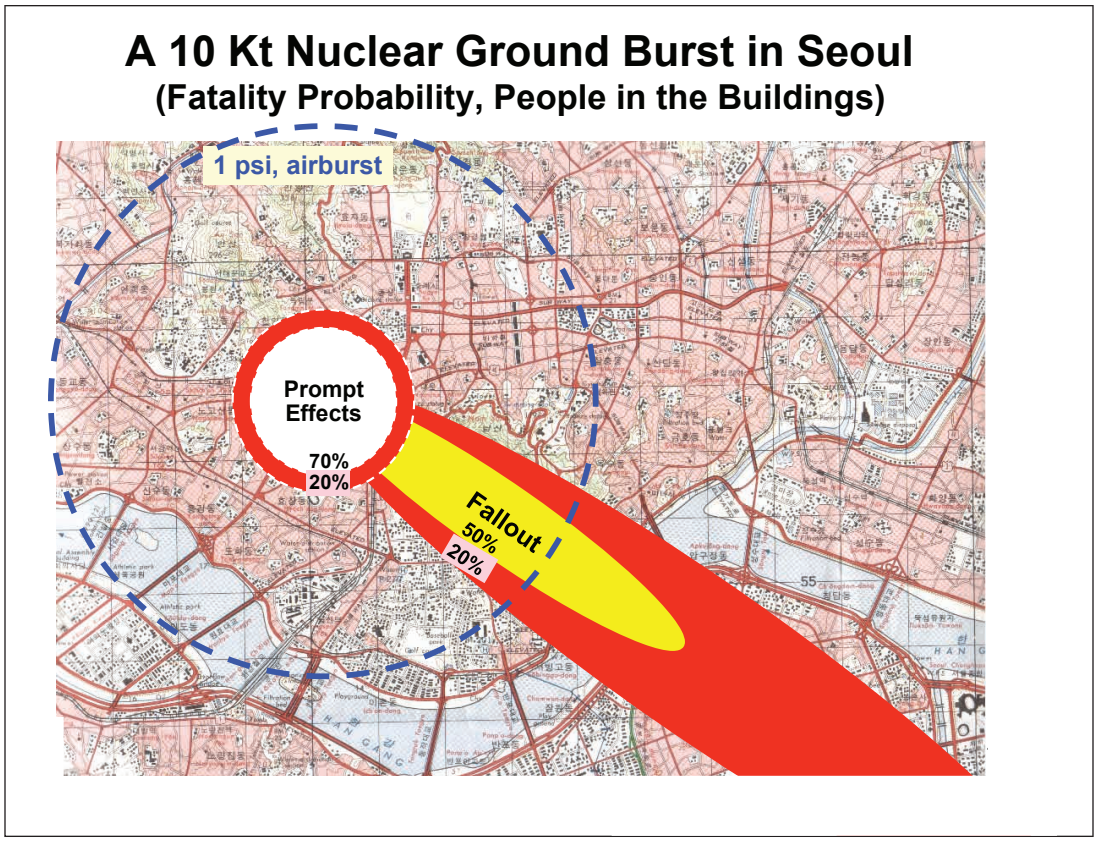
Nuclear Effects on People and Things

North Korea might consider various targets for its nuclear weapons. This table evaluates the *expected value* effectiveness of various attacks that North Korea could launch against forward ground forces, airfields, and cities. This analysis assumes an airburst weapon to maximize prompt effects and eliminate most fallout.

Thus, if North Korea uses one 10 Kt weapon against a ground force division, prompt effects would likely cause about 7 percent attrition, whereas the same weapon would cause an expected attrition of 33 percent at a typical airfield, or nearly 200,000 casualties in a city such as Seoul. A low-performance weapon with less yield, accuracy, and delivery probability would be much less effective against an airfield (because it would likely miss the target) and not very effective against the other target types. A warhead with higher yield, accuracy, and delivery probability would be more effective against each of the target types.

If North Korea increases the number of weapons used on a single target, it could also cause more damage against each target type, though with decreasing returns to scale against all targets with the medium- and high-performance weapons.

These numbers illustrate the ability of nuclear weapons to cause damage, assuming that North Korea has a small inventory of nuclear weapons. A few nuclear weapons used against the almost 50 ROK ground force divisions is unlikely to cause a substantial effect other than in the immediate area in which the weapons are used. And even airfields suffer generally modest damage unless North Korea develops high-performance weapons; still, given that the ROK has only about 15 major combat airfields, this damage could become significant. It therefore seems clear why North Korea would threaten ROK cities with nuclear weapons, given its small nuclear weapon inventory.



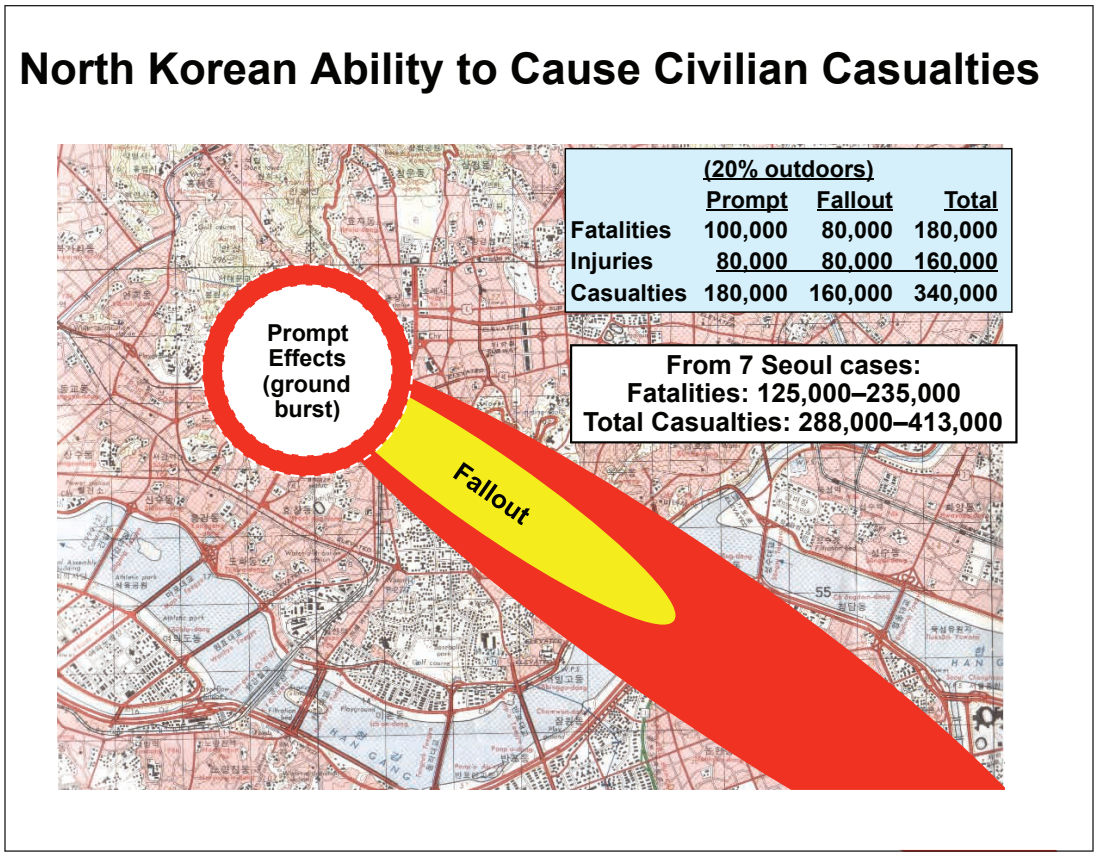
In this slide, two circles are laid on top of a map of Seoul, representing the areas that could be damaged by prompt effects from a 10 Kt nuclear ground burst. The circles show the distance at which 70 percent of the people would be killed (the white circle) and 20 percent of the people would be killed (the red circle). The location for the detonation, at the center of the circles, was arbitrarily chosen; depending on the accuracy of the missile that delivers such a nuclear weapon, the actual detonation location could be kilometers away from the intended location. Still, if the target is a large city such as Seoul, even an explosion kilometers away would still fall within the city.

Note that "prompt effects" refers to how quickly the damage is done to people. They are almost immediately exposed to radiation or the blast wave from a nuclear burst, or cut by glass from broken windows. This is not to say that those receiving lethal exposures will all die instantaneously. Those close to the detonation likely will die promptly, but many people affected will survive, at least for hours or days or even weeks. The chances that these people survive is discussed below.

» A ground burst also causes fallout—radioactive particles blown by the wind. The yellow ellipse shows the distance at which about 50 percent of the population could be killed by fallout, and the red ellipse is the distance at which 20 percent could be killed.

» If, instead, the nuclear weapon is airburst, there will be relatively little fallout.[7] The blue, dashed circle shows the distance out to which the blast effects of an airburst would shatter many of the glass windows in buildings (at 1 psi overpressure), the glass potentially becoming a source for injuring people in the surrounding area.

[7] An airburst at about 500 meters would cause roughly optimal blast damage to an urban area, and that height would be well above the threshold for negligible fallout effects for a 10 Kt weapon.



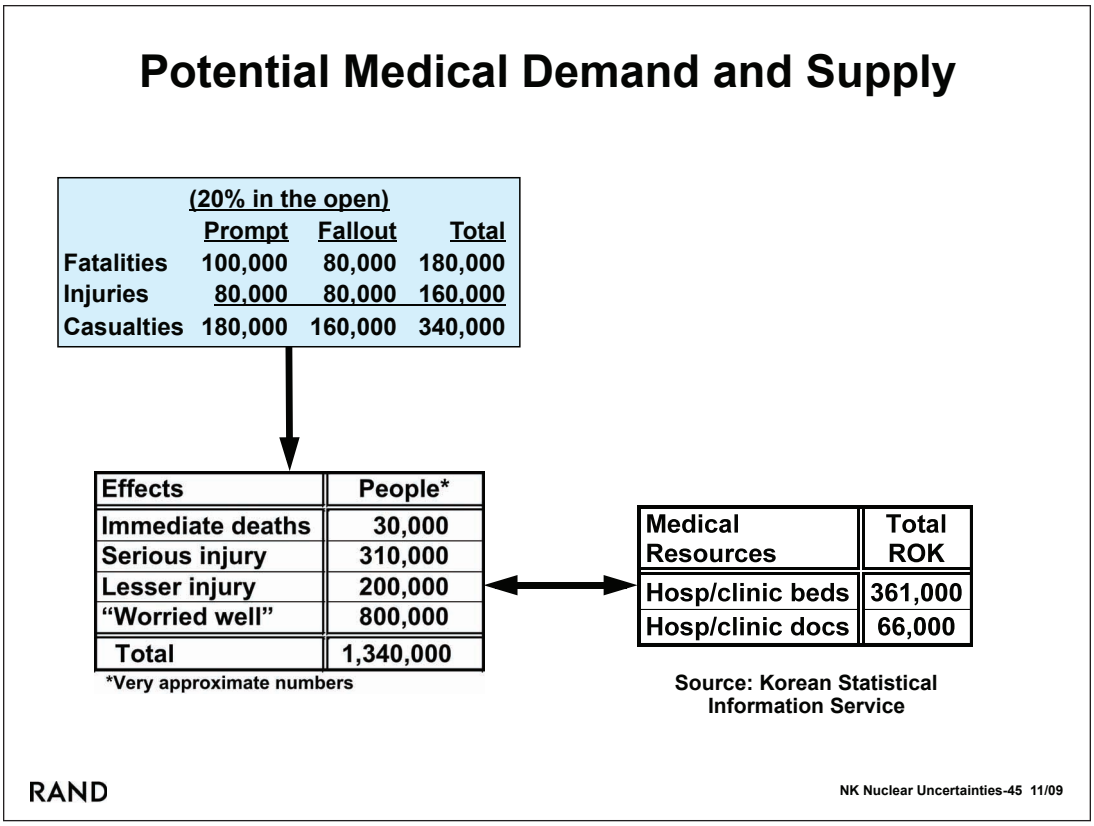
This chart adds specific details on expected fatalities and casualties, assuming a detonation in Seoul roughly as shown here. Assuming that the population of Seoul stayed in their peacetime locations (the city had not been evacuated), and that 20 percent of the population would be outdoors,[8] this detonation location would result in about 100,000 prompt fatalities plus 80,000 nonfatal prompt casualties. There would also be about 80,000 fatalities from fallout and another 80,000 nonfatal medium-term fallout casualties. Total serious casualties and fatalities would be about 340,000. In addition to these serious casualties, others would suffer lesser injuries from flying glass or other sources.

The number of casualties depends significantly on where in the Seoul area a North Korean nuclear weapon detonates. Focusing on just the downtown area, seven cases were examined, which yielded fatalities and casualties in the ranges shown here.

These outcomes result from a population database that reflects nighttime (residential) population locations. If the North Korean attack were to occur during the day and involve a nuclear detonation amid office buildings filled with workers in central Seoul, the numbers of casualties could potentially be double or more what are shown here. Alternatively, if during a conflict many people evacuated the Seoul area before the nuclear attack, the numbers of casualties could be much lower.

It is therefore important to recognize that any estimates of casualties are very approximate and highly dependent on many factors that are difficult to predict.

[8] The question of being indoors or outdoors is most associated with fallout. People in buildings are usually protected from a significant percentage of the fallout radiation; people outside are not. The 20 percent outside is assumed to reflect a wartime situation in which many people are outside, attempting to relocate. Also, some people who are inside when the nuclear weapon detonates will go outside after the explosion and be affected by fallout, and some buildings will lose windows and allow fallout inside, reducing the protection normally assumed for those buildings.



Starting from the previous estimate of fatalities and casualties in Seoul, one of the major issues of concern is managing the medical care of these people.

» While an estimated 180,000 would eventually die from this attack, only a small fraction of these people would die at the time of the explosion. The remainder, along with the other serious casualties, would be injured in ways that would require medical care. Indeed, it could be difficult in the early hours or even days to differentiate those who would live from those who would likely die, especially since radiation exposure would be a primary cause of casualties. Some 500,000 or so people would likely require medical care, including some lesser casualties with cuts from broken glass and similar injuries. WMD attacks are also likely to cause a large number of "worried well," people who generally have not suffered physical casualties but perceive that they have and would seek medical care, especially in an environment where radiation is a primary cause of casualties. Well over 1 million total people could seek medical care for physical or psychological reasons.

» But in all of the ROK, there are only about 360,000 hospital or clinic beds, and only 17 percent of those are in the Seoul area. And there are only about 66,000 hospital- or clinic-based doctors in all of the ROK. So medical demand would vastly outstrip medical supply. For many, medical care would just not be available, and that situation could cause panic and disruptive behavior as people demand access to medical care.

Approximate Nuclear Ground Burst Effects on ROK, Japanese Cities

City	10 Kt		Casualties	
	Fatalities	Casualties	1 Kt	50 Kt*
Seoul	180,000	340,000	92,000	900,000
Pusan	150,000	260,000	72,000	650,000
Taegu	125,000	220,000	60,000	500,000
Kwangju	170,000	290,000	80,000	600,000
Taejon	110,000	200,000	56,000	500,000
Tokyo	170,000	320,000	90,000	800,000
Osaka	160,000	280,000	80,000	600,000

*Maximum casualties, assuming weapon detonates in the worst location.

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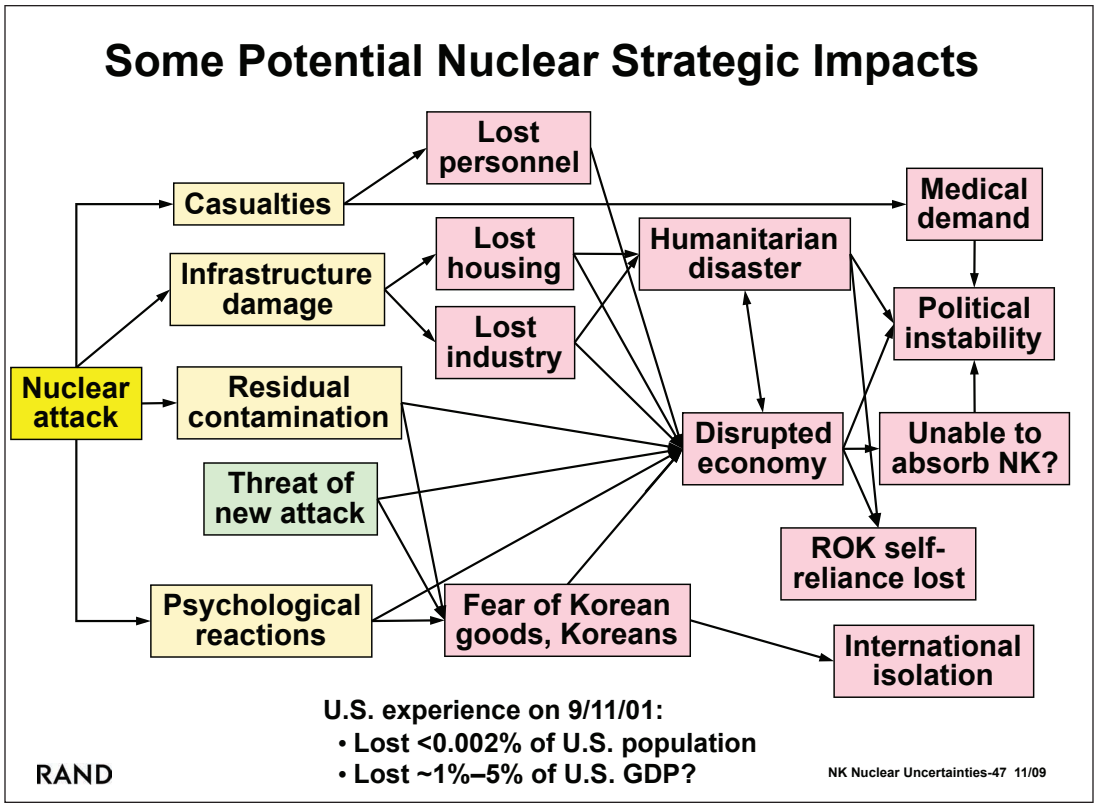
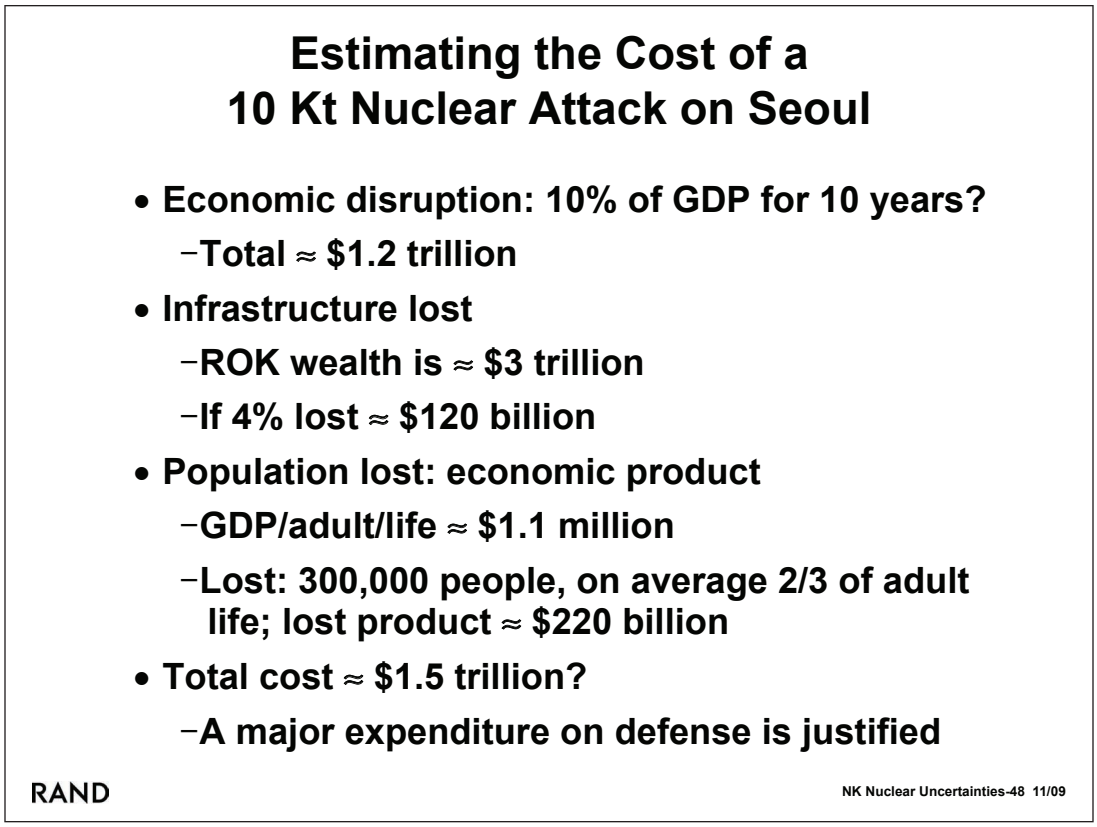
This chart examines the approximate level of casualties that might be expected in other ROK and Japanese cities. As suggested above for Seoul, actual fatalities and casualties would be highly dependent on where in a city the weapon detonated and the circumstances surrounding the attack. With a 10 Kt ground burst nuclear weapon, North Korea might cause well over 100,000 fatalities in a number of ROK and Japanese cities and several hundred thousand total casualties (including fatalities).

A North Korean weapon could have a smaller weapon yield. For example, the North Korean nuclear test of October 2006 appeared to be less than 1 Kt, perhaps in part because of poor performance of the weapon design. For a 1 Kt weapon, the total casualties would tend to be a little less than one-third of the casualties from a 10 Kt nuclear weapon. But if North Korea were somehow able to deliver a larger nuclear weapon yield of perhaps 50 Kt, the number of total casualties could double or even almost triple beyond the 10 Kt levels.



Indeed, there are actually many types of impacts that nuclear weapon detonations can have, as suggested in the slide. In addition to casualties and economic damage, nuclear weapons would cause infrastructure damage, including lost housing and lost industry. These would affect the economy but could also cause humanitarian effects. Nuclear weapons would usually leave behind fallout (residual contamination) and cause psychological effects that would bring instability to the ROK, in addition to the effects described above.

While the correlation between casualties and economic effects is uncertain, the U.S. 9/11 experience provides an interesting benchmark. The 9/11 attacks caused something less than 0.002 percent serious casualties to the population of the United States, and yet caused between a 1 and 5 percent loss in U.S. GDP that year (2001), according to various sources.



To better estimate the impact on the ROK of a North Korean nuclear weapon attack, consider the elements of economic damage that such an attack could cause.

As the 9/11 attacks did to the U.S. economy, a nuclear attack on the ROK would immediately disrupt the ROK economy. We estimate that such an attack would cost *at least* 10 percent of GDP the first year. Of course, once such a disruption occurs, economic growth begins from this reduced level and might be impeded by the effects of the attack. Thus, the GDP loss of the attack will continue for many years. If 10 percent of the ROK GDP were lost over the following ten years, that would amount to about $1.2 trillion.

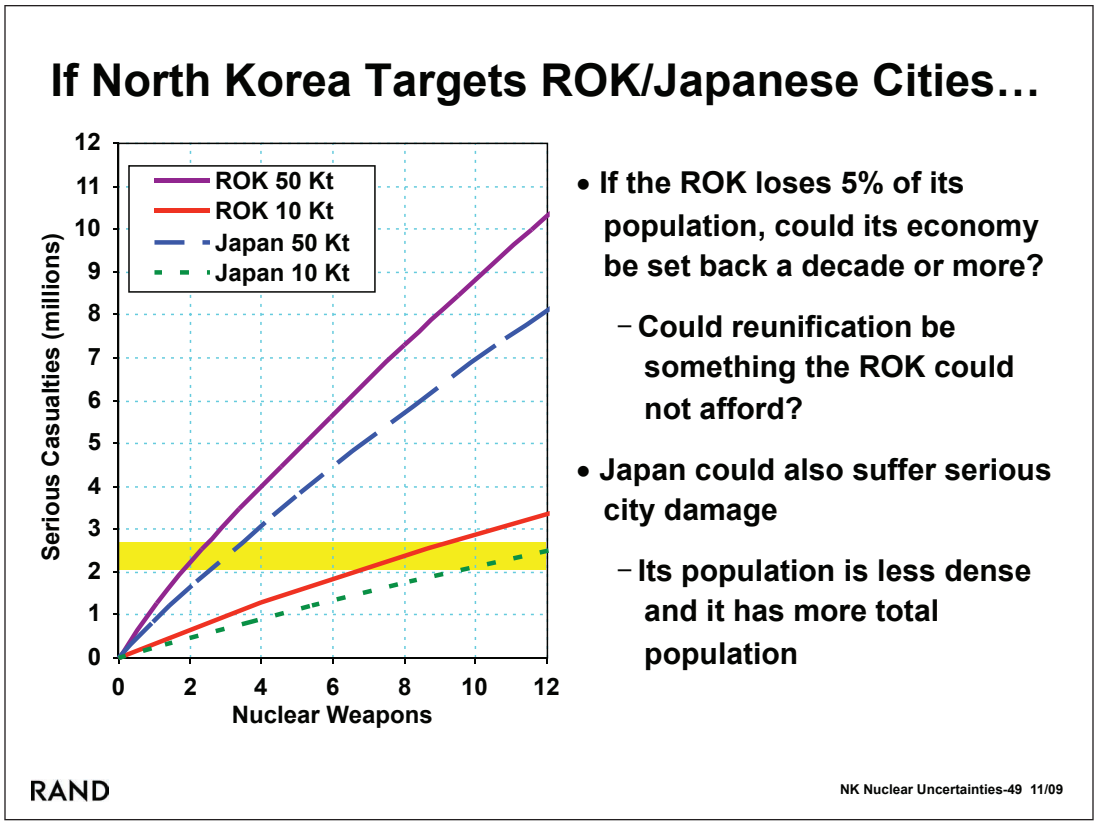
A nuclear attack would also destroy ROK infrastructure. As a rough estimate, if 4 percent of ROK infrastructure were damaged, that cost would be over $100 billion.

The population lost would deny the ROK their long-term contribution to the ROK economy, which for ROK civilians averages about $1.1 million.[9] Those lost might average two-thirds of their productive life remaining, for a total loss of perhaps $220 billion.

The total GDP losses thus could be about $1.5 trillion. Against such a loss, a major defense effort would be justified even if the likelihood of a North Korean nuclear weapon attack were small. For example, if North Korea had only a 5 percent chance of ever using nuclear weapons, an investment of $75 billion would be justified for a perfect defense, or $40 billion for a defense that worked half of the time. This ignores the fact that such a defense would reduce the likelihood of North Korea ever using nuclear weapons.

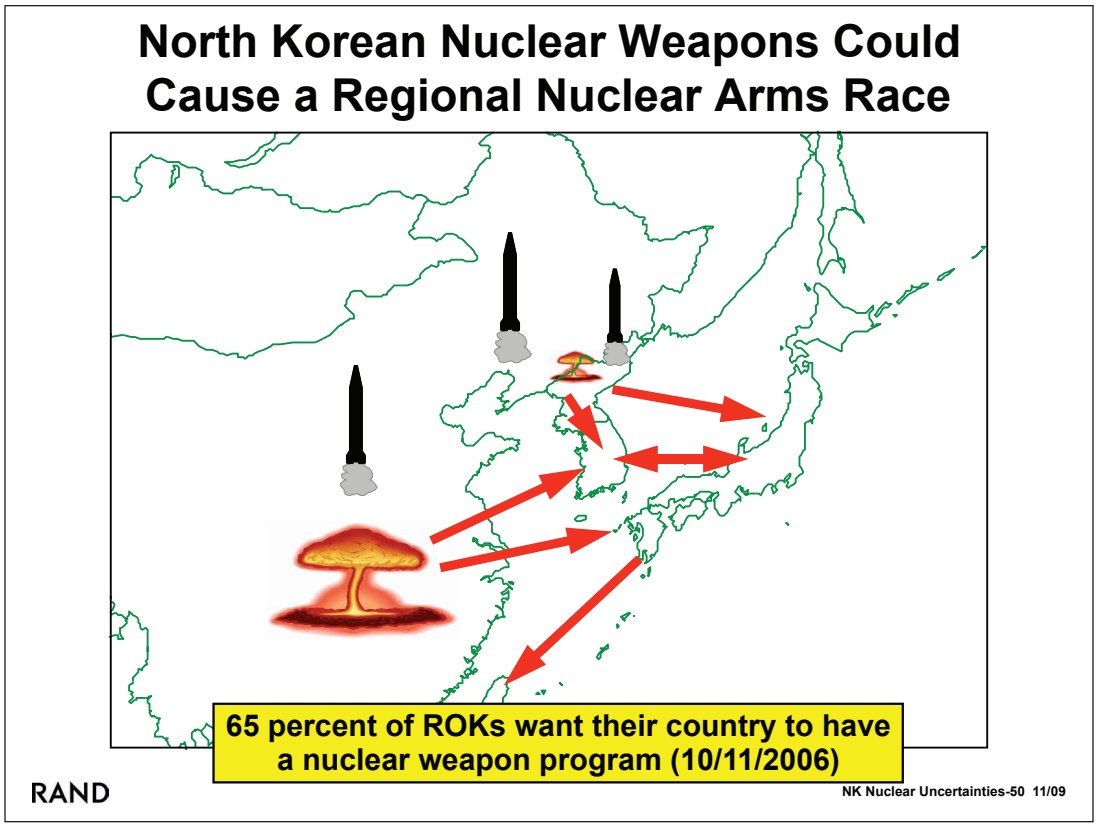
All of these estimates assume that the nuclear attack would not cause fractures in the ROK economy, that is, that the economy would remain coherent. In practice, it is unlikely that the ROK economy would remain coherent with such massive losses, suggesting that the total GDP losses could be greater.

[9] Lee, 2009.



This chart shows the aggregate casualties (including fatalities) that could occur if North Korea were to detonate varying numbers of nuclear weapons on the highest-density parts of cities in the ROK and/or Japan. It considers weapon yields of 10 Kt and 50 Kt. In these cases, a few 50 Kt detonations or about eight 10 Kt detonations could cause casualties to about 5 percent of the ROK population (the area highlighted in yellow), a significant fraction. Moreover, the economy tends to be more vulnerable than the population; the ROK economy could potentially be set back a decade or so by such nuclear attacks. If that were to happen, the ROK could have difficulty paying for unification with North Korea.

Japan could also suffer serious damage from such attacks, though Japanese cities tend to have somewhat lower population densities than ROK cities. Moreover, Japan has more than twice as many people as the ROK, reducing the percentage of the overall population affected. Still, several North Korean nuclear detonations on Japan would have serious economic consequences for Japan, as well.



Another concern relative to North Korean nuclear weapons is their potential to induce ROK and Japanese development of nuclear weapons.

Just a few days after the North Korean nuclear weapon test in 2006, one of the biggest newspapers in the ROK conducted a poll on whether the ROK needed its own nuclear weapons: 65 percent of those polled responded positively.[10] Similar poll results were found after the second North Korean nuclear weapon test in mid-2009. It might be that the North Korean tests pushed these poll numbers higher than they would otherwise be—but if North Korea tests more nuclear weapons or pursues other provocations, the ROK public could press for ROK development of nuclear weapons. In particular, some ROK conservatives feel that it is only a matter of time before the United States abandons the alliance, and that when that happens, the ROK must have nuclear weapons to deter North Korea and provide a military balance.[11]

Japan could react similarly. For decades, the discussion of nuclear weapon acquisition was a taboo in Japan, but no longer:

> The fact that leaders can talk out loud about nuclear weapons, even if rarely, is the result of Japan's maturity and *its growing sense of vulnerability*. That vulnerability was brought home in 1998 when North Korea tested a non-nuclear missile over Japan and again in 2002

[10] Shin, 2006.

[11] Kim, D., 2007.

> when Pyongyang confirmed that it had abducted a dozen Japanese citizens in the 1970s and 1980s.[12]

A ROK or Japanese decision to build nuclear weapons could prompt the other to take similar action. If they do, they could imperil the nuclear Nonproliferation Treaty, start a regional arms race, and raise questions in the United States about the wisdom of its alliance with these countries.

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[12] A statement by Masahiro Akiyama, a former Japanese Vice Defense Minister, quoted in Robbins and Fairclough, 2005. The italics are mine.

SECTION 6

Conclusions

North Korea is a failing state. The state cannot adequately feed its people, nor does it have a viable economy. The regime suffers from serious corruption, criminal activity, and other forms of rebellion, all signs that Kim Jong-Il is losing control. Facing this jeopardy, he is trying to assert his authority and is willing to take risks with provocations, such as the missile launches and nuclear tests in 2006 and more recently in 2009. Although North Korea has yet to demonstrate a working ballistic missile that can reach the United States, it is moving in that direction, and it does have working shorter-range ballistic missiles that could threaten the ROK, Japan, China, and Russia.

North Korean nuclear capabilities are uncertain, though various sources are increasingly arguing that the North can likely put a nuclear warhead on a ballistic missile.

Thus far, North Korean discussion of how it would use nuclear weapons has focused on targeting cities in the ROK and Japan. If North Korea ever does detonate a nuclear weapon on a ROK or Japanese city, casualties would likely be in the hundreds of thousands, and the economic damage could exceed $1 trillion, a huge cost.

North Korea's leaders might believe that their nuclear weapons would allow them to control escalation and strive for some hope of victory in a war. Such a belief would undermine U.S. efforts to deter North Korean aggression in desperate circumstances.

For years, the ROK has looked upon the failure of the North Korean state as an opportunity to reunify Korea and achieve a serious goal of the Korean people. While reunification thus

offers the ROK a great opportunity for a real victory, North Korean use of nuclear weapons against the ROK could impose such tremendous costs that the result could be a Pyrrhic victory for the ROK. Indeed, damage to the ROK economy might make it difficult or impossible for the ROK to pay the high costs that unification will require.

Bibliography

"A. Q. Khan's Network," GlobalSecurity.org, no date. As of January 29, 2010: http://www.globalsecurity.org/wmd/world/dprk/khan-dprk.htm

Albright, David, and Paul Brannan, "The North Korean Plutonium Stock," Washington, D.C.: Institute for Science and International Security, February 20, 2007. As of January 29, 2010: http://www.isis-online.org/publications/dprk/DPRKplutoniumFEB.pdf

Bennett, Bruce W., *Fatality Uncertainties in Limited Nuclear War*, Santa Monica, Calif.: RAND Corporation, R-2218-AF, 1977. As of January 29, 2010: http://www.rand.org/pubs/reports/R2218/

Berejikian, Jeffrey D., "A Cognitive Theory of Deterrence," *Journal of Peace Research*, Vol. 39, No. 2, March 2002, pp. 165–183.

Bermudez, Joseph S., "The Democratic People's Republic of Korea and Unconventional Weapons," in Peter R. Lavoy, Scott D. Sagan, and James J. Wirtz, eds., *Planning the Unthinkable: How New Powers Will Use Nuclear, Biological, and Chemical Weapons*, Ithaca, N.Y.: Cornell University Press, 2000, pp. 182–201.

Defense Intelligence Agency, *Mathematical Background and Programming Aids for the Physical Vulnerability System for Nuclear Weapons*, DI-550-27-74, November 1, 1974.

Department of Defense, *The National Defense Strategy of the United States of America*, March, 2005.

———, *Deterrence Operations: Joint Operating Concept*, Version 2, December 2006.

Dobbins, James, "Nation-Building: The Inescapable Responsibility of the World's Only Superpower," *RAND Review*, Summer 2003. As of January 29, 2010: http://www.rand.org/publications/randreview/issues/summer2003/nation1.html

Glasstone, Samuel, and Philip J. Dolan, *The Effects of Nuclear Weapons*, Washington, D.C.: U.S. Government Printing Office, 1977.

Han, Hosuk, "The US-DPRK Relations at the Close of the 20th Century and the Prospect for United Korea at the Dawn of the 21st Century," 2000. As of March 21, 2008: http://www.kimsoft.com/2000/hanho.htm

Hersh, Seymour M., "The Cold Test: What the Administration Knew About Pakistan and the North Korean Nuclear Program," *The New Yorker*, January 27, 2003.

Hildreth, Steven A., *North Korean Ballistic Missile Threat to the United States*, Washington, D.C.: Congressional Research Service, RS21473, February 24, 2009.

"Hill Says N.K. Must Hand Over Plutonium," *The Korea Herald*, October 17, 2007.

International Institute of Strategic Studies, *North Korea's Weapons Programmes: A Net Assessment*, January 21, 2004. As of January 29, 2010: http://www.iiss.org/publications/strategic-dossiers/north-korean-dossier/north-koreas-weapons-programmes-a-net-asses/north-koreas-nuclear-weapons-programme

Jervis, Robert, "The Political Effects of Nuclear Weapons," *International Security*, Vol. 13, No. 2, Fall 1988.

Kang, Chol-hwan, "Power Struggle Looms in N. Korea," *The Chosun Ilbo*, May 8, 2009. As of January 29, 2010:
http://english.chosun.com/site/data/html_dir/2009/05/08/2009050800706.html

"KBS Reports Plan to Topple Kim Il-Sung," *Washington Times*, March 25, 1994, p. 16.

Kim, Dae-joong, "Abandoned at a Nuclear Crossroads," *The Chosun Ilbo*, March 12, 2007.

Kim, Hyun Sik, "The Secret History of Kim Jong Il," *Foreign Policy*, September/October 2008.

"Kim Jong Il Vanishes from Public Eye," *Donga Ilbo*, August 7, 2006.

Kim, Myong Chol, "The Future of the Agreed Framework," Northeast Asia Peace and Security Network, November 24, 1998. As of February 17, 2010:
http://www.nautilus.org/archives/pub/ftp/napsnet/special_reports/PF23C_Kim_on_Agreed_Framework.txt

———, "Kim Jong-il's Military-First Policy a Silver Bullet," *Asia Times*, January 4, 2007.

———, "Nuclear War Is Kim Jong-il's game plan," *Asia Times*, June 12, 2009. As of January 29, 2010:
http://www.atimes.com/atimes/Korea/KF12Dg01.html

"Korean Reunification 'Will Cost $5 Trillion,'" *The Chosun Ilbo*, January 5, 2010.

Korean Statistical Information Service, Web site, no date. As of February 24, 2010:
http://kosis.kr/

Lankov, Andrei, "Pyongyang Puts Politics Above Dollars," *Asia Times*, November 26, 2008. As of January 29, 2010:
http://www.atimes.com/atimes/Korea/JK26Dg01.html

Lee Ji-yoon, "How Much Is a Newborn Baby Worth to Economy?" *The Korea Herald*, December 23, 2009.

Lee, Wha Rang, "Wagging the Dog—The Korean Style," December 25, 1998. As of March 21, 2008:
http://www.kimsoft.com/1997/wagdog.htm

Levy, Jack S., "The Diversionary Theory of War: A Critique," in Manus I. Midlarsky, ed., *The Handbook of War Studies*, Ann Arbor: The University of Michigan Press, 1989, pp. 259–288.

———, "An Introduction to Prospect Theory," *Political Psychology*, Vol. 13, No. 2, June 1992, pp. 171–186.

Lurie, Ranan R., "In a Confrontation, 'North Korea Will Definitely Be Annihilated,'" *Los Angeles Times* (Washington Edition), March 24, 1994, p. 11.

Moore, Malcolm, "North Korea Claims US Could Provoke Nuclear War," Telegraph.co.uk, June 14, 2009. As of January 29, 2010:
http://www.telegraph.co.uk/news/worldnews/asia/northkorea/5532319/North-Korea-claims-US-could-provoke-nuclear-war.html

"N. Korea Admits to Using 26 Kg of Plutonium for Nuclear Bombs," East-Asia-Intel.com, July 10, 2008.

"N. Korea May Have Sea-Based Missile System: Report," *The Korea Herald*, March 17, 2009.

"N. Korean Poster Seems to Confirm Succession," *The Chosun Ilbo*, September 25, 2009. As of January 29, 2010:
http://english.chosun.com/site/data/html_dir/2009/09/25/2009092500912.html

Na, Jeong-ju, "3 Million NK Refugees Expected in Crisis: BOK," *The Korea Times*, January 26, 2007.

National Intelligence Council, "Strategic Implications of Global Health," ICA 2008-10D, December 2008. As of January 29, 2010:
http://www.dni.gov/nic/PDF_GIF_otherprod/ICA_Global_Health_2008.pdf

Nitikin, Mary Beth, *North Korea's Nuclear Weapons: Technical Issues*, Washington, D.C.: Congressional Research Service, July 1, 2009.

Niksch, Larry A., *North Korea's Nuclear Weapons Program*, Washington, D.C.: Congressional Research Service, October 9, 2002.

———, *North Korea's Nuclear Weapons Program*, Washington, D.C.: Congressional Research Service, IB91141, updated August 27, 2003. As of January 29, 2010:
http://fpc.state.gov/documents/organization/24045.pdf

"North Korea Declares 31 Kilograms of Plutonium," Nuclear Threat Initiative, October 24, 2008. As of January 29, 2010:
http://www.nti.org/d_newswire/issues/2008_10_24.html#6AE4B313

"North Korea Mum on Kim's Location Since Sept. 15," East-Asia-Intel.com, October 11, 2006.

"North Korea Warns of Improved Nuclear Deterrent," Nuclear Threat Initiative, March 18, 2005. As of January 29, 2010:
http://www.nti.org/d_newswire/issues/2005_3_15.html#955B871E

"North Korea Warns of 'Sea of Fire' as U.S. Envoy Arrives," *The Sydney Morning Herald*, January 13, 2003.

"North Korean Nuclear Weapons: CIA Estimate for Congress," FAS.org, November 19, 2002. As of January 29, 2010:
http://www.fas.org/nuke/guide/dprk/nuke/cia111902.html

"Nuclear Nightmare—Understanding North Korea," Discovery Channel, August 6, 2003.

Ochmanek, David, and Lowell H. Schwartz, *The Challenge of Nuclear-Armed Regional Adversaries*, Santa Monica, Calif.: RAND Corporation, MG-671-AF, 2008. As of January 29, 2010:
http://www.rand.org/pubs/monographs/MG671/

Quinlivan, James T., "Burden of Victory: The Painful Arithmetic of Stability Operations," *RAND Review*, Summer 2003. As of January 29, 2010:
http://www.rand.org/publications/randreview/issues/summer2003/burden.html

"Researcher: North Korea Has 'Weaponized' Plutonium," Associated Press, January 17, 2009.

Robbins, Carla Anne, and Gordon Fairclough, "North Korea Sparks Proliferation Fears Throughout Asia," *Wall Street Journal*, June 16, 2005, p. 1.

"'SCUD C' Variant (Hwasong 6) and 'SCUD D' Variant (Hwasong 7)," *Jane's Strategic Systems*, October 25, 2006.

Shapiro, Margaret, "1990 KGB Document Concluded North Korea Had 'Nuclear Device,'" *The Washington Post*, June 25, 1994.

Shin, Chang-un, "In Poll, 78% Say Engagement Policy Should Change," *Joongang Ilbo*, October 12, 2006. As of January 29, 2010:
http://joongangdaily.joins.com/article/view.asp?aid=2825906

Smith, R. Jeffrey, and Joby Warrick, "Pakistani Scientist Depicts More Advanced Nuclear Program in North Korea," *The Washington Post*, December 28, 2009.

"Survival of the Wickedest," Strategypage.com, June 26, 2008. As of January 29, 2010:
http://www.strategypage.com/qnd/korea/articles/20080626.aspx

"Syria 'Boosts Accuracy' of Scud D," *Jane's Missiles and Rockets*, January 1, 2006.

U.S. Joint Chiefs of Staff, "Over-All Effect of Atomic Bomb on Warfare and Military Organization," J.C.S. 1477/1 (from the U.S. National Archives), October 30, 1945.

Woodrow Wilson International Center, "The History of North Korean Attitudes Toward Nuclear Weapons and Efforts to Acquire Nuclear Capability," May 17, 2005. As of January 29, 2010:
http://www.wilsoncenter.org/topics/pubs/edossier141.pdf

"Yonhap Cites DPRK Warning to Japan on US Cooperation Causing 'Nuclear Sea of Fire,'" *Seoul Yonhap* (in English), September 23, 2004.