2015 INTERNATIONAL WORKSHOP ON ENVIRONMENT AND ALTERNATIVE ENERGY
"Increasing Space Mission Resiliency through Sustainability"

MANAGING RISKS OUTSIDE THE FENCE

Laurent Jauniaux

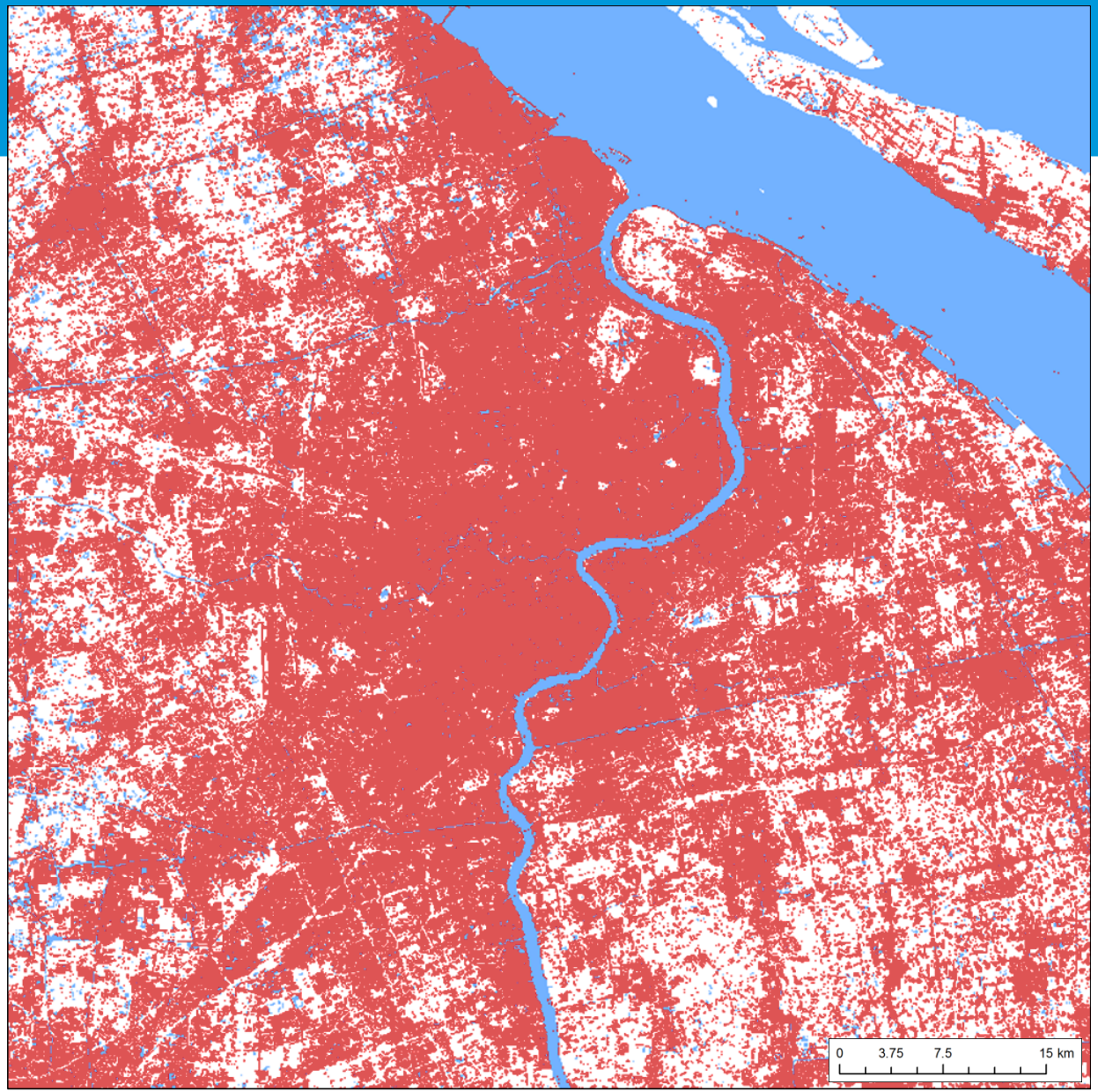
12 November 2015 NASA/ESA – ESAC Villa Franca

Urban

Growth

1990

2000

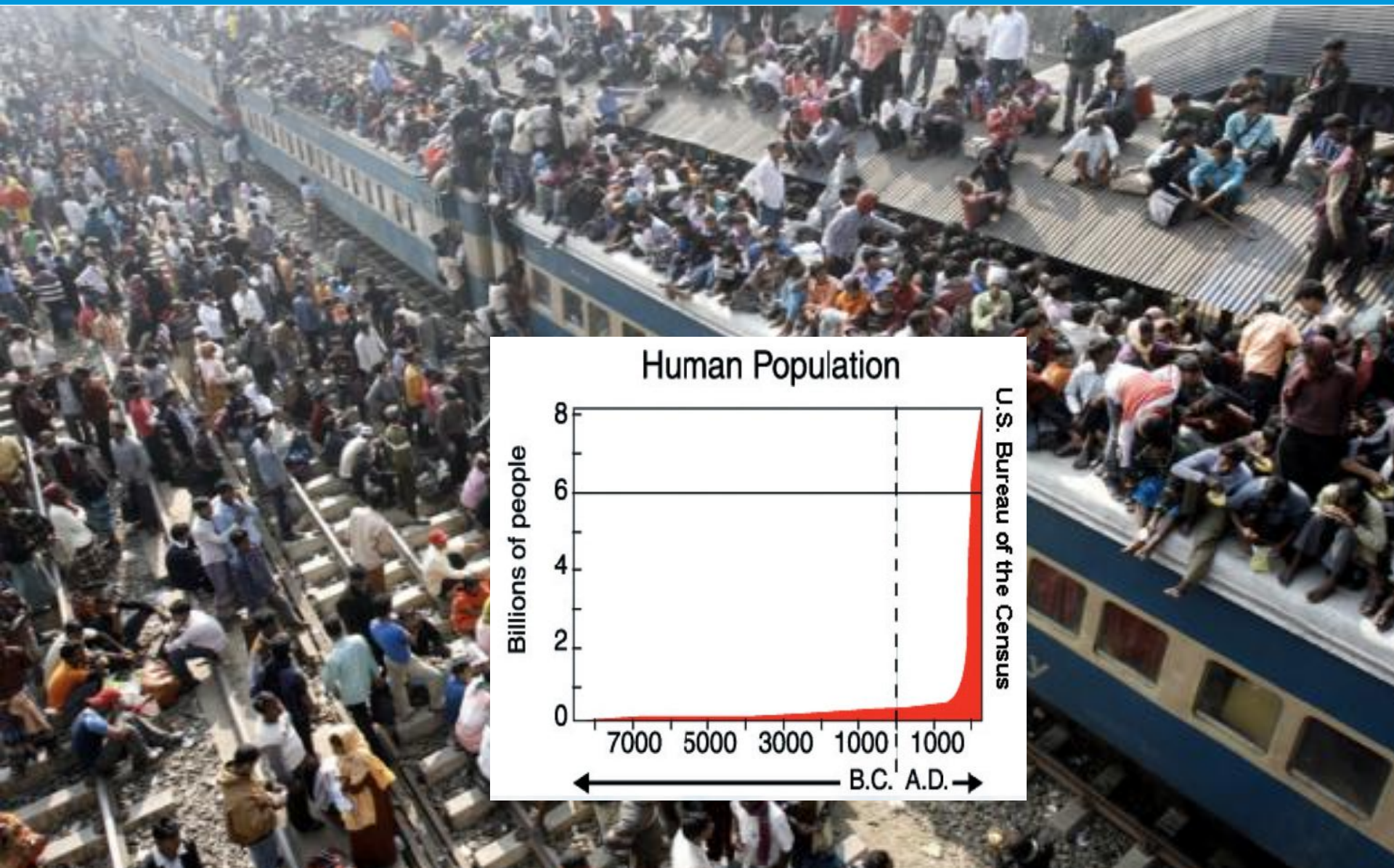


Shanghai

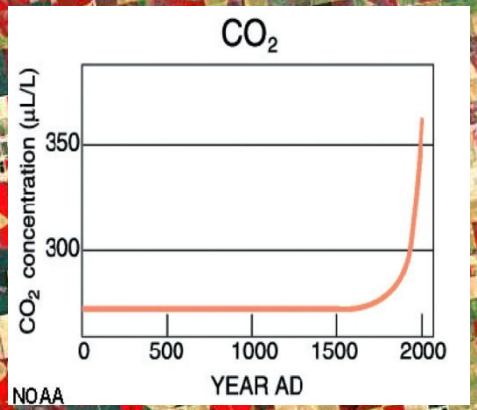
European Space Agency

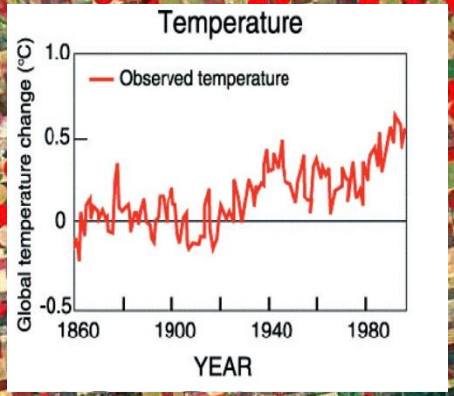
ESA UNCLASSIFIED – For Official Use

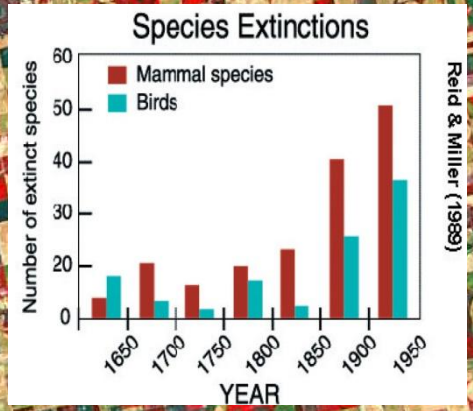
Do we still have a doubt on the environmental impact of the Human factor ?

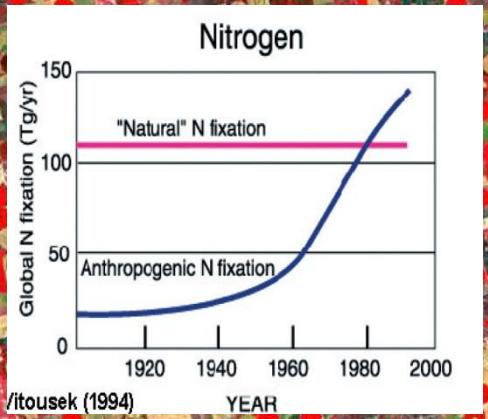


Do we still have a doubt on the impact of the Human factor ?





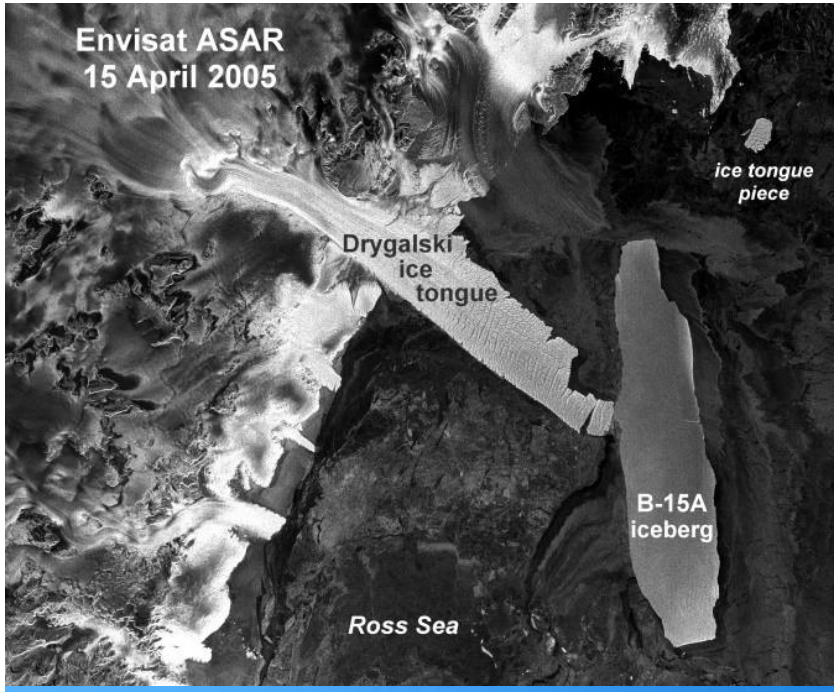




Climate change

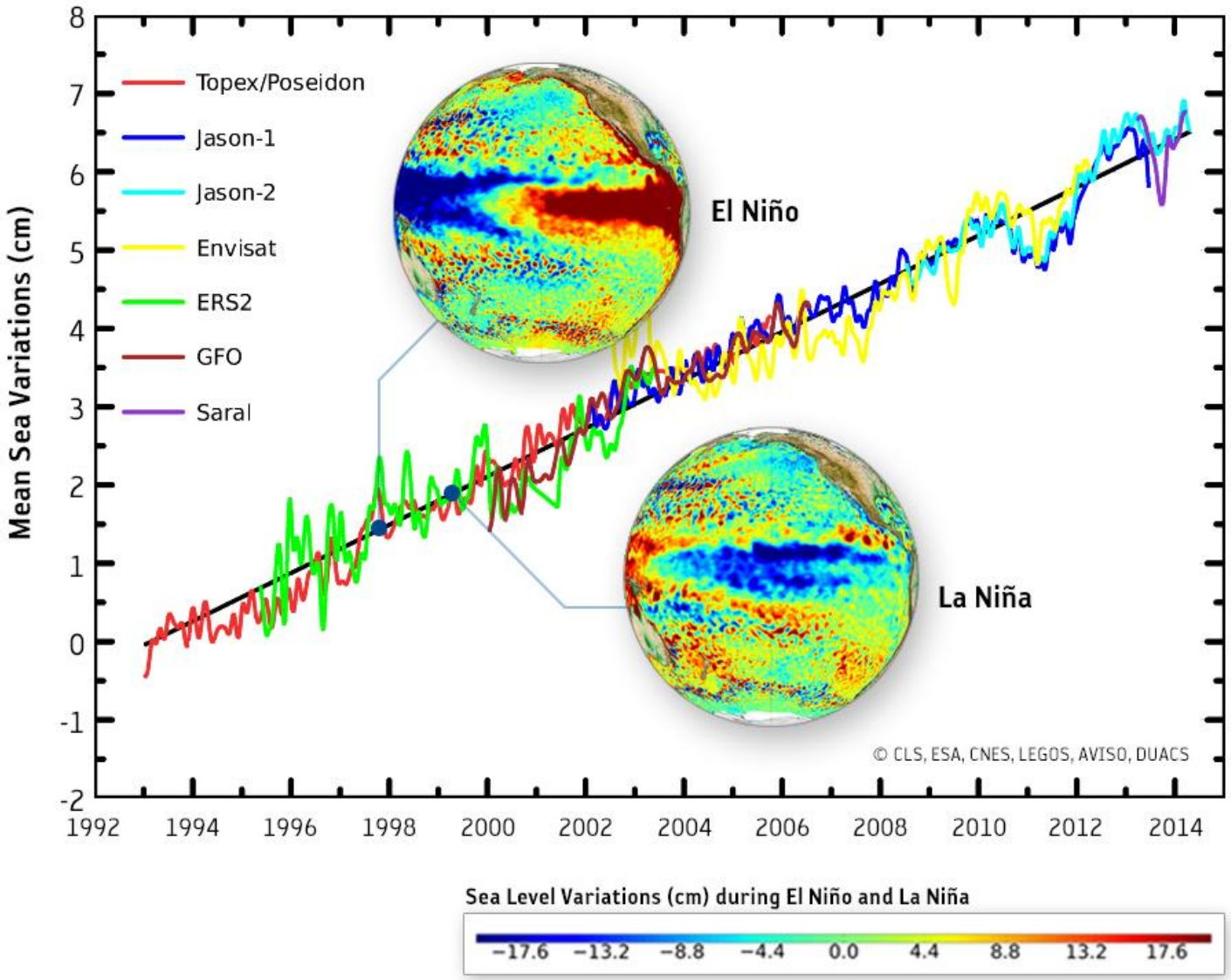
Global temperature increase between + 2.4 and 6.4 degrees until 2100

- **Arctic:** ice-free by 2nd half of 21st C.
- **Sea level rise:** up to 26-59 cm until 2100
- **Gulf Stream:** weakened
- **Precipitation:** decrease in arid regions and increase in wet areas
- **Storms:** significantly stronger
- **Greater unpredictability** of seasonal climate
- **Permafrost:** up to 90% melting until 2100



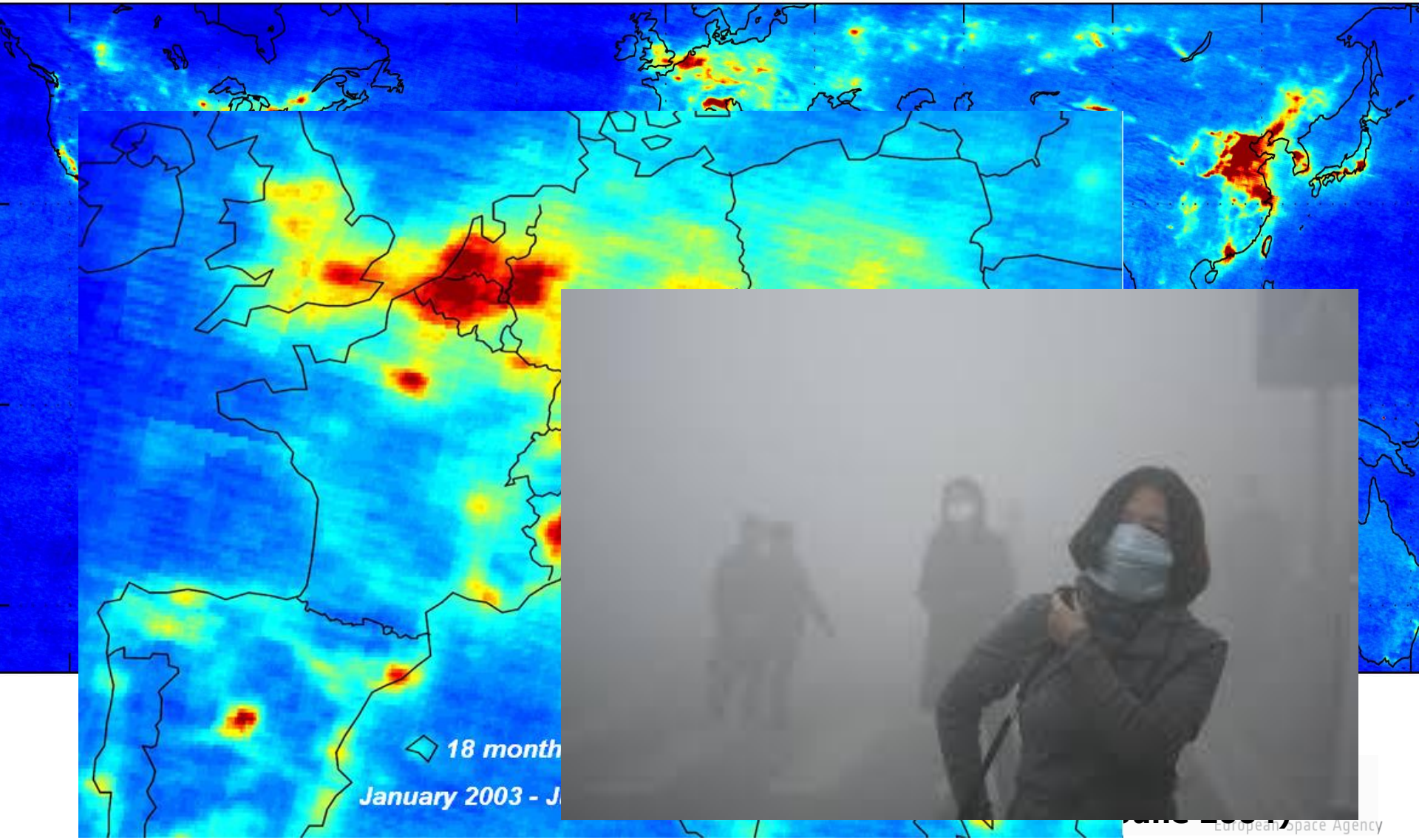
ESA UNCLASSIFIED – For Official Use

Rising Sea Levels



Average value:
3.1 mm/year
(CCI)

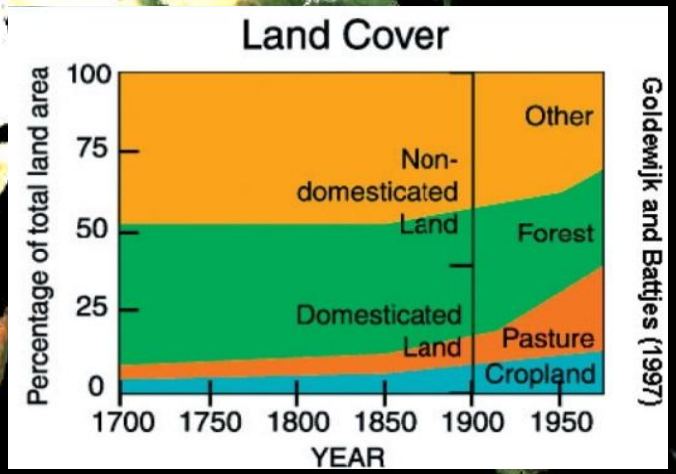
Air quality – NO2



Food Security – doubling food supply in 30 years

Earth: 71% Ocean, 29% Land Masses

Land (without Antarctica):
22% Deserts, Ice, Snow
13% Others (Urban,…)
28% Forests
25% Grazing
12% Crops



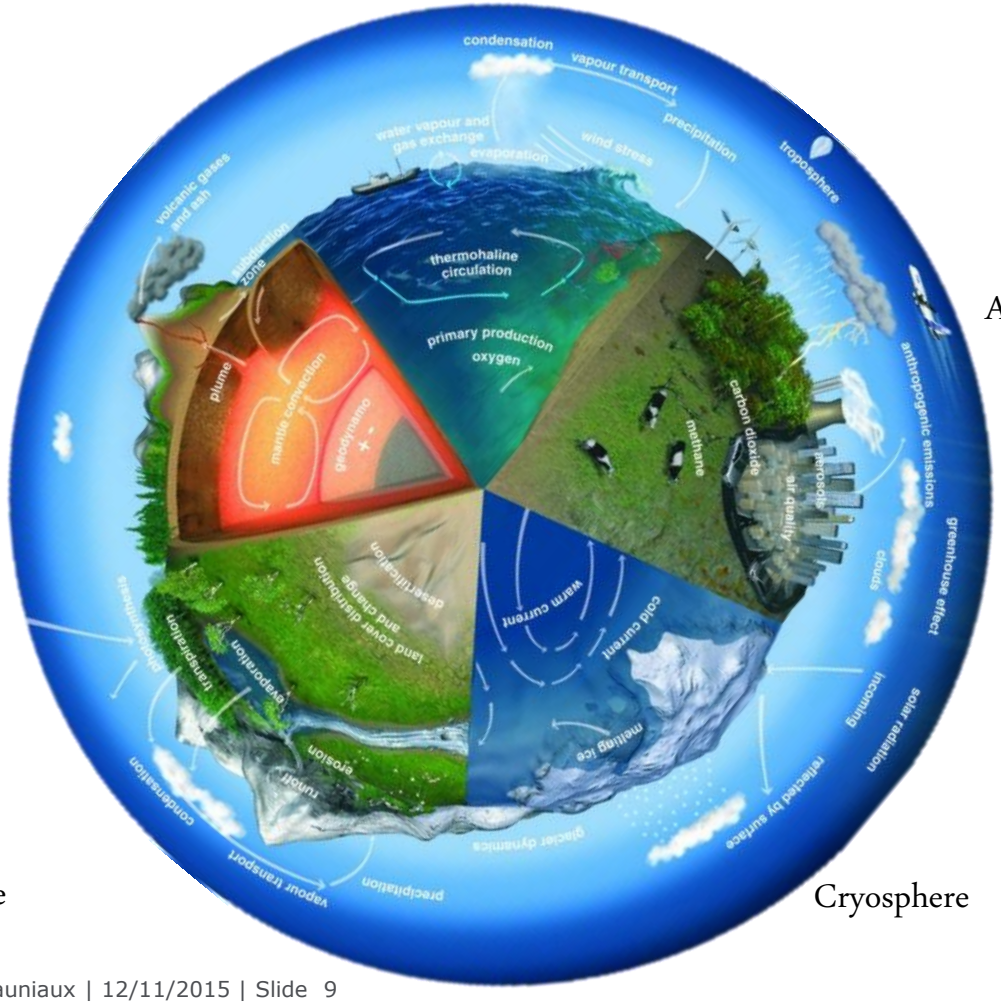
99% of our food calories are obtained from 37% of our land

Source: FAO "The State of the World's Land and Water Resources for Food and Agriculture", 2011 (adapted)

A complex (coupled) Earth System …

Ocean

Solid Earth



Atmosphere

Land Surface

Cryosphere

ESA UNCLASSIFIED – For Official Use

What about other risks ?

Not only Environnemental risks need to be considered…

- Polution, epedimic, pandemic
- Food scarcity

- Natural disasters

- Geopolitics (conflicts) and societal instability
- Security
  - Terrorism & Criminality
  - Cyber & Direct Espionage

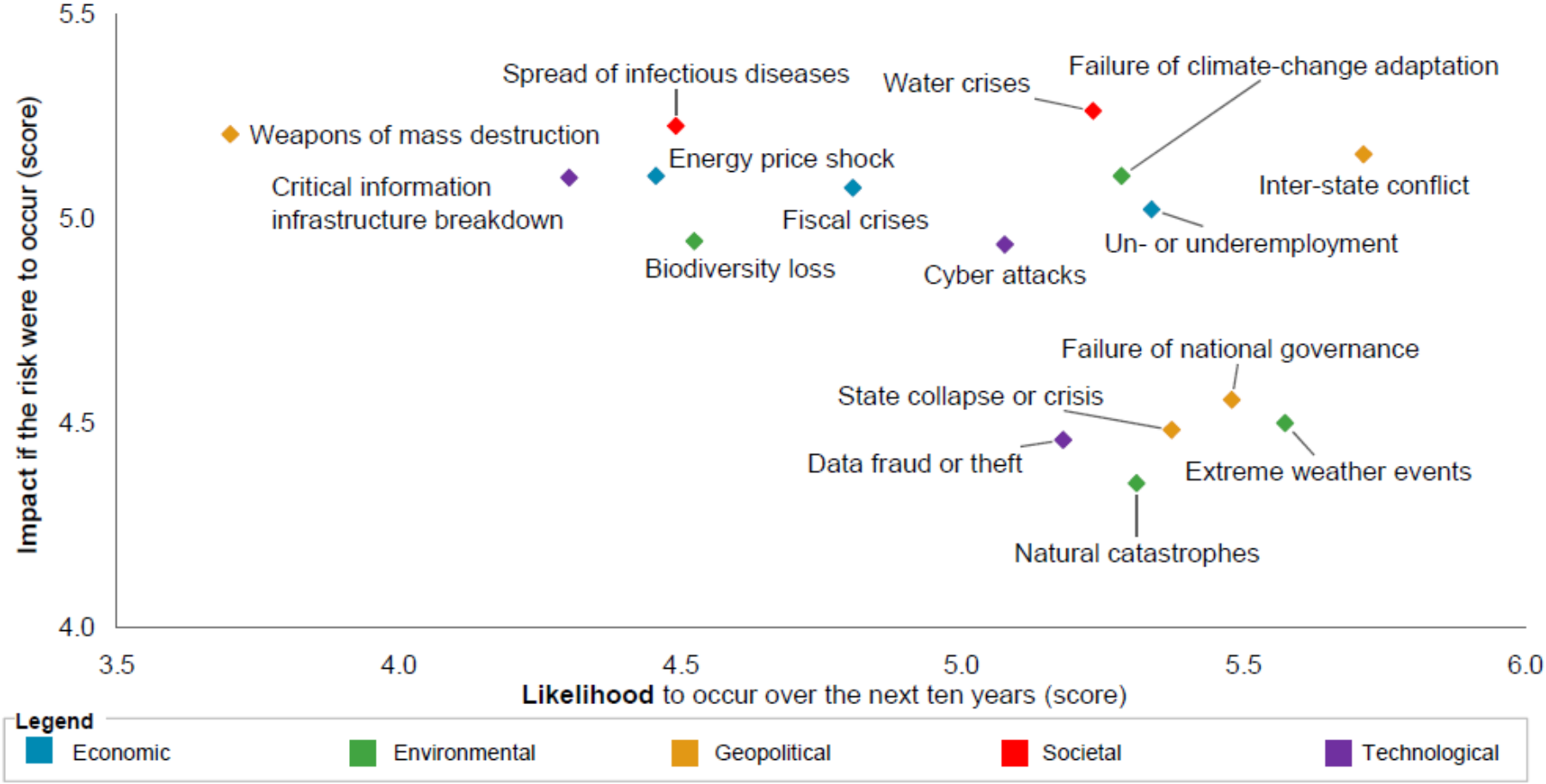
- Economical & Financial

- Legal, Image, …

ESA UNCLASSIFIED – For Official Use

Global Risks 2015

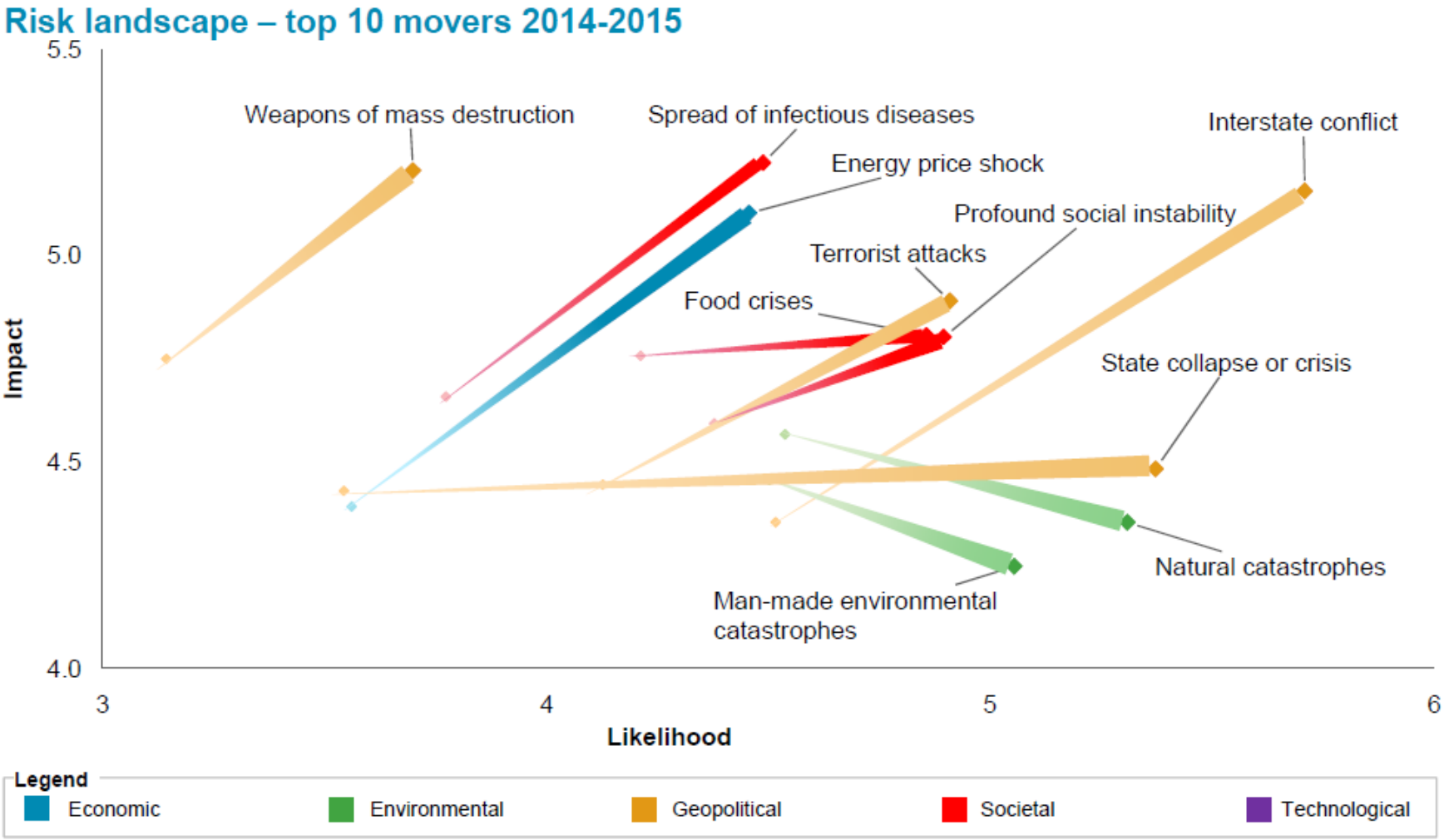
Risk landscape – top risks[1]



Source: World Economic Forum, *Global Risks 2015*
1 Top 10 risks in terms of impact and the top 10 risks in terms of likelihood. 4 Risks rank in the top 10 in terms of both impact as well as likelihood.
Note: Respondents were asked to rate each risk based on its impact and likelihood on a scale from 1 to 7

ESA UNCLASSIFIED – For Official Use

2014 -> 2015 trend



Source: World Economic Forum, *Global Risks 2015*

ESA UNCLASSIFIED – For Official Use

Short term to mid term scope evolution

Risks of highest concern – by time period

Rank	Next 18 months	Rank	10-year horizon
1	Inter-state conflict with regional consequences	1	Water crises
2	State collapse or crisis	2	Failure of climate change adaption
3	High structural un- or underemployment	3	Profound social instability
4	Failure of national governance	4	Food crises
5	Large-scale terrorist attacks	5	Extreme weather events
6	Large-scale cyber attacks	6	High structural un- or underemployment
7	Profound social instability	7	Large-scale cyber attacks
8	Rapid and massive spread of infectious diseases	8	State collapse or crisis
9	Extreme weather events	9	Major biodiversity loss and ecosystem collapse
10	Fiscal crises in key economies	10	Failure of national governance

Legend

Economic | Environmental | Geopolitical | Societal | Technological

Source: World Economic Forum, *Global Risks 2015*

ESA UNCLASSIFIED – For Official Use

Different Geographical concerns and challenges

North America

1. Failure of critical infrastructure
1. Large-scale cyber attacks
3. Failure of climate change adaption

Europe

1. Structural un- or underemployment
2. Large-scale involuntary migration
3. Profound social instability

MENA, Central Asia and Russia

1. Water crises
2. Inter-state conflict
3. Profound social instability

LatAm and Caribbean

1. Profound social instability
2. Failure of urban planning
3. Failure of national governance

Sub-Saharan Africa

1. Structural un- or under-employment
2. Food crises
3. Spread of infectious diseases

S. Asia, E. Asia, and the Pacific

1. Inter-state conflict
2. Failure of urban planning
3. Man-made environmental catastrophes

Legend

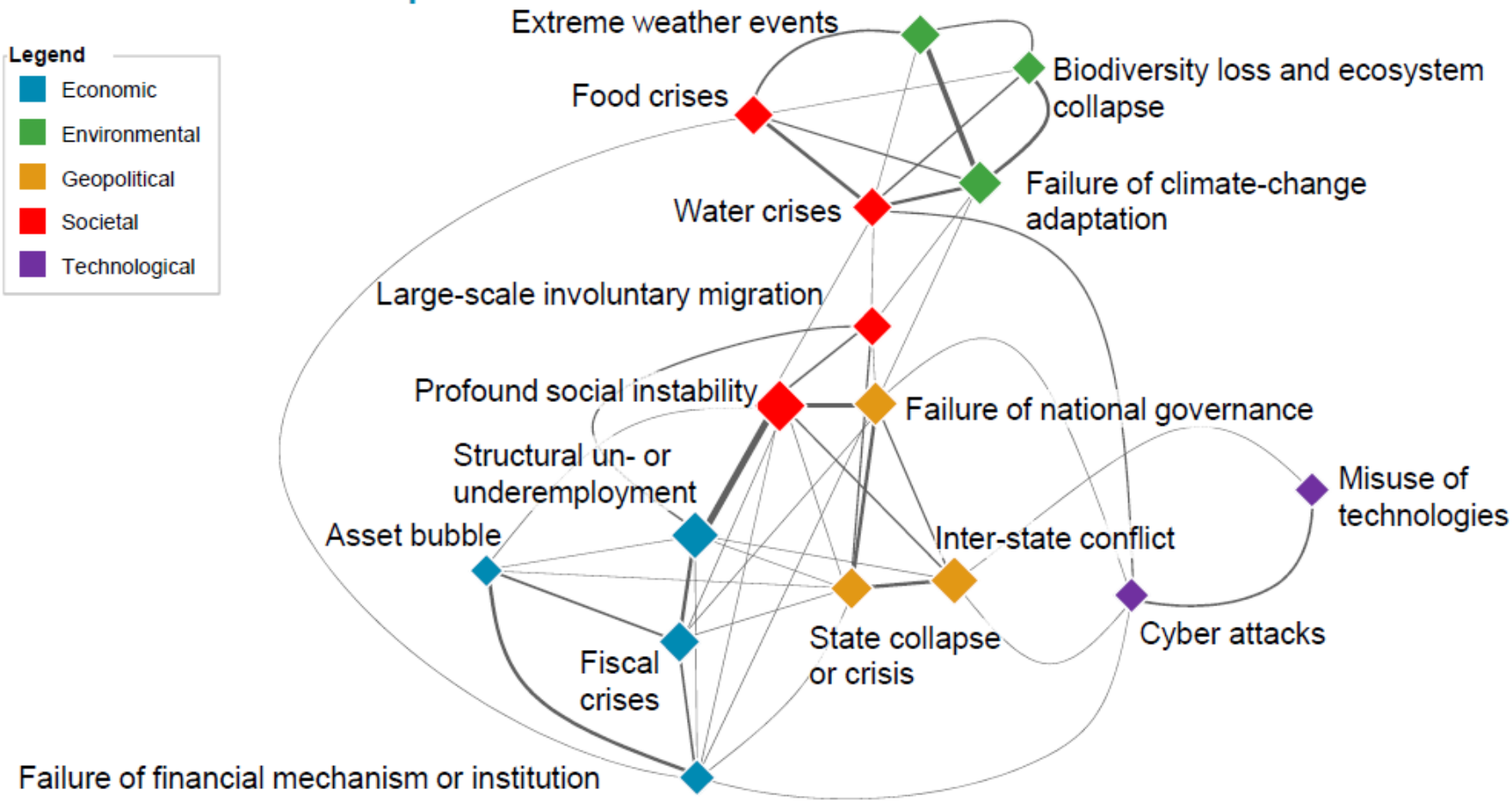
Economic | Environmental | Geopolitical | Societal | Technological

Source: World Economic Forum, *Global Risks 2015*

ESA UNCLASSIFIED – For Official Use

Social instability lies at the center

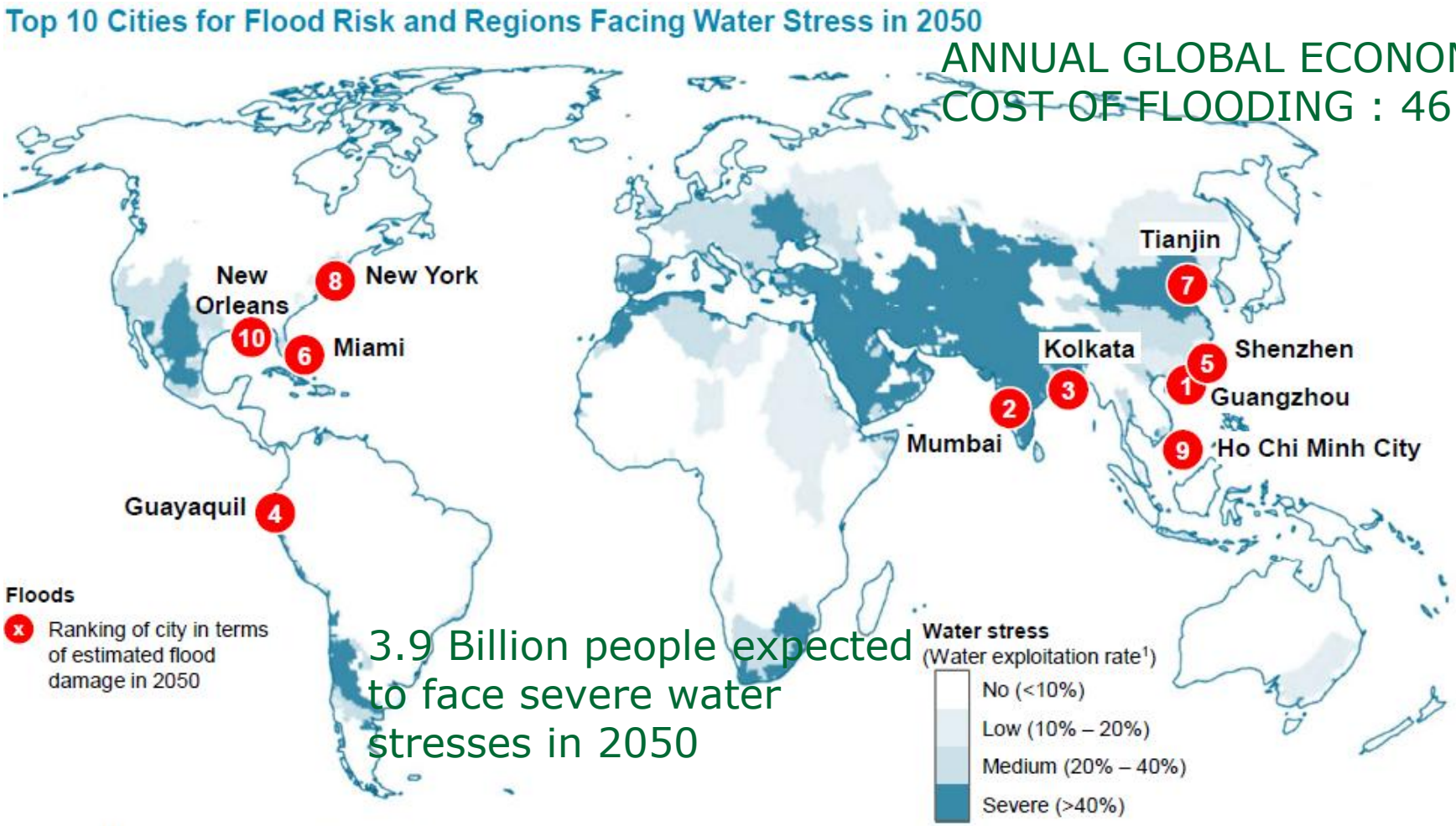
Risk interconnection map 2015



Source: World Economic Forum, *Global Risks 2015*

ESA UNCLASSIFIED – For Official Use

Water stresses and flooding



ANNUAL GLOBAL ECONOMIC COST OF FLOODING : 46 M$

3.9 Billion people expected to face severe water stresses in 2050

Source: World Bank, OECD and others (2013), OECD (2012)

1 The water exploitation rate is the average annual fresh water demand from river basins compared to the annual average amount of water available

ESA UNCLASSIFIED – For Official Use

Which response ?

The methodoly is known

Likelyhood	Consequences				
	Insignificant *Risk is easily mitigated by normal day to day process*	Minor *Delays up to 10% of Schedule* *Additional cost up to 10% of Budget*	Moderate *Delays up to 30% of Schedule* *Additional cost up to 30% of Budget*	Major *Delays up to 50% of Schedule* *Additional cost up to 50% of Budget*	Catastrophic *Project abandoned*
Certain *>90% chance*	High	High	Extreme	Extreme	Extreme
Likely *50% - 90% chance*	Moderate	High	High	Extreme	Extreme
Moderate *10% - 50% chance*	Low	Moderate	High	Extreme	Extreme
Unlikely *3% - 10% chance*	Low	Low	Moderate	High	Extreme
Rare *<3% chance*	Low	Low	Moderate	High	High

- Risks Assesment and Mitigation actions
- Emergency Preparedness,
- Crisis Management,
- Disaster Recovery plan,
- Business Continuity plan.

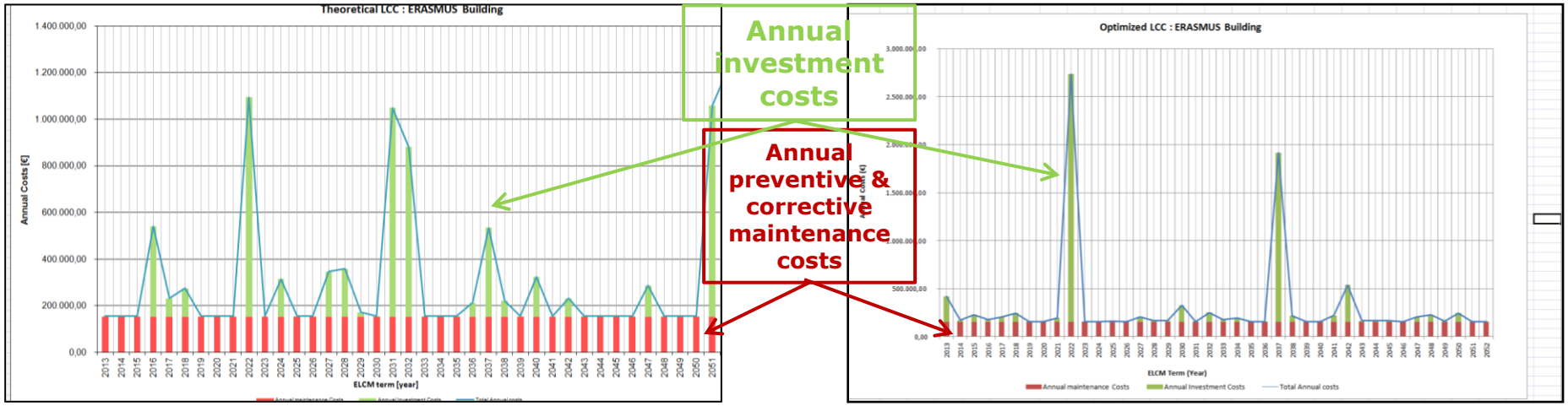
ESA UNCLASSIFIED – For Official Use

ESA approach

- ✓ ESA societal contribution by its Space programs and activities :
  - ✓ Earth Observation, Telecom, Technology development, …
  - ✓ Lobying and networking, …
- ✓ ESA own operations at all sites:
  - ✓ Environmental risks assessment and EMS (ISO 14001)
  - ✓ Health and Safety risks assessment and HSMS (OHSAS 18001)
  - ✓ Crisis Management structure
  - ✓ Security Threat assessment
  - ✓ Estate Life Cycle Management
  - ✓ Energy management (ISO 50001) and SD initiatives
  - ✗ Disaster Recovery plan,
  - ✗ Business Continuity plan.

ESA UNCLASSIFIED – For Official Use

Estate Life Cycle Management



Methodology based on :

- 15 years cycle for major investments and 60 years life time.
- Regular building/equipment condition assessment audits.
- Compliance with IPSAS 17.

Allowing ESA to prioritize investment proposal for infrastructure renewal.

ESA UNCLASSIFIED – For Official Use

For each ESA site a mapping of the risk

Class - NACE codes	Risk Management	Passive Protection	Occupancy Related Hazards	Human Element	Active Protection	Surveillance	Third Party Exposure	BI Exposure	Fire Vulnerability
3 - 7200a	Above Standard	Standard	Above Standard	Above Standard	Below Standard	Standard	Low	Moderate	41
3 - 6300	Above Standard	Standard	Above Standard	Above Standard	Below Standard	Standard	Low	Moderate	41
3 - 6300	Above Standard	Standard	Above Standard	Standard	Standard	Above Standard	Low	Moderate	31
3 - 6000	Above Standard	Below Standard	Above Standard	Above Standard	Poor	Standard	Low	Moderate	58
3 - 6300	Above Standard	Standard	Above Standard	Standard	Below Standard	Standard	Low	Moderate	44
2 - 8200b	Standard	Standard	Standard	Standard	Below Standard	Standard	Low	Low	58
3 - 6000	Above Standard	Above Standard	Above Standard	Above Standard	None	Above Standard	Low	Moderate	51
3 - 6000	Standard	Standard	Standard	Below Standard	None	Standard	Moderate	Moderate	81
3 - 7200a	Above Standard	Standard	Above Standard	Above Standard	None	Standard	Low	Moderate	60
3 - 6000	Above Standard	Below Standard	Standard	Above Standard	Standard	Standard	Low	Moderate	37
3 - 6000	Standard	Standard	Standard	Below Standard	None	Standard	Low	Moderate	80
3 - 6000	Standard	Standard	Standard	Below Standard	None	Standard	Low	Low	78
3 - 6000	Standard	Below Standard	Standard	Standard	None	Standard	Moderate	Moderate	82
2 - 7200a	Above Standard	Below Standard	Above Standard	Standard	None	Above Standard	Low	Moderate	51
4 - 5210h 5210h	Standard	Standard	Below Standard	Standard	None	Below Standard	Moderate	Low	100

ESA at a glance

headquarters
Located in Paris, home to the main programme directorates that steer and formulate ESA policy.

estec
The European Space Research and Technology Centre, Noordwijk, the Netherlands, is the largest site and the technical heart of ESA.

esoc
The European Space Operations Centre, Darmstadt, Germany, tracks and controls European spacecraft.

esrin
ESA's centre for Earth observation activities, near Rome, Italy, also develops information systems and hosts the Vega launcher project.

eac
The European Astronaut Centre, Cologne, Germany, trains astronauts for missions to the International Space Station and beyond.

esac
The European Space Astronomy Centre, near Madrid, Spain, hosts the science operation centres and archives for ESA's astronomy and planetary missions.

redu
Redu Centre in Belgium is part of ESA's ground station network and is also home to ESA's Space Weather Data Centre.

harwell
Harwell Centre, in Oxfordshire, UK, is focusing on commercialisation and partnerships in space activities.

guiana space centre
ESA's launchers lift off from Europe's Spaceport in Kourou, French Guiana. It is jointly operated by the French space agency (CNES) and Arianespace with the support of European industry.

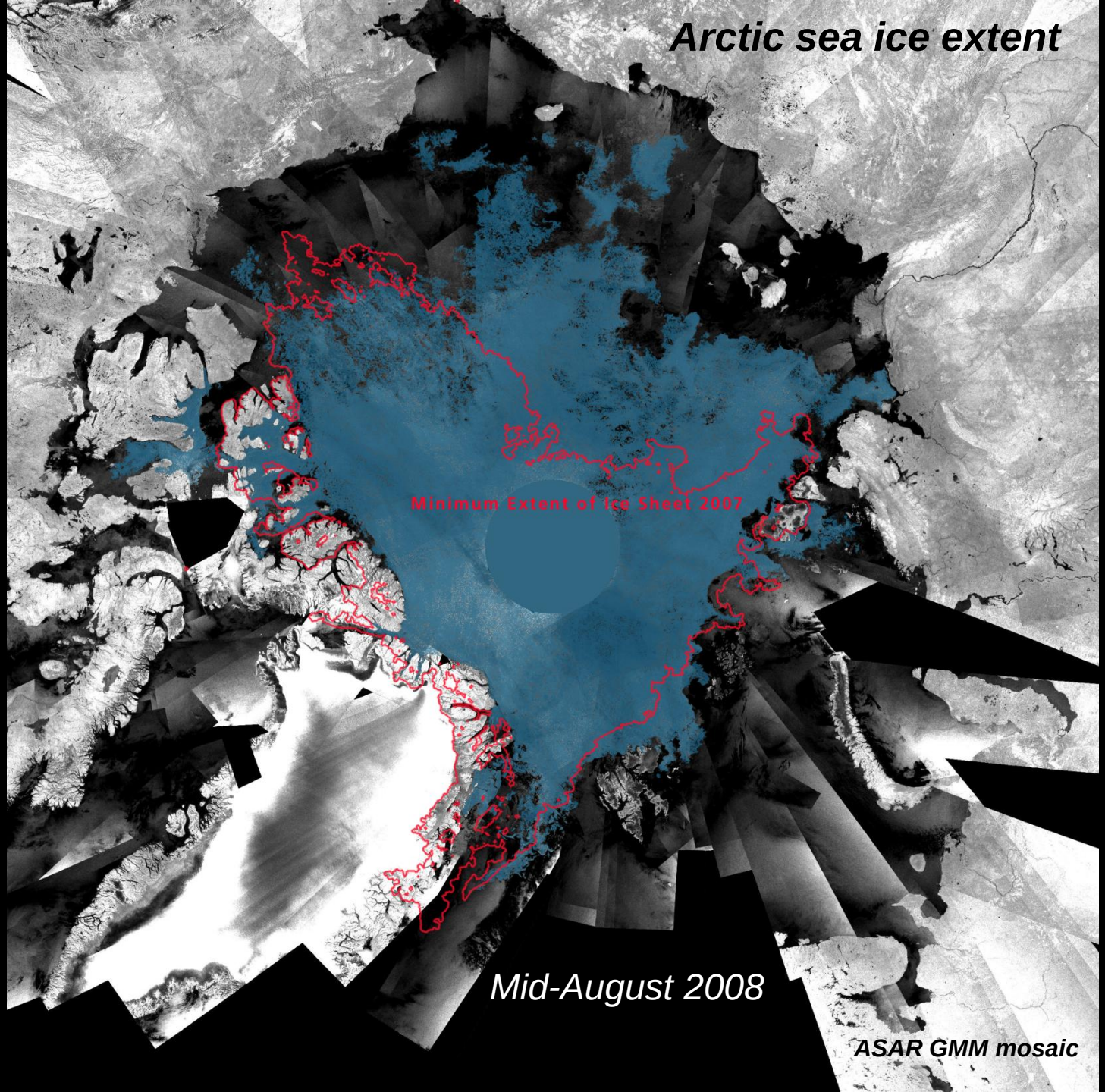
More premises:
- **Liaison offices** : Brussels, Washington, Moscow
- **Ground stations :** Kiruna (Sweden), Cebreros (Spain), Kourou (French Guiana), Perth (Australia)…
- **Integrated teams :** Baltimore (NASA), Pasadena, (NASA), Toulouse (CNES)

More than 250,000 m^2 building surface

5000 on site employee

ESA UNCLASSIFIED – For Official Use

The Human factor is the issue


Arctic sea ice extent
Minimum Extent of Ice Sheet 2007
Mid-August 2008
ASAR GMM mosaic

Would you like to know more?

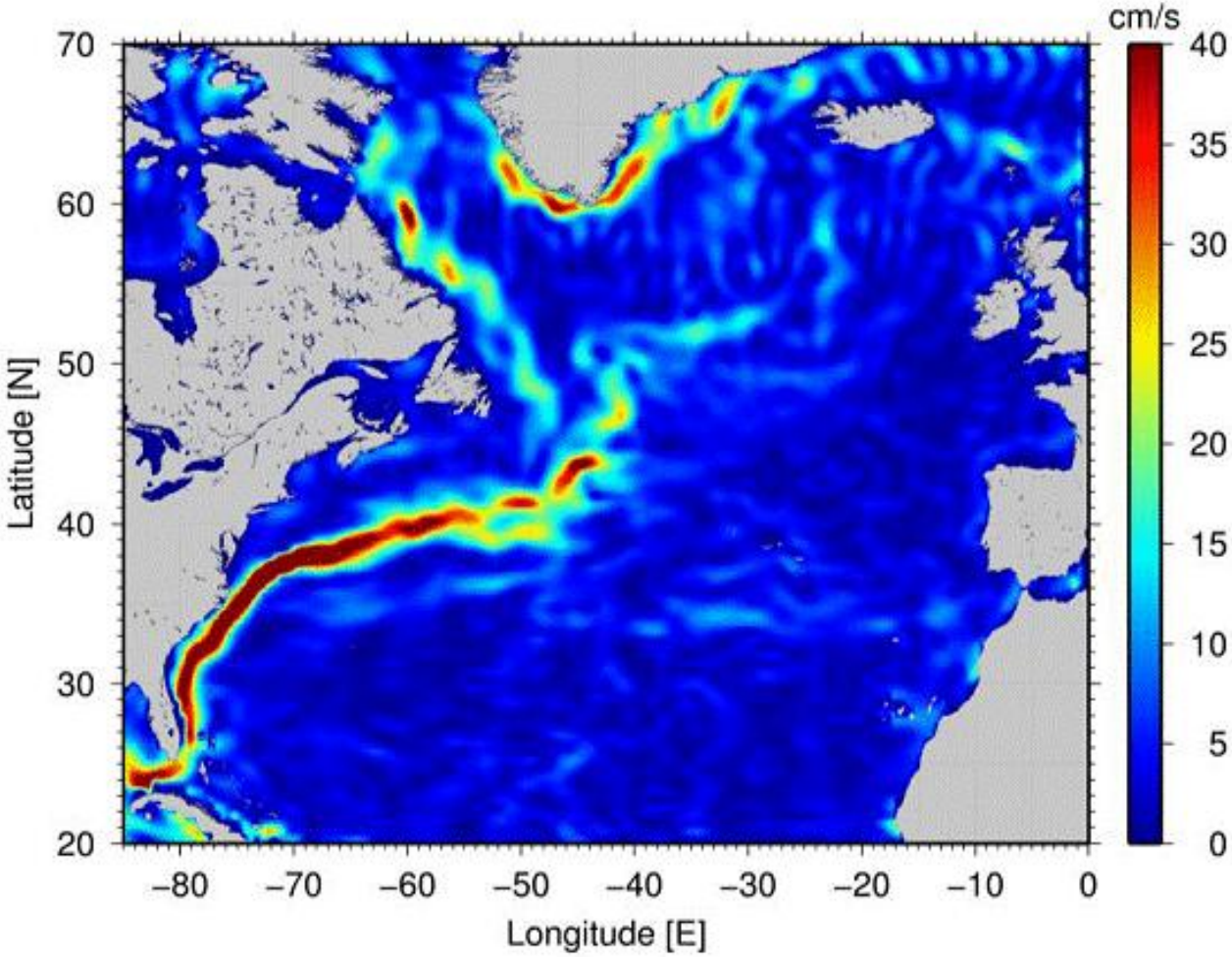
www.esa.int

COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE

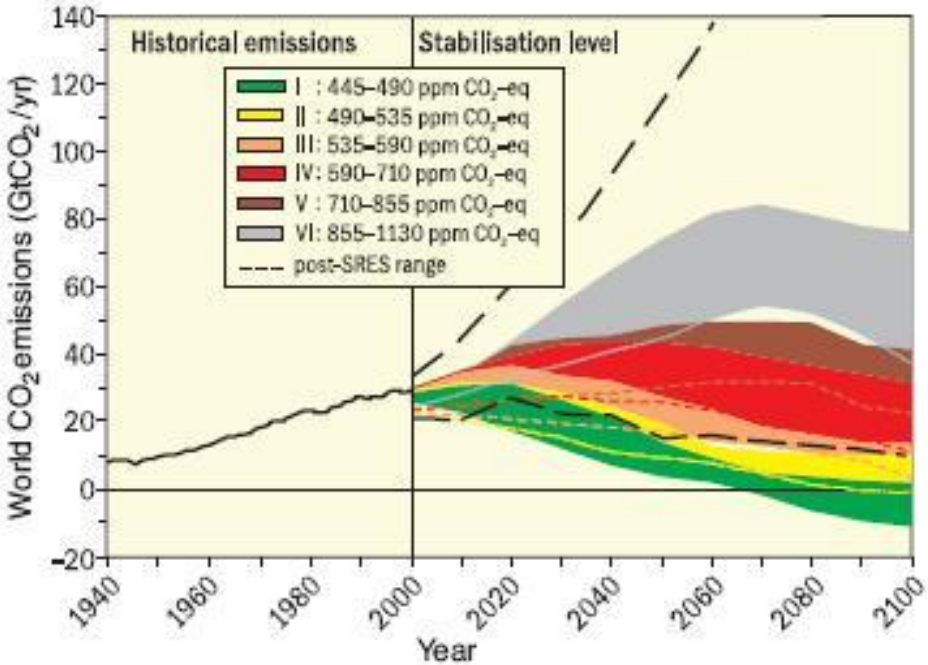
European Space Agency

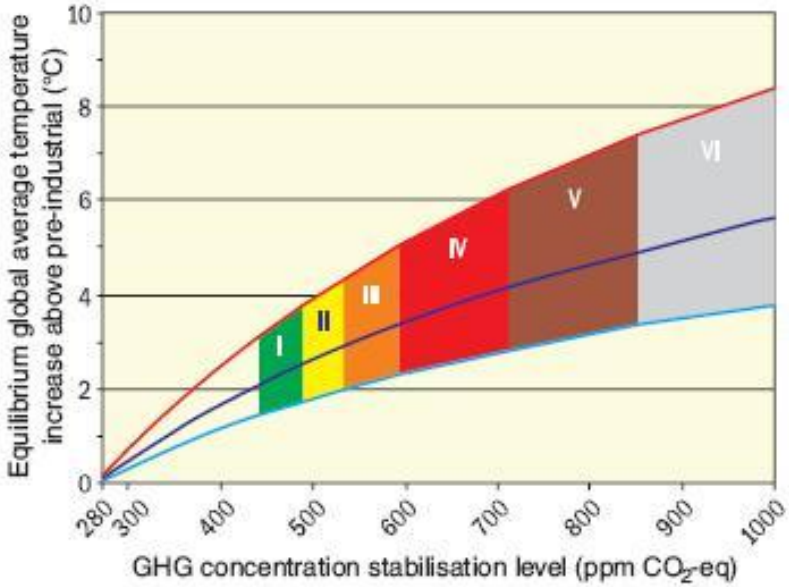
Rising Sea Levels … and Gulf Stream

Geostrophic surface velocities Gulf stream area from **GOCE** and altimetric-derived mean sea surface



Emission scenarios / stabilisation levels

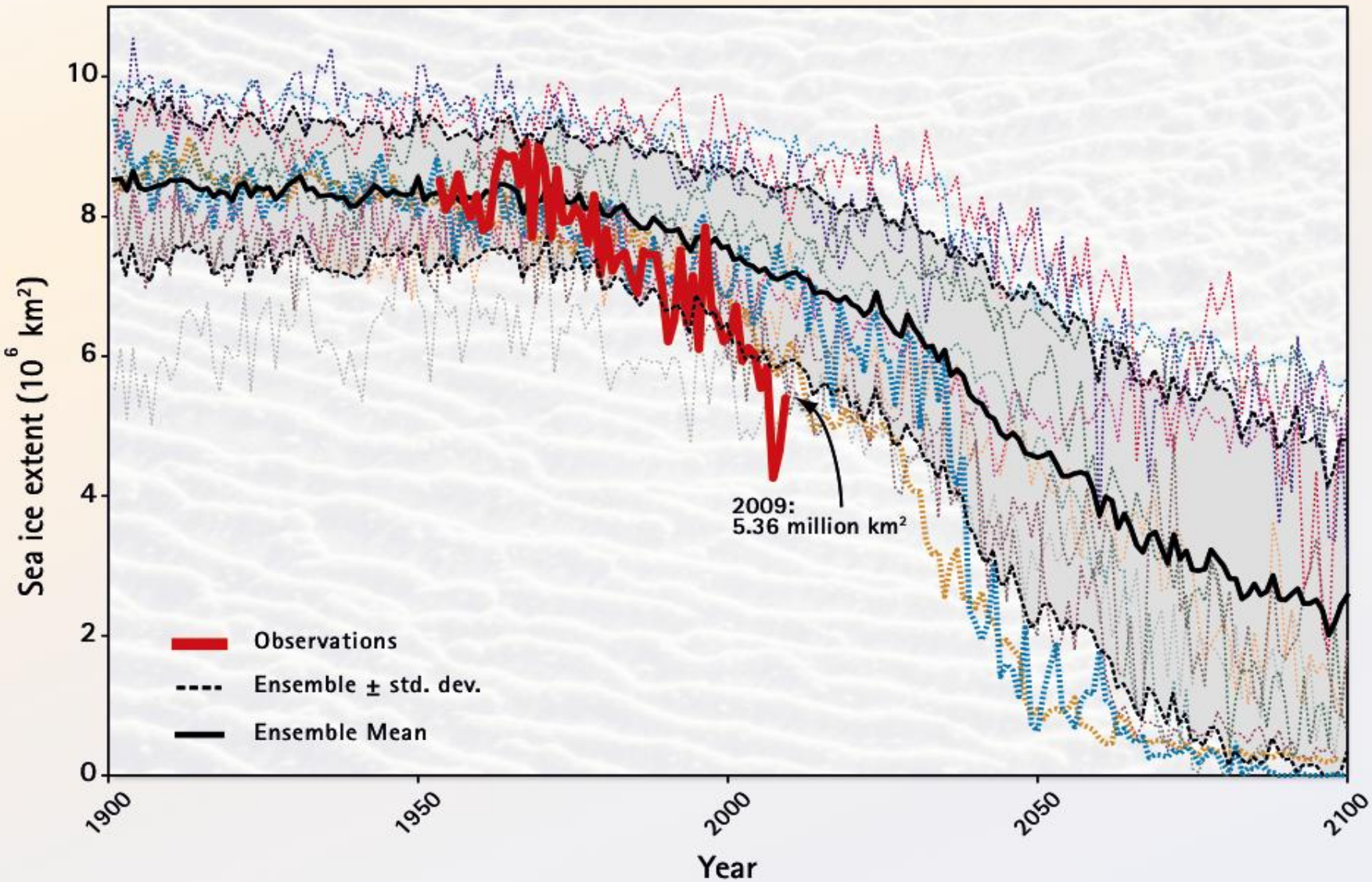
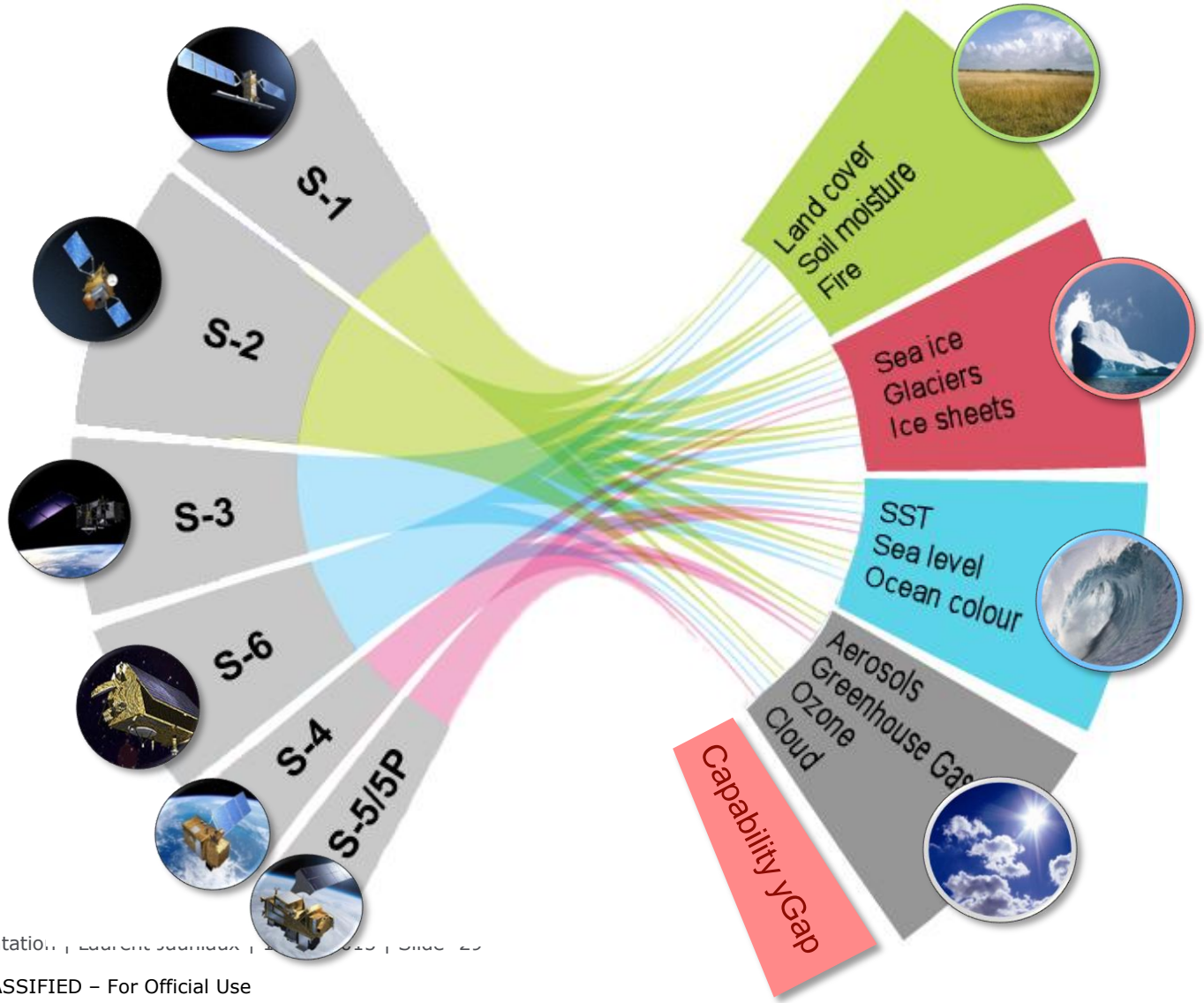




IPCC (2007) WG III, Figs. SPM.7,8

ESA UNCLASSIFIED – For Official Use

Discrepancy between sea ice extent models (IPCC) and satellite observations…



No single user served by a single mission → need for a 'space system architect'