



# **Space Technologies and Climate Change:**

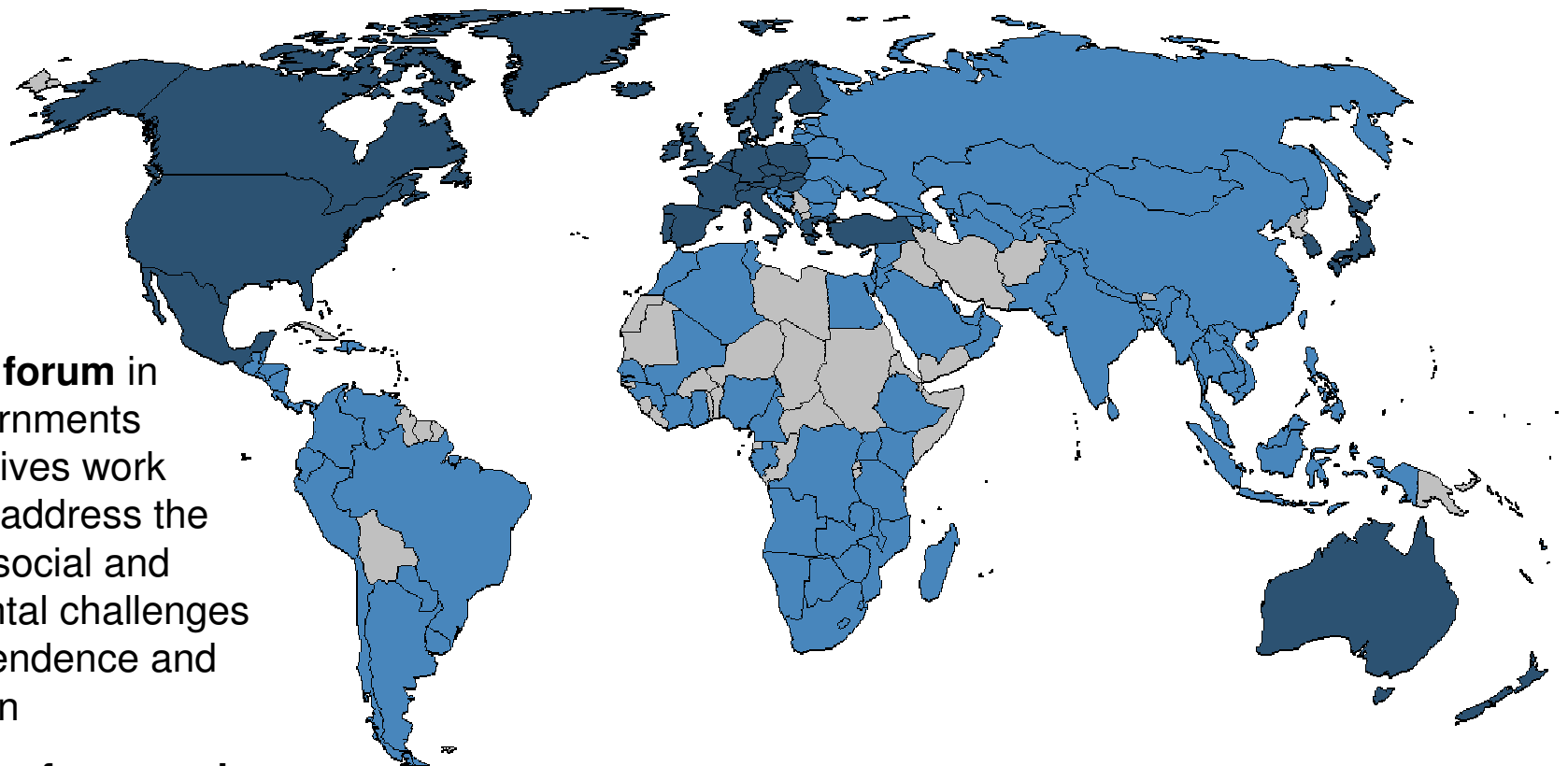
## **The Socio-Economic Angle**

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# The Organisation for Economic Co-operation and Development (OECD)

- **A global forum** in which governments representatives work together to address the economic, social and environmental challenges of interdependence and globalisation
- **A source of economic statistics** - provider of comparative data, analysis and forecasts to underpin multilateral co-operation ([www.oecd.org](http://www.oecd.org))



**OECD Member Countries**



**Countries/Economies Engaged in Working Relationships with the OECD**

# OECD and Space

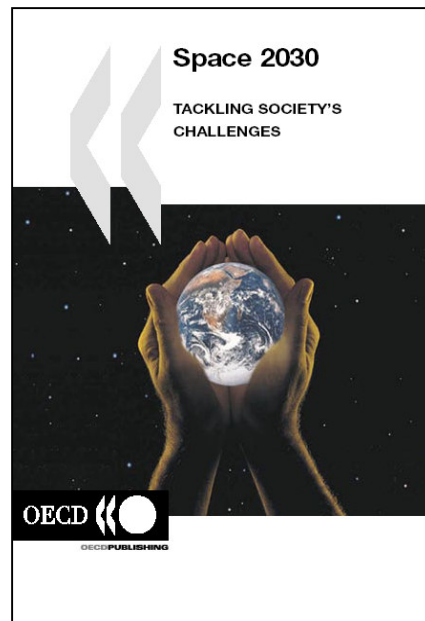
- **2002-2005: Futures Project on the Commercialisation of Space**
  - 25 participants from public and private space & non-space sectors, large consultation (+100 organisations)
  - Broad socio-economic demand-oriented approach( i.e. the demand for space services is derived from the need to finding solutions to society's challenges) and prospective study with long-term horizon at both national and international levels
  - Key recommendations on framework conditions
- **Since 2006: The OECD Forum on Space Economics**
  - Originally 9 organisations (ASI, BNSC, CNES, CSA, ESA, NASA, NOAA, Norwegian Space Centre, USGS) and GEO Secretariat (observer)
  - Mandate to better identify statistically the sector, and investigate its economic dimensions as an infrastructure for the larger economy

# OECD Publications on Space



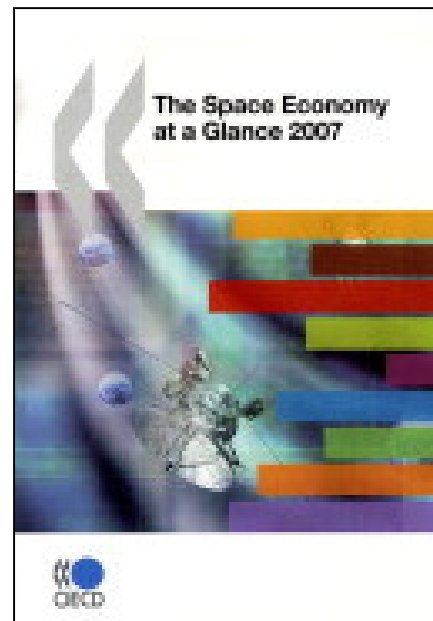
**2004**

**Prospective**



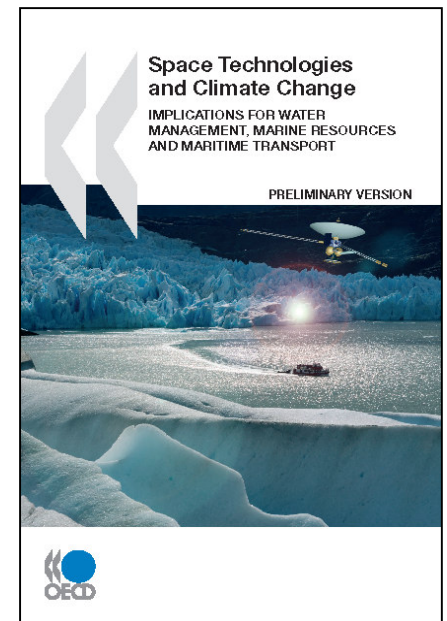
**2005**

**Policy  
Recommendations**



**2007**

**Economic  
Dimension**



**2008**

**Socio-Economic  
Contributions  
(Tool-Box)**

# Are there / will there be derived socio-economic contributions?

- ☐ A relatively recent issue... More usual question: is the mission carried out nominally?
- ☐ Impacts of activities derived from imperatives:
  - Strategic / military
  - Science
  - R&D and industrial competitiveness
  - Prestige
  - Profit
  - **Socio-economic contributions**

# Case Studies in the OECD Space Forum

- ❑ **Objective:** explore the broad economic and social dimensions of space applications & the larger space infrastructure
  
- ❑ **2 steps:**
  - ❑ Case study on fresh water management (2007)
  - ❑ Extension to **CLIMATE CHANGE** problematic + pragmatic case studies on marine resources & maritime transport (2008)
  
- ❑ **Publication's Theme:** Climate change context, with emphasis on three domains with exploration of socio-economic contributions:
  - Fresh water management
  - Marine resources
  - Maritime transport

# Results in the Publication

CHAPTER 1. CLIMATE CHANGE: TRENDS AND OUTLOOK

CHAPTER 2. FRESH WATER MANAGEMENT: TRENDS AND OUTLOOK

CHAPTER 3. MARINE RESOURCES AND MARITIME TRANSPORT: TRENDS  
AND OUTLOOK

CHAPTER 4. CAPABILITIES OF SPACE TECHNOLOGIES

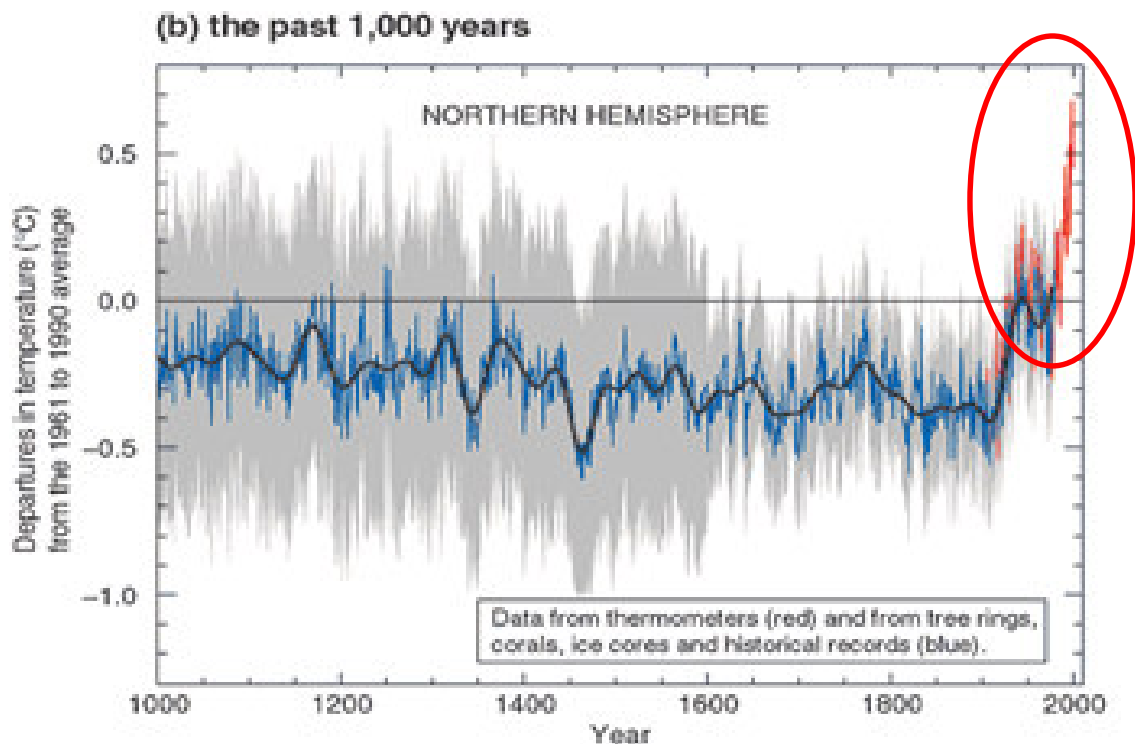
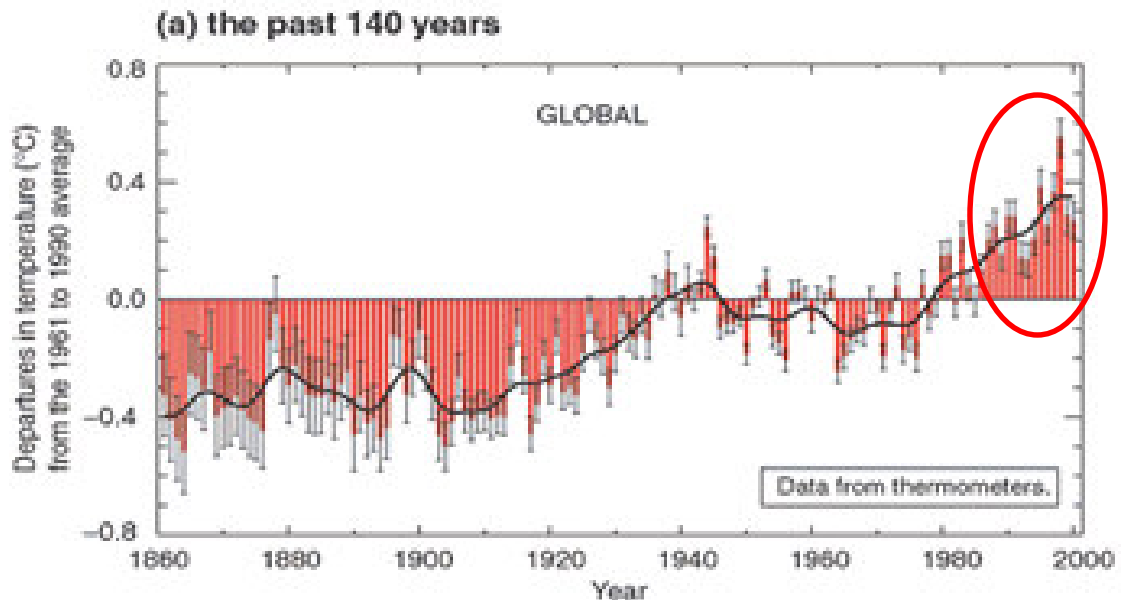
CHAPTER 5. OUTLOOK FOR SPACE TECHNOLOGIES

CHAPTER 6. TOOL-BOX FOR POLICY-MAKERS: COSTS, BENEFITS  
AND INVESTMENT DECISIONS

# Variations of Earth's Surface Temperature

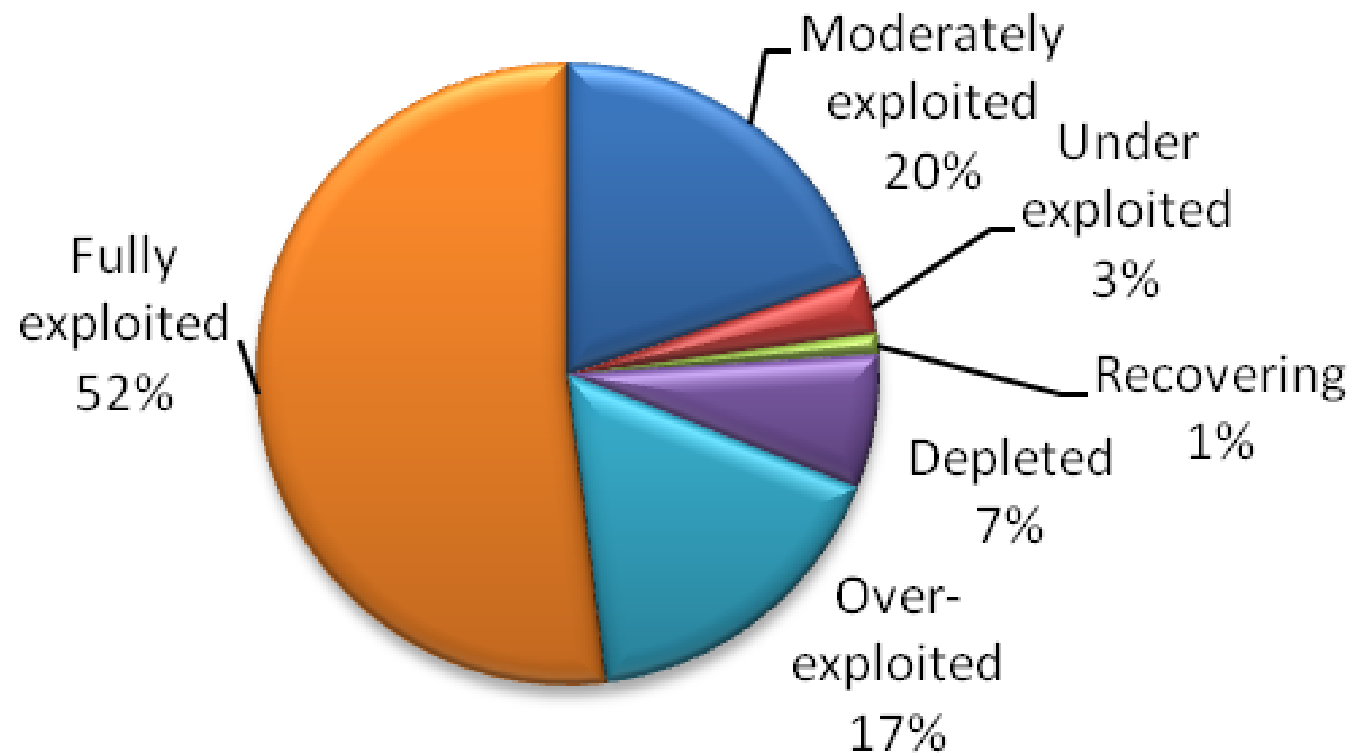
Climate change is a modification in long-term weather patterns, likely caused by greenhouse gases, which make the Earth warmer by trapping energy in the atmosphere.

Source: IPCC (2007)





## Management of Marine Resources: Status of World Fish Stocks in 2005



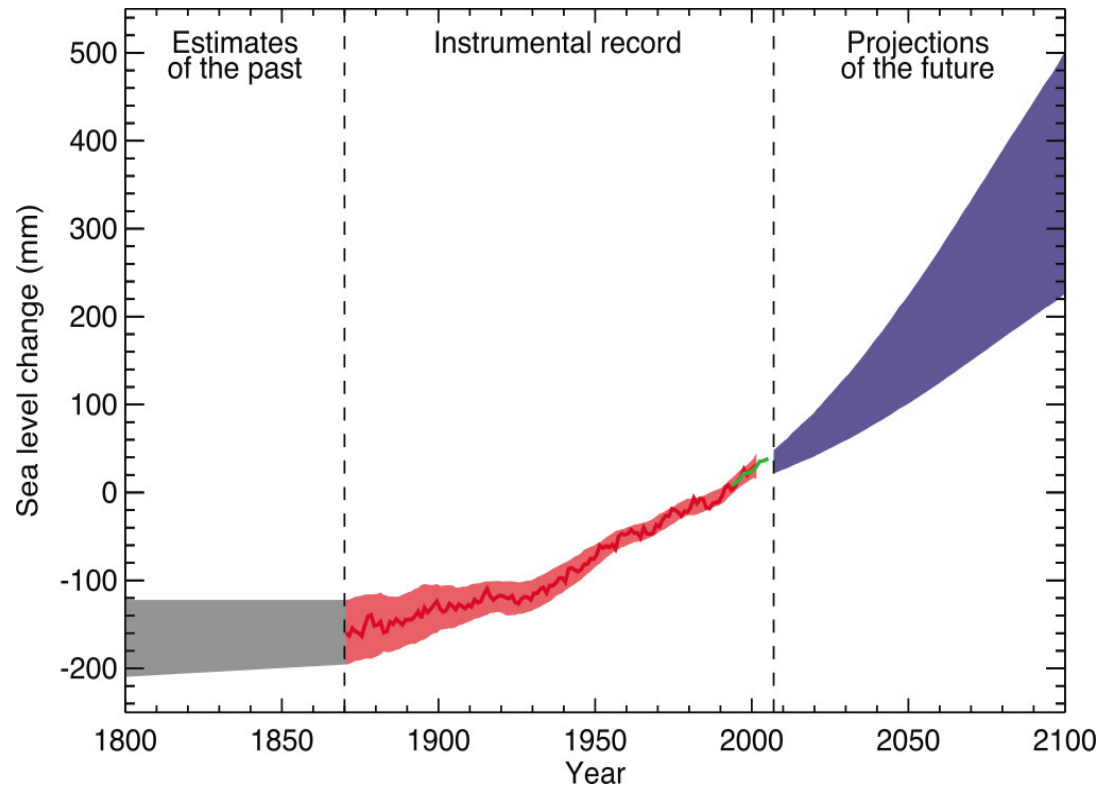
Source: Based on OECD/FAO (2007)

# **Demonstration of Usefulness: Essential Climate Variables (ECVs) and Their Dependence Upon Satellite Observations**

<b>Atmospheric</b> (over land, sea and ice)	<b>Surface:</b> Air temperature, <i>Precipitation</i> , Air pressure, Surface radiation budget, Wind speed and direction, Water vapour  <b>Upper-air:</b> <i>Earth radiation budget (including solar irradiance), Upper-air temperature (including MSU radiances), Wind speed and direction (especially over the oceans), Water vapour, Cloud properties</i>  <b>Composition:</b> <i>Carbon dioxide</i> , Methane, <i>Ozone</i> , Other long-lived greenhouse gases, <i>Aerosol properties</i>
<b>Oceanic</b>	<b>Surface:</b> <i>Sea-surface temperature</i> , Sea-surface salinity, <i>Sea level, Sea state, Sea Ice</i> , Current, <i>Ocean colour (for biological activity)</i> , Carbon dioxide partial pressure.  <b>Sub-surface:</b> Temperature, <i>Salinity</i> , Current, Nutrients, Carbon, Ocean tracers, Phytoplankton
<b>Terrestrial</b>	River discharge, Water use, Ground water, Lake levels, <i>Snow cover, Glaciers and ice caps</i> , Permafrost and seasonally-frozen ground, <i>Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), Biomass, Fire disturbance, Soil moisture</i>

Source: CEOS (2008)

# Key role: Contribute to Reduce Uncertainties About Trends



1. Need to close gaps in our knowledge (e.g., climate processes, state of resources)
2. Need to reduce uncertainty surrounding future projections

➤ **This will come at a cost, but will investments be forthcoming?**

# Set of Tools Available to Decision-Makers (OECD, 2008)

## 1. R&D PROGRAMMES' IMPACTS ANALYSIS

*Scientific returns* Quantifiable measure of publications

*Economic returns* Quantifiable parameters to try and link R&D intensity and economic activity (e.g. technology transfers)

## 2. "CLASSIC" RETURN ON INVESTMENT TECHNIQUES

*Key performance indicators* Quantifiable performance measures

*Cost-benefit analysis (CBA)* Measures tangible and intangible benefits and assesses these against costs

*Break-even analysis* The amount of time necessary for benefits to equal costs

*Transaction costs* Segmentation methods to calculate use and benefits to different user groups

*Cost-effectiveness* Marginal costs for achieving specific goals

*Net present value* The difference between the present value of cash inflows and outflows at a given discount rate

*Initial rate of return* The discount rate that makes net present value of all cash flows equal to zero

*Value assessment* A complex method that captures and measures factors unaccounted for in traditional return on investment (ROI) calculations

*Portfolio analysis* A complex method that quantifies aggregate risks relative to expected returns for a portfolio of initiatives

*Real options analysis* Analysis of capital investments in terms of the options they contain, with uncertainty accounted for by risk-adjusting probabilities ("equivalent martingale approach")

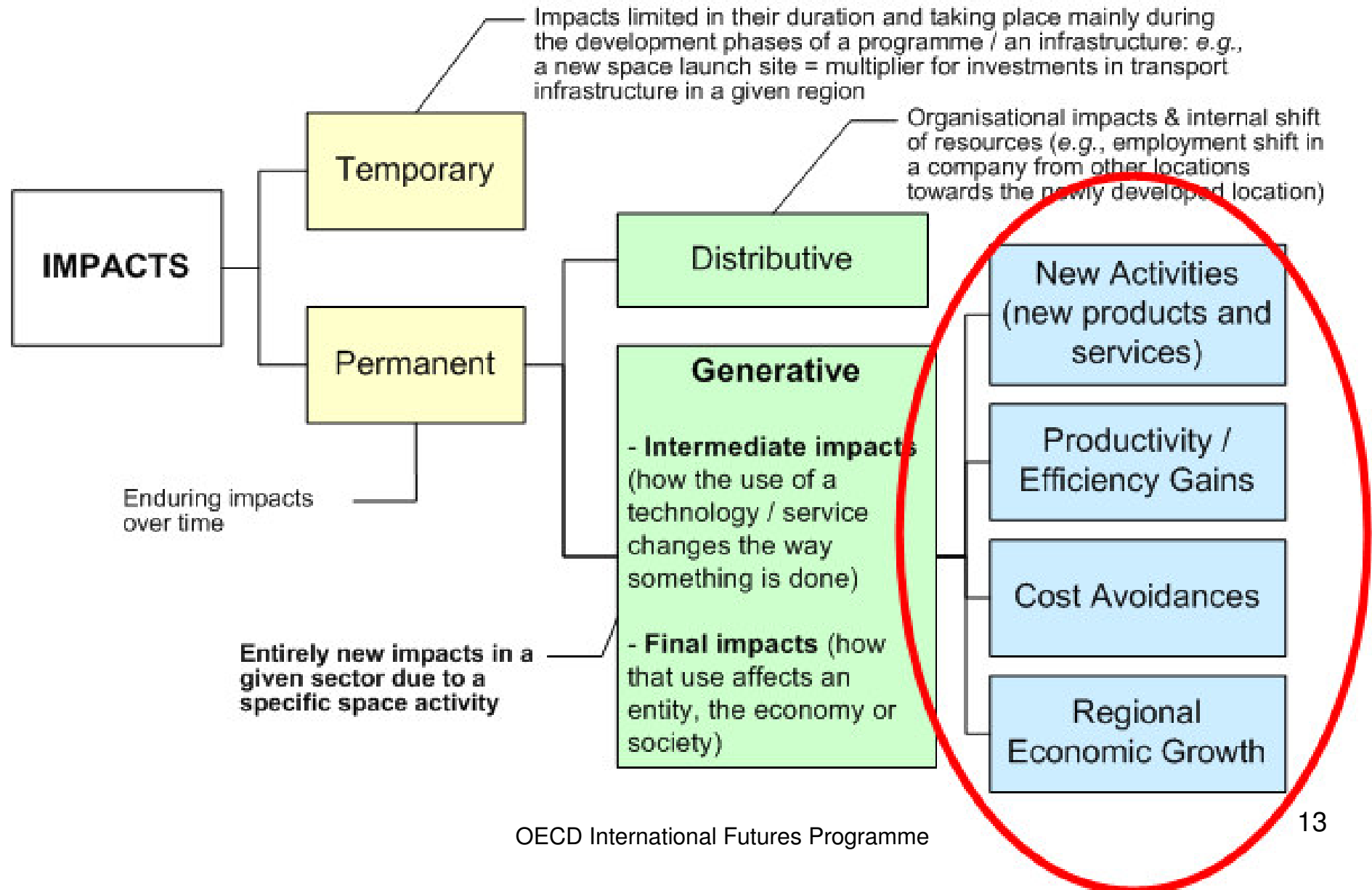
## 3. INFRASTRUCTURE APPROACH

Benchmarking investments in space systems against terrestrial infrastructure investments

## 4. RISK MANAGEMENT APPROACH

Addresses investments in satellite systems from the point of view of monitoring and mitigating major risks and reducing uncertainties

# Impacts of space-related applications



## **E.g. Productivity / Efficiency Gains**

- **Sea shipping transit-time**

Canada: Annual transit times savings of CAN 18 million because of improved routing information (radar imagery)

- **Fishing industry**

Australia fishing fleets: around 50% gains in efficiency since late 1980s, linked to use of GPS plotters

(in parallel improved surveillance of fishing activities)

## E.g. Productivity / Efficiency Gains

- **Control of Exclusive Economic Zones**
  - Ground receiving station installed on the French Kerguelen (South Indian Ocean) in early 2004 to acquire, process, and correlate data from Envisat and Radarsat with the fishing Vessel Monitoring System (authorised fishing ships in the area are required to carry onboard a detector), and followed up by ship patrol, to protect the local stocks from illegal fishing.
  - Since then, the surveillance system has cut the number of illegal fishing incursions in the vicinity of Kerguelen Island by nine-tenths by late 2005 and no illegal incursion was detected in 2007.

# **Additional Approaches for Investments Decisions (Focus on Earth Observation)**

- ☐ Infrastructure approach
  - ☐ Value for money comparisons with other infrastructure (roads, water, telecommunications, national statistical offices)
  
- ☐ Risk management approach
  - ☐ Risk management based on magnitude of current and potential losses in human life and economic assets due to water mismanagement and extreme weather events



# 1. Infrastructure Approach

Estimated annual investments (maintenance, replacement, expansion)  
in Earth observation (2004-2006)\*

Year	Annual investments (in billion USD and as % of total in-orbit assets at end-2006)	
2006	3.2	15%
2005	1.1	6%
2004	1.6	10%

Worldwide investment of roughly **USD 38-40 billion**, averaging **USD 1.5 to a little more than 3 billion a year**, seems necessary for additions and maintenance in the next decade (2008-2020).

\* Around 100 missions from both OECD and non-OECD countries. Not taking into account some large previous R&D investments in instruments & necessary support space-based infrastructure.

Estimated average annual world infrastructure expenditure  
(additions and renewal) for selected sectors, 2000-20, in USD Billion

Type of infrastructure	2000-10	2010-20
Road	220	245
Rail	49	54
Telecoms	654	646
Electricity	127	180
Water	576	772

## 2. Risk Management Approach

### **a) Not take any specific step to reduce uncertainties.**

However this may come at cost. **Costs of inaction** in terms of economic growth and loss in GDP (estimates underestimated since extreme events and non market impacts still often not included).

### **b) Reliance on the transfers of risks** of extreme weather events to individuals and markets, via insurance, reinsurance and capital markets (e.g. catastrophic bonds).

- ☐ Notable rise in extreme weather events. Insured natural peril losses on the rise for the past 20 years (increased value concentration in high-risk populated areas, higher vulnerabilities and widening of insurance coverage).

- ☐ Risks over next decades concerning financial capacity of the international insurance and reinsurance industries, as well as capital markets, to absorb costs of very large scale disasters.

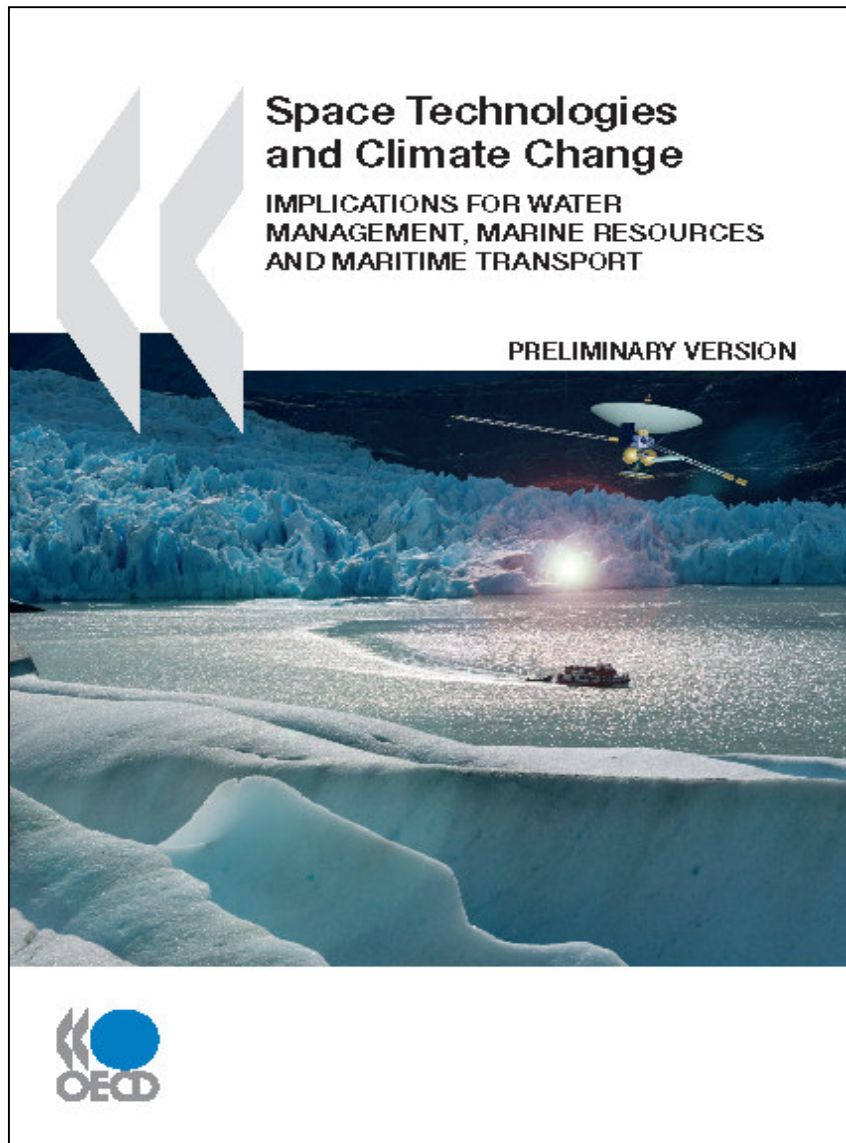
# Risk Management Approach

## **c) Develop tools to make better informed decisions & management aids.**

☐ Amongst those tools, space technologies -particularly Earth observation- provide unique capabilities.

☐ Many systems already, but question remains on what other key data might be *missing* if missions to replace current systems are not launched soon (especially climate-related satellites measurements).

# Added Value of This Exercise



- ☐ Large audience in policy circles
  - ☐ « Demand-based » and socio-economic angle (not exclusively a technology-oriented or scientific report)
  - ☐ Prospective view (climate change + general trends in water, marine and maritime domains)
  - ☐ Review of socio-economic methodologies when looking at space applications: “tool-box”
- **Result of the exercise = a comprehensive picture of current & probable future context + rigorous analysis of socio-economic contribution of space infrastructure**

# The Way Ahead

- Important **need** to continue building the **knowledge base** on:
  - The economics of space applications, especially as they become integrated with larger information systems
  - The statistical realities of the « space economy »

INVITATION to COPUOS Delegates:

- ***IAF Technical Committee on the Space Economy*** launched during Congress in Glasgow (28th Sept. 2008).  
Next meeting on March 16th in Paris
- ***Involvement in the OECD Space Forum*** activities  
Next meeting on June 12th in Paris

# Thank you

**For more information:**

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