HARVARD Kennedy School
BELFER CENTER
FOR SCIENCE AND INTERNATIONAL AFFAIRS
Managing the Atom Project

A Darkening Horizon: Nuclear Challenges Around the World

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Effect of a single nuclear weapon

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Source: Time-Life

2

The nuclear horizon has darkened in the last 10 years

3

- Radically increased U.S.-Russian and U.S.-Chinese hostility
  - Dramatic worsening from the war in Ukraine
  - Repeated Russian nuclear threats
- Large expansion of Chinese nuclear forces underway
  - U.S. considering nuclear buildup to cope with "two nuclear peer" threat
- Major advances in evolving technologies that complicate nuclear balances – missile defenses, AI, cyber, counter-space, more…
- Substantially increased doubts over U.S. leadership
  - Increased anxieties among U.S. allies
- Arms control + risk reduction measures greatly weakened
  - INF Treaty, U.S. + Russian participation in Open Skies treaty gone
  - Almost all U.S.-Russian gov-gov communication cut off, much U.S.-Chinese gov-gov communication
  - New START expires 2/26, little prospect for replacement in treaty form

3

The nuclear horizon has darkened in the last 10 years (II)

4

- Major expansion in North Korean nuclear + missile arsenal
- Dramatic increase in Iranian nuclear capabilities (and expanded missile force, ongoing support for armed groups)
- Ongoing arms competition in South Asia
- Ongoing nuclear terrorist threats
  - Reduced capabilities of global terrorist groups (al Qaeda, Islamic State)
  - Expanded insider threats from violent domestic extremists in many countries
  - Reduced global focus on the danger – nuclear security summits long over
- Increased tensions between nuclear haves and have-nots
  - Symbolized by the nuclear weapons ban treaty, now in force
  - Makes nonproliferation progress more difficult
- Ongoing (expanding?) obstacles to progress toward disarmament

4

Russia's war on Ukraine has upended much of the international order

5

- A founding member of the United Nations – charged with ensuring international peace and security – is waging large-scale aggressive war
  - Using nuclear threats as shield to protect its offensive war
- A state that gave up the nuclear weapons on its soil for security assurances is being torn apart
- Impacts on security, food, energy are reverberating around the world
- U.S.-Russian talks cut off

Source: Reuters

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The war in Ukraine requires rethinking most aspects of nuclear policy

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- With a more aggrieved Russia, more willing to use military force, and more willing to rattle the nuclear saber, nuclear deterrence needs new thinking
  - With weakened conventional forces, Russia will be more dependent on nuclear weapons than before
  - U.S. allies seeking still stronger assurances
- The future of nuclear arms control is in doubt
  - Intense U.S.-Russian hostility means more nuclear danger, fewer chances to take steps to reduce it
- The future of nuclear nonproliferation is uncertain
  - Ukraine's fate may lead other countries to reconsider nuclear options
- Requires rethinking nuclear energy, nuclear safety, and nuclear security with the possibilities of wars, political unrest, state collapse in mind

6

Cuban Missile Crisis: The tale of sub B-59

7

- Diesel sub, designed for northern waters, not the Caribbean
  - >110° on board – carbon dioxide high, sailors passing out
- Sub armed with a nuclear torpedo – physical capability to fire
  - U.S. Navy did not know it was nuclear-armed
- U.S. Navy using "practice depth charges" to force it to the surface
  - Those on sub believed war had begun, they were under attack
- Captain reportedly ordered nuclear torpedo prepared for firing
- Differing accounts of details – but agreement that Capt. Vasily Arkhipov – also on the sub by sheer chance – prevented use

The fog of crisis can lead to disaster

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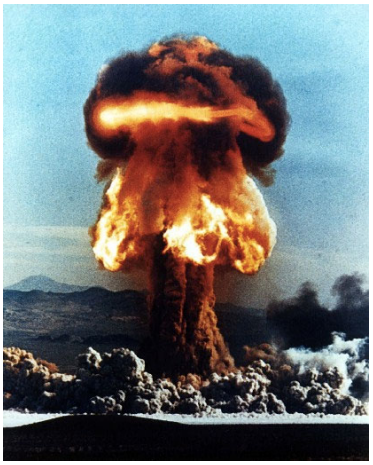
How might a nuclear war start?

8

- Nuclear deterrence makes a rational decision to begin a nuclear war hard to imagine…
- But Cold War crises, and pre-nuclear wars, highlight the dangers of unintended escalation, miscalculation in the heat of the moment, accidents, unauthorized use, decisions based on wrong information…
- Leaders might believe a <u>limited</u> use of nuclear weapons could avoid devastating defeat – and they could deter further response



Source: Department of Energy

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Evolving technologies may be reducing deterrent stability

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- BMD, cyber, counter-space, precision conventional, automomy create new complexities → greater escalation risks
  - Cyber blurs lines between peace and conflict, difficult to control
  - Counter-space and cyber may both create incentives to hit first, early
  - Missile defenses complicate strategic planning
  - "Entanglement" of nuclear and conventional forces, command and control create incentives to escalate
  - AI-enabled decisions may shorten decision time, change decision environment

Hypersonic weapon concept. *Source:* space.com

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Dateline: Russia

10

- Aggressive war in Ukraine; nuclear threats, modernization, novel weapons, exercises; cyberattacks; election interference…
- Intense U.S.-Russian tensions
  - Almost all communication cut off – risk of escalation to direct conflict
- Russian forces, command and control vulnerable; arms control in crisis; potential for launch on false alarm or unintended crisis escalation

Source: ITAR-TASS

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Will Russia use nuclear weapons during the Ukraine war?

11

- Russian leaders might think could break "hurting stalemate," stop a Ukrainian breakthrough, or end NATO support with nuclear use
  - Destroy armored formations
  - Threaten cities and demand surrender (Putin has referred to "precedent" of Hiroshima and Nagasaki)
  - Use against NATO countries
- US has threatened "catastrophic" response
  - Might Russia conclude it could deter substantial retaliation?

Loading an Iskander missile, 2015 *Source:* Reuters

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Dateline: China

12

- Much smaller nuclear force, but major modernization underway
  - ~400 weapons, but increasing
  - 100s of nuclear missile silos under construction – possibly a goal of parity with the United States
- Heightened U.S.-China tensions – Taiwan, South and East China seas, trade, cyber, other issues
- No arms control, verification, or dialogue on strategic issues in place
  - China (and Russia) concerned over U.S. missile defenses, conventional strike capabilities, nuclear forces

Source: AP, Li Gang

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Dateline: North Korea

13

- Unpredictable dictator armed with dozens of nuclear weapons, ballistic missiles
  - Flurry of missile testing, nuclear test any day, HEU, Pu production unabated
  - Has threatened to rain "nuclear fire" on ROK, Japan, United States
- History of provocations against ROK – could lead to conflict
- Agreements, sanctions, threats have all failed
- No clear prospects for "denuclearization"

Source: KCNA

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From Kim's perspective: A potential conflict scenario

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- Imagine:
  - A major North Korean provocation – e.g., shelling an island again
  - South Korea insists on striking back harder, to reestablish deterrence
  - North Korea uses ~6 conventional missiles against a U.S. airbase
  - ROK, U.S., begin an air campaign to destroy the DPRK's missiles
- DPRK faces "use them or lose them" pressures
- Can they tell the air campaign is not intended as a prelude to an all-out regime-change attack?

Source: Reuters

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Dateline: South Asia

15

- Ongoing nuclear arms race between Pakistan and India – who have fought 4 wars
- Military doctrines with unclear redlines; terrorists might provoke conflict; could blunder into war
  - But have managed recent crises successfully
- Pakistan has a growing nuclear arsenal, and some of the world's most capable terrorists
- Some modeling suggests even Indo-Pakistani nuclear war could cause "nuclear fall"

Source: Wikimedia Commons

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Dateline: Iran

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- Nuclear agreement reduced risk – but attempts to rebuild it have failed
- Iran now has ability to produce several bombs' worth of HEU quickly
- Iran continues to support terrorist groups, undermine countries in the region, threaten Israel, test longer-range ballistic missiles – and has never given an honest declaration of its past nuclear weapons efforts
  - Israel/Hamas could become regional war
- Where next?

Source: khamenei.ir

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The surprising success of nonproliferation

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- No net increase in nuclear-armed states in 35 years
- All but 5 states are parties to the nuclear Nonproliferation Treaty (NPT)
  - Obligated not to get nuclear weapons, and to accept inspections
  - Many other accords, initiatives, support the overall regime
  - Never in human history has the most powerful weapon available to our species been so widely forsworn
- What explains success?
  - Most states realize they are better off if they and their neighbors don't have nuclear weapons
  - Treaty changes states' decision-making: Foreign Minister, Finance Minister now more likely to be at the table, and nuclear weapons advocates need to reverse a decision already made
  - NPT creates norms – easier to build coalitions against programs

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But growing challenges to the global regime

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- Many states unhappy with the NPT – no consensus at reviews in 2015, 2022
- More states reconsidering security options
- Ongoing challenges controlling sensitive technologies – new tech. such as additive manufacturing makes more difficult
- Possible spread of ostensibly civilian enrichment and reprocessing as nuclear energy grows and spreads
- Ban Treaty manifests frictions

Source: AFP

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Some good news about nuclear weapons

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- 78 years with no nuclear attacks – amazing success
- >80% of the world's nuclear weapons have been dismantled
- <5% of worlds states have nuclear weapons – same as 35 years ago
  - No net increase in 3.5 turbulent decades – amazing success
- >50% of the states that started nuclear weapons programs gave them up
  - Efforts to prevent proliferation succeed more often than they fail
- >50% of the states that once had potential nuclear bomb material on their soil have eliminated it
- Nuclear material around the world is far more secure than it was 25 years ago – much harder for terrorists to get
  - Most egregious weaknesses fixed – but more to be done

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May still be options for reducing dangers

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- Both the United States and Russia have reasons to want to avoid an unrestrained arms competition
- When the Ukraine war ends, new opportunities may open
- Even if treaties are difficult to reach, may be able to use executive agreements, political commitments, unilateral-reciprocal initiatives to make progress
- Though China rejects arms control for now, also good reasons for it to want to avoid unregulated race for the long haul
- Variety of risk-reduction proposals still being put forward
- "Track II" (non-government) dialogues are developing, stockpiling ideas for when governments are ready
  - Have explored most of the key ideas needed for the next round of nuclear arms control – and some novel risk-reduction approaches

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Further reading…

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- Full text of Managing the Atom publications: http://belfercenter.org/mta
- Full text of Bunn publications and presentations, by topic: https://scholar.harvard.edu/matthew_bunn
- "Pathways to Disaster: How Might a Nuclear War Start?" presentation, Oak Ridge National Laboratory, 2022 https://tinyurl.com/ypz7osd8
- *The Iran Nuclear Archive: Impressions and Implications,* 2019 https://tinyurl.com/2o7gqcm3
- *Revitalizing Nuclear Security in an Era of Uncertainty*, 2019 https://www.belfercenter.org/NuclearSecurity2019
- "For Security's Sake: Saving U.S.-Russian Arms Control," presentation, Oak Ridge National Laboratory, 2018 https://tinyurl.com/y5u4p7xh

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Back-up slides

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We need risk-reduction action on each step on the pathway to nuclear war

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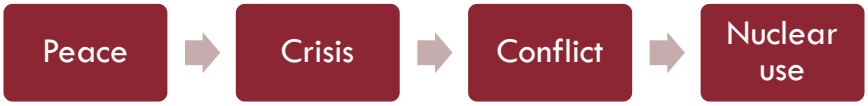

- Key step: preventing crises. Any militarized crisis between nuclear-armed states is dangerous – "fog of crisis" raises risks
  - Avoiding crises is partly deterrence – but mainly foreign policy
  - A more modest foreign policy for a dangerous nuclear era?
- Preventing escalation from crisis to conflict
  - Partly deterrence – partly de-escalation, reassurance
- Preventing escalation to nuclear use
  - Similar issues – but heavier emphasis on deterrence
- How to reassure, reach resolutions, in atmosphere of hatred, fear, misperception, disinformation, time pressure?

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"Rethinking Nuclear Deterrence": A global research network

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- Harvard-led research network launched in 2022, with support from the MacArthur Foundation
- Why rethink nuclear deterrence?
  - Terrible dangers and serious moral ambiguities of nuclear deterrence have always been there
  - Changing geopolitics, changing technologies raise complex issues
  - Need ideas to address changing dangers
- Scores of scholars and practitioners from ~25 countries involved, in four working groups:
  - Preventing nuclear war
  - Legal, ethical aspects of nuclear deterrence
  - Evolving technologies and arms control
  - Beyond nuclear deterrence
  - Other projects, outreach efforts, beyond the working groups

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The importance of presidential judgment

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- Cuban Missile Crisis:
  - Initially, Kennedy's advisors called for air strikes followed by an invasion
  - Kennedy pushed back, asking for another option
  - The recommended course might well have led to nuclear war
- Kennedy: Key lesson was always to give the adversary a choice between humiliating defeat and nuclear war
- The world relies on sober judgment by the leaders of nuclear states

Source: JFK Library

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Some key takeaways

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- Nuclear weapons continue to pose real risks to U.S. and global security, requiring constant attention to minimize
- Evolving technologies may reduce deterrent stability – but there is likely to be more continuity than change
- Nuclear arms control has had real benefits for U.S. and global security, and is worth trying to continue
- The global effort to stem the spread of nuclear weapons has been surprisingly successful, and serves almost everyone's interests
  - But requires constant effort for continued success
- Nuclear and radiological terrorism remain real dangers
- Good policy has managed to reduce nuclear dangers in multiple areas – and can do so again in the future

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Taking the "security dilemma" seriously

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- What U.S. actions for defense and deterrence might provoke adversary responses that undermine U.S. security?
- Are U.S. missile defenses:
  - Part of the cause of Russia's new types of strategic nuclear weapons?
  - Part of the cause of China's buildup?
- Are U.S. counterforce capabilities a major reason why Russia relies on a "launch on warning" strategy?
- Do U.S.-ROK "kill chain" and decapitation strategies increase North Korean incentives for limited use of nuclear weapons early in a conflict?
- Do U.S. and Israeli threats, operations, increase Iran's desire for a nuclear weapons option?

Need to think through long-term net effect of U.S. actions

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From Putin's perspective: next steps in arms control

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- Imagine: it's 2024, talks on a new arms control agreement are beginning
- The U.S. wants
  - Significantly lower numbers
  - An accord that limits all warheads – including Russian tactical weapons
  - On-site inspections at warhead sites
  - Inclusion of new Russian weapon types in the treaty's limits
  - But the U.S. refuses any serious limits on missile defenses (including space-based ones) or precision conventional strike capabilities, Ukraine unresolved
- Should Russia agree?

Source: kremlin.ru

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From Xi's perspective: participate in arms control?

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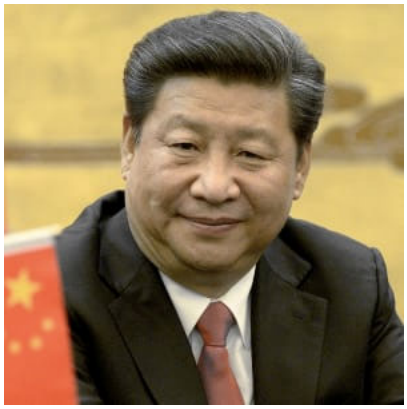
- Imagine: it's 2024
- The U.S., concerned about China's growing (but still small) arsenal, wants China to agree to limits
  - China doesn't want to be formally locked into an inferior position
  - But China wants to be seen as an advocate of disarmament
  - U.S. is unwilling to constrain missile defenses that China sees as threatening its deterrent
- What limits, if any, should China agree to?
  - Formal, informal possibilities



Source: Muneyoshi Someya/Getty Images

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The Iran nuclear archive

- 6 key conclusions:
  - Iran had focused program to produce, test nuclear weapons
  - Made more technical progress than had previously been known
  - Has ability to reconstitute
  - Much more foreign assistance than previously understood
  - Some facilities, activities went undetected
  - Issues will have to be addressed in future deals
- Many mysteries remain…

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From Khamenei's perspective: what to agree to, for what price?

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- Imagine: it's 2023, all sides have returned to the JCPOA
- U.S. is asking for new accord – longer timelines, limits on long-range missiles…
- U.S. is offering broader sanctions relief in return
- What should Iran be prepared to offer, for what concessions from the United States or others?
  - What would make U.S. promises credible to you this time?
  - Should you authorize a new deal?

Source: Anadolu Agency via Getty Images

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Dateline: Unknown Nuclear and radiological terrorism

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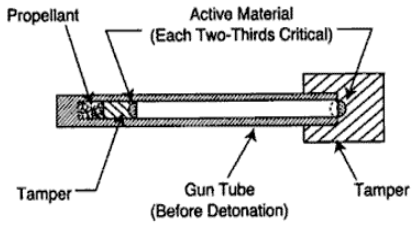
- Numerous gov't studies: terrorist group *could* plausibly make a crude bomb if it got material
- ~20 cases of seizure of stolen HEU or plutonium
- Aum Shinrikyo, al Qaeda both pursued nuclear weapons
- ISIS intent unclear, but had more money, people, territory under control, ability to recruit globally than al Qaeda ever had



Source: NATO

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Dateline: Unknown
Nuclear and radiological terrorism (II)

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- Terrorists could also sabotage nuclear facilities (potentially cause Fukushima-scale accident), or use radioactive material in "dirty bomb"
- Policy options
  - Improve security for nuclear and radiological materials, facilities (How to sustain momentum with the summit process years in the past?)
  - Block nuclear smuggling (How to find the needles in the haystacks?)
  - Counter high-capability terrorist groups (How can we do better?)
  - Prepare to respond (How much can this mitigate the harm?)

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One U.S.-Russian nuclear arms control agreement left – what's next?

34

- ABM Treaty, INF Treaty, both terminated
- Presidents Biden and Putin extended New START for 5 years – but what comes then?
- New START is working
  - Both sides have met key limits
  - Inspections on hold as a result of pandemic
  - Expires 2/2026
- Intense U.S.-Russian hostility, Russian treaty violations, make it very difficult to reach, ratify new treaty
- What about China? What about non-strategic nuclear weapons? What about missile defenses, counter-space weaponry, other factors affecting strategic stability?

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Why should we care?
Benefits of nuclear arms control

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- Benefits of the agreements themselves:
  - Reduced mutual perceptions of threat
  - Force structure stability
  - Predictability (important for planning)
  - Transparency
  - Reduced cost of maintaining forces
- Benefits of the arms control process:
  - Discussions allow greater mutual understanding of nuclear policies, plans, perceived dangers
  - Build relationships, habits of cooperation that spill over to other areas
  - Offers arena in which Russia is treated as an equal – helps assuage prestige, humiliation concerns

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Dateline: United States
Strategic modernization

36

- U.S. strategic weapons are aging
- Obama administration laid out a plan for new ICBMs, SLBMs, submarines, bombers, and cruise missiles, with "life extended" (upgraded) warheads
- Trump endorsed, expanded with new low-yield SLBM, nuclear SLCM, new warhead – Biden budget continues
- >>$1 trillion cost over 30 years
- Bipartisan support – especially with Ukraine war
  - But we need a broader debate over deterrence needs, costs, risks, arms control
  - Some say further weapons needed

Source: DOD

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The rest of the Middle East – and East Asia

37

- Iran's program has given other countries in the region incentives to explore nuclear options
  - Saudi Arabia – statements threatening to get nuclear weapons if Iran does; possible deal with US for both reactors and enrichment
  - Egypt – past safeguards violation never fully resolved; expanded civilian nuclear energy plans
  - Turkey – new statements calling NPT commitment into question, expanded civilian nuclear energy plans
- North Korea's program gives its neighbors incentives to worry – especially if extended deterrence weakened
  - Japan (full fuel cycle in place), ROK (majority support for nuclear weapons), Taiwan (faces growing threats, weaker U.S. commitment)
- Few apparent risks in other regions

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Dateline: Global Chemical and biological threats

38

- Current pandemic shows the impact contagious disease can have
  - Imagine if more contagious, more deadly
- Widespread chemical use by Syria – even after alleged disarmament
- North Korea and Russia apparently used chemical weapons for assassinations—may indicate other stocks
- Terrorists have pursued chemical, biological weapons
  - Islamic State produced, used its own mustard gas
  - Aum Shinrikyo conducted nerve gas attacks in Tokyo subways
  - Aum Shinrikyo, al Qaeda pursued anthrax, other biological agents
  - New gene editing technology (e.g., CRISPR) could increase risks
- Some state biological weapons programs persist
- Deep dual-use dilemmas, verification challenges

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Group assignment: allocate effort to reduce nuclear risks

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- What percent of total nuclear risk reduction effort (high-level political attention, $, other resources) should be allocated to reducing risks posed by:
  - U.S.-Russian conflict
  - U.S.-China conflict
  - North Korea
  - Iran
  - South Asia conflict
  - Nuclear/radiological terrorists
  - Other?
- Base allocations on:
  - Scale of risk to U.S. or global security (probability x consequences)
  - Degree to which U.S. or global policies could reduce the risk

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A risk-informed approach

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- Risk: probability x consequences
- What's the problem?
  - Identify, prioritize, risks and objectives
- What are the options to address it?
  - Start with broad categories – get specific later
- What are the plausible outcomes of each option?
  - Estimate probability, consequences of each outcome
- Choose the option that offers lowest risk/most benefit

In real life, these judgments are highly uncertain, debatable – but this approach offers a structure for thinking and choice

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Iran: should Obama have cut a deal?

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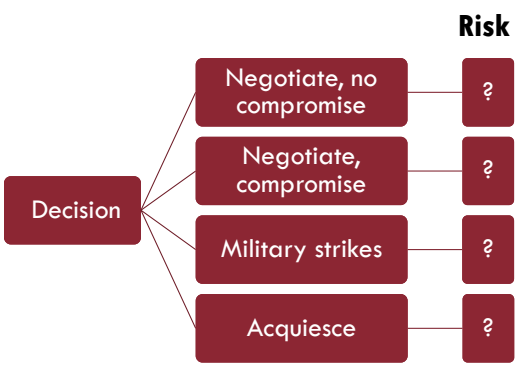

Criteria

- Minimum chance of Iranian bomb
- Impact on other Iranian threats, regional, global security
- Impact on regional, global proliferation risk
- Costs and security risks
- Impact on human well-being
- Impact on politics of Middle East, Iran…
- Impact on U.S., U.N. leadership, credibility

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Comparing the alternatives

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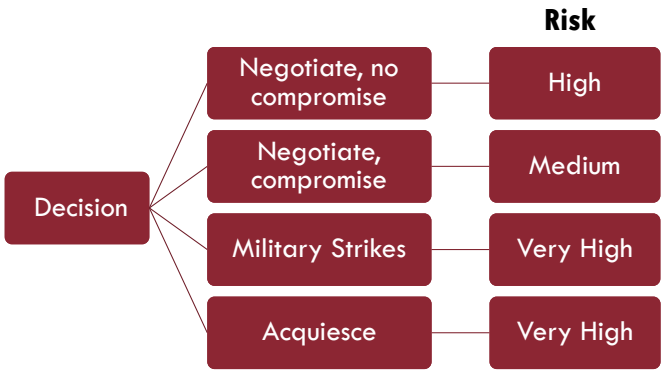

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Huge, transformational nuclear growth needed for substantial climate role

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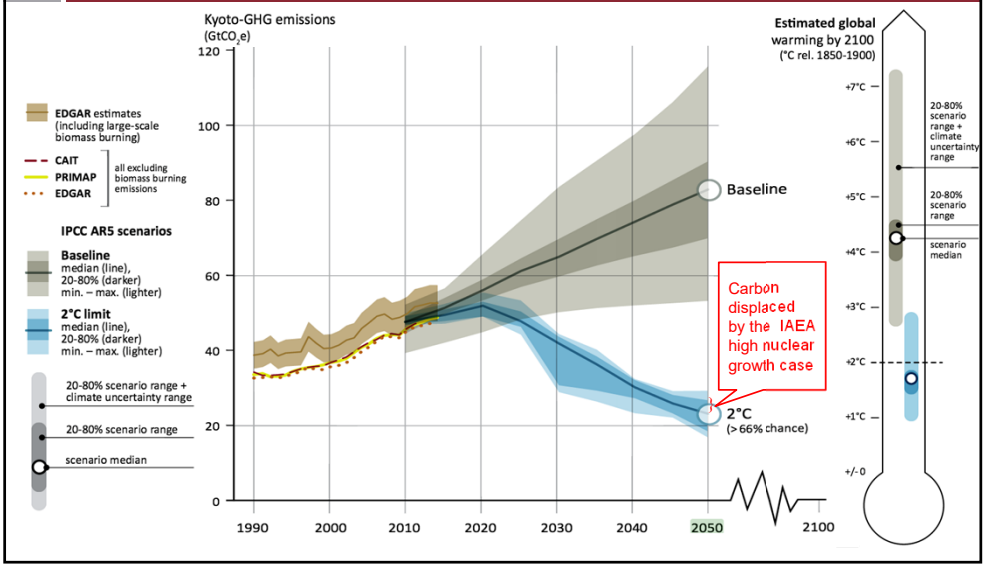

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Particulates may be even more important than climate in driving clean energy

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Smog in Beijing. *Source:* inhabitat.com

- **>3 million deaths/yr globally from fine particulates**

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Key constraints on large-scale nuclear energy growth – can they be loosened?

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- Economics
- Safety risks – real and perceived
- Security risks – real and perceived
- Nuclear waste management – mostly politics
- Siting and public acceptance
- Limited government and industry capacity
- Stringent regulation
- Proliferation risks – mainly from the nuclear fuel cycle
- U supply: Not likely to be a constraint this century

In each area, both new policies and new technologies have the potential to loosen past constraints on growth

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Maintaining U.S. nuclear influence

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- U.S. role in the nuclear market is now greatly reduced
- But the United States offers world-leading innovation, and approaches to safety, security, and nonproliferation
- Both economic and security benefits to maintaining a significant U.S. position in nuclear markets
  - Important to U.S. influence over other countries' nuclear choices
- President Biden has to grapple with:
  - How to avoid losing nuclear's domestic low-carbon contribution
  - How to ease the path to commercializing new technologies
  - How to help U.S. firms compete against state-owned (or assisted) firms from other countries
  - How best to advance U.S. nuclear safety, security, nonproliferation objectives

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