Climate Change and peace: The 5th IPCC assessment report (AR5)

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Thanks to the Walloon government and to my team at the Université catholique de Louvain for their support
“Climate Change War” Is Not a Metaphor

The U.S. military is preparing for conflict, retired Navy Rear Adm. David Titley says in an interview.

On our current path, climate change could pose an irreversible, existential risk to civilization as we know it—but we can still fix it if we decide to work together.

http://www.slate.com/articles/technology/future_tense/2014/04/david_titley_climate_change_war_an_interview_with_the_retired_rear_admiral.html
“Climate Change War” Is Not a Metaphor

Climate change worsens the divide between haves and have-nots, hitting the poor the hardest. It can also drive up food prices and spawn megadisasters, creating refugees and taxing the resiliency of governments. When a threat like that comes along, it’s impossible to ignore. Especially if your job is national security.

http://www.slate.com/articles/technology/future_tense/2014/04/david_titley_climate_change_war_an_interview_with_the_retired_rear_admiral.html
“Climate Change War” Is Not a Metaphor

Retired Navy Rear Adm. David Titley co-wrote an op-ed for Fox News:

« The parallels between the political decisions regarding climate change we have made and the decisions that led Europe to World War One are striking – and sobering. The decisions made in 1914 reflected political policies pursued for short-term gains and benefits, coupled with institutional hubris, and a failure to imagine and understand the risks or to learn from recent history. »

http://www.slate.com/articles/technology/future_tense/2014/04/david_titley_climate_change_war_an_interview_with_the_retired_rear_admiral.html
Lying With Statistics, Global Warming Edition

Temperature Plateaus — 1912-2012

Lying With Statistics, Global Warming Edition

Temperature Change From 1961-1990 Average

Why the IPCC?

Established by WMO and UNEP in 1988

to provide policy-makers with an objective source of information about

• causes of climate change,
• potential environmental and socio-economic impacts,
• possible response options (adaptation & mitigation).

WMO=World Meteorological Organization
UNEP= United Nations Environment Programme
What is happening in the climate system?

What are the risks?

What can be done?
WG I (Physical science basis): 209 lead authors, 2014 pages, 54.677 review comments

WG II (Impacts, Adaptation, and Vulnerability): 243 lead authors, 2500 pages, 50.492 review comments

WG III (Mitigation of Climate Change): 235 coordinating and lead authors, 2000 pages, 38.315 review comments
What is happening in the climate system?
Change in average surface temperature 1901-2012

Warming in the climate system is unequivocal
Plateau Glacier (1961) (Alaska)

(Alaska)

It is *virtually certain* that the upper ocean (0-700 m) warmed from 1971 to 2010, [...]. It is *likely* that the ocean warmed between 700 and 2000 m from 1957 to 2009.
Atmospheric CO$_2$ concentration
The atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years.
Carbon cycle: unperturbed fluxes

Atmosphere

pre-ind: 597 GtC

(1 ppmv = 2.2 GtC)

280 ppmv

Ocean

Physical, Chemical, and Biological processes

70.5

70

respiration

119.5

photosynthesis

120

matière organique en décomposition

2300

rivières

1

Ocean

38000

partie I

partie II

partie III

partie IV

Combustibles fossiles (charbon, pétrole, gaz naturel)

3700

Units: GtC (billions tons of carbon) or GtC/year (multiply by 3.7 to get GtCO₂)

vanyp@climate.be
Carbon cycle: perturbed by human activities
(numbers for the decade 1990-1999s, based on IPCC AR4)

Atmosphere

- Pre-ind: 597 GtC + 3.2/yr
- 280 ppmv + 1.5 ppmv/yr (1 ppmv = 2.2 GtC)

Units: GtC (billions tons of carbon) or GtC/year

Stocks!

vanyp@climate.be
The carbon cycle is policy-relevant

• CO₂ accumulates in the atmosphere as long as human emissions are larger than the natural absorption capacity
• Historical emissions from developed countries therefore matter for a long time
• As warming is function of cumulated emissions, the carbon « space » is narrowing fast (to stay under 1.5 or 2°C warming)
Tyndall (1861) measures gas absorption of radiation as a function of wavelength.
A Progression of Understanding: Greater and Greater Certainty in Attribution

AR1 (1990): “unequivocal detection not likely for a decade”


AR3 (2001): “most of the warming of the past 50 years is likely (odds 2 out of 3) due to human activities”

AR4 (2007): “most of the warming is very likely (odds 9 out of 10) due to greenhouse gases”

AR5 (2013) «It is extremely likely (odds 95 out of 100) that human influence has been the dominant cause... »
Three stabilisation scenarios: RCP 2.6 to 6
One Business-as-usual scenario: RCP 8.5

AR5, chapter 12. WGI- Adopted version / subject to final copyedit
Only the lowest (RCP2.6) scenario maintains the global surface temperature increase above the pre-industrial level to less than 2°C with at least 66% probability
Surface temperature projections

(a) Change in average surface temperature (1986–2005 to 2081–2100)

RCP 2.6

RCP 8.5

(°C)
Precipitation projections

(b)

Change in average precipitation (1986–2005 to 2081–2100)

AR5 WGI SPM - Approved version / subject to final copyedit
RCP2.6 (2081-2100), *likely* range: 26 to 55 cm

RCP8.5 (in 2100), *likely* range: 52 to 98 cm

(Reference level: 1986-2005)
Since 1950, extreme hot days and heavy precipitation have become more common.

There is evidence that anthropogenic influences, including increasing atmospheric greenhouse gas concentrations, have changed these extremes.
# Extreme weather and climate events

<table>
<thead>
<tr>
<th>Phenomenon and direction of trend</th>
<th>Assessment that changes occurred (typically since 1950 unless otherwise indicated)</th>
<th>Assessment of a human contribution to observed changes</th>
<th>Likelihood of further changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warmer and/or fewer cold days and nights over most land areas</td>
<td>Very likely</td>
<td>Very likely</td>
<td>Likely</td>
</tr>
<tr>
<td>Warmer and/or more frequent hot days and nights over most land areas</td>
<td>Very likely</td>
<td>Very likely</td>
<td>Likely</td>
</tr>
<tr>
<td>Warm spells/heat waves. Frequency and/or duration increases over most land areas</td>
<td>Medium confidence on a global scale Likely in large parts of Europe, Asia and Australia</td>
<td>Likely</td>
<td>Not formally assessed</td>
</tr>
<tr>
<td>Heavy precipitation events. Increase in the frequency, intensity, and/or amount of heavy precipitation</td>
<td>Likely more land areas with increases than decreases</td>
<td>Medium confidence</td>
<td>Likely over many land areas</td>
</tr>
<tr>
<td>Increases in intensity and/or duration of drought</td>
<td>Low confidence on a global scale Likely changes in some regions</td>
<td>Low confidence</td>
<td>Low confidence</td>
</tr>
<tr>
<td>Increases in intense tropical cyclone activity</td>
<td>Low confidence in long term (centennial) changes Virtually certain in North Atlantic since 1970</td>
<td>Low confidence</td>
<td>Low confidence</td>
</tr>
<tr>
<td>Increased incidence and/or magnitude of extreme high sea level</td>
<td>Likely (since 1970)</td>
<td>Likely</td>
<td>Likely</td>
</tr>
</tbody>
</table>

IPCC, AR5, Table SPM.1
Global ocean surface pH (projections)

Ocean Acidification, for RCP 8.5 (orange) & RCP2.6 (blue)
Oceans are Acidifying Fast...

Changes in pH over the last 25 million years

- It is happening now, at a **speed and to a level** not experienced by marine organisms for about 60 million years
- Mass extinctions linked to previous ocean acidification events
- Takes 10,000’s of years to recover

Turley et al. 2006

“Today is a rare event in the history of the World”

Slide courtesy of Carol Turley, PML
What are the risks?
18-20000 years ago (Last Glacial Maximum)

With permission from Dr. S. Joussaume, in « Climat d’hier à demain », CNRS éditions.
Today, with +4-5°C globally

With permission from Dr. S. Joussaume, in « Climat d’hier à demain », CNRS éditions.
Adapted from: International Geosphere Biosphere Programme Report no.6, Global Changes of the Past, July 1988
WIDESPREAD OBSERVED IMPACTS
A CHANGING WORLD
Effects on Nile delta: 10 M people above 1m
With 8 metre sea-level rise: 3700 km² below sea-level in Belgium (very possible in year 3000) (NB: flooded area depends on protection)

Risk = Hazard x Vulnerability x Exposure
(Katrina flood victim)
More heavy precipitation and more droughts...

Warmer world implies more evaporation - but soils will dry out as a result. So dry regions will get drier unless storm tracks shift in a lucky way. And for some, they are expected to shift in an unlucky way.

At mid to low latitudes: wet get wetter, dry get drier.

Warmer world implies more evaporation - more water goes to the atmosphere where water is available on the ground (e.g., oceans). The atmosphere therefore will contain more water vapor available to rain out. And most places receive the majority of their moisture in heavy rain events, which draw moisture from a big area.
ADAPTATION IS ALREADY OCCURRING
WITH CONTINUED HIGH EMISSIONS INCREASE RISKS OF CLIMATE CHANGE
What can be done?
Cumulative emissions of CO₂ largely determine global mean surface warming by the late 21st century and beyond.
Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.
Limiting warming to \textit{likely} less than 2°C since 1861-1880 requires cumulative CO$_2$ emissions to stay below 1000 GtC. Until 2011, over 50\% of this amount has been emitted.

Accounting for other forcings, the upper amount of cumulative CO$_2$ emissions is 800 GtC; over 60\% have been emitted by 2011.
Compatible fossil fuel emissions simulated by the CMIP5 models for the four RCP scenarios.
GHG emissions accelerate despite reduction efforts. Most emission growth is CO₂ from fossil fuel combustion and industrial processes.
Can temperature rise still be kept below 1.5 or 2°C (over the 21st century) compared to pre-industrial?

- Estimated global GHG emissions levels in 2020 based on the Cancún Pledges are not consistent with cost-effective long-term mitigation trajectories that have at least 50% chance to limit global temperature change to 2°C relative to pre-industrial levels.

- Meeting this goal would require further substantial reductions beyond 2020.

- The Cancún Pledges are broadly consistent with cost-effective scenarios that are likely to keep temperature change below 3°C relative to pre-industrial levels.
Can temperature rise still be kept below 1.5 or 2°C (over the 21st century) compared to pre-industrial?

- Many scenario studies confirm that it is technically and economically feasible to keep the warming below 2°C, with more than 66% probability (”likely chance”). This would imply limiting atmospheric concentrations to 450 ppm CO$_2$-eq by 2100.

- Such scenarios for an above 66% chance of staying below 2°C imply reducing by 40 to 70% global GHG emissions compared to 2010 by mid-century, and reach zero or negative emissions by 2100.
Can temperature rise still be kept below 1.5 or 2°C (over the 21st century) compared to pre-industrial?

- These scenarios are characterized by rapid improvements of energy efficiency and a near quadrupling of the share of low-carbon energy supply (renewables, nuclear, fossil and bioenergy with CCS), so that it reaches 60% by 2050.

- Keeping global temperature increase below 1.5°C would require even lower atmospheric concentrations (<430 ppm CO$_2$eq) to have a little more than 50% chance. There are not many scenario studies available that can deliver such results, requiring even faster reductions in the medium term, indicating how difficult this is.
Mitigation requires major technological and institutional changes including the upscaling of low- and zero carbon energy.
Substantial reductions in emissions would require large changes in investment patterns.
Since AR4, there has been an increased focus on policies designed to integrate multiple objectives, increase co-benefits and reduce adverse side-effects.

- **Sector-specific policies** have been more widely used than economy-wide policies.
- **Regulatory approaches and information** measures are widely used, and are often environmentally effective.
- Since AR4, **cap and trade** systems for GHGs have been established in a number of countries and regions.
- In some countries, **tax-based policies** specifically aimed at reducing GHG emissions—alongside technology and other policies—have helped to weaken the link between GHG emissions and GDP
- The **reduction of subsidies** for GHG-related activities in various sectors can achieve emission reductions, depending on the social and economic context.
Effective mitigation will not be achieved if individual agents advance their own interests independently.

• Existing and proposed international climate change cooperation arrangements vary in their focus and degree of centralization and coordination.

• Issues of equity, justice, and fairness arise with respect to mitigation and adaptation.

• Climate policy may be informed by a consideration of a diverse array of risks and uncertainties, some of which are difficult to measure, notably events that are of low probability but which would have a significant impact if they occur.
The more we wait, the more difficult it will be
Mitigation can result in large co-benefits for human health and other societal goals.
All sectors and regions have the potential to contribute by 2030

(avoided emissions: the higher, the better)

IPCC AR4 (2007)

Note: estimates do not include non-technical options, such as lifestyle changes.
Climate change and conflicts: summary (IPCC AR5 WGII)

- Climate change [and climate variability] can indirectly increase risks of violent conflicts in the form of civil war and inter-group violence by amplifying well-documented drivers of these conflicts such as poverty and economic shocks (medium confidence)

- Violent conflict increases vulnerability to climate change. Large-scale conflicts harms assets that facilitate adaptation, including infrastructure, institutions, natural resources, social capital and livelihood opportunities
Does climate change cause violent conflicts?

• Some factors that increase risks from violent conflicts and civil wars are sensitive to climate change
  ‣ For example […] factors like low per capita income, economic contraction, and inconsistent state institutions are associated with the incidence of civil wars, and also seem to be sensitive to climate change.

• Climate-change policies, particularly those associated with changing rights to resources, can also increase risks from violent conflict.

• While statistical studies document a relationship between climate variability and conflict, there remains much disagreement about whether climate change directly causes violent conflicts.

AR5 WGII (TS) FAQ.9
Will climate change cause war between countries?

• Climate change has the potential to increase rivalry between countries over shared resources
  ‣ For example, (…) rivalry over changing access to the resources in the Arctic and in transboundary river basins.

• Climate changes represent a challenge to the effectiveness of the diverse institutions that already exist to manage relations over these resources.

• However, there is high scientific agreement that this increased rivalry is unlikely to lead directly to warfare between states.
  ‣ The evidence to date shows that the nature of resources such as transboundary water and a range of conflict resolution institutions have been able to resolve rivalries in ways that avoid violent conflict.

(AR5 WGII FAQ.12.5)
Climate change - conflict: insights from the past?

- Some studies show that the Little Ice Age in the mid-17th century was associated with more cases of political upheaval and warfare than in any other period, but (...) findings from historical antecedents are not directly transferable to the contemporary globalized world.

- Collectively the research does not conclude that there is a strong positive relationship between warming and armed conflict.

- There is some agreement that either increased rainfall or decreased rainfall in resource-dependent economies enhances the risk of localized violent conflict, particularly in pastoral societies in Africa (...)

Institutions able to peacefully manage conflict are highlighted as the critical factor in mediating such risks.

(AR5 section 12.5.1)
Example:

• Climate and the multiple causes of conflict in Darfur (AR5 Box 12-5):
  ‣ Most authors identify government practices as being far more influential drivers than climate variability, noting also that similar changes in climate did not stimulate conflicts of the same magnitude in neighboring regions, and that in the past people in Darfur were able to cope with climate variability in ways that avoided large-scale violence.
Conflict and Insecurity associated with Climate Policy Responses

- where property rights and conflict management institutions are ineffective or illegitimate, efforts to mitigate or adapt to climate change that change the distribution of access to resources have the potential to create and aggravate conflict.

For example:

- Maladaptation or greenhouse gas mitigation efforts at odds with local priorities and property rights may increase the risk of conflict in populations
- Research on the rapid expansion of biofuels production connects land grabbing, land dispossession, and social conflict
- Provision of financial resources in payment for ecosystem services projects (such as REDD), has the potential to stimulate conflict over resources and property rights
- Forced resettlement related to e.g. hydropower, other issues related to low-carbon energy
Violent Conflict and Vulnerability to Climate Change

• development studies and political science show that violent conflict undermines capacity to cope with changes

• conflict creates poverty and constrains livelihoods that, in turn, increases vulnerability to the impacts of climate change; violent conflict is a major cause of hunger and famines.

• armed conflict can decrease the capacity of governments to function effectively as well as the capacity for collective action, which also impedes adaptation

(AR5 section 12.5.3)
State Integrity and Geopolitical Rivalry

- Examples
  - Sea-level rise and other changes compromise human security, in particular in countries made up entirely of low-lying atolls.
  - Productive ocean fisheries are already directly affected by climate change (…) the movement of fish stocks has been suggested to increase transboundary rivalry.
  - The impacts of climate-induced water variability on transboundary water basins generates geopolitical concerns (…) particularly where challenges stemming from rising consumption and growing populations are already present.
  - Uncertainty and high likelihood of differential geographic impacts of geoengineering are anticipated sources of tension or conflict between states. These include regional effects of solar radiation management on reduced precipitation in specific areas in Asia or in the Sahel with negative food production implications.

(AR5 section 12.6)
Geopolitical Dimensions of Climate Change Impacts in the Arctic

- The Arctic has been warming at about twice the global rate since 1980, resulting in unprecedented loss in sea ice.
- These changes have implications for land-based infrastructure, shipping, resource extraction, coastal communities, and transport.
- There is medium evidence that changes will create or revive terrestrial and maritime boundary disputes among Arctic countries. There is little evidence the changing Arctic will become a site for violent conflict between states.
- At present, political institutions are providing forums for managing resource competition, new transportation practices, and boundary disputes, but anticipated increased stresses will test these institutions in the future.
Climate change and migrations

- populations most exposed and vulnerable to the impacts of climate change may have least ability to migrate

Figure 12.1: Relationship between vulnerability to environmental change and well-being.

Trapped population.
Climate change and human security

AR5 WGII
Fig 12.3
Climate change may undermine peace and security
Climate change exacerbates existing pressures on security as well as bringing new challenges, and the potential for violent conflict could increase. The operational responsibilities of the defence sector could also expand in the event of large-scale climate-driven disasters.

Security-Related Climate Change Impacts
- Increase in Drought and Inland Flooding
- Rising and Extreme Temperatures
- Declining Snow and Ice Cover
- Sea-Level Rise and Storm Surge
- Extreme Weather

Rising and Extreme Temperatures
Lower agricultural output, spread of disease, food insecurity, less renewable water resources, more heat-related illnesses, change in large-scale fish catch potential.

Geopolitical Concerns
Uneven distribution of impacts among countries depending on geographic setting and other factors affecting national and human security. Climate-related security threats greater in countries with weak or failing governments and with existing conflict.

Declining Snow and Ice Cover
Access to offshore resources in newly ice-free areas, freshwater insecurity, changes in geography and new openings for traffic.

Sea-Level Rise and Storm Surge
Increased vulnerability in the Low Elevation Coastal Zones, damage to infrastructure, changing transport links and integrity, population displacement, disease spread, loss of arable land, change in coastal resources.

Extreme Weather
Destruction of critical infrastructure, population displacement, pandemics/reemergence of disease outbreaks, humanitarian disaster.

Responding to Climate Change Impacts

Security-Related Climate Change Impacts
- Increase in Drought and Inland Flooding
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Responding Strategies

Flexible Response
Even with adaptation measures, changes in climate can have unexpected, adverse effects on military operations. Flexibility in planning and response will be essential in meeting long-term national security needs.

Planning for Displacement
Missions of people could depend on adoption measures to reduce displacement caused by coastal flooding and food loss.

Reduction of Risk
Action with emphasis on disaster risk reduction can increase climate resilience while setting in motion human livelihoods.

Anticipating Climate Risk
Anticipating climate risks can help planners reduce impacts. Numerous facilities may need to be relocated and strengthened, notably to secure naval bases against flooding and low sea-level rise.

Adjustments in Security Analysis
Nations will need to update strategic security planning to take into account risks and impacts of climate change.

Scenarios for Lack of Resources
Reduction of fresh, clean-water resources could increase competition in great-prone to conflict over extreme scarcity, as well as potential adaptation for brackish supplies.

Reducing the Carbon ‘Bootprint’
In many nations, defence forces are the largest single consumer of fossil fuel. Reducing fuel consumption would not only reduce greenhouse gas (GHG) emissions.

More Efficient Vehicles
Light-duty vehicles could be 40–70% more fuel efficient by 2038 than now.

Alternative Fuels
New aircraft typically offer 20–30% improvements in efficiency. Switching from kerosene to biofuels offers 50% cuts in direct CO2 emissions.

Operational Efficiencies
Avoiding carbon dioxide (CO2) emissions can be reduced through more efficient planning of operations, including routes, altitudes and speeds.

Climate change may undermine peace and security

Climate change exacerbates existing pressures on security as well as bringing new challenges, and the potential for violent conflict could increase. The operational responsibilities of the defence sector could also expand in the event of large-scale climate-driven disasters.

Reduction the Carbon 'Bootprint'

In many nations, defence forces are the largest single consumer of fossil fuel. Reducing fuel consumption would in turn reduce greenhouse gas (GHG) emissions.

**More Efficient Vehicles**
Light-duty vehicles could be 40–70% more fuel efficient by 2035 than now.

**Alternative Fuels**
New aircraft typically offer 20–30% improvement in efficiency. Shifting from kerosene to biofuels offers +30% cuts in direct GHG emissions.

**Operational Efficiencies**
Aviation carbon dioxide (CO₂) emissions can be reduced through more efficient planning of operations, including routes, altitudes and speeds.
Security-Related Climate Change Impacts

Increase in Drought and Inland Flooding
Food and freshwater insecurity, pandemic/epidemic disease outbreaks, loss of food production and arable lands, population displacement, livelihood insecurity.

Rising and Extreme Temperatures
Lower agricultural output, spread of disease, food insecurity, less renewable water resources, more heat-related illness, change in large-scale fish catch potential.

Geopolitical Concerns
Uneven distribution of impacts among countries depending on geographic setting and other factors affecting national and human security. Climate-related security threats greatest in countries with weak or failing governments and/or with existing conflict.

Declining Snow and Ice Cover
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Extreme Weather
 Destruction of critical infrastructure, population displacement, pandemic/epidemic disease outbreaks, humanitarian disaster.

Resilience Strategies

Flexible Response
Even with adaptation measures, changes in climate can have unexpected, adverse effects on military operations. Flexibility in planning and response will be essential in meeting long-term defence and security responsibilities.

Reducing Risk
Action with an emphasis on disaster risk reduction can increase climate resilience while helping improve human livelihoods.

Planning for Displacement
Millions of people could depend on adaptation measures to reduce displacement caused by coastal flooding and land loss.

Anticipating Climate Risk
Anticipating climate risks can help planners reduce impacts. Numerous facilities may need to be relocated and/or strengthened, notably to secure naval bases against flooding and sea-level rise.

Adjustments in Security Analysis
Nations will need to update strategic security planning to take into account risks and impacts of climate change.

Scenarios for Lack of Resources
Reduction of fresh, clean water resources could require increased peacekeeping in areas prone to conflict over extreme scarcity, as well as logistical adaptation for troop supplies.
Resilience

Many adaptations to climate change that involve the military can result in significant co-benefits, such as alleviating poverty and enhancing development, especially in developing countries:

- Flood preparedness
- Relocating military installations and bases
- Preparing for water insecurity
- Increasing resilience

Climate Change: Implications for Defence, June 2014 - Key Findings from the IPCC AR5
Mitigation Potential

The **global military complex is an energy-intensive industry** and in many nations, defence forces are the largest single consumer of fossil fuels.

- More efficient vehicles
- Alternative fuels
- Operational improvements
- NB: Note risk of unintended consequences of mitigation and adaptation
Conclusion

Climate change has the potential to increase the risk of conflict and insecurity because factors such as poverty and economic hardship, associated with a higher risk of violent conflict, are especially sensitive to climate change.

Although many climate risks warrant further investigation and there is a need for more comprehensive evidence across multiple locations and over long durations, it is likely that climate change over the 21st century will lead to new challenges to states and will increasingly shape national security policies.
Useful links:

- www.ipcc.ch : IPCC
- www.cisl.cam.ca.uk/ipcc : AR5 summary sheet on security
- www.climate.be/vanyp : my slides and other documents
- www.skepticalscience.com: excellent responses to contrarians arguments
- On Twitter: @JPvanYpersele

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