Global catastrophic risks connected with nuclear weapons and nuclear energy

All information here is taken from open sources

Explosions

Direct effects of nuclear explosions and nuclear war

Large scale nuclear war

• 10 000 nukes used
• Many countries participate
• Most big cities destroyed

Probability: medium, i.e. one per cent annually
Timeframe: any time
Extinction probability: small
Degradation level: first level, billions of survivors, could be first step in the extinction process, see degradation levels map

Accidental nuclear war

• Many near-misses occurred
• Near-misses may help estimate probability of war, my article
• See Bruce Blair book

Regional nuclear war

• Many nuclear pairs exist (India - Pakistan)
• Could have global consequences

Arms race
• Large nuclear stockpiles created
• New weapons invented
• Doomsday weapons deployed

Gigaton scale bombs

• In 1960s it was proved that no limits to energy output of fusion bomb exist (Saharov)

• Large bombs may be transported on ships

• Exact extinction threshold is not known: may be 20 bombs 10 GT each in most populated areas

• Current technology probably allows creation of 100 GT bombs weighing 20,000 tonnes and costing 10 billion USD.

• It is equal to 1 km. asteroid strike and not a human extinction risk if only one is built.

• Explosion's effects diminish very quickly with distance
Probability: small
Timeframe: after 2050
Extinction probability: small
Degradation level: millions of survivors, second level degradation, see degradation levels map

Large scale nukes in space

• The only factor which is able to penetrate Earth atmosphere is light and it could be used to create large scale fires. (100 MT bombs on 100 km may be optimal for it, as higher altitudes explosions create less light. See details in russian article.)

• Atmosphere may protect

• Could be created for anti-asteroid defence

• Could be built by self-replicating robots in space

• Space nukes may be used for first strike on an enemy and put on "peaceful" satellites or space-bombers like X-37

• Space nuclear powered lasers may be aimed on Earth, wiki

Probability: small
Timeframe: after 2050
Extinction probability: small
Degradation level: billions to millions of survivors, depending of quantity of bombs and size of the attack

Large scale proliferation because of new technilogies

Cheap and "homemade" nukes

Conditions:

• Reactor grade plutonium becomes easily convertible into weapon grade, bomb tested.
• 2000 tons of it has been accumulated which may be enough for 400, 000 bombs.
• As energy reactors become more popular, more plutonium is created
• Laser enrichment, wiki
• Pure fusion nukes, wiki, blog
• Antimatter triggered fusion, wiki
• Laser triggered fusion (cascade of pellets), article
• Muon catalysed fusion, wiki
• Widespread "peaceful" reactors used to create dangerous isotopes and fission materials
• Z-machine triggered fusion - electric, magnetic and explosives combinations
• Cold fusion based nukes (and other new physics)
• Nanotech or robots used to make nukes
• New energy sources found which could help to create bombs much stronger than nukes
• Impact ignition, link
• ITER-like fusion reactors may be used for proliferation, link
• Thorium has proliferation risk, link

Results:
• Very large nuclear arsenal exceeding size of the Cold war arsenal
• Widespread nuclear proliferation
• Many countries, organizations and private people have nukes
• Nuclear terrorism is a frequent occurrence
• Small nuclear wars are frequent
• Crypto or false flag attacks

Consequences:
Complex societies disintegrate
Somali-world begins
Economy collapse

Probability: unclear, depends on timing of AI
Timeframe: after 2030
Extinction probability: small
Degradation level: billions of survivors, first level degradation

Non conventual nukes

• Antimatter bombs, wiki
• Positron bombs (were researched in 2003 in US)
• Hafnium bomb, currently impossible, wiki

Global antipopulation war using targeted nukes

• At least 1-10 million one-megaton bombs needed to destroy all known human settlement.

• This is 10-100 time more than the Cold war arsenal.

• The world has 5 million villages.

• UFAI could do it.

Radioactivity

Salted large-scale bombs

• Stationary doomsday cobalt bomb (Doomsday weapon for blackmail), see Szilard
• Cobalt bomb cluster could create targeted radiation patterns
• Yield: Gigatons
• Size: Similar to a nuclear reactor, 10,000 tonnes total mass, 10 Gigatone range
• Price: 10 billion USD
• Other effects: earthquakes, smoke
• Other isotopes salted bombs are possible and danger mostly depends on biochemistry: some isotopes are able to accumulate in body (iodine, strontium) and result in longer and more dangerous internal radiation.

Probability: small, feasibility not clear
Timeframe: not clear
Extinction probability: medium
Degradation level: second level, billions to millions of survivors, depends on size

Other variants
• Other dangerous elements are capable of being deposited inside human tissue: C-14, tritium, strontium, polonium.
• Nuclear torpedo with cobalt war heads (Status-6).
• Nuclear power plant, converted into dangerous isotope factory.

Nuclear attack on nuclear power stations

Fact: 400 active reactors in the world as of 2015

The worst possible scenario: During war, ballistic and cruise missiles are launched at **all known nuclear facilities** (reactors and **spent fuel storage** facilities) in all countries. Reactors are operating at the time of the attack.

Results:
• A nuclear bomb explosion near reactor may result in higher yield due to fast fission of uranium and because reactor is already critical.
• The biggest part of accumulated radioactivity is in spent fuel storages. 240,000 tons of it exist with 600 TBq (16,000 Cu) ton radiocatvity and it easily catch fire.
• Almost all world radioactive materials will be **airborne.**
• Total world accumulated radioactivity in reactors and storages is 6 billion Curie (or 150 billion) and growing.
• **Main isotopes**: strontium-90, cesium-137 and plutonium-241.
• **Medium surface radioactivity:** If we take highest estimate we get 300 curies on sq.km, which means activity of 3 milliroentgen per hour, 25 REM/year, which is survivable.
• **Internal radiation** is 20 times more dangerous, so food production will be impossible or will result in cancer epidemic. Strontsium is able to accumulate in bones.

Consequences:
• Most **highly populated areas** will receive much higher doses which will result in acute radiation sickness and mass die-off
• Famine, curtailed lifespan, **societal collapse**, mass die-off

Probability: small
Timeframe: anytime
Extinction probability: small to medium
Degradation level: billions or millions of survivors, depends of unknowns

Triggering natural risks

Attack on supervolcanoes

• May be used as Doomsday weapon
• Potential targets: Yellowstone
• 20 known supervolcanoes on Earth
• Several nuclear strikes could reach magma chamber
Results: local pyroclastic flows, global – climate, because of soot and sulphur.

Penetration deep into Earth's mantle and to the core
• Stevenson probe – nuclear reactor melting through Earth's mantle
• Risks of this probe are known: degazation of liquid Earth core.
• Could be small size, if it is a weapon
• May result in artificial verneshots if high pressure chamber 50-300 km underground is reached.
Results: could cause total change in atmosphere's composition, temperature and climate, all terrestrial life extinction.

Probability: small
Timeframe: anytime
Extinction probability: high if it results in verneshot or in case of core penetration.
Degradation level: billions of survivors in the case of one super volcano, millions in the case of a verneshort, no one is case of core penetration and degazation.

Artificial nuclear winter

• Large scale taiga (or rainforest) fire started by nukes - 1 million sq km of taiga is needed to create firestorms that will create nuclear winter. Roland 1984 – idea, calculation was made by Moiseev based on forest density.

• Coal mine explosions by nukes – may result in large volume of soot in upper atmosphere.

Attack on methane hydrates: Artificial irreversible global warming

Facts and thoughts:
• Large deposits of methane hydrates found on the Arctic ocean bottom. wiki
• Methane hydrates are unstable and may release enormous amounts of methane if slightly disturbed. wiki
• Methane is a strong greenhouse gas, 100 times stronger than CO2.
• Previous large extinctions are associated with methane release and large temperature changes.
• Their abrupt release could result in positive global warming feedback loop.
• The positive feedback depends of the speed of release as methane has short life span in atmosphere: only quick release could start it.
• Runaway global warming may result in Venusian-style green house effect with temperatures as high as 1600 °C (for Earth) as water vapour is also green house gas.
• Many (10 000) nuclear explosions on the sea bottom may start large methane release.
• They could affect 10-100,000 sq km of ocean floor and result in release of 100 Gt of methane which would increase its atmospheric concentration 10 times and result in 10 C immediate global temperature increase (this is my Fermi calculation and need to be checked again).
• It could result in additional methane, CO2 and water vapor release and form positive feedback loop.
• Some scientists think that we are already on the verge of large methane eruption which may result in extinction in 21 century
• A similar effect can be achieved by dropping millions of ordinary depth charges on the seabed, and it may cost less.

Probability: small
Timeframe: any time
Extinction probability: high, but many unknowns about effect magnitude
Degradation level: no survivals if there is Venusian-style runaway global warming (more than 100 C), billions if there is "simple" global warming (2-10 C)

Natural fission or fusion material ignition

• First test 1945 – risks of atmosphere ignition – proved to be impossible (LA-602)
• Underwater test – deuterium ignition? – 20 times less concentration than is necessary for ignition, was estimated before underwater tests by Wood
• Other materials in other places may have enough concentration for detonation, like lithium in dry lakes
• But primary for ignition must be very large like 300 meter size, which will be overkill on Earth.
• Deuterium inside giant planets like Jupiter may be naturally concentrated by gravitational separation into a deep layer
• Sun detonation is impossible (no concentrated layers of deuterium are possible inside the Sun and ordinary hydrogen can't be ignited in normal conditions).

Probability: small
Timeframe: remote future
Extinction probability: high

Dangerous chemical ore explosion

• Nuclear weapons may be used to free large amounts of toxic chemicals from its natural deposit.

• It may be arsenium, or poisonous gas.

• But no known such deposits exist.

Artificial electromagnetic storm

Fact:
• Small nuclear explosions in ionosphere create much stronger electromagnetic pulse, which could knock out electricity 1000 km away, wiki.

• Small country like North Korea could do it, and they have already put a satellite in polar orbit which is most suitable for EMP attack, link.

• Nuclear war in space may result in global damage.

Results:

• All electric power in the world lost

• Societal collapse

Other risks

• Tectonic fault activation using nukes. Small chances of global consequences

• Large tsunami by large nuclear explosion. Small chances of global consequences

• Large landslide (La Palma) trigger tsunami. Small chances of global consequences

• Asteroids deflected to Earth.

Climate

Nuclear winter

Nuclear war against cities may fill upper atmosphere with soot, which will block sunlight and result in global cooling, wiki

Scenarios:

0) Nuclear autumn – several cold years, no danger
1) 1 °C temperature decrease:
• year without summer
• regional nuclear war
• billions of survivors, social unrest

2) 10 °C decrease for 10 years:
• large scale nuclear war
• hundreds of millions of survivors, large scale famine

3) 10-20 °C – irreversible nuclear winter starts new Ice Age:
• volcanic nuclear winter, positive albedo feedback
• billions of survivors, large scale famine, many countries perish

4) 30 C – Ice age results in Snowball Earth
• cause: CO2 removal
• total extinction
• very improbable

Nuclear summer

• A "nuclear summer" is a hypothesized scenario in which, after a nuclear winter has abated, a greenhouse effect then occurs due to CO2 released by combustion and methane released from the decay of the organic matter that froze during the nuclear winter. It is supported scientifically far less, than nuclear winter, as a risk – wiki.

• Global dimming (industrial air pollution that partly mitigates global warming) stops because of industrial collapse and accumulated global warming shows itself.

• Soot covers ice caps resulting in melting and reduced albedo

• Ozone layer is depleted

• Geo-engineering fails

Results:
• Mild case: extended problems with climate and food chain
• Worst case: runaway global warming

Accidents

Nuclear power accidents

• Meltdown at nuclear power station resulting in "corium", which melts through crust and results in volcanic or even verneshot eruption. (China syndrome).
Very improbable.

• Large scale explosion in fusion tokamak like ITER with cobalt-contaminated blanket or deuterium ignition in the blanket (wiki, article)

• Orion-style nuclear powered (300,000 nuclear bombs on board) starship is created and then suffers catastrophic failure (wiki).

Nuclear physics experiments go awry

An accelerator creates something strange and capable of growth and chain reaction:
- mini black hole,
- stranglet,
- false vacuum.

Something unknown

Nuclear-biological war

• Nuclear war between superpowers during or after which **hundreds of pathogens are released**, nuclear power stations are blown, nuclear winter starts.

• Long war: constant use of nukes and pathogens

• Multipandemic

Result:

• Earth is not suitable for long term survival: cold, dark, radioactive and infectious.

• Population in millions and constantly diminishing until full extinction

Nukes against bio

Sterilization failure: One may try to apply nuclear weapon to destruction of dangerous laboratories and sterilization of the infected areas; but result in wider bio-dissemination or nuclear war.

Bio helps nukes

Modified bacteria can be applied to extraction of uranium from sea water and for its enrichment, and also for extraction of plutonium from spent fuel.

Bio and nukes used together

Nuclear war occurs in world strongly infected with biological agents. War make impossible adequate rate of manufacture of vaccines, and simultaneously leads to intensive migration of people. Resources which could be used to protect against microbes are used to protect against radiation instead. Many people are weakened and are susceptible to diseases.

A country which is losing nuclear war releases hundreds of different pathogens and starting multipandemic.

High radioactivity after nuclear war results in higher mutation levels and growth of dangerous pathogens and creatures.

After a pandemic, many nuclear sites will be unattended and will melt down, resulting in severe radiological contamination.

Quarantine measure will be mistakenly implemented by nuclear weapons (if a city is infected with dangerous virus, some may try to stop its spread by nuking the city).

Bio and nuclear contamination of crops will result in famine or illness.

Nuclear winter results in crop failure, and remaining food is contaminated or affected by artificial pests.

System crisis

• Long term decline during which nukes are used many times, preventing stabilization

• Complex societies fail

• "Somali-world"

• No science and tech

• Resource depletion

• Global warming

• Accumulated environmental damage results in extinction

Natural risks

• Natural nuclear reactor in Earth's core goes critical (or in the mantle)

• Gamma-ray bursts

• Space neutrino burst

• Sun flares, superflares

Importance of risks

Importance (or urgency) of risks is subjectively estimated based on their probability, timing, magnitude of expected effect and scientific basis for the risk. Importance here means how much attention and efforts we should put to control the risk.

Green – just keep it in mind, do nothing
Yellow – pay attention, do reasonable efforts to prevent
Red – pay immediate attention to prevent

Plan B failure

• Large bunkers and shelters may be deliberately destroyed during nuclear war.

• Space colonies may be also targeted by space nuclear missiles

• Large shelters may continue to possess nukes or build them and use them later

• Remaining nuclear arsenals may result in "long war" and prevent return to peaceful reconstruction of the civilization.

Risk factors

Multipolar world

• Many nuclear enemy pairs
• MAD works only for two superpowers, in case of three becomes unstable
• Cypro wars are possible
• Proliferation
• Level of mutual hostility

Tech progress

• Tech progress accelerates
• Nuclear tech is developing too
• Arms race and tech progress connection
• Nanotech will make nukes simpler
• AI viruses – could gain control of missiles
• New physics – could help create stronger and cheaper bombs

Wars

• A war could become nuclear
• Regional nuclear war could become global
• War connected with nuclear terrorism
• Risks of war rise proliferation risks
• Risks of war rise arm race speed

Terrorism

• Nuclear terrorism could provoke nuclear war

Prevention methods

See x-risks prevention roadmap

Arms control

• Civil antinuclear movement
• Arms control agreements

Non proliferation

IAEA

Missile defence

Planet unification and control

Civil defence

New level of tech: nano, AI

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